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Distress learning in premature infants: Early antecedents of dysfunctional parent-infant relationships

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The Ohio State University, 1990
DISTRESS LEARNING IN PREMATURE INFANTS:
EARLY ANTECEDENTS OF DYSFUNCTIONAL PARENT-INFANT RELATIONSHIPS

DISSertation

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate School
of the Ohio State University

By
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The Ohio State University
1990

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FIELD OF STUDY

Developmental Psychology

Studies in child development and developmental disabilities
with Henry Leland, Ph.D.
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Harm to children by their caregivers has been documented since the beginning of recorded history (Solnit, 1980). In ancient times the infant had no rights until the right to live was ritually bestowed (Radbill, 1980). Radbill (1980) reports that "until then, the infant was a nonentity and could be disposed of with as little compunction as for an aborted fetus" (p. 3). He notes that in many cultures, the child was not really of this world until she/he had partaken of some earthly nourishment or survived a test of fitness. The plight of an at-risk infant was even more perilous. A weak, premature, or deformed infant was likely to be strangled when the mother was not looking (Radbill, 1980).

A shift toward a more humanitarian conception of the child occurred in the 17th century, when the European family became a more independent and autonomous unit (Radbill, 1980). This was reflected several hundred years later in the construction of foundling asylums, the emergence of schools for handicapped children, isolated convictions for sex offenses against children, and child labor laws.

According to Radbill (1980), the present level of concern may be traced to the 1940s when Dr. John Caffey reported a new syndrome in which subdural hematomas in infants were often associated with atypical fractures of the limbs and ribs. Silverman extended Caffey in 1951 and...
emphasized the intentional infliction of the injuries (Radbill, 1980). However, it was not until 1955 when Wooley and Evans blasted the medical profession for its reluctance to concede that the multiple injuries were committed willfully, that professionals began to pay attention (Frude, 1980).

Perhaps the most important event which focused attention on the problem of child abuse was a paper published in 1962 in the *Journal of the American Medical Association* entitled "The Battered Child Syndrome". Written by Kempe and his colleagues, the paper included pediatric, psychiatric, and radiological evidence of abuse and also considered relevant aspects of the law (Frude, 1980). By providing the diagnostic label, they had legitimized the attention of physicians and medical workers to a complex family and social problem (Weston, 1980).

**Current Perspective**

According to Helfer and Kempe (1976), the effects of abuse and neglect are cumulative. Once the developmental process of a child is insulted or arrested by bizarre child-rearing patterns, the scars remain. Research indicates that many abused children suffer extremely distorted emotional development (Elmer, 1967; Martin, Breezley, Conway & Kempe, 1974; Oates, Davis, Ryan & Stewart, 1978; Sandgrund, Gaines & Green, 1975); neurological impairment (Kempe Silverman, Steele, Droegmueeler & Silver, 1962); delays in cognitive, language and motor development (Elmer, 1978; Martin, 1980; Newberger & McAnulty, 1976; Solomon, 1979);
problems in school achievement and behavior (Elmer, 1978), and have more medical complications (Martin, 1980). Duncan, Frazier, Liten, Johnson & Barron (1958), Easson & Steinhilber (1961), and Silver, Dublin & Louri (1969) suggest that the child abuse phenomenon contributes directly to later violent behavior. Helfer, McKinney & Kempe (1976) observed delays in speech, low self esteem and difficulty with social relations in abused preschool and schoolage children.

Perhaps the most devastating effect of abuse is the inability to adequately relate to oneself or others. According to Helfer et al. (1976), the loss in interpersonal skills snowballs into "almost every other aspect of ones adult life...the lasting effect is that this lost skill prevents any semblance of reasonable parenting skills from developing" (p. 73). The effects are apparent in the next generation and the cycle continues.

Recognition of the seriousness of this problem is increasing, treatment programs are coming into place across the country, and professionals are beginning to think about early intervention and prevention. One specific population of children identified as at risk for abuse or neglect is premature infants (Klein & Stern 1971; Kennell, Voos & Klaus, 1979).

Premature birth requires adaptation to extrauterine life before organ systems are adequately developed. As a result these infants require thermal regulation, have increased incidences of jaundice, hyperbilirubinaemia, intraventricular hemorrhage, are more vulnerable to neurotoxic effects, and may require respiratory assistance because of immature lung structure and function (Cashore & Stern, 1984). Prematurity
Prematurity is generally defined as less than 36 weeks gestational age with birth weights of 2500 grams or less (Parmelee, Sigman, Kopp & Haber, 1975). It is now distinguished from infants born at term but who have low birth weights. The term small-for-gestational-age infant is used to describe those infants who are full-term but underweight, falling in the weight range of 1700-2500 grams (Denenberg & DeSantis, 1975). Generally speaking, birthweight is an indicator of growth of the baby, while duration of gestation is a guide to maturity (Chamberlain, 1984).

Researchers studying premature infants have typically separated these infants into categories based on weight to more adequately communicate information about their condition and prognosis. Premature infants who weigh between 1500 to 1800 grams are categorized as "low birth weight", premature infants who weigh 1000 to 1500 grams are categorized as "very low birth weight" (or very premature), and premature infants who weigh less than 1000 grams are categorized as "extremely low birth weight" (Resnick, Eyler, Nelson, Eitzman & Bucciarelli, 1987). Generally, the lower the birth weight and gestational age, the higher the incidence of developmental delays, handicapping conditions, and medical complications (Taylor, 1984). According to Taylor, low birth weight infants are more likely to have increased medical care needs in the NICU and are most frequently represented in the classification of "sick" or "ill" premature infants, although this classification is based on the health status of the

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1 The general term "premature" will be used when studies do not specify the exact categorical descriptor, such as "low birth weight", "very low birth weight", etc.
infant and includes all infants who present serious medical risks regardless of weight. In contrast, "well" premature infants, those typically weighing 1800 grams or more, require significantly less medical intervention and have a higher survival rate without sequelae. Their primary task while hospitalized is to grow and develop.

Research indicates that prematurely born infants constitute a disproportionately large number of both battered (23-31%) and failure-to-thrive children (Klaus & Kennell, 1976; Klein & Stern, 1971). Abuse is frequently conceptualized as an extreme distortion of parent-child interactions beginning early in the caretaking relationship. Early disturbances in the interactions of premature infants and their mothers have been identified (Brackfield, Goldberg & Sloman, 1980; Crawford, 1982; Friedman, Jacobs & Werthmann, 1982; Goldberg, Stern & Sostek, 1980; Als & Brazelton, 1981). Disturbances are also seen in mothers' perceptions of their premature infants (Goldberg et al., 1980; Laskey, Tyson, Rosenberg, Priest, Krasinski, Heartwell & Gant, 1983; Jeffcoate, Humphrey & Lloyd, 1979). Some researchers have attributed the development of dysfunctional mother-infant interactions to a lack of bonding between the mother and her infant (Kennell, Trause, & Klaus, 1980; Jeffcoate et al., 1979; Anisfeld & Lipper, 1983; Klaus & Kennell, 1982; Anisfeld, Curry, Hales, Kennell, Klaus, Lipper, O'Connell, Siegel & Sosa, 1983; Chess & Thomas, 1982). As conceptualized by Klaus and Kennell (1976), there is a sensitive period following birth which is optimal for the development of a bond between the mother and her infant. Mothers of premature infants not only are deprived of this early contact, but frequently are separated for extended periods of
time while the infant remains in the neonatal intensive care unit (NICU). Research exploring bonding has proliferated during the last 10-15 years. However, empirical evidence does not support the claims that early contact significantly affects the mother’s ability to form an attachment to her infant (Lamb, Campos, Hwang, Leiderman, Sagi & Svejda, 1983; Lamb, 1983; Lamb, 1982; Sluckin & Sluckin, 1982; Brown, LaRossa, Aylward, Davis, Rutherford & Bakeman, 1980; Goldberg, 1983). The development of an optimal bond between the mother and her infant has a complex etiology with early contact being just one of these factors (Egeland & Vaughn, 1981). Other risk factors include unstable domestic arrangements and maternal immaturity (Sluckin & Sluckin, 1982), maternal age (Leventhal, Egerter & Murphy, 1981), and the child’s own characteristics (Chess & Thomas, 1982). Early contact with the infant certainly is important and to be encouraged, but logic dictates that separation of the mother and infant cannot solely account for the poor interactions frequently observed between premature infants and their mothers.

Therefore, it is necessary to explore more diverse aspects of the premature infant’s early experiences to explain the frequent development of dysfunctional parent-infant interactions in the premature population. One area of concern is the NICU environment. Researchers have recently investigated experiences that the premature infant encounters in the NICU, such as stimulation levels (Linn, Horowitz & Fox 1985; Parmelee, 1985; Cornell & Gottfried, 1976), quality of caretaking (Gottfried 1985; Marton, Dawson & Minde, 1980), and aversive medical procedures (Gaiter, 1985).
Studies of caretaking in the NICU (Gottfried 1985; Marton et al., 1980) reveal that the majority of infant contacts were task oriented involving medical nursing care and seldom included pleasant social activities. Infants were approached infrequently for the sole purpose of vocalization, social handling, touching or rocking (Linn et al., 1985). This was particularly evident in low birth weight infants.

In addition, premature infants, especially low birth weight infants, experienced significantly more medical interventions of an aversive nature (Gaiter, 1985) than normal full-term infants. Although reactions to these procedures have been studied in older children (Bray, 1983; Lynn, Opheim & Tyler, 1984; Jones, Beasley, MacFarlane, Davis & Hall-Davies, 1984; Beales, 1979; Hahn & McLone, 1984), investigators have just begun to explore the reactions of normal full-term infants to intrusive or aversive medical procedures.

It has been held that due to the lack of myelination, infants do not experience pain (Owens, 1984). However, research findings do not support this claim (Vater & Wandless, 1985; Kirya & Werthmann, 1978; Marshall Stratton, Moore & Boxerman, 1980; Holve, Bromberger, Groveman, Klauber, Dexon & Snyder, 1983; Williamson & Williamson, 1983; Harpin & Rutter, 1983; Owens & Todt, 1984). Significant decreases in transcutaneous oxygen levels and crying, and increase in heart rate were observed in experimental but not control infants, which correspond to physiological responses observed in adults when presented with clearly aversive stimuli (Owens,
The authors speculated that, besides being unpleasant, these experiences may affect the establishment of parent-infant interactions (Holve, et al., 1983; Marshall et al., 1980) in these infants.

Low birth weight premature infants who endure many aversive procedures may be more at risk for deleterious effects, specifically, dysfunctional parent-infant interactions. Based on the findings of Gottfried (1985) and Marton et al. (1980), it can be assumed that most of the contacts between premature infants and other humans could be considered negative experiences. Lipsitt (1983) has documented that neonates are differentially responsive to both positively and negatively valued events in their environment, and that adults respond differentially to resulting unambiguous signals about the infant’s state. After numerous pairings of human contact with an aversive medical procedure, infants may develop an expectancy that all contact will be unpleasant or aversive. It may be hypothesized that low birth weight premature infants, who experience extensive medical care, develop a conditioned emotional distress response to contacts initiated by their NICU caregivers which will generalize to interactions with other caregivers they encounter both in and out of the hospital (e.g., parents).

Elements supporting this hypothesis have been demonstrated. However, a causal link has not been established. The first factor, classical conditioning (using auditory, visual, and tactile stimuli) has been demonstrated in premature and full-term infants (Fitzgerald & Brackbill, 1976). The second factor, distress reactions to caregivers, was suggested by Sexson, Schneider, Chamberlin, Hicks & Sexson (1984). After observing
the agitated behavior of a preterm male infant who underwent extensive medical care on the NICU for six months, the authors speculated that through conditioning and stimulus generalization, this infant now equated any human contact with "negative stimulation". However, Sexson et al. (1984) relied on subjective reports and observations, and failed to record any physiological or behavioral responses which would indicate an aversive reaction to human contact. Additionally, they did not consider the infant's state during intrusive medical procedures. Stefanski, Schulze, Baleman, Kairam, Pedley, Masterson, and James (1984) caution that the results of research with neonates could be misinterpreted if the effects of infant state are not considered. State has been shown to influence the duration of preferential looking (Gardnes, 1976), orientation toward sound (Clifton, Morrongiello, Kulig & Dowd, 1981), and the sucking response (Williams & Galenski, 1979).

**Statement of Purpose**

The purpose of this study is to investigate the physiological response of low birth weight premature infants to medical experiences on the NICU. More objective dependent measures such as heart rate, clearly defined behavioral responses and state ratings will be obtained during intrusive medical procedures. Infants will be selected whose prematurity and medical condition place them at risk for numerous medical procedures. This
study will seek evidence of agitated behavior during human contact experiences, recognizing that the intensity of the response will be modulated by the state of the infant.

