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An exploratory investigation on the impact of excessive infant crying on the caregiving environment

Pinyerd, Belinda Jo, Ph.D.
The Ohio State University, 1991

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AN EXPLORATORY INVESTIGATION ON THE IMPACT
OF EXCESSIVE INFANT CRYING ON THE
CAREGIVING ENVIRONMENT

DISSERTATION

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

by

Belinda J. Pinyerd, B.S., M.S.

* * * * *

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DEDICATION

First and foremost I dedicate this work to my family. My husband, Jeff, spent hours upon hours watching the "kids" so I could study, write and even nap on occasion. Without his loving support, none of this would have been possible. Next are my three children, Lindsey Nicole, Lane Jeffrey, and Lucas Alan, who had to give up many evenings and week-ends "so Mommy could study." Had we not suffered (and lived) through Lindsey's colic, this project would have never even existed. It still amazes me how at such an early age their small vocabularies included the phrase, "are you a doctor yet, Mommy?" The effort I spent studying pales in comparison to the restraint they exercised when they had to leave me alone.

This work is also dedicated to the many individuals at Children's Hospital who were instrumental in the timely completion of this project. In particular, the staff at the Clinical Study Center: Alexis for the many hours she spent pouring through Emergency Room and clinic records; Paulette (and her family) for all the hours she spent scoring tapes; Cathy for assisting me with baseline visits; Sandra for the great forms and worksheets she created; and Adrienne for the unfaltering dedication, enthusiasm, and speed in which she
completed the home visits (let alone the miles she put on her car). Last my mentor, Dr. Zipf, who encouraged me in the first place, and who boosted me up when I was tired of it all. His confidence and support were unaltering.
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Finally, to the mothers and fathers and infants who participated in this project I express my sincerest appreciation to them for opening their lives and sharing their feelings, insecurities, and fears about what it is like to live with an infant who has colic. With their help this project has moved the field closer to understanding this mysterious affliction of infancy.
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CHAPTER I
INTRODUCTION

But who am I?
An infant crying in the night
An infant crying for the light.
And with no language but a cry.

Alfred Lord Tennyson

"Persistent" crying has been labeled as a developmental crises of parenthood given the feelings of inadequacy it engenders in new parents (Castiglia, 1987; Lester & Zeskind, 1978). Lester has described infant crying as the "first real test for parents, the first real demand from the infant, the first time or issue around which the parent is faced with saying 'no' or placing limits, the first issue around which the parent feels angry because of something the baby did, and the first stress and challenge around successful child-rearing" (1985, p. 23). Lester hypothesized that crying can become a microcosm for psychodynamic aspects of the parent-infant relationship and when unsuccessfully resolved, it can be transferred to other areas where control can be prominent, such as feeding, sleeping, and tantrums. Crying is viewed as both a cause and a symptom of problems in the parent-infant relationship.
During the past few years there have been lay (Ayllon, 1989; Dunn, 1977; Farran, 1983; Gray, 1987; Jones, 1983; Kirkland, 1985; Sammons, 1989; Sears, 1985; Weissbluth, 1984; Young, 1988) and professional (Lester, in press; Lester & Boukydis, 1985; Murry & Murry, 1980) books written specifically on infant crying. In addition, there has been the establishment of an international cry research group (Kirkland, 1987) and the development of support networks for parents of crying babies (Kirkland, Deane & Brennan, 1983; CRY-SIS, 1986). While these are noteworthy developments, systematic inquiry to collect normative data on cry vocalizations and variations in normal infants has been sparse. Most work has focused on the cry characteristics of infants with medical problems as opposed to the characteristics of crying of normal infants. In order to better identify and understand the abnormal, it is essential to first understand the characteristics of crying of normal infants.

STATEMENT OF THE PROBLEM

Periods of "unexplained fussiness" known to occur during early infancy in all infants (Bernal, 1972; Brazelton, 1962; Emde, Gaensbauer & Harmon, 1976; Rebelsky & Black, 1972), are an example of normal variation that has been empirically neglected. Infant "colic", another poorly understood, possible "normal" variation on the maturational continuum, has remained unexplained. This is surprising given that child care professionals find colic to be one of the most common and most confusing complaints encountered in
Research on excessive infant crying or colic has been motivated by an attempt to account for the burden of irritable, virtually inconsolable crying on parental caregiving and energy. Although commonly perceived as "benign" and resolved by four months of age (O'Donovan, 1980), there may be environmental consequences that result in infant morbidity and/or mortality. Indeed, colicky infants could produce such sufficient stress within a family (Darbyshire, 1985; Hewson, Oberklaid & Menahem, 1987; Schmitt, 1981; Thompson, Harris & Bitowski, 1986) that the most serious consequence may be child abuse. Furthermore, colic may have longer term effects on parenting and on the mother-infant or father-infant relationship well after the colic ends. The impetus for investigating the dynamics of this phenomenon is that early identification of those infants who are more difficult to console, more unpredictable in daily patterns, and cry more than normal will result in a better understanding of effective ways of helping parents (Lester, 1985).

The major assumption underlying this research study was that infant crying is one way in which the infant affects the caregiving environment. The purpose of this investigation was to examine the impact of having an infant with "colic" on the mother-infant dyad.
RESEARCH QUESTIONS

1: What are the correlations between subjective and objective measures of cry quantity and quality in colic group mothers and control group mothers?

2: Do colic/control mothers differ in psychosocial characteristics?

3: Do colic/control infants differ in biobehavioral characteristics?

4: Can the cry of the infant with colic be categorized as a distinctive cry type via acoustical analysis?

5: What is the relationship between presence/absence of colic and the infant's caregiving environment?

6: What is the relationship between baseline maternal cry perception and the infant's caregiving environment?

7: What is the relationship between infant cry quantity and the infant's caregiving environment?

8: What is the relationship between maternal psychosocial characteristics and the infant's caregiving environment?

9: What is the relationship between infant biobehavioral characteristics and the infant’s caregiving environment?

10: What is the relationship between maternal perception of "other infant" cries to maternal perception of "own infant" cries?

DEFINITION OF TERMS

COLIC:

1. Conceptual - infant irritability, agitation, fussiness, or crying that is excessive, unrelated to any physical problem, usually accompanied by other behavioral manifestations, and unrelieved by usual methods (Paradise, 1966; Weissbluth, Christoffel & Davis, 1984).

2. Operational - mother’s report of total daily infant crying time of at least 2 hours per day, 3 days per week, verified via a seven-day maternal-maintained infant behavior record.
CAREGIVING ENVIRONMENT:

1. Conceptual - attributes of the infant's environment, such as mother-infant interaction, home surroundings, and family functioning.

2. Operational -
   1) maternal scores for the Nursing Child Assessment Feeding Scale (Barnard, 1978b), for the HOME (Caldwell, 1970), and the maternal discrepant score on the self-report FFPS (Roberts & Feetham, 1982), which examines maternal values and relative importance of family functions.

CRY PERCEPTION:

1. Conceptual - evaluative dimension of the infant cry quality as perceived by the mother.

2. Operational - maternal self-recorded response to a tape-recorded infant cry for 29 attributes along three dimensions (aversiveness, semantic differential, and caregiving behavior) as measured on the RSJ (Green, Jones & Gustafson, 1987).

MATERNAL CHARACTERISTICS:

1. Conceptual - sociodemographic attributes and psychological functioning of the mother.

2. Operational - maternal response to the following self-report questionnaires: POMS, SCLR-90, and the demographic data form.

BIOBEHAVIORAL CHARACTERISTICS:

1. Conceptual - physical parameters and behavioral attributes of the infant.

2. Operational - maternal description of infant physical characteristics and sleeping, eating, and crying patterns.
ACOUSTIC PARAMETERS -

1. Conceptual - acoustic patterning of infant crying as extracted via one of several techniques.

2. Operational - summary variables of: average fundamental frequency, variability of fundamental frequency, average first formant, variability of first formant, duration, amplitude, number of short utterances, and percent dysphonation, as derived from an automatic computer-based signal processing system.
CHAPTER II
LITERATURE REVIEW

Chapter II presents the theoretical framework and a review of the related literature. The theoretical framework is Barnard's (1978a) Parent-Child Interaction Model (PCIM), selected because of its interactive focus on the mother and the child. This ecological model originated from work on interactions between environments, parents, and children in the first three years of life. Empirical support for this model is evident in the related works of Bowlby (1969), Dubowitz (1977) and others (Ainsworth, 1969; Sander, 1964; Yarrow, 1968), including Barnard who recently reported normative data on scales that were designed to reflect the model variables (Barnard, Hammond, Booth, et al., 1989). The chapter consists of the following major sections: the PCIM, normal infant crying, infant "colic", and state of nursing knowledge.

THE PARENT-CHILD INTERACTION MODEL

The main components of the Parent-Child Interaction model are the caregiver/parent tasks and characteristics and the infant's tasks and characteristics (see Figure 1). Implicit in this model is that
infant characteristics are an important part of what drives the interaction. The infant "sends" cues such as sleepiness and hunger to his/her caregiver. The skill and clarity of which these cues are sent will make it either easy or difficult for the parent to "read" the cues and make the appropriate modification of his/her own behavior. The infant too must "read" maternal cues so he/she can modify his/her behavior in return. As the responses and reactions to responses (represented by the arrows) go back and forth between the pair, each may adapt their own behavior to accommodate the other and also modify the other's behavior. The characteristics of the infant and the mother exert a mutual and reciprocal influence, yielding unique patterns of behavior.

Within this framework, the mother-infant interaction system is seen as a dialogue, or a mutually adaptive "dance" between partners.
Both the partners and the dialogue must have certain features for this dance to proceed smoothly.

First, the partners in the conversation must each possess a sufficient repertoire of behaviors so that interlocking sequences are possible and a smooth-flowing interactive system develops (Barnard et al., 1989). The infant's potent effect on the caregiver has been acknowledged (Lewis & Rosenblum, 1974). Similarly, Thoman (1975) has stated that "the nature of parental behavior is in large measure a function of the child's characteristics" (page 98). This feedback system rewards the parents for the demands the infant places on his/her caregiver. For example, the infant "sends" cues such as hunger to his/her caregiver. The skill and clarity of which these cues are sent will make it either easy or difficult for the parent to "read" the cues and make the appropriate modification of his/her own behavior. Among the crucial skills the infant brings to the encounter are such perceptual abilities as seeking and hearing, the capacity for sustained mutual regard, smiling, physical adaptation of the body to holding or movement, sootheability, and regularity or predictability of response. The infant needs to "read" maternal cues in order to modify his/her behavior in return. The parent brings an ability to read the infant's cues, a repertoire of stimulating skills, including language ability, and the ability to delay responding or stimulating until the infant signals readiness. As the responses and reactions to responses go back and forth between the pair, each may adapt their own behavior to accommodate and modify the
other's behavior. The characteristics of the infant and the mother, exert a mutual and reciprocal influence to yield unique interaction patterns. If there is interference with this reciprocity, such as when the infant cries relentlessly, fails to give readable cues, or resists responding to the parent's interventions, then the "dance" is interrupted, and interactive quality is compromised.

The second critical feature of the optimum parent-infant interaction is that the responses of the mother and infant must be contingent on one another. Such contingency response is related to later cognitive outcomes and the security of mother-infant attachment.

The third important element of parent-child interaction concerns the richness of the interactive content. The amount of time the mother spends, the amount of verbal stimulation she provides, the degree of positive affect she conveys, and the range of complex toys she provides are all related to later cognitive or social skills in the child (Barnard et al., 1989).

The final element, suggested by Sameroff and Chandler (1975), is a transactional emphasis. The specific adaptive patterns between mother and infant must change over time. For example, the specific stimulation needed by a 2-month old is different from the stimulation needed by a 2-year old.

The investigator's conceptualization of what occurs to the mother-infant dyad when the infant experiences colic is as depicted in Figure 2. At birth the mother/colicky infant interaction does not
FIGURE 2: Interruption of Maternal-Infant Reciprocity by Excessive Crying ("Colic") in the Infant

differ from the mother/not-colicky infant interaction. In both situations the mother-infant relationship is developing as a result of their reciprocal interaction. When the infant's colicky behavior
begins, it interrupts the interaction between the infant and the mother. The cues of the infant may be confusing, ambiguous, and present problems in the basic caregiving requirements and eventually stress the mother’s adaptive activities. While the infant’s crying may signal distress, the mother is unable to alleviate the distress for any great length of time. Korner (1974) has asserted that the mother’s capability to soothe her infant is one of the cardinal challenges faced in the infant’s earliest weeks of life such that success or failure "cannot help but leave an impact on her feelings of effectiveness and competence as a mother" (p. 108). At some point in time the mother’s response is interrupted and what results is a stressed mother-infant dyad with the distress of one being transmitted to the other (Hewson et al, 1987).

INFANT CRYING

Crying qualifies as one of the main events in infancy (Call, 1984), in that it is the most common problem of new mothers (Forsyth, McCarthy & Leventhal, 1985) and is also an infant behavior that induces new parents to seek medical advice (Carey, 1984). Furthermore, it is the primary mode through which the infant’s needs and wants are transmitted to the caregiving environment. Infant crying is examined in regard to anatomical, physiological, and social correlates of infant cry behavior.
VOCAL ANATOMY OF THE NEONATE

The vocal repertoire of a species may be thought of as a sound system with the sounds emitted being the predictable outcome of that species' vocal tract behavior and its movement constraints (Bauer, 1986). Crying, the major vocal behavior of the neonate, is a complex motor performance that involves anatomical, respiratory, and peripheral, and central nervous system mechanisms (Lester, Corwin & Golub, 1988).

Crying, one prelinguistic vocal behavior of infants, contains prosodic or qualitative features of speech, such as intonation patterns, inflection, melody form, and intensity. These are the same features animals use to call and signal (i.e. communicate) to each other (Lester & Boukydis, in press). Lieberman (1985) has discussed the vocal tract anatomical differences between neonates and adults, which impact respiratory mechanisms, phonation, and cry production. Human neonatal vocal tracts are in some ways more like the adult chimpanzee vocal tract than the adult human (Laitman & Crelin, 1976). Compared to the adult chimpanzee, human neonate tracts have short vocal tracts, a relatively short pharyngeal cavity, a relatively anterior tongue mass, a gradual rather than angular bend of the oropharyngeal tube, and a high position of the larynx (Bauer, 1986). In addition, the vocal folds of the human neonate and adult chimpanzee are shorter and less robust, which contributes to the relative higher fundamental frequency range. Despite these similarities, however, chimpanzee sounds in general, while they carry
information, lack closants and thus the segmental contrastivity of varied consonants and vowels in rapid succession which are characteristic of human infant sounds.

THE PHYSIOLOGY OF SOUND AND CRY PRODUCTION

While the exact mechanism of sound/speech production in both adults and infants remains controversial, Scherer (1982) has provided a rather straight-forward explanation of the nature of voice production based on the Fant's (1960) acoustic theory of speech production. According to this theory, sound production (including adult speech and infant crying) are described as the excitation of a configuration of acoustic cavities (such as oral, nasal, sinusal, laryngeal, and pharyngeal cavities) by one or more sources of acoustic energy as a consequence of air flow from the lungs. The sound waves that comprise human vocalizations are produced by interruptions of an air stream that is pushed up and through the vocal tract during exhalation ("egressive vocalization") or sucking in during inhalation ("ingressive vocalization"). These air particles are set in vibration and produce audible sound waves when they encounter an obstacle that prevents them from freely passing through the tube-shaped vocal tract. The major obstacle for air pushed up from the lungs through the trachea during exhalation is the glottis if the focal folds are closed. In this case the pressure of the air column below the glottis (subglottal pressure) rises, forcing the vocal folds to open. After a puff of air has escaped, the vocal
folds close. This cycle is repeated, and the series of air puffs released by this vibratory action of the vocal folds ("glottal pulses") are passed through the vocal tract and emerge at the mouth opening as a periodic sound wave. Sounds that are produced by the opening and closing of the vocal folds are called "voice sounds." If the vocal folds are permanently open during exhalation, the air can pass freely through the glottis but may encounter obstacles (such as lips and teeth to produce the 's' sound) farther up in the vocal tract. In this case, the air particles are affected by turbulence, and the resulting sound waves are called "voiceless" or "unvoiced." Voiced vocalizations are characterized by pure tones, while unvoiced vocalizations are noise-like in character.

The characteristics of the sound waves emitted from the mouth opening are not only determined by the nature of the obstacle that interrupts air stream but also by the general shape of the vocal tract, which undergoes rapid changes with growth in addition to the continuous changes that occur during speech; this is particularly true for voiced sounds. They are modified by the specific configuration of the vocal tract that serves as an acoustical filter. Thus, the sound waves that represent human vocalization have been shaped by and thus carry information about, the state of the vocal apparatus and the phonation and articulation processes during this vocalization.

The cry sound is generally thought of as an acoustic phenomenon produced by excitation at the glottis causing the vocal cords in the
larynx to oscillate. However, the aerodynamic and physiological bases of neonate crying remain both theoretical and controversial. What is well established is that crying is intimately related to respiration. The motor component of the cry or the "cry act" (Truby & Lind, 1965) originates in the CNS and requires the respiratory system to adapt to the generalized motor response. The respiratory pattern of crying dominates normal tidal respiration, converting it into a form of dyspnea in which the effort and duration of expiration are increased.