Research Questions:

(1) Will the infant develop a conditioned emotional distress response resulting from numerous medical procedures experienced on the NICU as evidenced by an increase in agitated behaviors such as an increased rate of crying, heart rate increase, facial grimace, and increased limb movements.

(2) Will there be a direct relationship between the state of the infant and the presence of the distress response.

Definitions

1. NICU - the NICU is an intensive care facility for neonates that is designed to sustain life and enhance the possibility of survival with minimal developmental sequellae.
2. Prematurity - Prematurity is generally defined as less than 36 weeks gestational age with birth weights of 2500 grams or less and is distinguished from infants born at term who have low birth weights. Three categories based on weight typically are used to communicate information about the infant's condition and prognosis. These include low birth weight (1500 to 1800 g), very low birth weight (1000 to 1500 g), and extremely low birth weight (500 to 1000 g).

3. "At risk" - The term "at risk" is used to imply an increased probability of an adverse consequence in later childhood. The infant can be at biological risk for later sensory, motor, or mental handicaps on the basis of pregnancy, perinatal and postnatal factors, or at risk for physical abuse or neglect because of distortions in the caregiver relationship.

4. State - State refers to the level of arousal of the infant as defined in Brazelton (1973). It is dependent upon physiological variables such as hunger, nutrition, medical status, and the time within the wake-sleep cycle of the infant, and affects the infant's responsiveness to stimuli within its environment.
CHAPTER II

LITERATURE REVIEW

Many premature infants, by the vary nature of their condition, require numerous aversive medical procedures in an attempt to sustain life. These include aversive procedures such as heel sticks, venous transfusions, venopunctures, tracheal suctioning, endotracheal tubes, nasogastric tubes, intravenous infusions, and thoracotomy with thoracic tubes to alleviate pneumothorax. While medical technology has advanced tremendously in its ability to keep larger numbers of high-risk, low-birthweight premature infants alive, we have failed to study the emotional and social impact of this treatment on infants and their parents. In addition to their risk for cognitive delay, research has shown that premature infants are at high risk for abuse and neglect. Efforts to explain this phenomenon using the bonding hypothesis have proved inadequate, and we are forced to explore additional factors that place the premature infant at risk, such as their learning history during their stay in the neonatal intensive care unit (NICU). The present literature review will begin with an examination of the interactions between premature infants and their caregivers and their interactions while in the NICU. Next, research that discusses learning in premature and full term infants will be reviewed. Finally, studies which examine the measurement of physiological and behavioral responses in the premature and full term infant will be discussed.
Early Interactions and Caregiving Experiences of Premature Infants

Infants are social beings who are structured in such a way that they reliably elicit from caregivers the types of behavioral responses that ensure their own potentiation and increasing differentiation (Als & Brazelton, 1981). Early infant signals, such as smiling, crying, clinging, sucking, and eye contact, elicit maternal attention and caregiving and form response patterns leading to the development of reciprocity (Donovan, Lewis, Leavitt & Balling, 1978). These early interactions are important antecedents of later attachment and function to shape the attachment relationship. The formation of the attachment is reciprocal and the behavior of the infant and mother influence each other. According to Waters, Vaughn and Egeland (1980), interaction is dyadic and mutual influence is the rule. In the absence of regular contingent responsivity, neither infant nor caregiver develop feelings of efficacy, and the development of a secure attachment relationship may be impeded (Cicchetti, 1987).

Research comparing categories of spontaneous behaviors known to affect caregiving and the attachment process has identified early disturbances in the interactions of premature infants and their caregivers. Premature infants are reported to smile less in interactions with their mothers (Brackfield et al., 1980; Crawford, 1982; Cohen & Beckwith, 1979), to be fussier (Brackfield et al., 1980; Crawford, 1982), less soothable (Friedman et al., 1982), to engage in more head and gaze aversion (Goldberg
et al., 1980 and Als & Brazelton, 1981) than full term infants; and to have an annoying high-pitched cry (Frodi, 1981; Frodi & Lamb, 1980; Zeskind, 1980). Some authors have documented that these interactional disturbances are present as long as two years (Field, 1987; Cohen & Beckwith, 1979) and seven years after birth (Hansen & Bjerre, 1977).

Using their Face-To-Face assessment paradigm, Als and Brazelton (1981) found that in contrast to full term infants, 5 month old premature infants actively avoided social interactions. Mothers rarely succeeded in holding the infants’ attention for any length of time during various interactive processes, even when they intensified their efforts. These infants had developed many avoidance strategies, and smiles occurred only briefly when eyes were averted. Even at 9 months of age, these infants rarely attempted to engage their parents in play. Anders and Keener (1985) observed that at 6 months of age premature infants were not as likely to be removed from their crib as full term infants, and were more likely to be put in their crib awake at bedtime. Magyary (1977) found that, in contrast to full term infants, the interaction between mothers and their premature infants at four and eight months was characterized by a nonattentive infant coupled with an attentive mother. During both play and routine care interactions, dyads spend a minimal mean percentage of time (1-18%) in synchronous social exchange. Infants rarely initiated gazes at their mothers, although mothers were readily responsive. When mutual gaze did occur, the infant was likely to withdraw after a few seconds.
According to Ais, Tronick, Adamson and Brazelton (1976), low-weight premature infants gave the appearance of being stressed when handled by their mothers. Similarly, full term infants with early neonatal difficulties formed anxious, resistant attachments to their mothers (Waters, Vaughn & Egeland, 1980; Cicchetti, 1987). These infants cried longer, showed fewer positive responses and more negative responses to being held, more negative responses to being picked up and to being put down, and were less active in face-to-face interactions. The authors suggested that the caregiver may find it difficult to coordinate their behaviors with the behaviors of these infants, thus impairing the development of an optimal attachment. In addition, these early difficulties may limit the quality of the caregiving environment, especially if the caregiver is very young, inexperienced, and is under stress. These infants also obtained lower scores on the *Neonatal Behavioral Assessment Scale (NBAS)* (Brazelton, 1973) in orientation, motor maturity, and state regulation. Such delays are also commonly present in premature infants (Rose, 1983; Krafchuk, Tronick & Clifton, 1983; Friedman et al., 1982) and, according to these authors, may reflect problems in integrative and adaptive mechanisms which influence later behavior development, especially in the context of a stressful environment.

Lasky (1984) examined mother-infant interactions in 20 dyads during routine office visit. Behaviors were observed in the waiting room and during four examining room situations, which included a history taking, mother and infant waiting alone, nurse returning, and blood draw. He found that mothers of one year old full term infants were more likely to adopt an 'en face' position, play with, comfort, talk to, and smile at their infants.
than were mothers of premature infants, and the infants were more likely to smile in return. While blood was being drawn, mothers of full term infants were more likely to remain close and look at their infants, while mothers of premature infants were more withdrawn during the aversive procedure. Laskey (1984) suggested that the behavior capabilities of the premature infants may have evoked less affectionate maternal behavior, although a cause-effect relationship could not be established.

Some studies suggest that mothers of premature infants must work harder to engage their infants because their behavior is less organized, less alert, and they communicate their needs less clearly than full term infants. For example, DiVitto and Goldberg (1979) found that 4 month old premature infants were less likely to be held close during feeding and were stimulated more during feeding than full term infants. These infants were less alert, less responsive to stimulation and more likely to cry. Macey, Harmon and Easterbrooks (1987) examined mother–infant interactions in full term and premature dyads in routine care and free play during the first two years of life. Results indicated that premature infants were less active, explored less, stayed closer to their mothers, and had mothers who initiated more interactions than full term infants. Bakeman and Brown (1980) compared interactions during feeding in full term and premature infants and their mothers at birth and during the first year of life. They found that mothers of premature infants seemed to work harder and carry more of the interactive burden and that these infants were less engaging and less responsive. They proposed a 'compensatory care' model of caregiving to explain these interactional patterns. However, their findings are limited by
their only including feeding situations which may not provide a broad enough sample of behavior. According to High and Gorski (1985), the weak or subtle behavioral signals of the premature infant may be difficult to read, thus causing frustration for caregivers when attempting to meet their needs.

Minde, Perrotta & Hellman (1987) found that mothers of premature infants with developmental disabilities (mean weight 1019 g, mean gestational age 28.3 weeks) initially touched, smiled at, and talked to their infants significantly more often than mothers of normal premature infants (mean weight 1110 g, mean gestational age 29.4 weeks). All infants were observed with their mothers during maternal visits to the nursery and at 1, 3, 6, and 9 months after discharge. However, by 6 to 9 months, the pattern of interaction had changed. These mothers now touched their infant more instrumentally (touching with a functional or caretaking goal), whereas, mothers of normal infants engaged in more affectionate and nonfunctional touching. The authors suggested that the mother’s initial high response level was possibly an attempt to stimulate and carry the infant’s share of the interaction, indicating a 'compensatory care' model.

In contrast, Brachfield, Goldberg and Sloman (1980) found that parents of premature infants were under responsive. They examined parent-infant interactions during free play in full term, healthy premature and sick premature infants and found that at eight months, the sick premature infants cried more, played less, stayed closer to their mothers, and had mothers who smiled less often. These findings are contradictory and,
according to Minde et al. (1987), suggest that two patterns of abnormal interactions may be present. Caregivers may withdraw and under respond, or they may try to compensate and over respond.

Disturbances are also seen in mothers' perceptions of their premature infants. Mothers frequently rate their premature infants as more difficult to interact with (Goldberg et al., 1980; Lasky et al., 1983; Jeffcoate et al., 1979 and as more difficult temperamentally (Field, 1980). These ratings often persist until late childhood (Kolvin, Atkins, barber, Tweddle, Scott & Neligan, 1976). Laskey et al. (1983) compared three groups of high risk premature infants to a full term control group using the Infant Behavior Rating of the Bayley Scales of Infant Development (Bayley, 1969). Results indicated less desirable IBR ratings for high risk infants, particularly those who had been ventilated. Frodi, Lamp, Leavitt, Donovan, Neff and Sherry (1978) found that the high pitched cry of premature infants was rated as more aversive and elicited greater autonomic arousal in mothers and fathers than the cry of full term infants. Parents also rated their premature infants as less physically attractive (Frodi et al., 1978; Boukydis, 1981) and were negatively affected by their bodily appearance (Blake, Stewart, & Turcan, 1975; Wolke, 1987). Donovan, Lewis, Leavitt and Balling (1978) found that mothers who rated their infant's temperament as more difficult were less responsive to changes in infant expression (i.e., cry to smile). The authors suggested that these mothers would, therefore, be less responsive to positive infant behaviors and would fail to benefit from the mutual interchange of positive behaviors. Stern and Hildebrant (1986) investigated the stereotyped view that parents frequently have of premature infants by
comparing interactions between 27 dyads of mothers and full term infants labeled as either full term or premature. They found that infants labeled as premature were described as less cute, less likeable, and smaller. Mothers touched these babies less during a smile-eliciting and toy-play task and chose the smallest, simplest rattle as the most appropriate toy with which to engage the infant. This general consensus regarding the difficulty in interactions at home between caregivers and their premature infants is preceded by evidence demonstrating similar problems in neonatal intensive care units (NICU).

Parents frequently experience stress following the birth of a premature infant (Klaus & Kennell, 1982; Goldson, 1979; Harper, Sia, Sokal & Sokal, 1976; Doherty, 1979; Gennaro, 1985; Macey et al., 1987). This stress is heightened by associated medical complications (Minde, Whitelaw, Brown & Fitzhardinge, 1983) and the imposing equipment present in the NICU (Harper et al., 1976; Wolke, 1987). Research suggests that these factors can disrupt the development of positive mother-infant interactions (Goldson, 1979; Nugent & Goldsmith, 1979) and that maternal stress can affect the quality of the infant's early interactive behaviors (Crnic, Greenberg, Robinson & Ragozin, 1984). For example, mothers of premature infants tended to visit the NICU infrequently (Rosenfield, 1980; Jeffcoate et al., 1979; Perrault, Collinge & Outerbridge, 1979; Yu, Jamieson & Astbury, 1981; Paludetto, Faggiano-Perfetto, Asprea, deCurtis & Margora-Paludetto, 1981) and often stated that they felt the infant belonged to the doctors and hospital, and not to themselves (Jeffcoate et al., 1979). Crnic et al. (1984) examined maternal stress, general life satisfaction, satisfaction with
parenting, and social supports in 105 mother-infant pairs. They found that perceived stress and the availability of social support were significant predictors of maternal attitudes and the quality of interactions with their infants over an 18 month period. Mothers who reported more stress had infants who were less responsive and gave more ambiguous cues. No significant groups differences were found between mothers of full term and mothers of premature infants, although the latter generally reported higher levels of stress and less satisfaction with parenting.

Jeffcoate et al. (1979) found that parents of premature infants suffered more stress and emotional disturbance, had delayed or inadequate maternal attachments, and reported more management problems in caring for their infant, than parents of full term infants. It also appeared that the mother’s inability to cope placed additional stress on the father. Some parents reported that at times they had felt violent towards the infant.

Macey et al. (1987) suggest that the stress associated with the birth of a premature infant, in combination with other factors such as the availability of social support and the interactive characteristics of the infant, may contribute to the higher incidence of maltreatment among premature infants. Similar conclusions were proposed by Jeffcoate et al. (1979) who state that the lack of responsiveness and unattractive appearance of the premature infant may be an important factor in delaying attachment. Karan and Rao (1983) found that participation of mothers in the care of their infants in the NICU resulted in improved mother-infant interactions and perception of their infants.
Research which examines the health status of the premature infant indicates that it may be an important factor in influencing the quality of parent-infant interactions. Field (1977, 1979) found that premature infants with respiratory distress syndrome were less socially responsive and showed more gaze aversion than well premature infants. Macey et al. (1987) attributed the disruption of attachment in their sick premature group to medical complication and hospitalization when compared to health premature infants. Mullen, Coll, Vohr, Muriel and Oh (1988) found that mothers of small for gestational age infants scored lower on appropriateness of initiations of interactions than mothers of normal infants, despite a similar pattern of infant behavior. Brachfield et al. (1980) suggested that the disruption in interactions they observed between parents and sick premature infants may be attributed to the combination of medical complications and hospitalization associated with the sick premature group, rather than to the prematurity alone.

Minde et al. (1983) investigated the effects of serious medical complications in premature infants on mother interactions. During feeding observations in the hospital, mothers of seriously ill premature infants touched, looked, and smiled at their infants significantly less than mothers of well infants, despite a very similar pattern of infant behavior. To further explore these findings, the seriously ill premature infants were assigned to groups representing those who were seriously ill for more than 35 days and less than 17 days. Initially mothers in both groups showed little interactive behavior. However, by the second home visit, mothers of seriously ill infants (CA: 45.7 days) were even less active with their
infants. Furthermore, long duration illness in these infants had a more powerful effect on mothers' interactions and activity level than a number of interpersonal background variables. It appears that these seriously ill infants may initially signal their parents to decrease their interactions, but that this decrease continues even after medical recovery. The authors concluded that the mothers may be so overwhelmed by the precariousness of their infants' chance of survival that they withdraw from them or that it represents sensitivity to the lack of behavioral integration of the infant.

Carlson, Cicchetti, Barnett and Braunwald (1989) found that maltreated infants are more likely to be rated as insecurely attached to their caregivers and are particularly likely to demonstrate a disorganized or disoriented attachment.

These studies have shown that disruptions are frequently present in the interactions between premature infants and their caregivers, which may reflect difficulty in establishing an optimal attachment relationship. Studies also suggest that the premature infant's early caregiving experiences in the NICU are often distorted and aversive.

Caregiving Experiences of Premature Infants in the NICU

Many premature infants must spend their early days and weeks in an isolette where most of their interactions are of an intrusive and aversive nature. Rice (1985) describes the premature infant as "lying passively in
restraints, in awkward, uncovered positions, on ventilators, tubes down
their throats and in their noses, needles in their veins, and heels scarred
from needle pricks" (p. 42).

Research indicates that the early interactions of premature infants
on the NICU primarily involve medical nursing care and seldom include
pleasant social activities (Gottfried, 1985; Rice, 1979, 1985). Blackburn
and Barnard (1985) showed that premature infants in the NICU received only
brief and functional nursing contacts. Marton, Dawson and Minde (1980)
found that NICU infants primarily received contacts during medical
procedures, whereas post-NICU infants contacts consisted of holding,
touching, and burping. Linn et al (1985) observed that premature infants in
the NICU were exposed to more adult speech than full term infants, but less
than 5 per cent was directed toward the premature infant. The introduction
of new monitoring and treatment procedures has also resulted in an
increased number of medical-nursing contacts (Wolke, 1987). Research has
documented that sleep disruptions and higher incidences of hypoxemia,
bradycardia, apnea, hypertension, feeding problems and behavioral distress
are associated with handling (Gorski, Hole, Lennart and Martin, 1983) and
medical intervention (Peabody & Lewis, 1985).

According to Gottfried (1985), NICU caretakers often did not attempt
to soothe crying infants during contact which may serve to delay the
development of contingency between the infant’s behavior and a response
from his environment. Similarly, Linn et al. (1985) and Castillo and
Butterworth (1981) found that premature infants had few opportunities to
control or to predict the occurrence of events in their environment, and that
few contingent experiences occurred in the NICU. They contend that the
ability to control environments is important for full term infants, and
probably is important for premature infants as well. Wolke (1987) concurs
and states that the issue is not over or under stimulation but an
inappropriate pattern of stimulation which results in little meaningful and
contingent information reaching the infant in the incubator.

Wolke (1987) argues that the NICU is an "unnatural, restrictive, and
diffuse" environment that is not consonant with the infant's level of
behavioral organization (p. 18). He suggests that the high noise levels on
the NICU are associated with medical and behavior side effects. In addition,
the masking of meaningful noise by the incubator may impair the infant's
ability to associate a particular sound with a particular stimuli (i.e., voice
with face) (Kuhl & Meltzoff, 1984). Furthermore, the inability to escape
from the noise may present a classical learned helplessness situation for
the infant (Wolke, 1987). Wolke (1987) also suggests that the tactile and
kinesthetic experiences experienced by infants in the NICU was aversive,
auditory experiences were often disturbing, meaningful visual experiences
were limited, and vestibular stimulation not associated with nursing or
medical procedures was rare. Rice (1979, 1985) believes that the NICU
environment is very stressful for the infant. Her studies have shown that
these infants are frequently tactile defensive in response to touch, which
she attributes to the number of painful and noxious stimuli that they
experience associated with medical procedures. Oehler (1984) also found
that sick premature infants (30 - 34 weeks postconceptual age) respond to
talking and touching with significantly more avoidance signals, such as grimaces, cries, yawns, and tongue protrusions, than well premature infants.

High and Gorski's (1985) 24-hour observations of infants in the NICU revealed that caregivers were present at the infant's bedside a minimal amount of time, approximately 6% - 11% of the total time observed. In addition, very little time was spent observing the infant's responses to interventions. Gaiter (1985) also found that the caregiving experiences of premature infants include significantly less handling, affectionate contact, vocalization, and vestibular stimulation. Observations on twelve occasions over a three-day period revealed that sick premature infants were handled less (4% vs 32% of observation period) frequently, were handled in response to monitoring alarms, and experienced more aversive medical procedures (60% vs 1% of observation period) than full term infants. Gottfried (1985) found similar results and concluded that premature infants receive predominately medical-nursing care (98%) and relatively few social contacts. Minde, Trehub, Corter, Boukydis, Celhoffer & Marton (1978) found that mothers were initially hesitant to engage in active interaction with their infants despite encouragement by staff to touch the infant and that their initial activity level was correlated with the duration of their visits and the number of phone calls to the NICU. However, maternal smiling, vocalization, touching, and 'en face' looking increased over time proportionate to their initial activity level.
It should be noted that premature infants produce fewer behaviors that signal their caregivers as to their needs, thus failing to elicit their interactions. Linn et al. (1985) observed infant and caregiver behaviors over a three-day period and found that premature infants vocalized, cried, looked at caregivers less than full term infants. They found that 49% never vocalized, 37% never looked at caregivers, and 29% never cried during interactions with caregivers. The authors suggested that the lack of contingent responding on the part of the infant did not reinforce the caregiver's attempts at interaction, and may be a factor in staff burnout. It may also be one factor in the lower interactive level observed in parents of premature infants.

These studies indicate that the premature infant's early NICU experiences primarily involved medical nursing procedures which can be viewed as aversive in nature. Some studies suggest that this may impair the development of positive infant-caregiver interactions.

Reactions of Premature Infants to Aversive Medical Procedures

Research has demonstrated that full term infant experience pain associated with aversive medical procedures such as suctioning, circumcision, and heel sticks (Vater & Wandless, 1985; Kirya & Werthmann, 1978; Marshall et al., 1980; Holve et al., 1983; Williamson & Williamson, 1983; Harpin & Rutter, 1983; Owens & Todt, 1984; Grimes, 1978; Soliman & Tremblay, 1978). Although no studies have systematically studied the responses of premature infants to aversive medical procedures, behavioral
reports of their reactions would substantiate the claim that premature infants also experience similar pain. For example, Wolke (1987) reported defensive strategies such as avoidance of eye contact, arching away, crying or drowsiness, hiccups, skin color changes, vomiting, and changes in heart rate and respiration in response to too active interaction attempts and crying in response to painful procedures. Gorski et al. (1983) noted hypoxaemia, behavioral distress, and hyperventilation during and after chest physiotherapy. Blackburn and Barnard (1985) noted problems in state regulation after medical and technical procedures in contrast to diapering and feeding interactions. Rice (1985) observed passive infants who did not cry in response to intrusive procedures. She termed this "inhibition of action" (i.e., the inability to respond to stress by either fighting or fleeing) and stated that infants became passive and tactiley defensive and refused to respond even with a cry because of feelings of anguish and hopelessness. The response is similar to the learned helplessness phenomena (Maier, 1970; Seligman & Maier, 1967; Weiss, 1970).

Anderson and Auster-Liebhaber (1984) suggest that critically ill premature infants sometimes develop "stereotypic postures and patterns of movement which seem to be related to the necessary medical intervention" (p. 91). They observed withdrawal and distress responses, such as tightly closed eyes and facial grimacing, in the premature infant in response to painful stimulation. Field (1980) found that minimal care neonates in the ICU who received pacifiers during heelsticks were less physiologically aroused as demonstrated by lower heart rate and respiration rate, and less fussing and crying during and after the procedure. Field emphasizes the
importance of this finding for the health status of the infant because it reduces high energy expenditure in the form of fussing, crying and excessive activity which may interfere with growth. High and Gorski (1985) add that the premature infants have few neurologic controls available with which to inhibit their exaggerated and costly response to intrusive stimulation.

In summary, these findings suggest that distortions and disruptions are present in the interactions between premature infants and the caregivers. These interactions may be influenced, in part, by characteristics of the NICU environment, the infant's early experiences in the NICU, and the proponderance of early interactions involving intrusive and aversive medical procedures. In order to understand this relationship more fully, the learning capabilities of the neonate must be explored to provide us with evidence as to why aspects of the infant's NICU environment may have adverse effects.

Learning in Premature Infants

It has been well established that basic learning does take place in full term (Bohlin, Lindhagen & Hagekull, 1981; Bench & Mentz, 1978; Campos, Emde, Gaensbauer & Henderson, 1975; Fuller, Weber & Fujikawa, 1981; Meltzoff & Borton, 1979; Nelson, Clifton, Dowd & Field, 1978; Slater, Morison & Rose, 1983, 1984; Donovan et al., 1978) and premature infants (Leader, Baillie, Martin, Molteno & Wynchank, 1984; Madison, Adubato, Madison, Nelson, Anderson, Erickson, Kuss & Goodlin, 1986; O'Connor, 1980; Wolke, 1987;). Operant conditioning (Dunst, 1974; Lancioni, 1980; DeCaster
& Carstens, 1981; Enright, Rovee-Collier, Fagen & Caniglia, 1983; Sullivan, 1982), and classical conditioning have been demonstrated in full term (Blass, Ganchrow & Steiner, 1974; Daniel, Zakreski & Lipsitt, 1982; Fitzgerald & Brackbill, 1976) and premature infants (Fitzgerald & Brackbill, 1976). These findings in conjunction with reports of associative learning (Tuber et al., 1980), the pattern of the orienting and defensive response (Bench & Metz, 1978; Bohlin et al., 1981; Campos et al., 1975; Fitzgerald & Brackbill, 1976; O'Connor, 1980), and demonstration of habituation (Field, 1980; Leader et al., 1984; Slater et al., 1983, 1984) underline the evidence that premature infants learn.

According to Linn, Horowitz and Fox (1985) the human fetus is capable of perceiving sounds by the start of the third trimester as demonstrated by changes in fetal heart rate in response to externally presented sounds and movements. Their ability to recognize their mother's voice and associate it with the mother's face during the first weeks after birth further suggests intrauterine learning (Wolke, 1987). Fuller et al. (1981) found that 14-18 week old full term infants could discriminate between repetitive and random presentations of a stimuli using an averaged evoked potential technique, demonstrating the presence of recognition memory. Meltzoff & Borton (1979) showed that 29 day old infants were capable of detecting tactual-visual correspondences by recognizing which of two visually perceived shapes matched the one they have previously explored tactualy.
DeCasper and Carstens (1981) conditioned the sucking response in 2 day old full term infants using music as a reinforcer. Interestingly, they found that infants exposed to noncontingent music prior to the conditioning trials, failed to learn the contingency. Enright et al. (1983) demonstrated operant conditioning in 3 month old infants in massed and distributed practice. Conditioning trials included either one 18-minute session, two 9-minute sessions, or three 6-minute sessions, separated by a 24-hour interval. Infants learned to activate a mobile contingent upon leg movement. Results indicated that infants in each training group learned the contingency, but that infants who received the one massed practice session continued to perform the conditioned response during cued-recall tests after 7 to 14 days. The authors speculated that the infants receiving distributed practice would have retained the contingency if provided with spaced practice opportunities, because the nature of the infant's sleep-wake patterns results in their being exposed to natural learning experiences that are distributed. Similarly, Sullivan (1982) trained 3 month infants to move an overhead mobile contingent upon footkicks. They also found no retention after two weeks in the control group, but infants who received a 3-minute reactivation trial 24 hours before testing retained the contingency.