Golub (1980; Golub & Corwin, 1985) has proposed a physiological model of infant cry production. This model is derived from Fant's (1960) acoustic theory of speech production, infant vocal anatomy, and the interaction between crying and respiration. An infant's vocal tract functions acoustically as a one-quarter wavelength tube resonator of specified length which can be used to predict the formant frequencies of the cry. Golub has suggested that neonates control tension in their muscles, especially the smaller muscles of the larynx, in a quantal or noncontinuous fashion and that differences in the acoustic properties of some cries can be explained by the relative tensions of two laryngeal muscles (vocalis and cricothyroid) and one respiratory muscle (abdominal). Golub (1980) used a source-filter linear system to examine the production of cry sound generated at the larynx and in the airways above the larynx. This model may provide a physiological explanation for the
differences in pitch between the phonated and hyperphonated cry types described by Truby and Lind (1965).

Lester developed a neural model of cry production which builds on Golub's physioacoustic model. Lester's model (Lester, 1984; Lester et al, 1988) explains how the cry is modulated by the nervous system, particularly the brainstem. Lester has proposed that the vagus nerve sends impulses to and receives impulses from the larynx, particularly the intrinsic muscles that determine vocal fold vibration, hence the fundamental frequency of the cry. The vagus (cranial nerve ten), which originates in the brain stem of the central nervous system, has six branches and contains parasympathetic and sensory fibers carrying feedback to and from the brain. The vagus can receive messages from the motor areas of the cerebral cortex through fibers in the corticobulbar tract which terminate in the brain stem on motor nuclei of the vagus. The primary area of the motor cortex, or Brodman's area four, is a motor strip that controls the larynx and is near Broca's speech area, supporting the notion that early cry patterns may be related to the development of speech and language. More recently Lester and colleagues (Lester et al., 1988) have expanded their original notion to include not only the vagus but the other cranial nerves as well (the "vagal complex"), all of which are hypothesized to determine sound qualities of the cry including the fundamental frequency and the formant frequencies. In fact, a recent study on brainstem auditory evoked response (BAER) and acoustic cry characteristics provided evidence that the cry is
mediated by brainstem activity. However, while the brain stem is necessary for the production of the cry, it is not sufficient. Higher brain structures seem to be involved (Jurgens, 1986). Based on this model, Lester and others have proposed that the cry as a measure of nervous system involvement is the final common pathway through which a variety of clinical conditions are expressed.

TERMINOLOGY FOR INFANT CRY

Many different terms are encountered in the literature that describe sounds produced by small infants, including cry, vocalization, utterance, phonation, articulation, and non-verbal communication (Michelsson, 1980). Crystal (1976) recommends using the term "vocalization" to refer to any sound produced by an infant, including crying, babbling, and all other early pitch patterns that are emitted.

Both cry and nondistress vocalizations represent the infant's early communicative behavior that result in an acoustic signal. Nondistress vocalizations, often operationally defined as "comfort sounds" (Murry, Hoit-Dalgaard & Graco, 1983) or as "vegetative functions" (Hollien, 1980), include burping, sucking, cooing, coughing, hiccoughs, gasps, smacks, etc. These sounds are characterized as undifferentiated soft sounds that most likely occur when the infant is in a biological state of equilibrium.

The term "cry", generally referring to a sound characteristic of the human neonate, has been categorized along a variety of
dimensions. Truby and Lind (1965) emphasized that the cry sound is accompanied by a motion (or action) from which the sound derives. Hence, the study of infant cries can be approached both acoustically (sound) and cinetically (motion), which separates the "cry sound" from the "cry act." Truby and Lind have described the "cry cycle" to mean the total vocalization period, including the sub-parts called alarm, arousal, approach, onset, attack, cruising, subdual, comfort, and peace.

The classification of cries into different "cry types" has also been undertaken, with labels reflecting the inferred need state of the infant on the basis of contextual cues. The first investigation carried out on cry types were reported by Sherman (1927), who studied two infants 3 to 7 days old who were "induced" to produce four types of vocalizations: hunger, fear, anger, and pain. Wasz-Hockert and colleagues (Wasz-Hockert, Lind, Vuorenkoski et al, 1968) defined four different cry types (birth, pain, hunger, pleasure) as signals with different meanings. Wolff (1969) described three cry types: the basic (or hunger) cry, the mad (or angry) cry, and the pain cry. Wolff has contended that of the three, the basic is the most common form of sustained crying in the young infant, and it is also the cry type to which most infants will eventually revert from other cry types if they cry for a long enough period. Lester and Zeskind (1978) and Murry, Gracco, and Gracco (1979) referred to distress and non-distress vocalizations. From an acoustic perspective, Truby and Lind (1965) referred to three acoustic types of cry, including
phonation (basic cry), dysphonation (turbulence), and hyperphonation (shift).

The idea of categorizing cries both acoustically and by the human ear remains a hotly debated issue in the field. The current thought is that the cry should not be defined by its eliciting stimulus, for a cry is a sound that is not necessarily static and related to one specific stimulus, but changes over time.

As evident, while the field of cry research has established some basic vocabulary, uniform definitions are needed so that the findings across investigations can be compared. The pain cry is commonly used in comparing the cries of infants with different diseases, and has been recommended as the standard cry type to be employed in similar studies (Michelsson, 1980). Other investigators contend that the method used to elicit crying should be based on the hypothesis under investigation (Lester, personal communication, 1989).

THE MEANING OF THE NEONATAL CRY

The Cry as an Innate Releaser of Behavior. The major assumption underlying this view is that the cry is a distress signal, similar to the nonlinguistic signals used by non-human primates (Bastian, 1965; Lieberman, Harris, Wolff et al., 1971) that evolved, along with other attachment behaviors, to promote close proximity between infants and their caregivers for protection from predators and other dangers (Ainsworth, 1969; Bowlby, 1969), and hence the
nickname the "acoustic umbilical cord" (Ostwald & Murry, 1985). Infants, then, must be genetically programmed to cry when out of contact or distressed (Bowlby, 1969). The cry is an early and temporary means of achieving proximity until the infant gains neuromuscular control to emit "coos" and smiles which are social signals which will in turn gather contact and care. Adult caregivers are thought to develop reciprocal mechanisms that are both immediate and appropriate in response to the cry signal in order for the human species to survive.

The problem with this adaptive perspective relates to differences observed across cultures in terms of parental responsivity. If infant crying is an innate, adaptive mechanism, it seems odd that anthropologists have reported a wide variation in parental sensitivity and responsiveness to crying between cultures (Landau, 1982; Mead & Newton, 1967). For example, in Western cultures, crying is viewed as a beneficial breathing exercise (Ribble, 1965) and thereby more "tolerated" by caregivers. Here, responses are delayed and the infant may cry for several hours each day. In primitive and traditional societies, on the other hand, where the cry is treated as an emergency signal and responded to immediately, excessive crying or "colic" is seldom heard of. The !Kung babies of Africa, for example, spend as much as 90 percent of their time directly on their mothers' bodies and do not exhibit excessive crying behavior (Geber, 1958; Jordan, 1980; Lozoff & Britten, 1979).
The Cry as an Aversive Stimulus to the Listener. This view, closely tied to the learning theory tradition (Moss & Robson, 1968), hypothesized that parents respond to the cries of their infants in order to reduce the aversiveness of the stimulus, just as they would any other noxious sound. In this model, the cry sound itself has no special properties or powers. Rather, the principles of negative reinforcement, psychophysics, auditory experience, and the physical characteristics of the sound combine to produce a response from the listener. Ostwald (1963) has summarized this model in the following quote:

One can appreciate why the parent must interfere with the baby’s cry: this sound is too annoying to be tolerated beyond a short period of time, particularly at close range. Thus, the cry cries to be turned off. The listener who cannot escape usually reduces the noise by soothing whatever baby needs occasion it (p. 46).

The greatest weakness of this model is that it does not account for actions to remove the source of the distress (Murray, 1985). It best accounts for actions that result in escape from or avoidance of the crying infant. The motivation of the parent is self-serving; the parent is described as motivated to reduce his/her own distress rather than the infant’s.

The Cry as an Elicitor of Empathy and Altruism. This view was designed to integrate the altruistic and egoistic frameworks just described into a single perspective. Hoffman (1975) has proposed that observers of another’s distress will experience emphatic
distress, an involuntary and forceful experiencing of the other's painful emotional state. According to this formulation, the intensity of the observer's affect is positively related to the number of pain cues emitted by the victim. Hoffman (1977) also hypothesized that there is an optimal range of distress cues, such that the cues must be sufficient to activate distress in the observer but not so disturbing as to elicit avoidance or aggression toward the victim. Excessive and prolonged crying, or particularly aversive-sounding crying, may exceed limits of tolerability and overly tax parents' abilities to withstand continuing high levels of emotional arousal.

Murray (1985) has contended that most of the findings support this last framework. The fact that subjects tend to respond to infant cries with a stress reaction is consistent with Hoffman's (1975) claim that distress cues from another individual trigger empathic distress that is more than a reaction to an aversive stimulus (Sagi & Hoffman, 1976).

CRY AS A PRELUDE TO SPEECH

The relationship of early neonatal vocalizations to the later development of speech production skills is not clear. Some investigators suggest that these early sounds are divorced in their developmental history from the booing-babbling sounds which eventually merge into the acoustic productions of speech (Lenneberg, 1967). In fact, Darwin (1965) believed that vocal sounds were...
originally the results of involuntary and purposeless contractions of the muscles of the chest and glottis accompanying emotional excitement. In a similar vein, Osgood (1953) described the vocal apparatus as a "muscular system, where activity here partakes of the randomly exercised, and when air happens to be pushed through the oral cavity, varying patterns of sound are produced " (p. 684). Hollien (1980) stressed that the neonate, capable of few (if any) volitional communicative acts, communicates with his world on a reflexive basis. To him, crying has little (if any) cognitive dimensions, but rather is a functionally autonomic process.

On the other hand, there is some evidence that phonemes or at least speech-related sounds can be identified perceptually as occurring in the cries of neonatal infants (Stark, Rose & McLagen, 1975). Again, while there are probably no cognitive components with respect to such activity, it may be that the infant is developing the speech system via random production of possible sounds at a below-conscious level (Jakobson, 1941). Planned or intentional control over vocal signals is not exhibited until around nine months of age.

PHYSIOLOGICAL CONSEQUENCES

At a physiological level, crying may be beneficial given that it: facilitates the reorganization of the cardio-respiratory system, improves pulmonary capacity, and helps maintain hemostasis (Brazelton, 1962). In addition, temporal data has suggested that
crying enhances vocal tract physiological developmental, as it in
effect serves to provide the infant with an outstanding regimen of
exercise along with ample opportunity to develop the aerodynamic
physiological support necessary for the subsequent development of
speech and language (Liebman, 1978). For these reasons, then it is
commonly assumed that infant crying is normal and healthy.

Other scholars have contended that there is absolutely no
beneficial effect of crying (Sears, 1985), and that it may be
"unhealthy" when it is excessive. It has been hypothesized that
excessive cry behavior makes such high energy demands of the infant
that it has the potential to effect changes in the cardiovascular
(including cerebral blood flow) and endocrine systems that may be
harmful physiologically (Brazy, 1988; Burroughs, Asonye, Anderson-
Shanklin et al, 1978; Dinwiddie, Pitcher-Wilmont, Swartz et al.,
1979; Goddard, Keith, Marcovitch et al., 1954; Woodson, Morgan, Jones
& Chamberlain, 1982). For example, some researchers have reported
that "unresponded to" crying resulted in increased heart rate
(greater than 200 beats per minute) and diminished oxygen in
bloodstream (Dinwiddie et al., 1979). Likewise, even the
physiological benefits of the anxiously awaited for first (i.e.
birth) cry is now under fire. As evident, there is some degree of
controversy as to whether neonatal crying is beneficial versus
potentially harmful, particularly when excessive.
SOCIAL CONSEQUENCES

Infant crying can be maladaptive as it is frequently cited as a major trigger for child abuse (Frodi & Lamb, 1980a; Lester & Zeskind, 1982). Although crying is an infant behavior that parents expect to encounter, when it is exaggerated in its intensity or duration, the phenomenon acquires a pathological meaning. Persistent or in-consolable crying can result in a crisis in two respects, the first being the impact it has on the mother's ability to be a competent and loving caregiver. A fatigued and anxious mother will be limited in terms of how she responds and interacts with her infant. On a more tragic note, crying has been shown to be the most common reason given for aggression toward infants (Caffey, 1974; Ludwig & Warman, 1984; Menahem, 1979; Weston, 1968). The medical literature (Krugman, 1985; Schmitt, 1987) and popular press (Berens, 1987; O'Connor & Bell, 1985; Parachinie, 1984; Parents agree baby, 1986) both highlight the relationship between infant crying and "shaken baby" syndrome. The old sociological model of child abuse, where abuse tends to occur in pathological families, has been replaced by paradigms that view the child as having a role in the abuse (Gelles, 1973). While there are certain risk factors that may predispose a family to abusive interactions, infant abuse as a consequence of infant crying may occur in even the most nurturant environments when all other risk factors are absent.
CRY QUANTITY

Physiological and social consequences are undoubtedly related to cry quality and quantity. With respect to quantity, the issue is at what point does crying become potentially harmful, that is HOW MUCH crying is considered "normal" and how much (or little) is abnormal? Most of the normative studies available were undertaken on small samples of 1-3 month-old infants using different methods to quantify crying as well as different definitions of crying (see Table 1). The one notable exception is Brazelton's (1962) work with 80 mother-infant pairs. Brazelton reported that at two weeks of age the median amount of crying was 1 3/4 hours, at 6 weeks 2 3/4 hours, and thereafter the quantity of crying decreased. Some scholars are skeptical about sharing with parents this widely quoted "average of two to three hours per day" for fear that parents will conclude that it is "all right" to let their infant cry two to three hours per day (Sears, 1985). Sears has argued that infants of mothers advised on the significance of the cry signal or on how to intervene (unlike Brazelton's study mothers) would cry less as a function of maternal responsiveness.

Other normative studies (Table 1) have been conducted that differ both in methods and in the inclusiveness of the crying definition, yet all report similar estimates of average daily crying time. Based on diary data, four to six week old infants have been reported to cry 1.0 hours per day (Taubman, 1984), 2.1 hours/day (Humphry & Hock, 1989), 2.2 hours/day (Hunziker & Barr, 1986), and
<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>DESIGN&lt;sup&gt;a&lt;/sup&gt;</th>
<th>METHOD&lt;sup&gt;b&lt;/sup&gt;</th>
<th>INFANT AGE (weeks)</th>
<th>MINUTES of CRYING/DAY</th>
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<tr>
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<td>D</td>
<td>D</td>
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</tr>
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<tr>
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<td>D</td>
<td>D</td>
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<td>Bernal (1972)</td>
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<td>D</td>
<td>1.0</td>
<td>94</td>
</tr>
<tr>
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<td>T</td>
<td>1-3.0</td>
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<td>T</td>
<td>4-5.0</td>
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<td>T</td>
<td>6-7.0</td>
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<tr>
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<td>D</td>
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<td>12-13.0</td>
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<td>4-6.0</td>
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<tr>
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<td>7.0</td>
<td>90</td>
</tr>
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<td>T</td>
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<td>Barr et al. (1989)</td>
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<td>D</td>
<td>6.0</td>
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<tr>
<td>Humphry &amp; Hock (1989)</td>
<td>D</td>
<td>D</td>
<td>7.0</td>
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</tbody>
</table>

<sup>a</sup> (D)=descriptive, (E)=experimental

<sup>b</sup> (D)=diary, (T)=tape-recordings
1.5 hours/day (Wikander & Wahlberg, 1987). Based on live audio-recordings, four to six week old infants have been reported to emit "negative vocalizations" between 25 (Rebelskey & Black, 1972) and 29 (Barr et al., 1988) minutes per 24 hours. In view of the methodological diversity across studies, it is striking that every study reported two crying "peaks" (St. James-Roberts, 1989). One, an "ultradian peak," is associated with the late afternoon and evening excessive crying that occurs from one week to nine months of age. The second, a "developmental peak," refers to the gradual increase in daily crying from birth to 6-8 weeks of age which is followed by a rapid decline. These peaks are rather robust phenomenon, since they occur to a greater or lesser extent in most infants, have been reported in several countries, and have been found using both objective (electronic monitoring) and subjective (parental report) methods (St. James-Roberts, 1989).

Beyond three months, the quantity and quality of the cry changes, as well as does the function of the cry. It is generally perceived that the cry becomes less reflexive, more intentional, and more social-communicative in function. There is a shift from involuntary to voluntary control of the cry, probably occurring as a result of the repositioning of the larynx in the vocal tract as mentioned earlier. Another possible explanation is the "bio-behavioral" or "neuro-behavioral" shift that occurs between two to three months, although there is no conclusive evidence to support this contention. This change involves a broad spectrum of
neurological and behavioral functions that shift from basic physiological regulation to the beginnings of social regulation occurring at the time (Emde et al, 1976; Prechtl, 1984). Viewed as some kind of a central nervous system reorganization, what seems to transpire is qualitative changes in certain integrative processes, including attention, cognition, and the social behaviors of responsive smiling, eye-to-eye contact, and molding.

One problem in quantifying crying relates to differentiating cry vocalizations from "fuss" and other similar pre-cry vocalizations, a distinction that can not always be sharply drawn. Reports on crying quantity have either not included fussing in their descriptions or combined it with crying, resulting in divergent findings with respect to quantity. Wolff (1987) has defined "fussiness" as that condition when the infants made intermittent moaning or cry-like sounds which conformed to no distinct temporal pattern and were separated by periods of silence lasting three seconds or more. Fussing is an early response to an offending cause which, if left unattended, resulted in crying. For example, Wolff, who distinguished between fussing and crying, reported shorter cumulative percentage of crying time than did either Bernal (1972) or Brazelton (1962), who relied on parental reports for cry data. Humphry and Hock (1989) differentiated fuss and cry behaviors, defining fussy behavior as when the infant is "active and moving alot and vocalizing general restlessness." Given the overlap between the
two behaviors, studies employing caregivers as data collectors need to either explicitly differentiate or combine the behaviors.