The orienting response (OR) has been used in a number of studies as an indication of information processing and cognitive functioning in infants, and is frequently assessed using heart rate changes in response to stimulation. Consistent with Sokolov's (1963) work, cardiac deceleration following stimulus onset is a reliable index of the orienting response and can be used as a physiologic reflection of attentional processing, while
cardiac acceleration is considered an indicator of the defensive response (DR) and can be used as a physiologic reflection of arousal to stressful or unpleasant stimuli (Donovan et al., 1978; Bohlin et al., 1981). According to Sokolov's (1963) theory, the defensive response is elicited by strong stimulation, habituates slowly, and functions to reduce sensitivity. Thus, cardiac decelerations should be obtained under conditions of sensory intake and close attentiveness to the environment, whereas cardiac acceleration should be obtained under conditions requiring the organism to buffer itself from the effects of intense or noxious stimulation (Campos et al., 1978).

The orienting response can be examined using a variety of somatic and autonomic indices. However, Berntson et al. (1983) stated that the cardiac response appears to be one of the best measures because of its sensitivity and independence of somatic motor capacities.

Research suggests that the direction of the cardiac response can be influenced by the nature of the stimulus and numerous emotional and nonemotional factors. For example, heart rate decelerations have been observed in aversive conditioning studies (Obrist, Wood & Perez-Reyes, 1965) or in situations of aversive anticipation, i.e., the expectancy effect as described by Tuber et al. (1980) and Tuber, Ronca, Berntson, Boysen & Leland (1985). Donovan et al. (1978) found that cardiac deceleration accompanied the viewing of the cry signal, which suggests that unpleasant stimuli may be attention-provoking and thus elicit heart rate decelerations since infant cries function as a 'signal' to elicit maternal attention.
The orienting response is typically used to examine habituation, one of the most widespread and frequently studied forms of learning in infants. According to Friedman (1975), the waning of attention in response to repeated presentations of the stimuli represents the development of a schema or memorial representation of the stimuli. It is the efficient response to stimulation that is no longer providing the organism with additional information. Research suggests that habituation time should decrease with age (Slater et al., 1983). Research examining habituation generally utilizes four criteria to distinguish habituation effects from sensory fatigue (Madison, et al., 1986; Bohlin et al., 1981). These include (1) an inverse relationship between stimulus intensity and response rate, (2) response recovery upon presentation of a novel stimulus, (3) habituation to the novel stimulus, and (4) a more rapid response decrement upon re-presentation of the original stimulus.

Research demonstrating habituation in premature infants and young infants has been somewhat equivocal. Some studies provide clear and consistent evidence of habituation, others fail to demonstrate habituation, and some investigators obtained conflicting results. For example, Field, Dempsey, Hatch, Ting & Clifton (1979) found that premature neonates showed habituation of behavioral but not of cardiac responses.

Slater et al. (1983, 1984) examined habituation to visual stimuli in newborn infants less than 3 days old. They found that infants were able to discriminate between both a simple and a complex stimuli at birth and that they habituated with repeated presentations. Bench and Mentz (1978) found that heart rate acceleration in response to an auditory stimulus in neonates,
24-96 hours old, decreased with repeated presentation, which the authors interpreted as habituation. However, the decrease in heart rate was confounded with state changes and prestimulus heart rate. When these effects were removed by regression techniques, the progressive decrease in evoked heart rate with repeated stimulation disappeared apart from the first few trials. The authors suggest that there was habituation to the initial stimulation, but not subsequently when heart rate changes instead reflect changes in state. These findings appear similar to the biphasic heart rate response to auditory stimulation observed by Porges (1974) and Hock (1971) in neonates.

Fetal habituation to a repeated vibrotactile stimulus was investigated by Leader et al. (1984) using heart rate changes and fetal movements as indices of habituation as measured by a cardiotocograph and a real time ultrasound scanner. Subjects include 40 mothers who delivered full term appropriate for gestational age infants and 48 mothers who delivered full term infants that were small for gestational age. They found fetal heart rate accelerations and body movements to vibrotactile stimulation and significant response decrements in response to repeated applications of the vibrotactile stimulus, which was interpreted as habituation. Only three appropriate for gestational age and eight small for gestational age infants failed to habituate. Significantly, the two parameters appeared to be independent of each other. Similar results were found by Madison et al. (1986) using fetuses judged to be between 28 and 37 weeks gestational age. They noted fetal movement in response to vibrotactile stimulation that habituated with repeated presentation.
Additionally, Madison et al. ruled out sensory fatigue effects as a possible explanation for the response decrements by demonstrating response recovery to the presentation of a novel stimulus, response decrement to the novel stimuli, and more rapid response decrement upon re-presentation of the original stimulus.

Bohlin et al. (1981) compared auditory processing in 3-4 month old infants, 6-8 month old infants infants, and adults in 10 habituation and 2 dishabituation trials using the cardiac orienting response. They found that all infants showed a cardiac decelerative response to the initial presentation of the auditory stimuli, but the magnitude of the response was greater for the older infants. Adults showed the largest decelerative response to the dishabituation trials, which suggests that they had acquired an expectancy regarding the stimulus. The older infants did not show a reliable dishabituation response and the authors felt that they may require more habituation trials before testing to obtained dishabituation effects.

Krafchuk, Tronick & Clifton, 1983 examined habituation to an auditory stimulus by measuring changes in heart rate and body activity in premature infants. The infants were separated into three groups: high-risk infants, moderate-risk infants, and low-risk infants. A rattle at various intensity levels was used as the auditory stimulus. They found that low-risk premature infants showed significant heart rate acceleration & body activity in response to the auditory stimulus. The moderate-risk group also responded consistently to both intensities of the rattle, but were less active and had fewer startles. The high-risk infants failed to show reliable cardiac changes in response to the rattle. However, there was little
evidence of habituation in any of the infant groups. According to the authors, these findings suggest that the defense response is present earlier and may be a more primitive response. It functions to protect the organism by limiting the effects of stimulation by raising threshold sensitivity. Thus, the infant is less reactive and has a lower response threshold for making defense reactions to stimuli that are strong enough to pass the sensory threshold. "In combination, these functional qualities produce an infant who is less available to stimulation but more reactive once a response is initiated" (p. 124). According to Krafchuk et al., (1983) their data support the view that habituation is associated with increasing maturity of the central nervous system, which explains the questions concerning habituation in premature infants as compared to full term infants. Similar conclusions were made by Bohlin (1981) who stated that newborns were either unresponsive or showed heart rate accelerations to auditory stimulation, while older infants showed heart rate decelerations.

This view is not supported by Berntson et al. (1983) and Tuber et al. (1980) who were able to demonstrate habituation in decerebrate infants using a sensory disparity paradigm. They claimed that "with regard to the processes of habituation and learning, the functional capacities of the human brain stem are much more sophisticated than is often credited" (p. 87). In the sensory disparity paradigm, two sequential auditory stimuli are presented to the subjects with random solitary presentations of the first stimulus. If a conditioned associated develops between the two stimuli, the unexpected omission of the second stimuli will produce a disparity which elicits the orienting response. Results indicated a significant cardiac
acceleration in response to stimulus omission which differed from the cardiac deceleratory pattern observed during conditioning trials. Habituation to the paired stimuli was also observed during conditioning. These studies indicate that habituation is present in immature organisms, and therefore, should be within the response capabilities of premature infants.

The orienting and defensive response have also been used to examine fears, although relatively few studies exist which examined the fear response in infants. In a very interesting study, Campos et al. (1978) examined various cardiac and behavioral reactions in 5 and 9 month old infants to strangers, to determine whether the age-related changes from attention to fearfulness in response to strangers were accompanied by heart rate changes from deceleration to acceleration, and whether the direction of the heart rate change was related to the direction of change in facial expression. Results were in the expected direction, with heart rate changes from a deceleratory or orienting pattern to an acceleratory or fearful pattern, and were associated with associated changes in facial expression. In addition, the acceleratory effect was heightened when testing was done with the mother absent. Of note is the fact that 9 month old infants demonstrated an initial deceleratory followed by the acceleratory response which suggests that an initial period of attention and interpretation preceded the distress reaction. These findings are consistent with Sokolov's (1963) theory of the orienting and defensive response, but contradict findings of Donovan et al. (1978) and Obrist, Wood and Perez-Reyes (1965) who found a deceleratory response in reaction to unpleasant or
aversive stimuli. These differences might be explained by differences in the subject population and the characteristics of the fear stimulus. Or, according to Campos et al. (1975), aversive conditioning paradigms may provide a poor model for the study of aversion and fear. The stranger situation is obviously not a classical conditioning paradigm, and therefore, there is no expectancy effect, which may explain why we get the cardiac deceleration in aversive conditioning. However, in Campos et al. (1978) the deceleratory response did precede the defensive response. The authors attempt to resolve the inconsistency by stating that heart rate should decelerate in attentional states (to both pleasant and unpleasant) either because of activation of a stimulus-enhanced arousal system or because of the well-known relationship between attention and motor quieting. On the other hand, cardiac acceleration should be found in fearful states because of the activation of stimulus-buffering arousal systems, or because of the motor activity involved in gaze aversion, crying, frowning, puckering, etc.

This latter response might also be expected in the premature infant in reaction to aversive medical procedures, based on documentation of avoidance and withdrawal behaviors. The response also may become associated with particular stimuli in their environment through the naturally occurring processes of classical conditioning. In general, aversive conditioning of autonomic or somatic responses in infants has not been successful because, according to Fitzgerald and Brackbill (1979) the defense or withdrawal reaction constrains the infant's ability to respond alternatively. However, milder forms of an aversive unconditioned stimulus (UCS) have been used successfully (Fitzgerald & Brackbill, 1979).
If classical conditioning would allow the infant to recognize features of stable environmental predictors, such as the mother’s voice, odor, or touch and the events that they would predict (i.e., nursing, touch, etc.), as stipulated by Blass et al. (1984), it would seem reasonable that premature infants could recognize features of the NICU environment and the events they would predict. Since many or most of these experiences are medically oriented and aversive, the infant may develop a conditioned emotional distress response to adult contacts, which could later disrupt the developing relationship between the infant and his caregiver.

Classical conditioning in normal infants has previously been demonstrated, although it is often difficult to establish (Tuber et al., 1960). Blass et al. (1984) demonstrated classical conditioning of the orienting and sucking response in 1 and 2 day old infants. Conditioning consisted of ten trials of gentle forehead stroking followed by intraoral delivery of sucrose solution either immediately or at random intervals. Only infants who received the solution immediately presented evidence for classical conditioning. In a review of the literature Fitzgerald and Brackbill (1976) reported classical conditioning of the pupillary reflex in one month old infants, eye blinking to an air puff in 5 week old infants, and heart rate, eye blinking and nutritional sucking to an auditory conditioned stimulus in infants. They summarized the research and concluded that tactile, auditory and visual conditioned stimuli were more readily conditioned to somatic responses than to autonomic responses. Thus it appears that some conditioned stimuli can be conditioned to some conditioned responses (CR) but not to others, which acts as a constraint on learning. As a result of
their research, Fitzgerald and Brackbill (1976) developed several hypotheses concerning the development of classical conditioning in infants. These hypotheses stipulate that classical conditioning is a function of: (1) of the sensory modalities and their degree of interaction; (2) the infant's state; (3) individual differences in infant's initial responsiveness to stimulation; and (4) the complexity of the association required.

Fitzgerald and Brackbill (1976) also suggest that there is a direct relationship between orienting and conditionability. According to the authors, "Sokolov suggested that OR elicitation not only facilitated CR formation but was indispensable for successful conditioning" (p. 365). They claim that support for this can be found in heart rate conditioning studies where heart rate changes were observed to stimulus omission and suggest that the heart rate decelerations represents cardiac OR to the omission of the UCS. Other studies suggest that "anticipatory heart rate decelerations may represent conditioned OR preparatory responses, while HR decelerations to UCS omission reflect 'searching' responses" (p. 367).