One other issue associated with measurement of infant cry quantity is the nature of the data collection, particularly when such data is extracted in a naturalistic setting by the caregiver. Typically the measurement of behavioral states or activities involves tabulating the total time spent as a percentage of observation time and/or the mean duration of daily time engaged in the particular state or activity. Quantifying crying in this manner can be affected by when during the cry sequence the mother intervened. For example, Wolff (1987) noted that crying almost always provoked some social response from the mother which terminated crying before it had run its course. Also, Humphry noted that maternal reports of total daily crying time were overestimates of actual daily derived total daily crying time, the difference she attributed to maternal reports that the infants WOULD HAVE been crying if they had NOT INTERVENED. Therefore, cry quantity data obtained from the mother in the home setting is possibly more closely related to maternal perception of "would have been" cry duration as well as her particular child-rearing pattern than to the infant's "natural" cry pattern were it left to be expressed spontaneously.

These problems point to the real dilemma of operationalizing infant cry quantity. One of the major problems plaguing cry researchers aside from definition issues as previously discussed is objectively quantifying the behavior. Despite the acknowledged
potential for over- and under-reporting, most of the current knowledge about infant crying beyond the newborn period has come from parent-maintained diary studies. In addition to the above mentioned problems, the crying infant frequently causes such stress and anxiety in the parents that their observations, perceptions, and interpretations are distorted. The resultant data could be unreliable in terms of duration and severity of crying. Hewson and colleagues (1987) and others (Barr, personal communication, 1987) call for the use of a validated observation crying diary to collect objectively data in defining colic. While several investigators report the use of diaries in their research (Barr, Kramer, Boisjoly, McVey-White & Pless et al., 1988; Brazelton, 1962; Humphry, 1985, Lester, 1985; Lothe, Ivarsson & Lindberg, 1987; Taubman, 1988), only Barr et al. have reported any validation data.

Cognizant that parents could not produce a detailed record of infant crying, Barr and colleagues (1988) designed a diary in which parents provided information on crying clusters. The Barr diary was validated by comparing parental diary recordings of crying and fussing with electronically-recorded crying during a 24-hour period in 10 mother-infant pairs. Moderately strong product-moment correlations were obtained between duration of diary-recorded crying and negative vocalizations ($r = .65, p < .05$) and between frequency of crying/fussing episodes and clusters of negative vocalizations ($r = .71, p < .05$). If one poorly completed diary recording was eliminated, the strength of recording methods for these measures
improved further to .89 and .85, respectively. The Barr and colleagues diary is complex and cumbersome in that it incorporates five-minute recording segments. However, this diary has been successfully used by researchers (Hunziker & Barr, 1986).

The second attempt to operationalize infant crying was described by Ames and colleagues (Ames, Gavel, Khazaie & Farrell, 1985). This instrument was also designed to measure the variable of crying in infancy and included questions on: 1) how often the baby cried during an average day, 2) the length of the average crying episode, and 3) the length of the longest crying episode. A measure of the infant's crying was determined by summing the scores of these three questions together. The instrument incorporated a measurement of parental emotional response to the crying by adding the scores obtained on a 5-point rating scale of six adjectives. Data on the reliability and validity of this instrument has not been reported and the instrument has only been used experimentally in one reported investigation (Wilkie & Ames, 1986).

Another investigation conducted by a group at The Ohio State University (Loadman, Arnold, Volmer et al., 1986) designed an observational checklist called the Observations for Colic Behavior (OCB) that was specifically designed to objectively define "colic." The checklist was designed to be completed by the research assistant based on 15 second time sampled direct observation of vocal behaviors and movements. The vocal behaviors are assigned scores from 1 to 3 (i.e. fuss=1, cry=2, wails=3). The vocal behavior score in any given
15 second interval was the most colicky vocal behavior observed. The individual movement scores in each 15 second interval are summed to obtain an overall movement score. This score can range from 0 (no colicky movements) to 3 (severe colic). Both the vocal behaviors and the movements are combined to yield a colic score for each 15 second observation. The interval score can range from 0 (no colicky behaviors) to 6 (severe colicky episode). The observations for colicky behavior are to be conducted every 15 seconds for a total of 21 minutes on each of four consecutive days. The total score is obtained by summing the interval scores across the 21 minute sessions across the four days.

As is evident, valid and reliable measures of infant crying are only beginning to be employed and empirically validated. The instruments that have been designed to measure the concept have not been extensively used or tested, yet they are indeed a beginning and an improvement over previous methods. There is only one validated diary available (Barr et al., 1988) which is cumbersome and so detailed that some parents will not comply with its maintenance.

CRY ANALYSIS

Acoustic and temporal patterning of neonate and infant crying has been the subject of considerable investigation, and several techniques have emerged that are capable of extracting acoustical data. Acoustical analysis is attractive given that it is not only relatively easy to obtain a cry sound, but it is also noninvasive.
The actual technique available for analysis has both advantages and disadvantages that must be weighed when deciding which best serves the purpose of the analysis.

**Auditory analysis** entails cry analysis by the human ear. Over the years, from Hippocrates to Darwin, photographs, drawing, graphophones, gramophone records, and tape recorders have been employed to study infant cry signals. While auditory analysis is readily available and can be improved with listening and training, it provides only a fraction of the total information contained in the cry signal. Plus it is influenced by a host of organismic variables (i.e. gender, parity) that are only beginning to be delineated (Zeskind & Lester, 1978).

**Time domain information** is obtained from devices that graph sound magnitude versus time on a paper strip chart. While useful, easy to operate, inexpensive, and reliable, such devices are prone to problems such as pen inertia and paper speed variation. This results in frequency recordings that are of poor quality. Also cry features must be subject to manual measurement which is tedious and subject to human error.

**Frequency domain analyses** provides a coarse representation of the frequency spectrum characteristics of a sound. They utilize a bank of band pass filters that only allow input of a specified frequency range, that measure the average magnitude in that range, and give a visual display of the relative magnitude. Band pass filters are either one-third or one-half of an octave in width.
Ostwald, Freeman, and Kurtz (1962) used the half octave band analyzer to examine the cries from 32 sets of twins. The only information derived from these devices are the relative magnitude of various frequency ranges.

Perhaps the most notable achievement in acoustic analysis was the development of the sound spectrograph at the Bell Telephone Laboratories (Potter, Kopp & Fox, 1947). This apparatus, intended for use in speech therapy with the deaf, was found to be too slow a process. However, it is regarded as an efficient tool in phonetics and other areas concerned with the analysis and permanent visualization of the acoustical signal. In sound spectrography, the complex cry signals are dissected into bands of frequencies, and the bands are presented in a horizontal, permanent record where different parameters can be measured.

Over the past 20 years, most studies of infant cry have utilized the sound spectrogram (also called the sonogram or voice-print; trade name = "Sonograph"). In particular, research by Wasz-Hockert and Lind from Scandinavia has advanced our understanding of the infant cry. As described by Golub and Corwin (1985), they have defined spectro-graphically based cry parameters (see next section) that have been the basis for the language used throughout the field.

The spectrogram is relatively inexpensive and a useful way to "visualize" acoustic signals such as the infant cry. The disadvantage of sound spectrography is its relatively long, time-consuming mode of operation that requires a certain amount of
expertise. As a result, it is not possible to analyze a large sample of cries quickly and accurately. Second, it requires visual inspection of the output for interpretation, which presupposes a certain inaccuracy in the measurement procedures. The time needed for this operation, however, is believed by some to be compensated for by the large amount of information received from the spectrograms (Michelsson, 1980). Other disadvantages include poor dynamic range, inadequate frequency resolution, and difficulty in the measurement of acoustic information.

Golub and colleagues (Golub & Corwin, 1985) have developed an automatic computer-based signal processing system that can extract relevant acoustical information quickly. The original use of this system was to correlate medical abnormalities with acoustical measurements. This procedure consists of first obtaining a recording of the infant cry as follows: the infant is placed in supine position with a microphone held 15cm from the infants mouth. The first 30 seconds of crying following the stimulus (typically pain) is recorded on audio cassette. This cry signal is filtered above 5 Hz and digitized at 10kHz using the Golub system as described above. For each cry unit defined as the cry that occurred during the expiratory phase of the respiration, the Fast Fourier Transformation is used to compute the log magnitude spectrum for each 25 msec block of the cry unit. Measures of the fundamental frequency (f0), first formant (F1) and amplitude are computed for each 25 msec block. From the data
analyzed in 25 msec blocks, the following summary variables are computed: average and percent change in the fundamental frequency (thought to reflect neural control of the cry), average and percent change in the first formant (determined by the airways that form the vocal tract and by neural input that controls the degree of vocal tract mobility), amplitude (intensity of the cry), and duration (length of each cry unit). Analysis involves each feature individually or features are grouped into appropriate "tests." This system allows complete analysis of a cry in 5 to 10 minutes and is entirely automatic. The computer is able to control the tape recorder, so that one can merely insert a tape, tell the computer what time to start the analysis, and then return later to examine the results.

ACOUSTIC CHARACTERISTICS

One of the first objective reports of the acoustic structure of infant cries was published in 1832 by William Gardiner in his book "The Music of Nature." He wrote that "children have no difficulty in expressing their wants, their pleasures, and pains, by their cries, long before they know the use or meaning of a word." He also wrote that the tones of infant crying generally lie between the notes A and E in the middle of the piano keyboard, that the initial expiratory component is usually the most prominent feature of the cry and it has an up-and-down melodic pattern. The inspiratory component is much shorter.
Most of the definitions and nomenclature of cry attributes were developed by the Scandinavian cry researchers. While this basic vocabulary has been established, these definitions have been modified so there is an urgent need for uniform definitions across the field.

The acoustical parameters that were planned in this investigation were:

1. **Fundamental frequency (Fo)** - a physical characteristic of all periodic wave forms, referring to the number of times a complex wave form repeats itself in one second; the number of glottal openings determined by the number of times the vocal folds open and close per second; measured in cycles per second or hertz (Hz); the major physical correlate which the listener perceives as the speaker's "pitch"; when measured by computer analysis, mean value for fo based on the average frequency of the whole cry; is dependent mostly on the tension of the laryngeal musculature and the subglottal pressure; has been higher in cries of infants with diseases involving the central nervous system.

2. **Formant frequencies** - the resonance frequencies of the vocal tract, referred to as first formant (F1), second formant (F2), etc; usually independent of the fo and its harmonics.

3. **Harmonic** - a multiple of the fo, such that if the fo is 100 Hz, then the first harmonic would be 200 Hz, the second 300 Hz, etc.

4. **Shift** - an abrupt upward and downward movement of the fo; maximum values between 1000 to 2000 Hz; quite common in crying of healthy infants, appearing mostly at the beginning of signals; higher-pitched shifts occur in pain cries of infants with central nervous system disturbance.

5. **Phonation** - a segment of a cry unit that is periodic and typically has a fo from 250 to 700 Hz; commonly referred to as the "basic cry" that is heard during the egressive stage of the cycle.

6. **Hyperphonation** - a segment of a cry unit that is periodic and typically has a fo from 1000 to 2000 Hz; commonly referred to as "shift"; perceived as a very high-pitched sound or a shift to a higher pitch during the cry signal.
7. **Dysphonation** - a segment of a cry unit that is not periodic; commonly referred to as "turbulence"; heard as a "raucous" or "harsh" cry; results from extreme effort which overloads the larynx and produces a random distribution of energy.

In the late sixties, hunger, birth, pain, spontaneous, and pleasure cries were analyzed (Prechtl, Theorell, Gramsbergen & Lind, 1969; Wasz-Hockert et al., 1968; Wolff, 1969) and acoustical parameters were reported. And while individual infant cry utterances were found to be relative stable across infants, some cry parameters (cry duration and intercry interval) appear to be distinctive to individual babies. In fact, the cry may be a "print", as unique to the individual baby as is the "fingerprint." Cries analyzed in the same infants change very little from one day of life up to the age of six months. Caution is warranted however as most of these studies have not been replicated in either healthy or ill neonates, nor has there been any documentation of changes in cry structure beyond six months (Thoden & Koivisto, 1980).

Since the 1960's, many investigations have been conducted on the cry characteristics of infants with "medical problems" based on the assumption that variations in certain acoustic features of the cry (such as frequency or pitch) reveal properties of the nervous system and may be important for medical diagnosis. For example, in Down's Syndrome the cry has a flat melody sound with a lower fundamental frequency, a higher threshold to produce the cry and a
longer latency from stimulus to cry onset (Fisichelli & Karellitz, 1963). Higher pitch and more variability in pitch have been found in infants with elevated bilirubin levels (Wasz-Höckert, Koivisto, Vuorenkoski, Partanen & Lind, 1971), bacterial meningitis (Michelson, Sirvio & Wasz-Höckett, 1977a), birth asphyxia (Michelson, Sirvio, Wasz-Höckert, 1977b), clinically suspect and abnormal infants (Ostwald, Phibbs & Fox, 1968), and siblings of SIDS victims (Colton & Steinschneider, 1980). In a recent study, extreme cry characteristics were found in infants who later died of sudden infant death syndrome (Lester et al., 1988). In another study Lester and Dreher (1989) reported a dose response relationship between the cry and amount of maternal marijuana use during pregnancy. What is evident is that medical abnormalities and pre- and perinatal trauma affect the character of the cry, most often seen as increases in the frequency and variability components of the cry (Lester, 1984).

Variations in acoustical features of the cry have also been studied in relation to infant temperament. Lounsbury & Bates (1982) studied 12 four to six month-old infants who were identified as easy, average, or difficult temperament from maternal responses to the Infant Characteristics Questionnaire (Bates, Bennett-Freeland & Lounsbury, 1979). Spectographic analysis of the cries of these difficult infants revealed increased amounts of pausing within or between cry sounds, which is interpreted as adding a sense of urgent demand to the cry communication. The more difficult infants tended
to cry at higher fundamental frequencies at peaks of loudness, but
did not show higher pitch over the whole cry.

Wetzel (personal communication) studied the acoustical
characteristics of the cries of 12 maltreated infants and 12 matched
comparison subjects under controlled conditions at 12, 18, and 24
months of age. Cry samples were analyzed again by the computer
signal-processing method previously mentioned. She found that
maltreatment status was a predictor of significantly lower
fundamental frequency and decreased phonation content of the cry at
18 months of age. In addition, there were significant differences
between the insecurely attached (A/C) and securely attached (B)
babies in relation to fundamental frequency.

In summary, cry analysis, a non-invasive measure of neuro-
physiological integrity, has the potential to reveal important
information about the biological status of the infant that is not
provided by any other medical data. Studies to date suggest that the
acoustic characteristics of the neonatal cry have less utility as a
specific disease indicator than as a general assessment of risk.
While there does not appear to be a one-to-one correspondence between
cry characteristics and the infant's medical condition, cry analysis
provides a benchmark or signal of CNS dysfunction that when used in
conjunction with other medical information could lead to a
differential diagnosis.
CRY PERCEPTION

A great deal of work has been done on how adults perceive infant crying, generally via playing audio-recordings of crying infants and monitoring either physiological or self-report responses. Underlying this work is the assumption that these responses are indicative of how adults behave as caregivers (Lester & Boukydis, in press). Only recently has there been any interest in relating measured cry acoustics to adult perception. Recent work suggests that the following acoustic parameters seem to be related to more negative perceptions of the cry: higher average fundamental frequency (Lester, Garcia-Coll & Valcarcel, 1989; Zeskind & Marshall, 1988), higher formant frequencies (Lester et al., 1989), less voiced phonation (a ratio indicative of the amount of phonation in the cry), and a greater frequency and longer duration of pauses between cry bursts (Lounsbury & Bates, 1982).

Of significance to this study is work by Lounsbury and Bates (1982) and recent work by Lester and Boukydis (in press). In the former, home recordings of the cries of 4-6 month old full term infants were obtained and the infants were subsequently identified as easy, average, or difficult in temperament. Other mothers who rated the difficult infant cries higher on dimensions of anger/irritation, and spoiled, and judged the difficult infant as crying for more psychological/emotional reasons (fright, frustration, wanting attention), whereas easy infants were seen as crying from routine physical discomfort, such as hunger or wet diapers.
In a longitudinal study, Lester and Boukydis (in press) found that the acoustic characteristics of the cry predicted maternal ratings of temperament at nine months, suggesting that mothers are reacting to innate, constitutinally-determined behaviors in their infants. Alternatively, cry perception might reflect a change in the mothers understanding and feelings about the infant which could ultimately affect her behavior toward the infant. As such, cry perception might be useful in the study of the transactional aspects of early parenting (Seifer & Sameroff, 1986). In short, the suggestion that cry perception is a mediator of parenting behavior implies that studies are needed that examine the relationship among cry acoustics, parent perception, and parenting behavior (Lester & Boukydis, in press), as is proposed in this study of infants with colic.