These conclusions are consistent with the work of Tuber et al. (1980) and Berntson et al. (1983) who believe that the expectancy procedure yields rapid and consistent learning and may provide a more sensitive index of association than classical conditioning. Tuber, Ronca, Berntson, Boysen & Leland (1985) utilized the conditioned expectancy paradigm to test for associative learning, in preschool infants and children with developmental disabilities using an auditory stimulus. They observed a deceleratory cardiac response to presentation of the single-tone stimulus prior to the stimulus pairing which they interpreted as demonstrating associative
learning. In addition, there was an association between the magnitude of the cardiac OR and the level of behavioral competence. The authors suggested that the cardiac responses appeared to reflect the OR since they were evoked by a novel stimulus, demonstrated habituation over trials, were subject to dishabituation, and were predominately deceleratory.

In summary, these studies indicate that information processing and learning does occur in premature and full term infants as measured by the orienting response and using habituation and stimulus omission paradigms. However, the direction of the response is inconsistent and appears related to gestational maturity. Premature infants and neonates appear to respond to the presentation of stimuli with cardiac accelerations, while more mature infants (based on a previous history of conditioning the UCR) respond with cardiac decelerations, the more classical OR response. Cardiac accelerations were also observed in fearful states because of the activation of stimulus-buffering arousal systems, or because of the motor activity involved in gaze aversion, crying, frowning, puckering, etc. and would also be predicted in the premature infant in reaction to aversive medical procedures based on documentation of avoidance and withdrawal behaviors.

Fitzgerald and Brackbill (1976) point out that "Western classical conditioning research does not support the contention that conditioning occurs more readily in older infants than in younger ones, nor does it support the contention that the nature of the UCS determines the age at which CR formation occurs" (p. 371), although they do suggest it is related to neurological maturity.
Physiological Responses in Premature Infants

The selection of valid and reliable response measures is important when investigating learning in premature infants, and must take into consideration the physiological, neurological and behavioral immaturity of the organism.

Heart rate has been used extensively in infant research and has proved to be a good response measure in full term (Von Bargen, 1983; Hock, 1971, Bohlen, Lindhagen & Hagekull, 1981; Berg, Berg, & Graham, 1971; Clifton, Graham & Hatton, 1968; O'Connor, 1980), premature infants (Von Bargen, 1983; Vranekovic, 1982), and decerebrate infants (Berntson, Tuber, Ronca & Bachman, 1983; Tuber, Berntson, Bachman & Allen, 1980). According to Porges (1983), heart rate provides important information regarding the central nervous system and would therefore be predictive of autonomic and behavioral response patterns. Research has consistently identified directional heart rate responses to changes in stimulation, and has shown a correlation between heart rate variability and behavioral performance. Campos et al. (1975) contends that heart rate may be a more sensitive measure than behavior ratings because there is a greater range in heart rate variability than in behavior ratings.

O'Connor (1980) used heart rate changes to compare the responses of premature and full term infants (gestational age 57 weeks) in an auditory discrimination task. Both groups showed a monophasic decelerative orienting response (OR), which habituated over trials and showed response recovery to a novel stimulus. Stamps and Porges (1975) found a conditioned
decelerative response to a conditioned stimulus in anticipation of the unconditioned stimulus in newborn females, but not males. Tuber et al. (1980) used heart rate changes to demonstrate associative learning in two dizygotic twins, one of which was hydranencephalic. The infants, who were born two months prematurely, were tested on days 40, 57, and 62 after birth. An auditory and a visual stimulus were presented concurrently and learning was indicated by a notable long-latency cardiac acceleration to stimulus omission. Vranekovic (1972) compared heart rate responses to auditory stimuli in full term and premature infants. The mean age at testing for the full term group was 58.9 hours and for the premature was 36.9 gestational weeks. He observed a diphasic response which was initially accelerative followed by a secondary decelerative phase. Porges (1974) and Hock (1971) also found a biphasic heart rate response to an auditory stimulus in 2 and 3 day old infants. According to Obrist, Webb, Sutterer & Howard (1970), a noxious stimulus usually produces a monophasic heart rate increase or defensive response (DR) which, according to Von Bargen (1983), does not habituate.

A relationship between cardiac and somatic activity has also been documented (Obrist et al., 1970; Junge, 1979; Stefanski, Schulze, Baleman, Kairam, Pedley, Masterson, & James, 1984). Authors associated cardiac and somatic increases with the DR and stimulus rejection, and heart rate decreases with the OR and stimulus intake (Obrist et al., 1970; Von Bargen, 1983; Clifton, et al., 1968). Heart rate changes reflect what the body is doing somatically but is not secondary to the somatic event. Data strongly
suggest that both heart rate and behavior changes are the result of central processing since heart rate changes preceded behavioral change and occur in absence of motoric behavior (Von Bargen, 1983).

Nelson, Clifton, Dowd & Field (1978) examined the effects of using pacifiers when heart rate was the major dependent variable in studying the responses of newborns (mean age 56 hours) to an auditory stimulus during ongoing non-nutritive sucking. The auditory stimuli was presented four different times during sucking: just before a sucking burst, early in a burst, late in a burst, and just after a burst. They found both heart rate decelerations and accelerations, that were associated with the nature of the ongoing sucking activity suggesting that cardiac-somatic coupling is present in the newborn. Cardiac acceleration was more probable during sucking and deceleration was more probable if sucking was absent.

Rose (1983) examined the response of full term (CA = 2-3 days) and premature infants (CA = 30-35 days, born at 33 weeks gestation) to various levels of tactile stimulation during active sleep, using heart rate changes and behavioral responses. A monophasic heart rate acceleration to strong stimulation in full term but not premature infants was observed. Both groups responded behaviorally to strong stimulation, although premature infants gave a significantly weaker response. The author concluded that premature infants show less behavioral responsiveness to tactile stimulation, no discernible heart rate response in active sleep, a biphasic heart rate response during quiet sleep that is unlike the accelerative response more typically found in full term infants, and a low correlation between heart rate change and behavior responsivity, even though these
infants were close to term age. They proposed that heart rate was a more sensitive index of stimulus perception than behavior, which is consistent with the findings of Campos et al. (1975), Porges (1983 and Fitzgerald and Brackbill (1976).

Behavioral and physiological responses of infants have been measured to determine reactions to various stimuli and factors affecting the quality of mother-infant interactions and cognitive development. Infant behaviors such as gaze, activity, facial expressions, state, body movements, and vocalization have been used to determine the effectiveness of perinatal coaching for improving mother-infant interactions (Bristor, Helfer, and Coy, 1984), qualitative differences in mother-infant interactions at 1 year between low- and high-risk neonates (Laskey, Tyson, Rosenfeld, & Gant, 1984), the effects of delayed versus early circumcision on mother-infant interactions (Marshall, Porter, Rogers, Moore, Anderson, & Boxerman, 1982), and the relationship of mother-infant interactions at 2 and 3 months to cognitive development at 4 months (Watt & Strongman, 1985). Minde, Perrotta, and Marton (1985) used a continuous recording system to measure 11 infant behaviors during feeding and play periods to compare caregiving differences between mothers of premature and full term infants. Gaiter (1985) observed behaviors of full term and premature infants to document the pattern of nursery staff and infant interactions on the NICU and to compare the behavior and early caregiving experiences of these infants. Behavioral reactions, such as crying, limb movements, gaze aversion, and facial expressions, have been observed in normal full term neonates in response to circumcisions (Vater & Wandless, 1985; Kirya & Werthmann,
1978; Marshall, Stratton, Moore & Boxerman, 1980; Holve, Bromberger, Groveman, Klauber, Dexon & Snyder, 1983; Williamson & Williamson, 1983) and heel sticks (Harpin & Rutter, 1983; Owens & Todt, 1984) and have been demonstrated to be sensitive measures of behavior change.

Research with neonates must consider the infant's state, according to Stefanski et al. (1984). Nelson et al. (1978) also speak to the need of controlling for state when studying the neonates response to various stimuli as measured by heart rate. The ability of the body to maintain fairly constant state organization reflects underlying central nervous system maturity and positively correlates with later neurological outcome (Anders, Keener, & Kraemer, 1985). Infant state influences the duration of preferential looking (Gardner, 1976; Hack, Muszynski, & Miranda, 1981), and orientation toward sound (Clifton, Morrongiello, Kulig & Dowd, 1981). In research investigating central excitatory and inhibitory control over the acoustically-elicited cardiac response (ACR), VerHoeve and Leavitt (1985) found that infant state affected "the morphology of the neonatal ACR" (p. 235). Cardiac responses during awake (AW) and quiet sleep (QS) states remained sustained across the 9 second response period, whereas the active sleep (AS) group exhibited a brief triphasic response that returned to baseline. Williams and Galenski (1979) found that increases in sucking in response to stimulus change depended on infant state prior to that change. Emde, Harmon, Metcalf, Koenig, and Wagonfield (1971) found that neonates may respond by state changes in an attempt to control their environment.

The authors observed that prolonged periods of nonrapid eye movement (NREM) sleep sometimes followed aversive medical procedures in neonates.
These changes were not observed following crying in absence of stressful procedures. They interpreted these results as a conservation-withdrawal pattern in response to stressful stimulation in an immature organism that has a limited capacity to actively avoid stressful stimulation.

Fitzgerald and Brackbill's (1976) review of conditioning literature found that conditionability as indexed by heart rate reactivity was greater during quiet sleep than during active sleep, which appears consistent with the findings of Rose (1983). Rose (1983) suggests collecting continuous heart rate readings to control for state changes.

In addition, Rose (1983) points out the need to consider prestimulus levels when measuring the response to stimulation. Rose feels that there is an inverse correlation between prestimulus values and the magnitude of the response to stimulation. Thus, when the stimulus is excitatory, there will be a greater magnitude of response with lower prestimulus values, whereas with high prestimulus values, there will be either a negative change or no change at all.
CHAPTER III

METHOD

Previous research has provided evidence that premature infants are identified as "at risk" for abuse and neglect; and, suggests that low birth weight premature infants who experience numerous aversive medical procedures may be even more "at risk". Research utilizing classical conditioning has demonstrated that premature infants are capable of learning from environmental experiences; and, that the state of the infant may influence the learning process. However, our understanding of the relationship between these phenomena is quite limited. In the present investigation, objective measures of behavioral responses, heart rate, and state ratings were examined during aversive medical procedures to identify the possible presence of emotional distress responses in these infants which could so disrupt the developing relationship between infants and caregivers as to contribute to later problems of parent-child interaction.

Neonatal Intensive Care Unit

The Neonatal Intensive Care Unit (NICU) at Children's Hospital in Columbus, Ohio, provides specialized care to neonates to enhance the possibility of survival with minimal developmental sequellae. It consists of two adjoining rooms which contain open and closed isolettes, fetal heart

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rate monitors, ventilators, and other medical equipment required to provide medical intervention to premature infants. The majority of infants on the NICU are premature, although occasionally a full term infant with a severe medical problem may be placed on this unit. In general, the infant to nurse ratio on the NICU is 2:1, with each nurse assigned to provide the primary care for two designated infants. Infants remain on the NICU until their condition stabilizes to the point that they can be transferred to their local hospital or they are able to be discharged home. This is dependent upon the condition of the infants, their weight and gestational age, and can range from less than a week to several months or more.

Subjects

Fourteen low birth weight premature infants on the Neonatal Intensive Care Unit at Children's Hospital in Columbus, Ohio, were selected for participation in this study. Each infant was followed for approximately three to four weeks. Because this study was only observational in nature, the Human Subjects Research Committee at Children's Hospital waived the requirement for obtaining parental consent (see Appendix B). However, consent for participation was obtained from each infant's parent(s) or guardian(s). The observation procedures were explained to the parent(s) or guardian(s) and they were told that they were free to withdraw their consent and discontinue participation of their infant at any time during the course of the study. Parents were assured that observations would be
conducted on routine medical procedures that were already part of the daily care of their infant, and that no unnecessary medical procedures would be ordered. Consent was obtained by phone from parents who were unable or chose not to visit their infant in the NICU. All phone contacts were monitored and documented by a staff person in the Psychology Department of Columbus Children's Hospital.

The infants who were selected for participation in the study were between four and seven days old, had a birth weight between 1000-1800 grams (mean = 1365.85, SD = 234.62), and had a gestational age of at least 28 weeks (mean = 31.29, SD = 0.91). Five subjects were females and nine were males. The birth weight, sex, and gestational age of each infant is reported in Table 1.