INFANT COLIC

PREVALENCE

Nearly one out of five infants has colic, or over 700,000 infants in the United States each year (Weissbluth, 1984). "Colic" is not a disease, but an anomaly that is characterized by unexplained, excessive crying or screaming in the infant under three months of age (Mones & Asnes, 1986; Schmitt, 1985). While one of the most common complaints of new parents, it has eluded explanation. Debate continues to exist relative to the definition, etiology, treatment, and prognosis of the condition.
DEFINITION

No standard definition of the condition exists, due in part to the term itself. The word "colic" is derived from the Greek "kolikos", the adjective of "kolon", meaning the large intestine (Partridge, 1958). Use of the term along with the manner of the crying is suggestive that the infant is experiencing some type of abdominal or colonic pain, which is not the case for a majority of infants who exhibit the symptoms (Carey, 1984). The long-standing lack of a standard definition has resulted in the following problems: 1) it becomes difficult to compare one study to another, as many studies undoubtedly involve a heterogeneous group of infants with problems that may or may not be "colic" (Carey, 1984), and 2) it has resulted in differences in reported frequencies in the problem, and 3) it has enabled colic to become a "catch all" diagnosis for any unexplained crying in the infant. Most authors base the definition of colic solely on quantity of crying in terms of number of hours of crying per day, number of crying episodes per day, number of days of crying episodes per week, and number of weeks (Wessel, Cobb, Jackson, Harris & Detwiler, 1954). Infants with colic cry excessively (Mones & Asnes, 1986; O'Donovan, 1980), or greater than the averages for their age. In fact, Taubman (1984) demonstrated that colicky infants cry two and a half times more than normal infants. The cry of the colicky infant has been described as intermittent, unrelenting, and paroxysmal, or full force (Carey, 1984). Colicky crying can have an erratic pattern from day to day. Days may occur without any colic
spells, and the duration of spells may vary considerably from day to
day or within a given day (Weissbluth, 1984). Weissbluth has
cautions that it is never appropriate to make a diagnosis of colic
until at least three or four weeks of age when normal early fussiness
in the young infant has abated, which is contrary to the findings
that up to 88 percent of colic onset is by 14 days of age
(Illingworth, 1954).

CRY CHARACTERISTICS

While it is clear that one characteristic of colic is excessive
crying, it is not clear whether or not colic as a syndrome can be
equated with crying in general that is excessive. For example,
Illingworth (1985) has divided colicky crying into severe and mild
degrees, which suggests a continuous distribution. Brazelton’s
(1962) median duration of "normal" crying at 6 weeks of 2.75 hours
per day as well as more recent work (Hunziker & Barr, 1986) suggest
that colic may be a normal maturational phenomenon that coincides
with the ultradian and developmental crying peaks observed in
noncolicky infants. The alternative view is that colic is a syndrome
related to one or several system dysfunctions, such as intestinal
(Illingworth, 1985) or central nervous system (Lester, in press)
physiology. The clinical literature suggests a second set of
characteristics possibly reflective of an apparent pain complex in
the colicky infant (Hewson et al., 1987; Adams & Davidson, 1987).
Motor responses that accompany colicky crying include facial
grimacing, eyes closed tightly or wide open, back arched, red faced, brief periods of breath holding, increased motor activity, flexion of the elbows, clenched fists, generalized hypertonicity, tense abdominal wall, and a cry that is described as high pitched, all behaviors that are generally believed to infer that the young infant is experiencing pain (Mills, 1989).

Qualitatively, the cry of the infant with colic has been described as full-force (Carey, 1984), intense (Paradise, 1966), severe (Jakobsson & Lindberg, 1983), violent screaming (Hewson et al., 1987; Taylor, 1957), and paroxysmal (Carey, 1968; Forsyth et al., 1985; Hewson et al., 1987; Illingworth, 1985; Jakobsson & Lindberg, 1983; Karofsky, 1984; Rowell, 1978; Taubman, 1984; Weissbluth & Green, 1983; Weissbluth et al., 1984), suggesting that it too may have different acoustic features as compared to the cry of the non-colicky infant.

Recently Lester (in press) studied a group of 15 term and preterm infants between 1 and 4 months of age. Infants were considered "colicky" if: 1) their crying was excessive (3 hours per day, 3 days a week for 3 weeks), 2) the crying had a paroxysmal (sudden) onset, 3) the cry sounded high-pitched, 4) the infant exhibited signs of hypertonia, and 5) the infant was observed to be inconsolable. Cry recordings were obtained at one month and analyzed by computer via analog transformation. The cries of infants with colic had a 25 percent higher pitch (fundamental frequency), a 30 percent increase in pitch variability (wider fo range), and more than
twice as much turbulence (dysphonation or noise quality) than the cries of the matched controls. Disturbing features of the colicky infants' cries were: 1) the overall percent of hyperphonation and dysphonation, and 2) that both hyperphonation and dysphonation increase at the end of the cry. At the end of the last cry unit almost 60 percent of the cries were composed of hyperphonation and dysphonation in contrast to most cries where these characteristics tend to taper off as the infant continues crying. Lester proposed (personal communication, 1987) that what the mother is likely to find distressing about this pattern is the increased tension, higher pitch and turbulence at the end of the cry segment. In other words, the colicky infant's cry sounds worse the more he cries. In the same Lester et al study, mothers listened to the cry of their infant and were asked to rate the infant's cry on a series of eight, 7-point bipolar rating scales (Zeskind & Lester, 1987; Lester et al., 1989). Mothers of infants with colic rated these cries as more urgent, more piercing, more grating, and more arousing than mothers in the control group. They also reported that they felt more sad when listening to the cry of their infant than did the mothers of non-colicky infants.

As expected, differences in the acoustic characteristics of the colicky cries were indeed perceived by their mothers. These findings are significant given that acoustic characteristics of the cry have been found to directly affect the mother-infant interaction (Lester, 1984), and have been related to difficult infant temperament (Boukydis & Burgess, 1982). In the extreme case, crying may be
related to deficits in parenting. Teenage mothers differ from adult mothers in the perception of their infant’s cries by negating the aversive properties of the cries (Lester et al., 1989). Abusive mothers show more autonomic arousal and negative cry perception ratings to crying babies than controls (Frodi, 1985). No study has yet to examine the perceptions of mothers of colicky infants to crying babies that are not their own, in comparison to their perceptions of their own infant’s cries, as is being proposed in this investigation.

INCIDENCE

The incidence of colic is difficult to define due to the confusion and lack of clarity relative to its definition and differentiation from normal crying. Prospective studies have reported frequencies of 8 percent (Brazelton, 1962), 16 percent (Hide & Guyer, 1982), 20 percent (Keefe, in progress), 23 percent (Paradise, 1966), and 26 percent (Rubin & Prendergast, 1984). Reports based on general pediatric populations range from 21 percent (Illingworth, 1954) to 40 percent (Stahlberg, 1984). Lester (1989) has contended that “true colic”, as opposed to excessive crying, occurs in approximately 8 percent of the population. It is likely that the actual incidence depends on the method of eliciting information on infant crying behavior from the parents. Furthermore, mothers of infants whose colic is more severe are more likely to
consult their physician than mothers of infants who are less severely affected (Rubin & Prendergast, 1984).

**EPIDEMIOLOGY**

In term infants, onset of infantile colic is between three days and three weeks of age (Illingworth, 1954) with a mean of 1.8 weeks (Paradise, 1966). While Pierce’s (1948) data suggest that preterm infants may exhibit a delayed onset of colic which is proportional to their degree of maturity, this finding has not been replicated. Infants in whom colic begins during the first two weeks of life seem to have a longer overall duration of the condition than do infants who exhibit signs of the condition later in life (Holmes, 1969; Stahlberg, 1984). In addition, infants with colic tend to have siblings with colic (Stahlberg, 1984; Taylor, 1957). While several studies have suggested that colic can last up to 6 months of age (Pinyerd, 1987; Rubin & Prendergast, 1984), in the majority of infants colic subsides by 16 weeks of age (Illingworth, 1954) with a mean of 13.6 weeks (Paradise, 1966).

Despite voluminous literature, the data are conflicting on the relationship of colic to other variables. Some of the variables studied are maternal age (Illingworth, 1954; Paradise, 1966), intelligence (Paradise, 1966), education (Rubin & Prendergast, 1984; Wessel et al., 1954), parity (Illingworth, 1954), pregnancy/labor difficulties (Rubin & Prendergast, 1984; Wilkander & Wahlberg, 1987), or illness during pregnancy (Illingworth, 1954); family history of
gastro-intestinal problems (Paradise, 1966), history of allergy (Illingworth, 1954; Paradise, 1966); tension (Carey, 1968; Christopherson, 1981; Wessel et al., 1954); and social class (Humphry, 1985; Wessel et al., 1954); infant sex (Bruce, 1961; Illingworth, 1954; O'Donovan, 1980; Paradise, 1966; Rubin & Prendergast, 1984; Stahlberg, 1984; Taylor, 1957), birth order (Paradise, 1966); and birth weight (Bruce, 1961; Illingworth, 1954; Meyer & Thaler, 1971).

ETIOLOGY

The causes of colic are unclear as investigations and opinions are contrary. Basically there are two classifications of "causes": those that are within the infant (intrinsic), and those that are external to the infant (extrinsic) (see Table 2).

Although maternal tension has been suggested as a possible source of colic, there is little supporting evidence. First time mothers who are more tense and anxious may be more likely to have colicky infants (Bakin, 1956; Rambar, 1956; Wessel et al., 1954). However, only one study provides any support for this hypothesis (Wessel et al., 1954). Mothers whose infants develop colic do not have higher levels of trait anxiety (Humphry & Hock, 1989, Paradise,
## TABLE 2

**INTRINSIC AND EXTRANSM VARIABLES IMPLICATED IN COLIC**

<table>
<thead>
<tr>
<th>INTRINSIC</th>
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<tbody>
<tr>
<td>Hypertonia</td>
<td>(Levin, 1956; Spitz, 1965)</td>
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<tr>
<td>Immature GI tract</td>
<td>Brennemann, 1940</td>
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<tr>
<td>Excessive gas</td>
<td>Jorup, 1952; Snow, 1937; Stewart, 1954</td>
</tr>
<tr>
<td>GI spasms</td>
<td>Illingworth, 1954</td>
</tr>
<tr>
<td>Immature nervous system</td>
<td>Lester, 1984; Meyer &amp; Thaler, 1971</td>
</tr>
<tr>
<td>Progesterone deficiency</td>
<td>Clark, 1963; Weissbluth &amp; Green, 1983</td>
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<tr>
<td>Gut hormone deficiency</td>
<td>Lothe, Ivarson &amp; Lindberg, 1987</td>
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<th>EXTRANSM</th>
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<tbody>
<tr>
<td>Maternal anxiety</td>
<td>Carey, 1968; Paradise, 1966</td>
</tr>
<tr>
<td>Maternal personality variables</td>
<td>Bakin, 1956; Brody, 1979; Lakin, 1957; Rambar, 1956; Shaver, 1979; Spitz, 1965; Wessel et al, 1954</td>
</tr>
<tr>
<td>Inappropriate handling</td>
<td>Brazelton, 1974; Spitz, 1965; Taubman, 1984; Stewart et al, 1954</td>
</tr>
<tr>
<td>Maternal-child interaction</td>
<td>Shaver, 1979; Humphry, 1985</td>
</tr>
<tr>
<td>Parental tobacco smoke</td>
<td>Said et al, 1985</td>
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<tr>
<td>Overfeeding/Underfeeding</td>
<td>Birdson, 1975</td>
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</table>
1966; Shaver, 1979). Despite these findings, however, there persists a belief that infant colic is caused by the anxious mother.

As early as 1940, Neff (1940) suggested that colic could be an innate, developmental phenomenon of early autonomic behavior immaturity; unfortunately, he failed to explain why not all infants are afflicted. The following three recent observations implicate constitutional factors in the etiology: 1) fuss/cry behavior persists after switching from breast-feeding to formula feeding in infants who had "difficult" temperament scores prior to the switch (Barr et al., 1989), 2) shortened sleep durations persist even after dicyclomine therapy successfully eliminated or reducing crying (Weissbluth et al., 1984), and 3) supplemental carrying is effective in reducing crying in healthy infants without colic, but it does not impact cry patterns of infants with colic (Barr et al., 1991). Exactly what underlying mechanism is involved remains speculative, although several investigators have offered physiological explanations (Keefe, 1989; Lester et al., in press; Weissbluth, 1987). Weissbluth, for example, proposed that colic is a sleep disorder of infancy similar to the respiratory and sleep problems that have been linked to Sudden Infant Death Syndrome (SIDS). In a small retrospective study, he found a higher incidence of colic in a group of near miss SIDS infants when compared with a control group (Weissbluth, 1981). From this perspective, colicky crying spells could represent a transient extreme neurological arousal, excitation, or lack of inhibition that is terminated by naturally occurring periods of quiet sleep or
increased habitation. Emde and Metcalf (1970) demonstrated that fussiness and crying occur during "undifferentiated" or indeterminate rapid eye movement (REM) sleep states only during the first three months of life. This association between crying and indeterminate REM sleep disappears after about three months of age. During these first three months, these researchers also observed drowsy-REM sleep, which they characterized as a fixed facial expression with a strained, wide-eyed appearance. Hence, it is possible that a colicky spell of intense crying does not occur during wakefulness, even though the eyes are open. The periodicity of colicky spells then could be due to disturbances in evolving sleep/wake circadian rhythms.

Keefe (1988) proposed a similar framework to understand colic, which she terms "irritable infant syndrome." She asserts that colicky crying episodes are not simply due to nervous system immaturity, but also an inability of the infant to self-regulate and to initiate appropriate state changes. Within the general systems tradition, Keefe conceptualized colic as having two components, the first being relating to the infant's disturbed or delayed biorhythmic organization, and the second involving the interaction of mother and infant behavior. Keefe proposes that in the presence of persistent infant crying a negative feedback cycle is created that interferes with a coordinated exchange between the caregiver and the infant.

Other investigators have suggested that: 1) a combination of variables may in fact be associated with colic rather than any one
variable, or 2) what is actually being studied may not be colic but rather crying that is greater than normal (Weissbluth, 1984; Zuckerman, 1981). Carey (1984) has contended that there are various intrinsic and extrinsic factors interacting to produce excessive crying in the infant. Carey has advocated the use of an integrated approach when studying and managing the condition, a position supported by others (Asnes & Mones, 1982; Humphry, 1985; Oberklaid, 1979).

CONSEQUENCES

Since colic has been described as a "benign" (O'Donovan, 1980), self-limiting condition (Rubin & Prendergast, 1984) that the infant "outgrows" by 4 months of age (Karofsky, 1984), these infants have been thought to be no different from other children in later childhood (Meyer & Thaler, 1971; Bakin, 1956; Glaser, 1956; Illingworth, 1954). While some studies have reported significant relationships between colic and a variety of conditions (Table 3), neither the short-term consequences nor the long-term prognosis for children who as young infants cried excessively has been sufficiently investigated. From an attachment theory perspective, there is evidence to suggest that there may be reasons for concern.

Prolonged, excessive crying is hypothesized to have an appreciable impact on the mother and the mother-infant relationship. Lester (1984) found that certain acoustical qualities of the cry predicted the synchronicity in mother-infant interaction when the
<table>
<thead>
<tr>
<th>VARIABLES POTENTIALLY RELATED TO COLIC</th>
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<tbody>
<tr>
<td><strong>SLEEP DISTURBANCES</strong></td>
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<tr>
<td>Christopherson (1981)</td>
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<td>Humphry (1985)</td>
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<td>Taubman (1984)</td>
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<tr>
<td>Stahlberg (1984)</td>
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<td>Weissbluth et al. (1984)</td>
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<tr>
<td><strong>TEMPERAMENT</strong></td>
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<tr>
<td>Carey (1968) (1972)</td>
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<tr>
<td>Chess &amp; Thomas (1983)</td>
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<tr>
<td>Pinyerd (1987)</td>
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<tr>
<td>Weissbluth (1984)</td>
</tr>
<tr>
<td><strong>BEHAVIOR</strong></td>
</tr>
<tr>
<td>Chess &amp; Thomas (1983)</td>
</tr>
<tr>
<td>Ironside (1975)</td>
</tr>
<tr>
<td>Menahem (1978)</td>
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<tr>
<td>Pinyerd (1987)</td>
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<tr>
<td><strong>DEVELOPMENT</strong></td>
</tr>
<tr>
<td>Thompson et al. (1986)</td>
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<tr>
<td>Mazaide et al. (1987)</td>
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<td>Jones (1985)</td>
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<td><strong>ALLERGY</strong></td>
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<tr>
<td>Ironside (1975)</td>
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<td>Pinyerd (1987)</td>
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<tr>
<td><strong>IRRITABLE BOWEL SYNDROME</strong></td>
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<tr>
<td>Davidson &amp; Wasserman (1966)</td>
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<td>Jorup (1952)</td>
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<tr>
<td><strong>CONSTIPATION</strong></td>
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<tr>
<td>Davidson et al. (1963)</td>
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<tr>
<td><strong>RECURRENT ABDOMINAL PAIN</strong></td>
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<tr>
<td>Lebenthal (1980)</td>
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<tr>
<td><strong>SUDDEN INFANT DEATH SYNDROME</strong></td>
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<tr>
<td>Weissbluth (1981)</td>
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<tr>
<td><strong>CHILD ABUSE</strong></td>
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<tr>
<td>Caffey, 1974</td>
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<tr>
<td>Frodi, 1985</td>
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<tr>
<td>Frodi &amp; Lamb, 1980a, 1980b</td>
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<td>Humke &amp; Demro, 1979</td>
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<td>Johnson &amp; Morse, 1968</td>
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<td>Menahem, 1979</td>
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<td>Murray, 1979</td>
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<td>Schmitt, 1985</td>
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<td>Weston, 1968</td>
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infant was not colicky. This observation lends support to the hypothesis that the cry of the infant is a specific communication in the "typical" mother-infant dyad and exerts an influence on their interaction, resulting in a disrupted dyad.