Infants who participated in this study had no known central nervous system dysfunction, including seizures, coma, Grade IV intraventricular hemorrhage or chromosomal abnormality, no life threatening cardiac defects, and were not taking any sedative or muscle paralyzing drugs. It was important to control for these conditions, so that the infant's responsiveness would not be confounded with either condition or drug effects. Specifically, infants with Grade IV intraventricular hemorrhages were excluded because research has demonstrated that their prognosis is generally poor, and is associated cortical damage and severe neurological handicaps on follow-up evaluation (Cashore & Stern, 1984). Medication for cardiac defects and seizures frequently has a sedative effect which may reduce heart rate changes and behavioral responsivity. Infants who were
TABLE 1

Infant Gestational Age, Sex and Weight

<table>
<thead>
<tr>
<th>Subject</th>
<th>Gestational Age (weeks)</th>
<th>Sex</th>
<th>Weight (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>32</td>
<td>M</td>
<td>1560</td>
</tr>
<tr>
<td>02</td>
<td>30</td>
<td>M</td>
<td>1030</td>
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<td>M</td>
<td>1230</td>
</tr>
<tr>
<td>05</td>
<td>31</td>
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<td>1210</td>
</tr>
<tr>
<td>06</td>
<td>32</td>
<td>M</td>
<td>1740</td>
</tr>
<tr>
<td>07</td>
<td>33</td>
<td>M</td>
<td>1740</td>
</tr>
<tr>
<td>08</td>
<td>33</td>
<td>M</td>
<td>1710</td>
</tr>
<tr>
<td>09</td>
<td>31</td>
<td>F</td>
<td>1265</td>
</tr>
<tr>
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<td>M</td>
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<tr>
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<tr>
<td>12</td>
<td>30</td>
<td>M</td>
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<td>F</td>
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</tr>
<tr>
<td>14</td>
<td>31</td>
<td>F</td>
<td>1450</td>
</tr>
</tbody>
</table>
taking sedative or muscle paralyzing drugs were also excluded because of the possible impact on responsiveness. All infants were kept in a closed incubator (Isolette), which functions to regulate temperature.

**Apparatus**

Heart rate was recorded using the Burdick Color Trend Heart Rate Monitor, Model No. M565, which provides both a visual read out and a hard copy of heart rate data, on a continuous basis.

**Instrument**

The Infant Rating Scale was developed by the author and incorporated materials from Brazelton (1973). It was used to record infant behaviors during the observation period. The Infant Rating Scale consisted of four major behavior categories. The behavior categories included: GAZE (eyes open, eyes closed), VOCALIZATION (crying, not crying), FACIAL EXPRESSION (neutral/pleasant, frowning/grimacing), LIMB MOVEMENTS (movement, still). Eyes open was defined as lids open at least 25% or more, whereas eyes closed was defined as lids closed 75% to fully closed. To be coded as crying, the infant had to demonstrate an open mouth cry. An audible sound was not required because the lungs of premature infants are frequently so weak that they cannot produce a vigorous cry. In addition, the cry sound is muffled somewhat by the incubator. A neutral/pleasant facial expression was defined as either a blank facial expression or smiling, without
frowning, yawning grimacing or other similar facial expression. To be coded as frowning/grimacing, the infant had to demonstrate a wide open mouth with eyes closed in characteristic yawn or have lips retracted in a grimace with or without wrinkled forehead. (See Appendix B for the complete Infant Rating Scale).

STATE was classified into one of six categories as defined by Brazelton (1973): (1) Quiet Sleep, (2) Active Sleep, (3) Drowsy, (4) Awake Alert, (5) Active Awake, and (6) Crying. Quiet Sleep was characterized by eyes closed, no movement except startle, regular respiration. Active Sleep was indicated by rapid eye movements under closed lips, some motor activity, irregular respiration. Drowsy was demonstrated when eyes opened and closed, irregular respiration, increasing activity level, and possible mild fussiness. Awake Alert was characterized by eyes open, regular respiration, little or no body movements. Active Awake was indicated by eyes open, spontaneous motor activity, irregular respiration. Crying was code when the infant engaged in a sustained cry for over 15 seconds.

The Infant Rating Scale was piloted on the NICU at Children's Hospital, Columbus, Ohio. Video recordings of four premature infants receiving aversive and nonaversive caretaking procedures were obtained for training purposes. Raters included a masters level psychology student, two first year medical students, and a pediatric workstudy student. Definitions of the behavior codes and state classifications were distributed to all raters for their review prior to the training sessions. Preliminary training sessions were conducted prior to the reliability training to ensure the accuracy of the behavior and state definitions, and to ensure that all raters
scores the behavior codes and state classifications identically. When
disagreements occurred, the video tape was reviewed, and the behavior was
identified and discussed in order to obtain 100% consistency between
raters. Modification in definitions were made when indicated to ensure
reliability between raters.

Reliability training for heart rate was conducted at the infant’s
Isolette using continuous readings from the Burdick Color Trend Heart Rate
Monitor. A cassette tape signaled the beginning of each 10 second interval.
Upon hearing the signal, raters recorded the infant’s heart rate which was
displayed on the monitor.

Reliability for the Infant Rating Scale was determined by dividing the
number of intervals in which both raters marked the behavior as occurring
or nonoccurring (agreements) by the number of agreements plus the number
of intervals in which only one rater scored the behavior (disagreements) and
multiplying by 100. This formula for estimating reliability is appropriate
when an interval method of assessment is used (Kazdin, 1980). Reliability
for state and heart rate was determined by dividing the number of
agreements by the number of agreements plus disagreements and
multiplying by 100. Reliability checks on each infant were obtained
intermittently throughout the data collection period. Raters were unaware
of when reliability checks would occur. Overall interrater reliability for
the four raters was 93% for behavior ratings and 95% for state and heart
rate, which is within an acceptable level as discussed by Kazdin (1980).
Individual reliabilities between raters did not differ significantly, and were
consistent with the overall interrater reliability. Interrater reliabilities
for each behavior category were 97.7% for GAZE, 91.2% for FACIAL EXPRESSION, 97% for VOCALIZATION and 86.5% for LIMB MOVEMENTS.

**Procedure**

Infant behaviors, heart rate changes, and state ratings were recorded during an aversive medical procedure to demonstrate the presence of a conditioned emotional distress response in premature infants. Recordings were obtained for each infant on 4 different days spaced approximate 5 day apart (range of 4-7 days) during the observation period. This variability between recording sessions occurred because the investigator was not allowed in the NICU when there was a neonate in crisis and death was eminent, and when data collection interfered with the provision of care on the NICU. The aversive medical procedure selected for observation was a heel stick which is routinely performed by the NICU nurses and lab technician and involves swabbing the infant's heel with alcohol, sticking the heel with a needle, and collecting a blood sample for analysis.

Prior to each recording session, the nurse or lab technician performing the heel stick was informed of the recording procedures, so that the heel stick could be performed according to the outlined time frames. Sessions were not used when any portion of the recording procedure was violated. This primarily occurred when hospital staff opened the Isolette or performed the heel stick before a complete baseline was obtained.

Each recording session was 8 minutes long and was divided into 5 experimental conditions. These included: (1) BASELINE 1 (B1): A 3-minute
recording of infant behavior in the Isolette prior to the heel stick; (2) OPEN ISOLETTE (IS): A 30-second recording of infant behavior after the Isolette was opened; (3) SWAB (SW): A 30-second recording of infant behavior while the heel was being swabbed; (4) HEEL STICK (ST): A 1-minute recording of infant behavior during the heel stick; and (5) BASELINE 2 (B2): A 3-minute recording of infant behavior following the heel stick.

The behaviors GAZE, FACIAL, LIMB MOVEMENT, and VOCALIZATION, from the Infant Rating Scale, and HEART RATE were recorded at 10-second intervals continuously during the recording period for each condition on each of the 4 observation days. STATE was coded at the beginning of the recording period. A cassette tape signaled the beginning of each condition (B1, IS, SW, ST, B2) and the beginning of each 10 second recording interval. It was audible to both the recorder and the hospital staff performing the heel stick.

**Measures**

The subject measures GAZE (GAZE), FACIAL (FACE), VOCALIZATION (VOCAL) and LIMB MOVEMENT (BODY) from the Infant Rating Scale, HEART RATE (HR) and STATE (ST) were the dependent variables used in the data analysis. The dependent variables were analyzed across Day (D1, D2, D3, D4) and Condition (BASELINE 1 (B1), OPEN ISOLETTE (IS), SWAB (SW), STICK (ST), BASELINE 2 (B2)), which constitute the independent variables in the study.
Treatment of the Data

Because assessing the subject measures every 10 seconds created a large number of data points, it was determined a priori to use the mean of HEART RATE and the mode of GAZE, VOCAL, FACE, and BODY across a uniform number of the intervals. This number of intervals was based on the conditions OPEN ISOLETTE and SWAB which contained the smallest number of measurement intervals. Therefore, the data points analyzed were the means and modes of the measures in three consecutive 10 second intervals within each condition.

In addition, because each condition contained an unequal number of measurement intervals and the statistical methods that would be employed required an equal number of intervals, it was determined to test the equivalency of each minute of the baseline periods. Baselines were particularly problematic because they were each three minutes long in comparison to the other measurement intervals which were one minute or less. Therefore, a repeated measures analysis of variance comparing HEART RATE and a Chi-square analysis comparing GAZE, VOCAL, FACE, and BODY across each minute of B1 and B2 was performed to determine if the first two minutes of B1 were equivalent to the third minute of B1 and the last two minutes of B2 were equivalent to the first minute of B2. If the analyses indicated that there were no differences in any subject measures across these intervals, then the first two minutes of B1 and the last two minutes of B2 could be eliminated from the final data analysis. This would result in two 30 second intervals for B1(B11 and B12) and two 30 second
intervals for B2 (B21 and B22). Each 30 second interval would then be comparable to any interval during the intrusive procedure. Because the heel stick procedure lasted for one minute, it was also partitioned into two 30 second intervals. This resulted in eight levels of Condition, specifically, B11, B12, IS, SW, ST1, ST2, B21 and B22.

HEART RATE was analyzed using a repeated measures ANOVA with Day (D1, D2, D3, D4) and Condition (B11, B12, IS, SW, ST1, ST2, B21, B22) as factors to test for the effects of the conditioning of HEART RATE across the different days and across the different conditions. An ANOVA was selected for the analysis of HEART RATE because HEART RATE is a continuous dependent variable. The repeated measures design enabled an examination of the effect of Day and Condition on infant heart rate, adjusting for the fact that data collected from the same infant at different times are highly correlated. A planned comparison utilizing HEART RATE was obtained between D1 and D4.

Behaviors from the Infant Rating Scale (GAZE, VOCAL, FACE, BODY) were analyzed using the Mantel-Haenszel Chi-Square, a modified Chi-square statistic, which allows for stratification on a particular factor to determine what effects that factor has on the dependent variables of interest. This statistic is appropriate for categorical data and is a robust measure (Mantel & Haenszel, 1959). The Mantel-Haenszel Chi-Square will assess if aversive conditioning is present by determining whether the behavioral responses from the Infant Rating Scale were different across condition adjusting for days.
Because STATE was assessed only once at the beginning of each day, a
Chi-square analysis of STATE by Day was performed to compare the values
of STATE across days and determine if the frequency of STATE was the same
on each day of the study.
CHAPTER IV

RESULTS

It was hypothesized that low birth weight premature infants would develop a conditioned emotional distress response resulting from numerous medical procedures experienced on the NICU as evidenced by an increase in agitated behavior such as an increased rate of crying, heart rate increases, facial grimaces, and increased limb movements. In addition, it was hypothesized that there would be a direct relationship between the state of the infant and the presence of the distress response. These hypotheses were analyzed using a repeated measures ANOVA for the dependent variable HEART RATE and a Chi-Square test for the dependent variables GAZE, FACE, VOCAL, BODY and STATE to determine the effects of conditioning across Day and Condition. The results of these analyses will be presented in the following sections.

HEART RATE ANALYSIS

Equivalency of Baseline Measures for Heart Rate

The repeated measures ANOVA comparing HEART RATE (controlling for Day) across the six 30-second intervals of Baseline1 revealed no significant differences across the intervals, $F(5, 260) = .40, p = .77$. No significant
differences across intervals was obtained for the six 30-second intervals of Baseline2, $F(5, 260) = 1.01, p = .33$. Therefore, the first two minutes of Baseline1 and the last two minutes of Baseline2 were eliminated from the final ANOVA.

**Heart Rate Analysis by Day and Condition**

The repeated measures ANOVA analyzing HEART RATE by Day and Condition revealed a significant effect for Day, $F(3, 39) = 4.30, p = .02$. The planned comparison of D1 versus D4 indicated a significant difference, specifically, between Day 1 and Day 4 in all conditions. This suggests that HEART RATE differed significantly across days, with significant HEART RATE increases observed in all conditions on Day 4.