Humphry's and Hock's (1989) research has suggested that mothers of colicky infants have less opportunity to interact with their infants given the increased proportion of time spent in the cry state as opposed to the quiet/awake state. Field (1982) has found that some mothers of difficult infants tend to work harder at feeding their infants than mothers of quiet infants in that they exaggerate their responses to them, caress them more, and even poke at them. Field has suggested that the mother, in trying too hard, may be overlooking the infant's signal ("gaze aversion") to disengage or break from the interaction. Shaw (1977) found that mothers of 9-14 month old infants who had previous histories of excessive crying behavior produced fewer high quality responses to their infant's overtures. Similarly, Oberklaid (1979) has contended a "mismatch" in mother-infant interaction and Menahem (1979) has cautioned that the "major problem" with a colicky infant is the mother-infant interaction and their disturbed bonding. The only other study that examined maternal behavior towards her colicky infant within context of feeding (Wikander & Wahlberg, 1987) reported that among the colicky dyads there was a "tendency of a disturbed feeding rhythm." In particular, maternal smiles and laughs towards the baby was less frequent in the mothers of colicky infant. Similarly, infants with
coli may also contribute to synchrony disruption by virtue of their inability to give clear cues to caregivers. Humphry (1985) found that infants with colic tended to spend more time looking away from the mother during a 5-minute "play observation" when compared to control infants, yet her results suggest that the clarity of the cues between the two groups were no different. Shaw (1977) reported that 9-14 month-old infants who had cried excessively as newborns looked at, smiled at, and vocalized to their mothers significantly less than did the babies of the control group during a 30-minute play session. Similarly, Wikander & Wahlberg (1987) reported that colicky infants showed "dissatisfaction more frequently" during a feeding session than did the noncolicky infants.

Clinical research has shown that an objectively trivial medical problem (such as colic is commonly perceived) can be such a stress for the postpartum mother that her behavior towards the infant changes and ultimately effects the child's development (Kennel & Rolnick, 1960; Solnit & Provence, 1979). For example, a mother may conclude that the use of forceps for delivery made her "instrument baby" somehow different and less than normal (Carey, 1977).

The strain caused by the crying situation may be so intense that parents, many years later, can still vividly describe the crying episodes (Castiglia, 1987). Mothers of infants who cry excessively become depressed (Brazelton, 1962; Smith, 1981), exhausted (Jones, 1983; Menahem, 1978), angry (Waldman & Sarsgard, 1983) and resentful (Swaffield, 1984). Thompson et al. (1986) characterize the mother's
response to the crying infant as "parent colic", a biopsychological response characterized by crying, fatigue, guilt, depression, and resentment of the infant. Maternal response has been conceptualized to emerge as the three core experiences: emotive, cognitive, and affiliative, a combination of which influences overall coping ability of the mother (Keefe & Froese-Fretz, submitted).

Donovan (1981) proposed that a mother who has "learned" that her response to the crying of her infant is ineffective may develop patterns of interaction that fail to optimize the development of the infant. Maternal perception that responses are ineffective in controlling infant crying is consistent with the major tenet of the "learned helplessness" theory (Seligman, 1975). From what is known in terms of learned helplessness theory, one can hypothesize that maternal feelings of ineffectiveness and perceived loss of control provide the link between infant inconsolable crying and altered parent-infant relationship. The first time mother confronted with a colicky infant attempts one intervention after another, none of which will terminate the crying for any extended period of time. While at some point the infant does stop crying (if due to sheer exhaustion only), the mother perceives that termination is unrelated to her behavior. From this, one can hypothesize that the mother has, in effect, "learned" that nothing she did made a difference, that is she could not control the cry. Learned helplessness theory predicts that the mother exhibits motivational, cognitive, and emotional deficits, all indicators of the learned helplessness syndrome, which ultimately
are disruptive in her ongoing interaction and relationship with the infant. On a more positive note, mothers of colicky infants were found to hold stronger beliefs that their role as primary caregiver was essential to their infants' well-being (Humphry & Hock, 1989).

Several investigations have been conducted on infant crying and maternal stress and helplessness. Morsbach and colleagues (Morsbach, McCulloch & Clark, 1986) examined whether infant crying had a deteriorating effect on the concentration level of 45 mothers of infants below 12 months. The results supported the hypothesis that infant crying reduces performance more than a non-human noxious sound of equal volume level. Two other studies have looked at the relationship between infant crying and maternal ability (or inability) to escape the crying under experimental conditions. Both were conducted in laboratory settings, had small sample sizes, (Donovan & Leavitt, 1985; Kevill & Kirkland, 1979) and entailed a limited exposure to the aversive stimulus (i.e. tape recording of an infant cry). One included a sample of non-mothers (Kevill & Kirkland, 1979). These investigations have suggested that "inescapable" infant crying could result in maternal behavioral deficits.

Crockenberg (1982), a psychologist, is one of the leaders in mother-infant interaction research and its relationship to infant irritability. Based on research with 56 mother-infant pairs, Crockenberg concluded that: 1) neonatal fussing and crying is associated with unresponsive maternal attitudes and behavior, 2)
maternal parity and attitudes predict maternal-infant contact, and 3) by three months of age, antecedent maternal and infant characteristics contribute significantly to the prediction of observed mother behavior. Earlier, Crockenberg (1981) reported that the adequacy of the mother's social support seemed to be associated secure mother-infant attachment, particularly with irritable infants and their mothers.

While Crockenberg's findings suggest that excessive crying may negatively influence infant development, there is some evidence that the nature of the cry will elicit maternal behaviors that could optimize the infant's development. Karelitz, Fisichelli, Costa et al. (1964) found that the amount of newborn cry activity from an elicited pain cry was positively correlated with high Cattell scale scores at 15-20 months and higher Stanford-Binet IQ scores at three years. Mazaide and colleagues (Mazaide et al., 1987) also found that "difficult" infants had higher IQ's at four years than did "easy" infants. While these appear to be opposing findings, they may reflect threshold effects of maternal response to crying. Crying that is excessive, but consolable, will evoke from the mother an initial empathetic response. However, crying that is excessive and inconsolable could deplete her energies, ultimately overtaxing her ability to maintain this empathic response.

There are only a few reported investigations that have examined specific response patterns of adult listeners in response to infant crying. Worobey, Laub, and Schilmoeller (1983) conducted a
descriptive investigation on the relationship between infant irritability and parental use of soothing techniques. Twenty-four parents of infants approximately five days-old were recruited through birth announcements in a local newspaper. The investigators constructed a checklist-type of instrument (the "Parent Soothing Code") in which nine parental soothing responses were recorded. Utilizing an interval time sampling approach (Sackett, 1979), parental soothing behaviors were recorded until either the infant stopped crying or five minutes had elapsed. Inter-rater reliability was obtained on four of the 24 visits and was reported to be .82 with a range of .62 to .99 across observations. The most common types of behaviors employed were broadly labeled "auditory", "holding", and "position shift." Furthermore, contrary to expectations, tremulous infants did not appear to be restrained more and cuddlier infants were not held more. In fact, the more irritable infants were held and rocked more \((p < .05)\) than were the less irritable infants. Again, these findings must be interpreted with caution given the small size and the heterogeneous nature of the sample, two limitations that could disguise true differences between mothers and fathers.

Wilkie and Ames (1986) interviewed mothers and fathers of 30 firstborn, Caucasian infants who were between 40 and 60 days old to examine the relationship between gender and infant behavior on parental transition to parenthood. Findings suggested that the amount of infant crying was related to parental feelings of depression, particularly for mothers who evaluated the baby and
parenthood itself lower on the respective semantic differential scales. Mothers appeared to cope with the crying infants without having negative feelings about themselves or their spouses. Fathers, on the other hand, did not tend to make more negative judgements of their infants but rather experienced more anxiety, feelings of powerlessness, and negative feelings about themselves and changes in their life-styles than did mothers. This study, although limited given sample bias and the psychometric properties of the instruments, does provide the scientific community with beginning data on how parents who are confronted with infant crying on a daily basis are affected from a psychological standpoint.

Various authors have contended that the colicky experience also affects the emotional and physical development of the infant. Shaver (1979) reported that colicky infants were more irritable, tense, and displayed poorer feeding adjustment than the non-colicky infants at age 4 months (after the colic had ended), and concluded that the problem of colic contributed to a lower overall evaluation of functioning of the infant at age 6 months. In later childhood the once-colicky child has been described as an individual who has a high strung nervous drive (Holmes, 1969), is aggressive, is enthusiastic, and "runs everything in school" (Meyer, 1958). Meyer (1958) believed that these innate temperamental differences persist and Stahlberg (1984) stated that colic is primarily an expression of constitution or sensitivity that lasts into later life. Although colicky babies have been described as being especially delightful toddlers
(Karofsky, 1984), they may continue to sleep restlessly (Stahlberg, 1984), have shorter daily sleep durations, and have an increased frequency of night awakenings (Weissbluth, Davis & Poncher, 1984; Wessel et al, 1954).

Thompson and colleagues (Thompson et al., 1986) reported that parents and health care professionals perceived the once-colicky child as "more intelligent" and accomplishing major developmental tasks at an earlier age than normal. Infants with colic were also later perceived by their parents as being "special" or "exceptional". The infant's "specialness" resulted in the parent experiencing either an increased closeness to the infant after the colic had ended or an alienation from the infant due to the stress of the experience.

From a physical perspective, McGee (1950) contended that the once-colicky child is frequently absent from school due to recurrent head colds and digestive-type disturbances. Wessel et al. (1954) found that colicky babies had more upper respiratory infections, skin rashes, and avoidable accidents than the noncolicky babies. Other studies also support the notion that infants who are more difficult or more active tend to have higher accident rates (Carey, 1972; Matheny, Brown & Wilson, 1971). Farran (1983) has contended that a history of allergy seems to occur often in the families of colicky infants and Pinyerd (1987) found an increased incidence of allergic symptoms in once colicky children at five and 11 years of age as compared to never colicky children of the same age. Conversely, other authors (Illingworth, 1954; Paradise, 1966; Wessel et al.,
1954) have contended that allergies have no direct relationship to infantile colic either as a cause or a sequelae.

Gastrointestinal problems have been physical consequences associated with infantile colic. Jorup (1952) wrote that 40% of infants with colic later had diarrhea or pains of spastic colon. Davidson and colleagues (Davidson, Kugler & Bauer, 1963) also report a high incidence of a history of colic in 119 children between the ages of birth to 10 they evaluated for constipation. Lebenthal (1980) suggests that children with recurrent abdominal pain have past histories of colic in infancy, but in a 13 year follow-up study of 30 infants with colic, only one had recurrent abdominal pain in later childhood (Joseph & Lupu, 1984).

Colicky infants also appear to gain weight more rapidly than other infants (Taylor, 1957). This finding is consistent with the contention made by parents of colicky infants that these children have increased appetites as compared to their non-colicky siblings and their perception that their once colicky children are more obese than non-colicky children (Farran, 1983; Pinyerd, 1987). The "fussy" infant may be fed more frequently in an attempt to terminate the crying (Wessel et al, 1954) and hence gain more weight (Carey, 1985).

The stress of colic (Darbyshire, 1985; Humphry & Hock, 1989; Schmitt, 1981) may result in the most serious consequence: child abuse (Bakin, 1956; Green, Gaines & Sandgrund, 1974; Menahem, 1978; Schmitt, 1985). Johnson and Morse (1968) have reported that the child most likely to be abused was either overly active or the most
difficult to care for. Excessive crying was given as the reason for the abuse by the parents of 80 percent of battered infants less than one year (Weston, 1968). Detailed analysis of two case reports involving battered infants demonstrated colic to be the event eliciting parent aggression (Menahem, 1979). Caffey (1974) reported that 90% of subdural hematomas from shaking were triggered by colic or other crying in the older infant. Kirkland (1979) has suggested that if the crying itself does not trigger abuse, the inability to quiet the infant may elicit such behavior.

STATE OF NURSING KNOWLEDGE

The phenomenon of infant crying is of interest to scholars across many different disciplines, each choosing to view and investigate the phenomenon from its own perspective. Most scholars have contended that what makes nursing science and its body of knowledge different or unique from other disciplines is its "perspective" rather than its methods or subjects. A perspective not only defines the nature and limits of inquiry into phenomena but it offers unique ways of viewing the world (Donaldson & Crowley, 1978). Phenomena seen from a nursing perspective are not seen in exactly the same way as phenomena seen from a sociological or psychological or medical perspective. A nursing perspective is focused on health, comfort, care, and other domain concepts. The focus of nursing is on the responses of the individual to health and illness as the person interacts with an ever-changing environment (American Nurses'
Association, 1980). Nursing acts are implemented to promote the individual's health and to facilitate the person's growth toward his/her potential within the environment. Therefore, in nursing, one describes or explains a phenomenon from a "whole picture" perspective.
CHAPTER III

METHODOLOGY

Farran (1983) has asserted that "colic could be thought of as a naturally occurring 'experiment' that has been virtually ignored by social scientists" (page xiv). Unfortunately, there is no way to provoke or simulate a colic spell in the laboratory. Furthermore, controlled experiments are difficult because no infant's colic is exactly the same from day to day. Most of the empirical work has been either descriptive or correlational, and the results are often conflicting. The few experimental studies that have been conducted have focused on identifying a physiological basis for the excessive crying, such as cow's milk allergy (Adams & Davidson, 1987; Taubman, 1988), neurological immaturity (Oberklaid, Prior, Colvan, et al., 1984), gut hormone excess (Lothe et al., 1987), or melena deficiency (Kagen, personal communication, 1988). Research is virtually nonexistent relative to: 1) the cognitions of parents in coping with the day-to-day realities of parenthood, especially parenting an infant that is resistant to soothing, 2) the impact of the incessant crying on early mother-infant interaction, and 3) the later growth, development, and health status of these irritable infants. Boukydis
(1985) has asserted that what is now needed is observational designs that take into account quantitative and qualitative differences in the sound pattern of infant's cries while observing the mother-infant interaction, as is being reported in this investigation. In doing so, the recording of individual infants' cries and analyzing cry features will give a more independent, more detailed measure of what it is about the crying that mothers are responding to during an observed interaction. This chapter presents a discussion of the methods: design, population and subject selection, procedures, instrumentation and data analysis.

RESEARCH DESIGN

A cross-sectional, descriptive, correlational design with case-control comparisons was used to address the research questions. The independent variable, infant colic, was a non-manipulable variable.

The "posttest" or the outcome variable was the caregiving environment, operationalized as the summary scores derived from the Nursing Child Assessment Feeding Scale (NCAFS) (Barnard, 1978b), the Home Observation for Measurement of the Environment (HOME) (Caldwell & Bradley, 1984), the Feetham Family Functioning Survey (FFFS) (Roberts & Feetham, 1982), and the Family Apgar (Smilkstein, 1978).

The subjects in the "case" (colic) group consisted of mother-infant dyads where the infant had colic. The subjects in the comparison group consisted of mother-infant dyads where the infant
was not experiencing colic. Significance of this work relates to: 1) multiple operationalization of the infant cry (recognizing that no one method is error-free), 2) multiple operationalization of the mother-infant relationship, and 3) naturalistic setting for collection of outcome data. Similar studies have been conducted in laboratory or clinical settings, many on nonmothers, who listen to cries of infants who are unknown to them. This study examined maternal response and reaction to "own infant" crying in the home environment.

The investigator conducted a pilot study that examined the feasibility of the methods and procedures planned for the dissertation. A total of six dyads (3 colic and 3 control) participated in the pilot. Problems identified included: original take-home diary too confusing, infants enrolled "colicky" at baseline reverted to "noncolicky" over the next 10 days (which makes one wonder if there is some aspect of the study that was an intervention), cry tape recordings secured in the home were of poor quality, checklist to determine case group eligibility was difficult to administer, some words on several of the instruments were not understood, and there were fewer infants available than originally estimated. As such, the following changes were incorporated into this dissertation: the take-home diary was revised, there was more strict adherence to the colic checklist entry criteria, the cry tapes were obtained in the Clinical Study Center (CSC) at baseline, there was modification of several items on the study specific instruments.
to aid in comprehension, and three pediatric group practices were added to supplement hospital recruitment. The pilot study demonstrated that 1) mothers can and will comply with the heavy demands of the protocol (only one out of the six did not complete the study), and 2) the incentive of a 2-week diaper supply was sufficient.

POPULATION AND SUBJECT SELECTION

The population of interest was naturally occurring pairs of mothers and infants perceived by their mothers to cry excessively. The target (universal) population was defined as all mothers and their infants who cried excessively. The accessible population were those mother-infant dyads who: 1) received well-child and ill-child care at Columbus Children’s Hospital (CCH), 2) received primary care from one of the collaborating physicians, or 3) telephoned into the study site after an article about the study appeared in the city newspaper. This population was chosen primarily for three reasons: 1) the subjects were accessible to the investigator, 2) the pilot revealed that subject enrollment would be difficult if recruitment was limited to CCH, and 3) the geographical base from which the subjects were drawn would require minimal travel time with respect to the planned home visits. The obvious sample bias will limit future generalizability but was felt to be appropriate given the exploratory nature of the investigation.
Subsequent to enrollment, all case infants had to meet the following entry criteria:

1. Infant's mean daily fuss/cry time is two or more hours per day as per maternal-maintained diary
2. Infant between 36 and 42 weeks gestation
3. Infant normal growth and development
4. Infant without known chronic illness/disability
5. Infant without acute illness at time of recruitment
6. Infant without history of vomiting
7. Mother between 20 and 40 years of age
8. Mother reads and writes English
9. Mother provides verbal and written consent
10. Mother is primary caregiver

These criteria were selected to control for rival explanations that could confound the hypotheses under investigation, and to provide some homogeneity within the sample. Young maternal age, infant medical illness, prematurity, or developmental delay could all confound the results.