The repeated measures ANOVA indicated a significant effect for Condition, $F(7, 91) = 19.75, p = .0001$. This suggests that HEART RATE differed significantly across all condition. However, there was no significant interaction between Day and Condition ($p = .48$). Comparisons of mean heart rates indicated significant differences between IS and SW, $p = .03$, SW and ST1, $p = .001$, ST2 and B21, $p = .002$, and B21 and B22, $p = .002$. HEART RATE increased during SW and ST1, while HEART RATE decreased during B21 and B12, as shown in Table 2. (See Appendix B for summary of HEART RATE Anovas.) This pattern was consistent across days and suggests that while the absolute value of HEART RATE increased over days and was significantly different across condition, the overall pattern of HEART RATE was the same for all four days (See Appendix C, Figure 2.)
TABLE 2

Heart Rate Means by Day and Condition
(N = 14)

<table>
<thead>
<tr>
<th></th>
<th>DAY1</th>
<th>DAY2</th>
<th>DAY3</th>
<th>DAY4</th>
</tr>
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<tbody>
<tr>
<td>B11</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>150.76</td>
<td>147.71</td>
<td>152.88</td>
<td>157.52</td>
</tr>
<tr>
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<td>7.97</td>
<td>10.58</td>
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<td>15.56</td>
</tr>
<tr>
<td>B12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>148.42</td>
<td>147.80</td>
<td>152.43</td>
<td>153.07</td>
</tr>
<tr>
<td>SD</td>
<td>10.14</td>
<td>14.84</td>
<td>14.86</td>
<td>16.63</td>
</tr>
<tr>
<td>IS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>149.62</td>
<td>153.69</td>
<td>150.52</td>
<td>156.62</td>
</tr>
<tr>
<td>SD</td>
<td>11.76</td>
<td>11.69</td>
<td>13.33</td>
<td>12.52</td>
</tr>
<tr>
<td>SW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>154.21</td>
<td>158.21</td>
<td>159.74</td>
<td>162.03</td>
</tr>
<tr>
<td>SD</td>
<td>8.34</td>
<td>13.98</td>
<td>11.50</td>
<td>13.79</td>
</tr>
<tr>
<td>ST1</td>
<td></td>
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<tr>
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<tr>
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<td>12.04</td>
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<tr>
<td>B21</td>
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<td>158.69</td>
<td>157.74</td>
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<td>154.36</td>
<td>155.48</td>
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<tr>
<td>SD</td>
<td>10.46</td>
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<td>12.99</td>
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</tr>
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</table>
BEHAVIORAL MEASURES

Equivalency of Baseline Measures for Behavioral Measures

The Chi-square analysis comparing each of the behavioral measures (GAZE, FACE, VOCAL, BODY) from the Infant Rating Scale across the six 30-second intervals of Baseline 1 revealed no significant differences on any day. No significant results were obtained from the Chi-square analysis of behavioral measures across intervals of Baseline 2. Therefore, the first two minutes of Baseline 1 and the last two minutes of Baseline 2 were eliminated from the final Chi-square analysis. Table 3 and Table 4 contain the results of all Chi-square analyses for the equivalency of the B1 and B2 baseline measures.

Analysis of Behavioral Measures by Day and Condition

The Chi-square analysis of GAZE by Condition, stratifying on Day, revealed no significant difference between GAZE and Condition across days, Mantel-Haenszel Chi-square (7) = 1.53, p = .98. There was no significant difference in the frequency of eyes being open versus eyes being closed in any condition, controlling for day. Table 5 contains the frequency of GAZE by Condition for each day.
**TABLE 3**

Results of Chi-Square Analysis for Equivalency of Baseline Measures for Baseline 1

<table>
<thead>
<tr>
<th></th>
<th>Chi-square</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAZE</td>
<td>1.25</td>
<td>.94</td>
</tr>
<tr>
<td>FACE</td>
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<td>.49</td>
</tr>
<tr>
<td>VOCAL</td>
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<td>.41</td>
</tr>
<tr>
<td>BODY</td>
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<td>.60</td>
</tr>
<tr>
<td><strong>Day 2</strong></td>
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<td></td>
</tr>
<tr>
<td>GAZE</td>
<td>0.52</td>
<td>.99</td>
</tr>
<tr>
<td>FACE</td>
<td>5.06</td>
<td>.41</td>
</tr>
<tr>
<td>Vocal</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>BODY</td>
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<td>.06</td>
</tr>
<tr>
<td><strong>Day 3</strong></td>
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<td></td>
</tr>
<tr>
<td>GAZE</td>
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<td>.89</td>
</tr>
<tr>
<td>FACE</td>
<td>4.10</td>
<td>.54</td>
</tr>
<tr>
<td>Vocal</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>BODY</td>
<td>1.06</td>
<td>.96</td>
</tr>
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<td><strong>Day 4</strong></td>
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</tr>
<tr>
<td>GAZE</td>
<td>1.31</td>
<td>.93</td>
</tr>
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<td>FACE</td>
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</table>

1 Degrees of Freedom for all Chi-square tests = 5.
2 Because all values for Vocal on this day were the same, no test statistic could be computed.
### TABLE 4
Results of Chi-Square Analysis for Equivalency of Baseline Measures for Baseline 2

<table>
<thead>
<tr>
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<th>Chi-square</th>
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<tr>
<td>GAZE</td>
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<tr>
<td>FACE</td>
<td>4.32</td>
<td>.50</td>
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<td>.81</td>
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</tr>
<tr>
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<td>.75</td>
</tr>
<tr>
<td>FACE</td>
<td>0.78</td>
<td>.98</td>
</tr>
<tr>
<td>VOCAL</td>
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<td>.41</td>
</tr>
<tr>
<td>BODY</td>
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<td>.62</td>
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<td></td>
</tr>
<tr>
<td>GAZE</td>
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<td>.95</td>
</tr>
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<td>FACE</td>
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</tr>
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<td>VOCAL</td>
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<td>.41</td>
</tr>
<tr>
<td>BODY</td>
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<tr>
<td><strong>Day 4</strong></td>
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</tr>
<tr>
<td>GAZE</td>
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<td>.99</td>
</tr>
<tr>
<td>FACE</td>
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<td>.22</td>
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<td>.98</td>
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<tr>
<td>BODY</td>
<td>3.77</td>
<td>.58</td>
</tr>
</tbody>
</table>

1 Degrees of Freedom for all Chi-square tests = 5.
TABLE 5

Frequency of GAZE by Day and Condition
(N = 14)

<table>
<thead>
<tr>
<th>Condition</th>
<th>B11</th>
<th>B12</th>
<th>IS</th>
<th>SW</th>
<th>ST1</th>
<th>ST2</th>
<th>B21</th>
<th>B22</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Eyes Open</td>
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<td>4</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Eyes Closed</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td><strong>Day 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyes Open</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Eyes Closed</td>
<td>12</td>
<td>13</td>
<td>13</td>
<td>12</td>
<td>14</td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Eyes Open</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Eyes Closed</td>
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<td>13</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td><strong>Day 4</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Eyes Open</td>
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<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
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<td>10</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
The Chi-square analysis of FACE by Condition, stratifying on Day, was significant, Mantel-Haenszel Chi-square (7) = 119.11, \( p = .0001 \). The frequency of pleasant or neutral facial expressions versus grimaces or frowns was significantly different across conditions on all four days. On each day, the number of grimaces and frowns increased in ST1, and decreased in B21. This suggests that the infant was more likely to grimace or frown during the initial portion of the heel stick procedures and that the procedure was aversive for the infant. Table 6 contains the frequency of facial expression by Condition for each day.

The analysis of VOCAL by Condition, stratifying on Day, was also significant, Mantel-Haenszel Chi-square (7) = 87.11, \( p = .0001 \). The frequency of crying was significantly different across conditions on all days. Crying increased in ST1 and decreased in B21 on Day 1. However, on Days 2, 3 and 4, crying decreased during ST2. This suggests that there was an increased probability that the infant would cease to cry during the second interval of the heel stick procedure over days. Table 7 contains the frequencies by condition for each day.

The analysis of BODY by Condition, stratifying on Day, was also significant, Mantel-Haenszel Chi-square (7) = 43.56, \( p = .001 \). The frequency of movement was significantly different across conditions on all days. There was a slight increase in movement at ST1 on Day 1, with no decrease in the following conditions. However, on Days 2, 3, and 4, movement decreased slightly in ST2. This also suggests that the infant was less
<table>
<thead>
<tr>
<th>Condition</th>
<th>B11</th>
<th>B12</th>
<th>1S</th>
<th>SW</th>
<th>ST1</th>
<th>ST2</th>
<th>B21</th>
<th>B22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
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</tr>
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<td>1</td>
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<td>8</td>
<td>7</td>
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<td>3</td>
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<td>11</td>
<td>6</td>
<td>7</td>
<td>9</td>
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</tr>
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<td></td>
</tr>
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<td>11</td>
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<td>11</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Day 3</td>
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<td>11</td>
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</tr>
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<td>9</td>
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</tr>
<tr>
<td>Condition</td>
<td>B11</td>
<td>B12</td>
<td>IS</td>
<td>SW</td>
<td>ST1</td>
<td>ST2</td>
<td>B21</td>
<td>B22</td>
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<tr>
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<td>-----</td>
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</tr>
<tr>
<td><strong>Day 1</strong></td>
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<tr>
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<td><strong>Day 3</strong></td>
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</table>
likely to display agitated behaviors in response to heel sticks over time. Table 8 displays the frequency of movements versus no movements by condition for each day. (See Appendix C, Figures 3, 4, and 5 for a graphic presentation of the behavioral measures BODY, VOCAL, FACE respectively.)

ANALYSIS OF STATE

The analysis of STATE by Day was not significant, Chi-square (12) = 12.32, p = .42. There was no significant difference in STATE across days. The majority of infants were either in quiet or active sleep throughout the observation period. Table 9 contains the frequency of STATE on each day.
**TABLE 8**

Frequency of BODY by Day and Condition  
\( (N = 14) \)

<table>
<thead>
<tr>
<th>Condition</th>
<th>B11</th>
<th>B12</th>
<th>IS</th>
<th>SW</th>
<th>ST1</th>
<th>ST2</th>
<th>B21</th>
<th>B22</th>
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</thead>
<tbody>
<tr>
<td>Day 1</td>
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<td></td>
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</tr>
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<td>2</td>
<td>5</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
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<td>13</td>
<td>12</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Day 2</td>
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<td></td>
<td></td>
</tr>
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<td>1</td>
<td>4</td>
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<td>4</td>
<td>1</td>
<td>3</td>
</tr>
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<td>13</td>
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<td>10</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>11</td>
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<tr>
<td>Day 3</td>
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<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
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<td>11</td>
</tr>
<tr>
<td>Day 4</td>
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</tr>
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<td>4</td>
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<td>4</td>
<td>1</td>
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</tr>
<tr>
<td>No Movement</td>
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<td>12</td>
<td>13</td>
<td>10</td>
<td>3</td>
<td>10</td>
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</tbody>
</table>
TABLE 9

Frequency of STATE by Day
(N = 14)

<table>
<thead>
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<th>STATE</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Day 2</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
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<td>0</td>
</tr>
<tr>
<td>Day 4</td>
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<td>4</td>
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</tbody>
</table>
CHAPTER V

DISCUSSION

There were two major purposes of this study. First, this research attempted to demonstrate that low-birthweight premature infants would develop a conditioned emotional distress response resulting from numerous medical procedures experienced on the NICU as evidenced by an increase in agitated behaviors such as an increased rate of crying, heart rate increases, facial grimaces, and increased body movements. Secondly, this study attempted to show that the state of the infant would influence the presence of this distress response. In this chapter, the major findings of this study will be presented and considered in relation to current research in the field of neonatology and developmental psychology. Suggestions for future research will also be discussed.

Heart Rate Analysis

The analysis of heart rate indicates that heart rate differs significantly across days, with significant heart rate increases observed on Day 4 as compared to Day 1. In addition, heart rate differed significantly across all conditions. Mean heart rates were significantly different between OPEN ISOLETTE and SWAB, between SWAB and STICK and between STICK and BASELINE2. In general, heart rate increased slightly when the infant's heel was swabbed, increased significantly during the heel stick.
procedure, and then returned to baseline levels. However, there was no significant interaction between day and condition. This suggests that while the absolute value of heart rate increased over days and was significantly different across condition, the overall pattern of heart rate was the same in all subjects for all four days. For conditioning to have been demonstrated, measured heart rate increases should have occurred earlier during the measurement period, specifically, when the infant's heel was being swabbed or when the NICU caregiver opened the Isolette. Therefore, the findings for heart rate fail to support the hypothesis that infants develop a conditional emotional distress response after exposure to numerous intrusive and aversive medical procedures.

**Analysis of Behavioral and State Measures**

The data revealed no significant difference in state across day. Most infants observed were either in quiet or active sleep throughout all conditions in the observation period on all days. Although the literature supports the inclusion of state as an important variable when doing research in infants, the lack of variability of state in these infants mitigated against its contribution as an explanatory variable.

The data suggest that there was no significant difference in the frequency of eyes open versus eyes closed across conditions. In
general, infants eyes were usually closed during all conditions. This relationship was observed on all days, and suggests that this variable had little discriminative value when assessing the presence of the distress response.