Mother-colicky infant dyads were recruited until complete data sets were secured on 12 dyads. This sample size was sufficient for a "trial" run (Polit & Hungler, 1987) when data collection, reduction, and descriptive analysis strategies are designed to generate hypotheses for future studies. Complete data sets on 12 control mother-infant dyads also were obtained. All control infants were recruited through CCH clinics and via word-of-mouth. Control infants were defined as those infants whose crying time was within the norms of less than two hours per day established by Brazelton (1962). This value is consistent with the previous diary-conducted studies of others (Humphry, 1985; Hunziker & Barr, 1986; Taubman, 1984; Wikander
& Wahlberg, 1987). Mean minutes of crying per day were computed from the activity records of all control infants as a method of validating control group classification. If any infants were found to be misclassified in that their crying exceeded a mean of two hours per day, they were not included in the final analysis.

Control and colic dyads were recruited over a five-month period (January through May 1991). Originally the classification of dyads was to be treated as coded information, known to the principal investigator but not to the home visitor. However, group membership quickly became apparent given the state differences between the two groups of infants. Also, many mothers would comment to the home visitor in the interview about their infant's crying patterns. As will be discussed later, an additional rater was recruited who was masked to group membership.

The general matching strategy was to select the control dyads who matched the case dyads on the following variables: maternal education (± 2 years), maternal parity, marital status, infant age (± 2 weeks), and infant gender. Each control infant was enrolled subsequent to a colicky infant enrollment when these variables were found to be near parallel. The variable of gender was important because of the data demonstrating that male infants tend to be more irritable, less consolable, and more likely to evoke vigilant behavior from the mother (Korner, 1974; Moss, 1974). Level of maternal education has been associated with infantile colic (Stahlberg, 1984) and is generally accepted as a predictor of later
IQ and language (Bee, Barnard, Eyres et al., 1982). Parity could confound outcomes given the differences in caregiving experience associated with having other children.

HUMAN SUBJECTS CONCERNS

In the pilot study, the investigator shared the nature and procedures of this study with current mothers of colicky infants as suggested by Damrosch and Lenz (1984). The intent of this client-advisory strategy was: 1) to heighten the probability that the research effort would be a beginning attempt towards reaching the needs and concerns of the target population, 2) that the procedures were not overly intensive in terms of time demands, and 3) that the content and language of the study instruments were relevant, appropriate, and acceptable. Based on feedback from pilot mothers, relevant changes in procedures and instruments were incorporated into the proposed study.

The protocol was reviewed by Children's Hospital Institutional Review Board and The Ohio State University Behavioral Science Human Subject's Review Board prior to implementation (Appendix A). The consent form (Appendix B) provided information for the mothers regarding the nature of study procedures, what was being requested of her and her infant, and an estimate of the time involved with her participation. Additionally, the infant was acknowledged as being a vulnerable subject. However, given the potential benefits of the study in terms of the knowledge generated, the benefits outweighed
the minimal maternal psychological risks associated with her participation.

PROCEDURES

Prior to subject enrollment, the research assistant who conducted the home visit was trained by the principal investigator on study procedures. Recruitment of subjects involved multiple strategies. Nursing and medical staff of CCH ambulatory areas were informed of the purpose, procedures, and inclusion criteria of the study. Signs and brochures (Appendix C) were posted in all outpatient areas as a reminder and a $5.00 "finder's fee" was offered for identification of mother-infant dyads who were successfully recruited. Evening and week-end emergency room records were reviewed for infants seen and discharged with a diagnosis of "colic." Mothers of infants found to meet the study entry criteria were telephoned and invited to participate. Finally, an article on "colic" that appeared in the local newspaper following an interview with the investigator also resulted in the enrollment of several mother-infant dyads.

Potential mother-infant dyads who met the inclusion criteria were approached by a study recruiter for possible participation. Mothers who express interest were escorted by the recruiter to the Clinical Study Center (CSC) to meet the principal investigator who secured verbal and written informed consent. Telephone consent from mothers recruited through the Emergency Room or via the newspaper article was obtained. The baseline visit with the principle
investigator was identical to hospital-recruited dyads. All mothers were scheduled, interviewed, and tested individually.

Once consent was secured and all questions were answered, mothers listened to a series of three tape-recorded infant cries in a sound proof room. Infants were cared for in another room. Mothers were instructed on completing the activity record and were provided with enough records for eight days.

Next, each infant was physically examined and observed to make a determination of case/control enrollment. During the exam, a cry recording was obtained while the mother completed the data forms on infant behavior, maternal psychosocial characteristics, and family background variables. After the physical examination, the mother was interviewed on perceptions of cry quantity, colic-specific behaviors displayed by the infant, consoling techniques attempted, and maternal coping strategies.

Approximately seven days later (± 3 days) the research assistant conducted a home visit. First, the activity record was examined for completeness. Next, as the assistant set up the video and audio equipment, she instructed the mother on completing the SCLR-90 and the FFFS. After the mother has finished, the assistant then videotaped the maternal-infant interaction during a feeding session. The HOME (Caldwell & Bradley, 1984) was administered through a combination of interview and observation. It too was videotaped. Finally, maternal perception of cry quality was determined by having all mothers listen to a series of three tape-
recorded cries, one of which included the cry of her own infant that was secured at baseline. In an attempt to blind the mothers to this change from baseline procedures, the other two cry stimuli were recorded on separate audiotapes so that they could be removed from the recorder after each test. Again, the order of the stimuli were fixed so that in every case each mother's own infant cry was last. Both the NCAFS and the HOME were scored within seven days by the home visitor.

To enhance subject cooperation and reduce attrition, control mothers who complied with study procedures and who completed the study received a two week supply of diapers. Mothers of colicky infants also received a one-week loan of a Sleep Tight® "anti-colic" device if they so desired. Sleep Tight® is a medical device that attaches to the crib that simulates the motion and sound of a car ride. It was tested in a NIH-funded, Ohio State University-based clinical trial (Loadman et al., 1986) and is advertised as being 96 percent effective in reducing excessive crying. It was not offered to mothers of colicky infants until all data had been collected.

Approximately 3-4 weeks after baseline, case mothers were telephoned and questioned regarding current health status of the infant, effectiveness of Sleep Tight® device, and extent of colic resolution. This verified that case infants were not later found to be acutely or chronically ill.
INSTRUMENTATION

A strategy called "methodological triangulation" (Denzin, 1970), in which several different methods of data collection are used to measure one complex construct, was employed to measure the infant cry and the dependent variable, mother-infant relationship. Such a multimeasure approach is one means of diminishing systematic error, and is an appropriate approach to employ whenever: 1) one is studying one concept that contains many dimensions (Jick, 1979), 2) two or more different methods are available for use to measure one construct, and 3) it is possible to administer all instruments to every subject at the same point in time (Waltz, Strickland & Lenz, 1985). Mitchell (1986) has contended that use of multiple methods of data collection assists in tapping the various dimensions of a construct in addition to generating a rich and comprehensive picture of the phenomenon under study. The basic premise of this strategy, as originally conceptualized by Campbell and Fiske (1959), is that trait variance (which is what the investigator seeks to capture) can be separated from method variance, so that the end result will be that the different methods of measuring the same construct will correlate highly with one another.

In this investigation the correlations between the variables of mother-infant relationship and cry characteristics (acoustics, quantity, and maternal perception of cry quality) were obtained using different methods (trait variance) and the correlations between the measurement methods (observation, self-report, technological) across
traits were also ascertained (method variance). Table 4 lists the major variables and how they were operationalized.

MEASURES

Demographic Data Form. This form was designed specifically for the study to collect demographic, social, and physical data. The form (Appendix D) has four subsections: I Family, II Mother, III Father and IV Infant. The mother completed the form at baseline while the infant was being examined. Subsequent to pilot testing, several modifications were made on the form to aid in comprehension of some items.

Baseline Behavior. This form (Appendix E) was designed for the study to collect biological and behavioral information on the infant. The tool had four subsections: Feeding (10 items), Sleeping (7 items), Crying (15 items), and Soothing techniques attempted (17 items). Pilot testing verified that mothers understood most of the items; modifications were made on items that were consistently unclear. Again, the mother completed the form at baseline while the infant was examined.

Profile of Mood States (POMS) (McNair, Lorr & Droppleman, 1981). The POMS (see Appendix F) is a 65-item five-point adjective rating scale which assesses six common mood factors; tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. The measure was developed by a repeated factor analytic method and has demonstrated
internal reliability (.90) and retest reliability (.65 to .74) (McNair et al, 1981). The POMS has been found to have significant correlation with the Feetham Family Functioning Survey (FFFS); correlations ranged from .43 to .60. The tool was completed by mothers at baseline to obtain a measure of global psychological functioning.

Symptom Checklist-90 (SCLR-90) (Derogatis, Rickels & Rock, 1976). The SCLR-90 (see Appendix G) is a 90-item, self-report inventory of psychological functioning which requires approximately 15-20 minutes to complete. Each of the 90 items is rated on a five-point scale of distress (0 to 4 where 0 represents "not at all" and 4 reflects "extreme"). Resulting data include three indices of global distress (Global Severity Index, Positive Symptom Distress Index, and Positive Symptom Total) and nine primary symptom factors (Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism). Studies of the internal consistency (.77 to .90), factorial invariance, test-retest reliability (.78 to .90), content validity, and construct validity of the SCL-90R have demonstrated the psychometric acceptability of this instrument (Derogatis, 1983). The multidimensional nature of the SCL-90R makes it well-suited for use in screening individuals for global psychological functioning. The inclusion of the SCLR-90 in the present study as a second measure of psychological functioning was for the purpose of identifying group differences in global psychological distress.
### TABLE 4: OPERATIONALIZATION OF STUDY VARIABLES

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>OPERATIONALIZATION</th>
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<tbody>
<tr>
<td>Maternal cry perception</td>
<td>Rating Scale Judgement (Green et al., 1987)</td>
</tr>
<tr>
<td>Maternal psychosocial characteristics</td>
<td>Profile of Mood States (McNair et al., 1981)</td>
</tr>
<tr>
<td></td>
<td>SCLR-90 (Derogatis et al., 1976)</td>
</tr>
<tr>
<td></td>
<td>Demographic data form</td>
</tr>
<tr>
<td>Infant biobehavioral characteristics</td>
<td>Infant Behavior Form</td>
</tr>
<tr>
<td>Infant cry quantity</td>
<td>Activity Record</td>
</tr>
<tr>
<td>Presence/absence of colic</td>
<td>Symptom Checklist</td>
</tr>
<tr>
<td>Caregiving environment</td>
<td>Nursing Child Assessment Feeding Scale (NCAFS) (Barnard, 1978b)</td>
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<tr>
<td></td>
<td>H.O.M.E. (Caldwell &amp; Bradley, 1984)</td>
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<tr>
<td></td>
<td>Feetham Family Functioning Survey (Roberts &amp; Feetham, 1982)</td>
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<td></td>
<td>Family APGAR (Smilkstein, 1977)</td>
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Rating Scale Judgements (Green et al., 1987). The Rating Scale Judgement (RSJ) (Appendix H) measured the evaluative dimension of the infant cry quality as perceived by the mother. Mothers rated each of the three different cries on two occasions (day 1 and day 8-10) on 29 different 7-point attribute scales. The purpose of these cry perception studies were: 1) to examine the impact of maternal perception of cry quality on her behavior, that is caregiving environment, and 2) to examine the relationship between maternal perception of cry quality (subjective evaluation) to the more objective acoustical analyses of their own infant cry as well as to her behavior towards the infant.

The significance of this information to the general study aim related to the anecdotal evidence suggesting that infant crying may serve as a final spark triggering an abusive outburst by a caretaker (Frodi, Humke & Demro, 1979; Murray, 1979). Infant cries are aversive and arousing and mothers who have extended experience with "atypical" infants exhibit an exaggerated response pattern to aversive infant stimuli (Frodi, 1985). While recognizing that child abuse is a multifaceted problem, Frodi and Lamb (1980a,b) have demonstrated that abusive mothers were significantly more annoyed by, and less sympathetic toward, the crying infant than were nonabusive mothers. Furthermore, the cry elicited greater increases in heart rate and skin conductance but smaller increase in blood pressure. It follows then that mothers may have differing "built-in" degrees of
aversion to infant crying that may in part influence their caregiving behavior.

In order to standardize the stimuli, each mother listened to three different cries: "hunger," "colic," and "pain" (as defined by the eliciting stimuli). The three cries were chosen from a larger pool of eight cries that were provided by Dr. Barry Lester (of Boston University) and have been used in his cry perception studies. Each of the cries were from a different infant and each differed on measures of fundamental frequency and number of cry episodes. The average duration of each cry was 20 seconds. The test tapes were played to the mothers at a constant volume in a sound-proof room (away from the infant) in a fixed order. After each cry stimulus, mothers were given five minutes to rate the cry on 29 different 7-point attribute scales. They were also given the opportunity to listen to the cry again if they desired. The entire procedures took approximately 15 minutes. Since the first cry was included in the set as a practice, only cries 7 and 8 were used in the analysis.

The 29 different attributes on the RSJ cover a wide range of psychological responses. Green et al. (1987) chose the items from a compilation of items used in past research that made up four logical sets. The first 10 of the attributes are called the aversiveness judgement. Eight of these 10 attributes were originally by Zeskind and Lester (1978) and have been since used extensively in cry perception studies across diverse populations of listeners.
(Biological & Social Aspects, 1989). The 8 items are how urgent, grating, sick, arousing, distressing, discomforting, piercing, and aversive the cry sounds. Two other attributes that appear closely related to these 8, that have been used by Boukydis and Burgess (1982) and by Lounsbury and Bates (1982) and by Green et al. (1987) are included in the set: how irritating and how spoiled the cry sounded.

Because of the potential link between affective responses to cries and child abuse (Frodi, 1985), three affective items were also included. Mothers were asked to rate how angry, alarmed, and frustrated they felt in response to the cry. These items came from a pool of items studied by Russell (1980).

Items from the semantic differential (Osgood, Suci & Tannenbaum, 1957) have been used successfully to differentiate among cries (Brennan & Kirkland, 1982). The semantic differential was developed to explore dimensions of means of concepts related to objects, ideas, situations, and people (Osgood et al, 1957). Osgood et al. (1957) defined measuring the meaning of a concept as rating a concept against a group of bipolar adjective scales. Each scale provides a set of given alternatives (usually seven). The direction and distance of the individual's response to the set of scales can then be used as an index of the quality and intensity of meaning the individual places on the concept. Studies of overall reliability and validity of the SD model have provided a favorable evaluation of its
performance (Heise, 1970). It requires a short amount of time to complete and provides a general assessment of the mother's perception in an uncomplicated approach. In the present study, nine items were chosen from the semantic differential: three from the evaluation scale (pleasant/unpleasant, nice/awful, good/bad), three from the potency scale (rugged/delicate, hard/soft, heavy/light), and three from the activity scale (active/passive, fast/slow, sharp/dull). To score, unfavorable poles are scored a "1" and favorable poles are scored a "7". The final score is computed by summing all 8 adjective pairs; higher scores reflect a more favorable attitude towards the infant's crying and lower scores reflect an unfavorable attitude.

Next because mothers in the study had differing amounts of caregiving experience, seven items of caregiving behavior were rated by the mothers. These items asked mothers how likely they think they would be to feed, play a game with, rock or walk with, change diapers, give a pacifier to, check to see if baby in pain, and put the baby to bed. Again, similar items have been used by Lounsbury and Bates (1982), Boukydis and Burgess (1982) and Green et al., (1987).

Only Green et al. (1987) reported any test-retest reliability across repeated presentations of 10 cry pairs using the RSJ. For the 44 subjects, Pearson Product correlations ranged from .29 to .94 (median=.82) for the second and third representations of the cries.
For data averaged within subject groups, the reliability was higher; for example, mothers were .99.

**Acoustical Analysis of Cries.** The cry recordings provided a more objective measure via acoustical analysis of what exactly the cry sounds like to the mother. To ensure uniform cry recordings, a "fuss" (in the control group) and a "colicky" (in the case group) cry were recorded at baseline during the physical examination of the infant. In three of the control infants and in one of the case infants, the cry recordings were secured in the home when the infant did not cry spontaneously at the baseline visit. All infants were in a non-hungry state (no greater than two hours after last feed) and every attempt was made to secure a "spontaneous" cry, defined as a cry sound that can be elicited without a specific stimulus, such as hunger or pain. Infants were supine in a crib and the tape recorder was placed approximately 10 cm away from their mouths. Between 15- to 30-seconds of one continuous cry episode was secured from all infants.

Acoustical cry data were obtained by having the cry samples analyzed by the Lester-Golub computer signal-processing method (Golub, 1980; Golub & Corwin, 1985; Lester, 1984), as previously described. Copies of the original cry tapes were analyzed by Dr. Lester at 10 kHz by a high-speed computer (PDP 11/73) after being filtered at 5kHz. All episodes of crying that lasted 15 seconds were divided into cry units. The cry unit was defined as the sound that results during the passage of air past the vocal cords during a
single expiratory/inspiratory cycle. Expiratory cry units of at least .5 sec duration were used for the extraction of acoustic features. The Fast Fourier Transform (FFT) was used to estimate the log magnitude spectrum for each 25 msec block of crying. Measures of the fundamental frequency (fo), first formant (F1) and amplitude were computed for each 25 msec block. From the data analyzed in 25 msec blocks, three summary cry variables were derived. Respiratory effort was measured by the number, energy, and duration of cry utterances and relates to autonomic function. Laryngeal activity was measured by the average and variability of the fundamental frequency (fo) and was determined by neural input to the intrinsic muscles of the larynx. Upper vocal tract activity was measured by formant frequencies and is determined in part by neural control of the cross-sectional area of the airways. As such, the plan was to compute 11 summary variables.

Activity Record. Despite the acknowledged potential for over- and under-reporting, most current knowledge about infant crying beyond the newborn period has come from diary studies. While it is self-evident that parents cannot produce a detailed record of infant crying, they are capable of recording crying clusters and therefore provide useful measures of general crying characteristics (Barr, personal communication, 1987).

The paper and pencil instrument used in this study, the Activity Record, was a revision of a diary developed and validated by Barr (Barr et al, 1988) which incorporates some features of the
Nursing Child Assessment Sleep Activity Record (NCASAR) (Barnard, 1978a). Barr compared parental diary recordings of crying and fussing with electronically-recorded crying during a 24-hour period in 10 mother-infant pairs. Moderately strong product-moment correlations were obtained between duration of diary-recorded crying and "negative" (fuss and/or cry) vocalizations (r = .65, p < .05) and between frequency of crying/fussing episodes and clusters of negative vocalizations (r = .71, p < .05). If one poorly completed diary recording was eliminated, the strength of recording methods for these measures improved further to .89 and .85, respectively. The Barr (1982) diary which incorporates fifteen-minute recording segments, is somewhat cumbersome to complete given that the parent is to record something every minute of every day. The Barnard (1978a) NCASAR, broken down into one hour segments, is easier for mothers to maintain since: 1) she is requested to record only those behaviors that are being investigated (i.e. feeding, sleeping, fussing, crying), and 2) she is not to record her behavioral response to the crying as is requested on the Barr diary. In addition, the diary has been used extensively in the NCAST program and has been found to be applicable in clinical settings (Barnard, 1978).

The two-page-per-day activity record (see Appendix I) was in booklet format and included space for eight twenty-four hour days of data. The right side of the booklet is a blank page for notes, as was suggested by several of the mothers in the pilot. On the left side is the actual incremental ruler markings. Beginning at noon,
each hour is broken down into 15-minute increments and resembles the markings of a ruler. Specific symbols were devised for the mother to record three infant behaviors in order that she not be totally focused on amount and duration of crying. The dependent measures of infant behavior derived from the AR's were: 1) cry duration (hours per day, hours per week, and number of days per week of greater than 3 hours of crying/day), 2) frequency (episodes per day), 3) time of day when most of crying occurred (AM or PM), 4) fussing duration (hours per day, hours per week), 5) combined cry and fuss total (per day, mean per week), 6) sleeping (total hours of sleeping per day), and 7) feeding (episodes per day). Mothers were requested to keep diaries for a total of seven days. While Lester's experience (personal communication, 1987) with two longitudinal studies suggests that mothers of noncolicky infants do not object to 12 weeks of diary recording, it was discovered in the pilot that extensive diary maintenance is a problem for mothers of colicky infants. Therefore, a relatively aggressive incentive program to motivate the mothers was incorporated. Mothers were reimbursed for travel expenses to the CSC and they also received a 2-week supply of diapers.

This daily activity record has the strength of being a simplified version of a diary that has been validated with 24-hour tape-recordings (Barr et al, 1988). Never-the-less, there may be some variation between the actual number of minutes of crying for a group of infants and the number of minutes of crying recorded using 15-minute time divisions. However, this potential difference was
present for both control and case infants and hence did not interfere with group assignment or interpretation. Furthermore, future research in this area will require similar diary measurement as opposed to actual 24-hour recordings as a function of the logistics, cost, and time impositions associated with constant audio recording.

The AR was maintained exclusively by the mother for the next seven days. In two cases, diaries were maintained by maternal grandmothers for up to three hours on a given day. All mothers had a minimum of five complete diary days.

Colic Symptom Checklist. The CSC/R (see Appendix J) is an adaption of Lester's CSC and was completed at baseline through a combination of maternal interview and infant examination. The checklist was originally designed to distinguish between infants who cry more than normal from infants who are colicky, and was employed as such in this investigation. The impetus behind its creation is based on the hypothesis that colic is not only associated with excessive crying, but includes other criteria such as signs of paroxysmal onset of the colic episode, physical signs associated with hypertonic, high pitched pain cry, and poor soothability. Once it was determined via interview that the infant cried excessively, the mother was interviewed and the infant examined to determine which if any of the other four behaviors the infant exhibited. The decision rule for concluding that the infant was "colicky" did not require that the infant exhibit all four of the clinical symptoms; a minimum of two had to be present. This is because Lester and colleagues
believe that colic is not a "type," but rather a "syndrome." As a syndrome, which is defined as patterns of behavior, individual infants may have one or more of the accompanying behaviors, which would be termed a "mixed syndrome." This checklist has not been used outside of the work of Lester and colleagues. Therefore, it was included in this investigation as a beginning examination of its psychometric properties.

Semi-Structured Interview Guide. The interview guide (Appendix K) was designed for this study to generate qualitative data on parenting the colicky infant as an additional hypothesis-generating strategy. Included on the guide are questions on soothing techniques, characteristics of the cry sound, and sources of support. The interview lasted between 15 and 30 minutes, depending on maternal desire to share. It was administered simultaneously with the interview portion of the CSC/R.

Nursing Child Feeding Assessment Scale (Barnard, 1978b). This scale (Appendix L) consists of the observation of a mother feeding her infant (birth to 12 months). The feeding is chosen as the interaction setting for the observation because: 1) it is an activity which can be observed either in the home or the laboratory, 2) the mother's behavior during a feeding serves as a model to the mother's overall behavior toward the infant (Brody, 1976), 3) it consists of an easily identifiable unit that has a beginning and an end, and 4) it is the one type of interaction that begins the first day of life and continues throughout the first year.
The scale consists of 73 binary (yes/no) items in six subscales. These subscales are divided into four mother scales (sensitivity to infant, response to distress, cognitive growth fostering behavior and social emotional growth fostering behavior) and two infant scales (clarity of cues and responsiveness to caregiver). These subscales allow for the summary of mother's behavior, infant's behavior and a total score of the feeding interaction.

Normative data collected on approximately 800 mother-infant dyads was recently reported (Barnard et al., 1989). Findings of significance to the present study: 1) mothers with more education tended to have higher total parent scores, 2) young infants tended to receive somewhat lower scores, 3) infant scores tended to increase with age, and 4) infant and maternal scores were lower when the mothers were unmarried. Internal consistency alpha on the NCAFS (n = 630) across subscales ranged from .56 to .83, with the total score alpha being the highest at .86, suggesting that the entire set of items on the scale is tapping a basic dimension of behavior. As such, it is likely that the total score provides a more reliable basis for comparing groups. Test-retest reliability information on 30 dyads was respectively high for the total parent score (.75) and lower for the total infant score (.51) for the NCAFS.

Several studies have included sources of validity for the instrument. The total feeding scale score correlates with the Total HOME Inventory Score at .54; parent total subscore correlates at .48;
and child total subscore correlates at .48 (Barnard et al., 1989). The NCAFS parent subscale score correlates significantly with the Bayley Mental Development Index at three months of age ($r = .28$) for a sample of 116 infants (Barnard et al., 1989). Predictive and construct validity of the NCAFS have also been demonstrated.

In this study a prerequisite of the assistant(s) was that s/he be NCAST (Barnard, 1978a) certified. Interrater reliability on the NCAFS (observation) and the HOME (observation/interview) was assessed following training with the investigator present (overt assessment) using videotapes of mother-infant feeding interactions obtained. The assistant attained 85 percent agreement with the investigator on the NCAFS and 90 percent agreement with the investigator on the HOME (Barnard, 1978a) prior to conducting the first home visit. The research assistant videotaped all home visits and was told that reliability determinations would be obtained by the investigator on each mother-infant observation and interview. Such covert reliability assessment was included to reduce interrater reliability decline that has been documented in similar studies (Topf, 1988). In actuality, reliability checks were only made on a random selection of five (20 percent) observations.

Home Observation for Measurement of the Environment (HOME) (Caldwell, 1970). The HOME (Appendix M) is designed to examine aspects of the childrearing environment from birth to three years that support social, emotional, and cognitive development. The tool offers a way of determining both the positive and negative aspects of
the environment and how these meet the needs of the child. This instrument was selected for use based on the premise that the cry may modify the caregiving environment (Lester, 1984). Furthermore, the HOME aids in tapping the richness of the interaction. With the NCAF the certain constraints are placed on the interaction given the specific nature of the task (feeding) the mother is requested to perform. The HOME is administered by a person who goes into the home at a time when the child is awake. All but two of the HOME's items can be directly observed or ascertained during the course of a visit by encouraging the mother to talk freely about her baby and the baby's "routines." The entire procedure generally takes about an hour including scoring of the tool.

The HOME yields subscores for each of six subscales and a total score. The six subscales are: 1) emotional and verbal responsivity of mother, 2) avoidance of restriction and punishment, 3) organization of physical and temporal environment, 4) provision of appropriate play materials, 5) maternal involvement with child, and 6) opportunities for variety in daily stimulation. Internal consistency was computed using Kuder-Richardson Formula 20. The reliability for the total score is .89 for 174 subjects. Pearson's Product Moment (PMM) coefficient between 6 and 12 months was .62 (N = 174). Pearson's PM coefficient for 6 versus 24 months was .64 (N = 91) and for 12 versus 24 was .77 (N = 91) (Bradley & Caldwell, 1974).

All HOME assessments were conducted by one research assistant who was specially trained to administer the HOME and 90% interrater
reliability was established using procedures described in the HOME manual (Caldwell, 1970). While the HOME is more applicable for the child six months of age and older, this study incorporated home visits on infants two to seven weeks of age. As such, summary scores across the sample were expected to be lower than published standard scores given the inclusion of items that were inappropriate for young infants.

Feetham Family Functioning Survey (Roberts & Feetham, 1982). The FFFS (Appendix N) measures three major areas of family functioning: 1) the relationships between the family and the broader social units including the family and community and family and economy, 2) the relationships between the family and subsystems, and 3) the relationships between the family and each individual (Roberts & Feetham, 1982). The tool can be completed by either parent but is not suitable for single-parent families where the parent has no one assuming a spouse role. Single mothers who participated in the study did not complete the FFFS. One advantage of the FFFS is the ability to measure change in family functioning over time. Test-retest reliability and Cronbach alpha reliability has been reported as .85 and .81, respectively. The correlation coefficient of $r = -.54$ between the FFFS and the Family Functioning Index (FFI) is evidence of concurrent validity. The instrument consists of 21 items and takes approximately 10 minutes to complete. A discrepant score is calculated for each family based on "what is" as compared to what "should be". Scores closest to 0 indicate the greatest degree of
satisfaction and those farthest from 0 indicate that family functioning is not satisfactory. The FFFS has a significant positive correlations with the POMS ranging from .43 to .60 (Roberts & Feetham, 1982; Thomas & Barnard, 1985). The FFFS has also been significantly correlated with the mother’s score on the NCATS ($r = -.83$, $p < .05$).

**Family Apgar** (Smilkstein, 1978). The Family Apgar (Appendix 0) is a five-item questionnaire based on the premise that a family member’s perception of family function could be assessed by scoring that member’s report of satisfaction with five parameters of family function: adaptation, partnership, growth, affection, and resolve (commitment). Respondents are asked to score from 1 (never) to 5 (always) on items such as, "I am satisfied with the way my family and I share time together." The Family APGAR has shown positive correlation with: school, performance and behavior (Chen, Hsu, Hsu & Lin, 1980 and adaptation to parenthood (Lobo, 1982). Negative correlations have been found with depression (McNabb, 1983) and delivery and postpartum complications (Smilkstein, Helsper-Lucas, Ashworth, et al., 1984; Reeb, Graham, Zyanski & Kilson, in press). Chronbach’s Alpha is reported to be .86 with a 5-point Likert scale and test-retest reliability at .83. The 5-point Apgar was included as a measure of family functioning in dyads where a father figure was absent.
DATA ANALYSIS PLANS

A codebook was developed for management of the data. Each item within each instrument was specified within a data definition guide. The data definition guide included the number of columns needed for each variable, the variable names, the variable labels, source of the variable, valid range, missing values classification, and a column for comments. All data was entered into D-BASE III data files on an IBM PC and later downloaded to C.R.I.S.P. for analysis.

Key comparisons for this correlational, two group study focused on various mother-infant behaviors in interaction, maternal psychosocial characteristics, and infant biobehavioral data between the two groups. Mother-infant interaction was assessed via interview and observation of a feeding session. Questionnaires (the FFFS and the Family APGAR) were used as secondary variables. For maternal psychosocial characteristics, the POMS and the SCLR-90 were used as primary variables. For infant biobehavioral data, seven-day diary records of sleep, fuss, cry, and feeding patterns were used as primary variables. Number of formula changes and unscheduled visits to the Emergency Room or primary physician were considered as secondary variables.

An alpha level of .05 was used as the criteria to ascertain if there were statistically significant group differences. The null hypothesis of no difference between groups was used with chi-square and t-test statistics.
The two study groups were assessed for comparability at birth using race, gestational age, birth problems, 1- and 5-minute APGAR scores and birth anthropoemetrics. The two groups were assessed for success of matching of baseline variables using infant age, gender, maternal education and maternal parity. Other variables that were assessed for comparability at baseline included maternal age, paternal age, socioeconomic status (SES), annual income and feeding method.

Race, gender, gestational age, maternal and paternal education, religious preference, annual income, and feeding method are categorical variables that were analyzed using chi-square. Birth APGAR scores, birth anthropoemetrics, and SES are numerical values that were analyzed using Student's t-test for independent samples. The primary (NCAFS, HOME) and secondary (FFFS, Family APGAR) caregiving measures and the primary (POMS, SCLR-90) and secondary (CCRS, NPI) maternal psychosocial variables are all interval data that were analyzed using Student's t-test for independent samples.

Infant sleep, fuss, cry, and feeding measures were collected over seven days, beginning the day after enrollment. Again, these were analyzed using Student's t-test for independent samples. Secondary variables of doctor visits, formula changes, clarity of cues, and clarity of responses were similarly analyzed.

The colic group was further described with respect to onset age, resolution age and medications attempted.
Chapter IV
DATA ANALYSIS AND RESULTS

This chapter presents the data analysis and discussion in four sections. The first section summarizes subject enrollment with respect to recruitment method, the second is a description of the sample, and the third section addresses the research questions. The final section is a discussion of the findings.

Mother-infant dyads were recruited via multiple methods: physician referral, advertisements, recruiter solicitation, and word of mouth. Table 5 summarizes the number of case dyads with respect to recruitment method.

TABLE 5
RECRUITMENT METHODS: CASE DYADS WHO WERE CONTACTED VERSUS DYADS WHO COMPLETED THE STUDY

<table>
<thead>
<tr>
<th>Recruitment Method</th>
<th>Contacted</th>
<th>Completed</th>
<th>% of Contacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruiter</td>
<td>32</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>Word of mouth</td>
<td>14</td>
<td>9</td>
<td>64</td>
</tr>
<tr>
<td>Advertisement</td>
<td>12</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Referral</td>
<td>6</td>
<td>2</td>
<td>33</td>
</tr>
</tbody>
</table>
Of the 64 case mother-infant dyads screened, 34 were enrolled. The largest number of dyads screened (n = 32, 50%) were contacted by a paid recruiter at a cost of over $1500.00. Specifically, the recruiter searched the emergency room and clinic medical records, schedule books, and waiting rooms to identify potential participants. She then either telephoned them or met them in person, explained the study, and invited them to participate. Of the contacted mothers, none refused consent and only one case mother withdrew from the study due to exhaustion and inability to maintain the diary. Five colic dyads were not approached for enrollment after screening revealed they did not meet the entry criteria. Further, 12 dyads who were initially enrolled in the colic group failed to cry a minimum of two hours per day for at least five days. Ten (31%) mothers who were contacted by a paid recruiter completed the study.

Mothers who initiated the first contact after hearing about the study via word-of-mouth (n = 14, 22%) were most likely to complete the study. Four colic dyads and five control dyads who completed the study (64%) were enrolled via this mechanism.

Few dyads were referred to the study via other health professionals (n = 6, 9%) despite intensive efforts to solicit participation. Of the six referred dyads, only two (33%) completed the study. The others were not enrolled due to either extreme infant age (i.e. 16 weeks) or lengthy distance from the hospital.

Two of 12 contacted dyads (both colic) completed the study after an article about the study appeared in a local newspaper (17%).
Overall, considering dollar cost and success rate, recruitment by a paid recruiter and advertisement were the most successful recruitment strategies.

Control dyads were recruited for the study either via word-of-mouth ($n = 6$) or by a paid recruiter ($n = 6$). No controls who were approached for study participation declined consent.