In contrast, significant differences were observed for the remaining behavioral variables across conditions. The frequency of grimaces and frowns increased during the heel stick from the initial baseline level, and then decreased back to baseline. There was also an increased frequency of crying during the heel stick procedure as compared to baseline measures. Interestingly, crying significantly decreased during the second interval of the heel stick on the second, third, and fourth days of observation. A similar pattern of responses was observed for body movements. The frequency of movement was significantly different across conditions on all days. Body movements increased from initial baseline levels while the infant's heel was being swabbed, increased significantly during the heel stick procedure, and then returned to baseline levels. On the second, third, and fourth days of observation, body movements decreased slightly in the second interval of the heel stick. Thus, infants were less likely to display agitated behaviors in response to heel sticks over time. However, there was no evidence of agitated behavior occurring earlier during the observation period which would indicate the presence of a conditioned emotional distress response.

The findings for the behavioral measures, excluding gaze, were consistent with those for the heart rate analysis. Namely, the overall pattern of behavioral responses was the same for all subjects for all four
days. Of note is the decrease in crying and body movements in Day 2, 3, and 4 during the second interval of the heel stick. This may indicate a withdrawal or "shutdown" response by the infant to the aversive stimulus or increasing maturity of the central nervous system which facilitates state modulation.

Conclusions

The results of this study did not support the hypothesis that infants would develop a conditioned emotional distress response resulting from numerous aversive medical procedures experienced on the NICU, and that the state of the infant would influence the presence of this distress response. Neither increases in heart rate nor behavioral measures as indicated by agitated behaviors were noted when the isolette was opened and no change in the overall pattern of the infant's response during the observation period was observed which would indicate conditioning. Similar conclusions were noted by Owens and Todt (1984) in their research with full term infants experiencing heel sticks.

The increased behavioral responsivity during the swabbing of the infant's heel deserves comment. Owens and Todt (1984) observed a similar increase and suggested that it might be a result of the infant being restrained. Similar distress reactions to restraint have been observed in full term infants experiencing circumcisions (Grimes, 1978; Kirye & Werthmann, 1978). It is possible that this reaction indicates conditioning and was associated with the opening of the isolette. However, a closer
examination of each 10 interval failed to reveal a trend toward increased responsivity at successive points during the 10 condition. No significant or consistent increase in agitated behavior was observed until the infant's heel was actually swabbed.

It is also possible that conditioning occurred prior to the initiation of this study. This conclusion appears unlikely for a number of reasons. First, the health status of the premature infant is very unstable during the first few days of life. They require 3-4 days to adjust to their extrauterine environment and to return to a state of homeostasis. It is unlikely that conditioning could occur during this time period, especially considering the equivocal findings on conditioning in infants. Secondly, the consistency of these initial heart rate values with previous research would also question the possibility of conditioning occurring to persons near the isolette prior to the initiation of this study. In general, conditioning using a visual or an aversive CS in infants has been tenuous, and conditioning of a visual CS to an autonomic CR has been unsuccessful (Fitzgerald & Brackbili, 1976).

The overall increase in heart rate across days is interesting in that it is in the opposite direction from that expected with maturation of the autonomic nervous system. The basal heart rate for full term infants is approximately 30 bpm lower than preterm infants (Rose, 1983). According to Rose, the reasons for this difference are unclear and are not accounted for by gestational age. Rose speculates that this may represent immaturity in the development of the parasympathetic nervous system with resulting low vagal tone, but "there is no neurophysiological evidence which bears directly on this point" (p. 52). Porges (1985) proposes that there is poor vagal
innervation until approximately 1 month of age which explains why heart rate increases are observed to both attentional and aversive stimulation in premature infants and neonates. Rose found that the basal heart rate for full term infants during active sleep ranged from 94 – 140 bpm, whereas the range for premature infants (40 weeks gestational age) was 134-164 bpm. Similar findings were reported by Vranekovic (1972) for full term infants (100 – 141 bpm) and premature male infants (125 – 164 bpm). Although the mean heart rates during the initial baseline period (146.4 – 157.5 bpm) parallel this range and would be expectable heart rate levels for this population, the absolute value of heart rate for infants in this study increased across days. There are no current studies which have monitored the heart rate patterns of premature infants throughout their hospitalization. Thus, it is difficult to determine whether these increases are typical heart rate patterns or whether they reflect changes associated with the presence of caregiving staff or the experimenters around the isolette. The latter might suggest conditioning. Future studies should obtain running baselines for heart rate when there are no individuals located near the isolette to control for experimenter presence.

One possible reason for the lack of significant findings could be the relatively short period of time that these infant’s were observed. Infants were observed on four occasions over approximately 20 days. Classical conditioning of this type may require more time to develop. Studies have shown deficits in classical conditions in a retarded population (Tuber et al., 1985, Berntson et al., 1985) and the need for a large number of acquisition trials (Tuber et al., 1980). Because of the immaturity of the neural
pathways, the infant may require more pairings for conditioning to occur. The lack of contingency between the opening of the isolette and the experience of an aversive medical procedure may also have interfered with conditioning. Research has shown that most of the infant experiences on the NICU are non-contingent. According to DeCasper and Carstens (1981), infants exposed to non-contingent stimulation generally fail to learn the contingency. In addition, the interstimulus interval may have been too long for conditioning to have occurred. Although research recommends a longer interstimulus interval for young infants (Forges, 1985), traditional conditioning intervals range from .5 to 2.5 seconds. The time period from when the isolette was opened until the swab occurred was 30 seconds, and another 30 seconds elapsed before the actual heel stick occurred. This may have exceeded the time at which an association could have been made.

Conditioning may not have occurred because the opening of the isolette was not a discriminable cue (CS), particularly since most infants were in either quiet or active sleep. Behavioral and heart rate data did not indicate any difference in responsivity between the baseline period and the opening of the isolette. This would be supported by Field (1985) who suggests that premature infants have a high threshold for stimulation.

Another reason for the lack of conditioning may be the selection of heel sticks as the aversive procedure. Heel sticks last for only a minute. Thus, the duration of the procedure may not have been sufficient for conditioning. Additionally, there are fewer nerve endings in the heel, which may account for its selection as the site for frequent blood draws. Therefore, heel sticks may be only minimally aversive to premature infants.
when considering the number of other procedures they experience which are more painful, such as placing vein lines, chest pounding, intubations, etc. However, the consistent behavioral and heart rate increases that were observed during the heel stick would negate this conclusion.

It might also be argued that the behavioral measures selected for observation may not have been sensitive enough to demonstrate conditioning. However, research indicates that heart rate is very sensitive to change and it also failed to show the development of a conditioned emotional distress response. Similar behavioral measures have successfully been employed in previous infant research. In addition, Rose (1983) found that behavioral measures were better indicies of responsivity in premature infants than heart rate when using a tactile stimulus, although heart rate was a more sensitive index of responsivity in full term infants.

This research does support the view that premature infants experience distress with aversive medical procedures and is consistent with research which suggests that painful stimuli generally cause withdrawal and distress responses in premature infants (Anderson & Auster-Liebhaber, 1984; Owens & Todt, 1984; Dehler, 1984; Leader et al., 1984). Increased levels of agitated behavior as evidenced by crying, body movements, facial grimaces and heart rate increases, were observed during the heel stick procedure in all infants. Because of the immaturity of their nervous system, premature infants have fewer neurological controls available with which to inhibit their exaggerated and costly response to intrusive stimulation (High & Gorski, 1985). This contradicts Goldberg
(1978) and others who state that premature infants are hyporesponsive and often failed to show heart rate or behavior responses even to strong stimuli.

The observed increase in agitated behaviors and heart rate is characteristic of the defensive response as proposed by Sokolov (1963). According to Sokolov, the defensive response is present in situations where the infant needs to buffer itself from the effects of noxious and/or intense stimulation. It habituates slowly and functions to reduce sensitivity and restore state. The defensive response results in a “shutdown” to other incoming stimuli because the system is so highly aroused and allows for state modulation. This process also functions to block the conditioning or habituation process and interfer with the infant’s ability to profit from more positive learning experiences that occur in its environment.

Fitzgerald and Brackbili (1976) also noted a general defensive or withdrawal reaction to aversive stimuli in infants which they believed constrained the infant’s ability to respond alternately. It may be this process that explains the distortions in attachment-seeking behaviors that are frequently observed in premature infants and which may underlie the development of dysfunctional parent-child interactions.

The reduction of crying and body movements during the second interval of the heel stick appears to indicate the infant’s emerging attempts to modulate its attentional, motoric, and autonomic systems when faced with intrusive stimulation from the environment. Modulation of state or system organization which influences arousal levels has been proposed by a number of investigators to explain an organisms adaptation to environmental stimulation (Als, 1986; Field, 1982; Wolke, 1987). These
views purport that preterm infants have a limited range of stimulation to which they will respond optimally, and that they tend to show disorganized responding to higher intensity stimuli. With maturation of the organ systems, the infant's ability to modulate arousal and respond more adaptively to stimulation improves. This may explain the decrease in crying and body movements observed in these infants. Blackburn and Barnard (1985) state that the ability of the infant to organize behavioral and physiological rhythms after birth is crucial in allowing the infant to respond appropriately to its environment.

It could be argued that the decrease in behavioral responsivity during the second interval of the heel stick was due to habituation effects. The infant demonstrated more distress when initially experiencing the aversive procedure because it was an unknown. After numerous painful experiences, the procedure became more familiar and the infant became less reactive because the procedure was no longer novel. However, habituation appears questionable for a number of reasons. First, high levels of behavioral responsivity and heart rate increases were observed during the initial interval of the heel stick procedure throughout the observation period. These behaviors may eventually have habituated after prolonged exposure to aversive procedures, but a trend toward an overall increase in responding during ST 1 rather than a decrease was noted. Secondly, habituation effects during the second interval of the heel stick and return to baseline period were not distinguished from response fatigue. This could have been accomplished by introducing a new stimulus into the experimental condition to test for response recovery. Lastly, some studies suggest that habituation
can be confounded with state changes. Madison et al. (1986) found that much of the response change in infants that was attributed to habituation was really reflective of endogenous state changes. Therefore, these results are not definitive enough to attribute the decrease in responsivity of crying and body movements to habituation. However, they do support an interpretation of increasing maturation which is reflected in a more robust, integrated response to external stimulation.

The data also indicates that most infants were in a more agitated state after the heel stick procedure, and that this agitation lasted for at least 4 minutes. Yet no attempts were made by nursing staff to soothe these infants or to help them restore state. Als (1986) and others stress that the infant's internal behavioral systems should be supported and facilitated during and after handling procedures to avoid the infant's engaging in defensive strategies in an attempt to maintain system organization. For example, gentle stroking and containing the motor movements of the infant during an adverse procedures can be helpful in reducing undue stress.

The fact that a conditioned emotional distress response was not observed in the infants is certainly positive. This suggests that even though these infants endured up to four weeks of caretaking which involved numerous intrusive medical procedures, they were very adaptive and resilient. This information is important and should be communicated to parents. Possibly, only those infants who are more medically compromised and experience a much longer hospital stay will develop a conditioned emotional distress response. While conducting this study, the author
observed infants who had been on the NICU for 3-4 months who did exhibit the types of behaviors that would suggest conditioning. The infants in this study were not as severely ill as these infants and were discharged within a week or two after the study was completed. Future research should attempt to identify and select those infants for study who would be expected to have a longer hospital course due to their medical status.

Summary

The author proposed that low birthweight premature infants would develop a conditioned emotional distress response after experiencing numerous aversive medical procedures. It was felt that these early learning experiences may help account for the disruptions frequently observed in the interactions between premature infants and their parents. The data from this study did not support this conclusion. The findings suggested that premature infants respond to aversive medical procedures by withdrawal and defensive reactions which blocks the conditioning process and interferes with the infant's ability to profit from more positive learning experiences. It may be this process that explains the distortions in attachment-seeking behaviors that are frequently observed in premature infants and which underlie the development of dysfunctional parent-child interactions. The findings also supported a maturational basis for state modulation.

Future research should continue to explore the effects of medical procedure on premature infants. A wider range of physiological responses,
including PO2 levels, cyanosis, and bradycardia to aversive medical procedures, and the infant's ability to modulate state changes should be investigated. Infants should be selected who are more critically ill and who will be hospitalized for a longer span to discover if this type of reaction are only present in the more medically compromised infants. Researchers should also explore different aspects of the premature infants' NICU environment, such as stimulation levels, contingent learning experience, etc. Since the publication of articles describing the NICU environment as socially barren, changes in caregiving practices has taken place. Parents have more access to the NICU and may be providing the social stimulation necessary to foster the development of more optimal parent-infant relationships.
REFERENCES


APPENDIX A

INFANT RATING SCALE
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APPENDIX B

HEART RATE ANOVA
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**FIGURE 1**
Summary of Heart Rate Anovas
FIGURE 2

HEART RATE Means by Day and Condition
FIGURE 3

Frequency of BODY by Day and Condition
FIGURE 4

Frequency of VOCAL by Day and Condition
FIGURE 5
Frequency of FACE by Day and Condition