DESCRIPTION OF THE SAMPLE

The data were obtained from interviews, physical examinations, responses to questionnaires, home visit observations, telephone interviews, and diaries. Subjects were enrolled over a 5-month period (January through May 1991). The sample consisted of 12 colic ("case") mother-infant dyads and 12 control mother-infant dyads. For a dyad to be considered a "case," the mother-infant dyad had to meet all of the following criteria: maternal subjective impression of "excessive crying," diary data of at least two hours of infant fuss/crying per day for at least five of seven days, infant reported to have a high pitched, pain-sounding cry sound, maternal report of infant inconsolability, and physical symptoms indicative of hyper-tonia. Further, onset of colic symptoms had to be within the first six weeks of life and the infant had to be without acute or chronic illness.

Each control mother-infant dyad was enrolled subsequent to a colicky mother-infant dyad enrollment when the following variables were found to be near parallel: maternal education ($\pm 2$ years),
maternal parity, infant age (± 2 weeks), marital status, and infant
gender. All control infants daily crying via diary was less than two
hours per day, and none of the control infants’ daily cry quantity
exceeded a mean of two hours per day.

Table 6 depicts demographic data of the sample. Nine (75%) of
the colic group mothers were married, two (17%) were single, and one
(8%) was divorced. Of the control mothers, ten (83%) were married
and two (17%) were single. A married control mother-infant dyad was
matched with the divorced colic mother-infant dyad when the former
related that her husband had been serving in the Desert Storm since
before the birth of the baby (he returned home two days before the
home visit). All of the infants with colic and their mothers were
caucasian. Eight of the control mothers were caucasian and four were
black.

Religious preference for colic group dyads was eight
Protestant, two Catholic and two none. Of control families, three
were Protestant, three were Catholic, three were none, and three were
other (Baptist and nondenominational Christian). Ten (83%) of the
colic group dyads and nine (75%) of the control dyads lived in
houses; two (8%) of the colic dyads and three (25%) of the control
dyads lived in apartments. Two colic group single mothers and one
control single mother lived with their infants in the home of the
maternal grandparents. All mothers reported being the primary
caregivers.
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
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<tr>
<td><strong>MARITAL STATUS</strong></td>
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<tr>
<td>Married</td>
<td>9</td>
<td>75</td>
<td>10</td>
<td>83.3</td>
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<tr>
<td>Never married</td>
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<td>17</td>
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<td>16.7</td>
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<td>Divorced</td>
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<td>0</td>
<td>0</td>
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<td><strong>ETHNIC GROUP</strong></td>
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<tr>
<td>Caucasian</td>
<td>12</td>
<td>100</td>
<td>8</td>
<td>67</td>
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<tr>
<td>Black</td>
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<tr>
<td>Protestant</td>
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<td>66</td>
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<td>Catholic</td>
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<td>25</td>
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<tr>
<td>None</td>
<td>2</td>
<td>17</td>
<td>3</td>
<td>25</td>
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<tr>
<td>Other</td>
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<td>0</td>
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<td><strong>RESIDENCE</strong></td>
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<tr>
<td>House</td>
<td>10</td>
<td>83</td>
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<td>17</td>
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<td>$5000 - $9999</td>
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<td>2</td>
<td>17</td>
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<td>0</td>
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<td>34</td>
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<td>3</td>
<td>25</td>
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<td>Over $50,000</td>
<td>4</td>
<td>33</td>
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<tr>
<td><strong>PATERNAL EDUCATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; High school</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>High school degree</td>
<td>5</td>
<td>42</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Associate degree</td>
<td>3</td>
<td>25</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Bachelors' degree</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Master's degree</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Professional degree</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The family income reported by the mothers was different across the two groups. In general, colic families ($n = 10$, 83%) tended to have incomes of at least $30,000$, whereas only five (42%) control families had incomes of $30,000$ or more. More colic families (33%) had incomes over $50,000$, as opposed to only one (8%) of the control families. Sample selection bias may explain this difference; case and control group mothers were recruited via diverse mechanisms. For example, several case mothers were recruited after they read an article about the study in a local newspaper, whereas most control infants were recruited from the clinic population. In short, the observed income discrepancy may be more a function of sampling artifact than of real group differences. Future prospective studies could better address the relationship between colic and socioeconomic variables.

Maternal education varied from less than high school to earned Bachelor's degree and was similar between the two groups (as was expected because of matching). All of the mothers, except for one in each group, had earned a high school diploma. In the colic group, two mothers had earned an associate degree and two had earned a baccalaureate degree. In the control group, four mothers had earned a baccalaureate degree. Paternal education was similar between the two groups; six of the colic and control group fathers had high school degrees or equivalent. Three of the colic group fathers had Associate degrees or equivalent as compared to two of the control fathers. In the colic group, one father had a Bachelor's degree, one
had a Master's degree, and one was a physician. In the control group, three fathers had Bachelor's degrees, and one had a Master's degree (Table 6).

Table 7 summarizes maternal age, paternal age, and Hollingshead scores. There were no statistically significant differences between the groups. The mothers in the colic group ranged in age from 18 to 35 years with a mean of 25.2 (SD = 5.3) years. The mothers in the control group had a mean age of 24.5 (SD = 4.3) years with a range of 18 to 30 years ($t_{[21]} = .34, p = .74$). Fathers were similar in age ($t_{[17]} = -.20, p = .85$), with those in the colic group ranging from 22 to 33 years with an average of 27.5 years (SD = 3.5). Fathers in the control group ranged in age from 20 to 43 with an average of 27.9 years (SD = 6.5). There were no differences between the two groups in terms of socioeconomic status on the Hollingshead four-factor scale ($t_{[22]} = -.32, p = .75$). The mean score for the colic group

| TABLE 7 |
| DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE |

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
<th>t*</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERNAL AGE</td>
<td>25.2 5.3</td>
<td>24.5 4.3</td>
<td>0.34</td>
<td>0.7</td>
</tr>
<tr>
<td>PATERNAL AGE</td>
<td>27.5 3.5</td>
<td>27.9 6.5</td>
<td>-0.20</td>
<td>0.8</td>
</tr>
<tr>
<td>HOLLINGSHEAD</td>
<td>40.5 12.8</td>
<td>42.2 12.8</td>
<td>-0.32</td>
<td>0.7</td>
</tr>
</tbody>
</table>

* independent, two-tailed
was 40.5 (SD = 12.8, range = 22-66) and the mean score for the control group was 42.2 (SD = 12.8, range = 27-66). For nine mothers in each group, the infant subject was the firstborn. In both groups the older siblings were under age seven years.

The planning of the pregnancies and the gender preferences are depicted in Table 8. Six (50%) of the colic and three (25%) of the control group mothers reported that they had made a definite decision to get pregnant. Four (34%) colic group mothers and six (50%) control group mothers said they decided not to use contraceptives and "let it happen." Two (16%) mothers in the colic group reported that they were not using contraceptives and did not expect a pregnancy, as compared to one (8%) control mother. Two mothers (17%) in the control group reported they had undergone infertility treatment to conceive the study infant.

Seven (58%) of the control group mothers had no preference as to the gender of the baby, as opposed to only one (8%) colic group mother choose this category. Conversely, six (50%) of the mothers in the colic group reported that they had "wanted" a certain gender, whereas no control group mothers reported likewise. Equal number of mothers in both groups (n = 5) reported "preferring" one gender over another (Table 8). To assess the relationship between maternal gender preference and gender of baby, correlations were computed. In the colic group (r = -.03, p = .94) and in the control group (r = .43, p = .16) the correlation between gender preference and gender of baby was nonsignificant.
TABLE 8
COMPARISON OF GROUPS IN REGARD TO PLANNED PREGNANCY AND GENDER PREFERENCE

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>PREGNANCY PLANNING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definite decision</td>
<td>6</td>
<td>50</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>&quot;Let it happen&quot;</td>
<td>4</td>
<td>34</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>On contraceptives</td>
<td>2</td>
<td>16</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Infertility txs</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>PREFERENCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wanted boy</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Preferred boy</td>
<td>5</td>
<td>42</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>8</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Wanted girl</td>
<td>5</td>
<td>42</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Preferred girl</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>17</td>
</tr>
</tbody>
</table>

CHARACTERISTICS OF THE COLIC GROUP

Table 9 presents characteristics of the colic group, which consisted of 12 mother-infant dyads. Maternal perception of cry onset ranged from less than half a week to four and a half weeks of age, with a mean of 2.3 weeks. For those infants whose colic had resolved at the time of data analysis \((n = 11)\), the mean age was 12.1 weeks \((SD = 6.2, \text{range} = 6-28)\). The number of times infant formula was changed ranged from 0 to five with a mean of 1.5 \((SD = 1.6)\). Nine \((75\%)\) of the colic group mothers had initially breastfed; of these, only two were still breastfeeding at study entry.
TABLE 9
CRY CHARACTERISTICS OF THE COLIC GROUP INFANTS: Cry Onset, Cry Resolution, Formula Changes
(n = 12)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRY ONSET (weeks)</td>
<td>12</td>
<td>2.3</td>
<td>1.4</td>
<td>0.5-4.5</td>
</tr>
<tr>
<td>CRY RESOLUTION (weeks)</td>
<td>11*</td>
<td>12.1</td>
<td>6.2</td>
<td>6.0-28.0</td>
</tr>
<tr>
<td>FORMULA CHANGES</td>
<td>12</td>
<td>1.5</td>
<td>1.6</td>
<td>0-5</td>
</tr>
</tbody>
</table>

*one not resolved at 16 weeks

Six of the mothers (50%) reported that their infants' crying was erratic in that there was no one time each day when crying was more likely to occur (Table 10). Five of the colic infants cried more in the evening hours, and one mother reported that her infant cried more in the morning. Two mothers described how their infants' crying had changed from originally being erratic in nature to an every evening pattern.

Mothers reported the use of a variety of techniques to console their infants, but were asked to rate the two strategies that "worked best." Quick to point out that nothing worked consistently, most mothers (50%) reported some success with walking the infant, followed by a car ride (42%), and use of a pacifier (42%). Strategies reported by the mother as being least effective were stroller rides,
TABLE 10
CRY CHARACTERISTICS OF THE COLIC GROUP INFANTS: Time of day, Consolation, Medications, Maternal Theory
(n = 12)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIME OF DAY EPISODES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usually A.M.</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Usually P.M.</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>No pattern</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td><strong>CONSOLATION TECHNIQUES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Car</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Pacifier</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Rock</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Swing</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Hold</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Bounce</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td><strong>MEDICATIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mylicon®</td>
<td>9</td>
<td>75</td>
</tr>
<tr>
<td>Choral Hydrate®</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Phenobarbital®</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td><strong>MOM'S THEORY OF CAUSE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas/pain</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Bored</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>&quot;Me&quot;</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Overstimulation</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Neurological</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

*more than one response
clothes dryer, running the vacuum cleaner, massaging the infant's back, holding the infant in the "colic hold" (holding the infant prone over one's arm or lap), and having some sort of noise in the background.

Ten of the infants were on medication for the crying at study entry. The most common medication used was Mylicon®/Simethicone® (n = 9). Two of the infants were also receiving Chloral Hydrate®. Other medications were Cimetidine®, Benadryl®, Paragoric®, and Phenobarbital®. Mothers expressed various degrees of hesitation with respect to medicating their infants. Comments included, "I hate to do this but I don't know what else to do . . .", "I need to get some rest", and "I have no choice but to sedate her." Theories given by the mothers as to what was the "cause" of the colic included gas/gastrointestinal pain (n = 5), boredom (n = 2), "me" (n = 2), overstimulation (n = 1), and a neurological problem (n = 1).

Comments made related to boredom included, "she's a child's brain inside an infant's body," and "his mind is ahead of his body; he wants to do things he can't do yet." Mothers generally went into a lengthy defense of their positions; one insightful mother replied that colic was "a complex problem without one cause." Four of the mothers had been told by their pediatricians that their babies' colic was a reflection of the mothers' "nerves;" one mother's response to this statement was to call the physician one evening after a lengthy
crying spell and have him hear over the phone what a colic spell sounded like. His response was that since the cry sounded like a pain cry, the mother should immediately take the infant to the local emergency room. Another physician could offer no advice to the mother since "we really don't believe in it because it isn't well defined." Most mothers (n = 9, 75%) were discouraged with the care they had received from their primary physicians.

In addition to maternal report of excessive infant crying, colic infants were also evaluated with respect to physical symptoms generally associated with hypertonia, three cry characteristics typically associated with colic, and degree of infant consolability. These behaviors were included in the present study given the operational definition of colic being more than simply excessive crying (Forsyth, 1985). From this perspective, colic is viewed as a distinct syndrome that includes excessive crying in its presentation along with the potential for three other patterns of behavior (Lester, in press). The colic-associated behavioral patterns exhibited by the colic infants are summarized in Table 11.

Eleven of 12 mothers of colicky infants reported that their infants cried at least three hours per day. Diary data for the one infant whose mom reported that he cried less than three hours per day revealed that he fussed and/or cried on the average two and three-fourths hours per day. This infant was included as a "case" since he met all the inclusion criteria.
TABLE 11

BEHAVIORS EXHIBITED BY THE COLIC GROUP INFANTS

(n = 12)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCESSIVE CRYING</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>PHYSICAL SYMPTOMS*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hands/fists clenched</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>Elbows flexed</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>Increased motor activity</td>
<td>10</td>
<td>91</td>
</tr>
<tr>
<td>Face flushed</td>
<td>10</td>
<td>91</td>
</tr>
<tr>
<td>Legs drawn up</td>
<td>9</td>
<td>82</td>
</tr>
<tr>
<td>Arm muscles hypertonic</td>
<td>9</td>
<td>82</td>
</tr>
<tr>
<td>Tense abdomen</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Leg muscles hypertonic</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Back arched</td>
<td>6</td>
<td>55</td>
</tr>
<tr>
<td>Breath holding</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>Feet cold/mottled</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>Increased bowel sounds</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Circumoral pallor</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>CRY CHARACTERISTICS*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain sounding</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>Paroxysmal onset</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>High pitched</td>
<td>10</td>
<td>83</td>
</tr>
<tr>
<td>CONSOLABILITY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficult</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>Easy</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

* more than one response

During the physical examination, all of the infants exhibited clenching of the hands and fists and flexion of the elbows. Ten (91%) of the infants exhibited increased motor activity and flushing of the face and nine infants (82%) drew their legs up and displayed
hypertonicity in the arms. Over half of the infants also exhibited a tense abdomen and hypertonicity of the legs. Behaviors that were exhibited least often were circumoral pallor (n = 1), increased bowel sounds (n = 2), breath holding (n = 3), and cold/mottled feet (n = 3).

The cry of all the infants with colic sounded like the infant was in pain, and 11 (91%) of the cries were characterized as being of sudden ("paroxysmal") onset. Ten (83%) of the cries were high pitched. Of the two that were not high pitched, one infant exhibited a hoarse-sounding cry and the other exhibited a muffled cry due to esophageal atresia. Eleven (91%) of the infants were observed to be difficult to console at the baseline visit. At the three week follow-up phone call, only one infant had been diagnosed with an acute illness (i.e. reflux). Five of the eight infants (50%) who had tried the Sleep Tight® device reported that it reduced daily crying.

DATA ANALYSIS FOR RESEARCH QUESTIONS

The data analysis is organized in regard to the research questions. Specific strategies for data analysis are discussed with each research question. An alpha level of .05 was used in all hypothesis testing. Davis' (1971) correlation conventions were used to describe the magnitude of computed correlations.

QUESTION 1: DO COLIC/CONTROL MOTHERS DIFFER IN CORRELATION OF SUBJECTIVE AND OBJECTIVE MEASURES OF CRY QUANTITY AND QUALITY?
Data from several sources were used to address this question. These sources included: baseline maternal perception of average 24 hour cry quantity via questionnaire, maternal diary recordings of infant fuss/cry quantity averaged over seven days, maternal cry quality ("badness") ratings (semantic differential) of a standard pain cry, and maternal ratings of cry quality "badness" (semantic differential) of "own" infant cry sound. The intercorrelations among these measures are presented in Table 12.

It was expected that there would be significant intercorrelations among a majority of the cry measures and that colic and control group mothers' correlations of the cry variables would not differ.

### Table 12

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. QUANTITY / subjective*</td>
<td>.82**</td>
<td>.25</td>
<td>.58*</td>
</tr>
<tr>
<td>2. QUANTITY / objectiveb</td>
<td>.34</td>
<td>.61*</td>
<td></td>
</tr>
<tr>
<td>3. QUALITY / pain cry SD</td>
<td></td>
<td></td>
<td>.05</td>
</tr>
<tr>
<td>4. QUALITY / own cry SD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* total 24 hour crying via questionnaire  
  b mean fuss and cry quantity via 7-day diary  
  *p = .005, two-tailed, **p = .0001, two-tailed
There was a very strong positive correlation between maternal subjective impression of infant cry quantity and infant fuss/cry quantity via maternal-maintained diary ($r = .82, p = .0001$). If the mother reported little or excessive infant crying at baseline, the subsequent 7 days of diary data verified that observation. There was also a significant correlation ($r = .44, p = .03$) between subjective estimation and objective diary data on the number of episodes of crying per day (not depicted in Table). In addition, there was a substantial correlation ($r = .58, p = .005$) between maternal report of infant cry quantity and maternal perception of own infant cry quality "badness;" the more the infant cried, the higher was the "badness" score on the semantic differential. Maternal perception of the standard pain cry was unrelated to both the subjective ($r = .25, p = .23$) and objective ($r = .34, p = .12$) measures of cry quantity. Further, there was no relationship ($r = .05, p = .83$) between maternal perception of the "badness" of the standard pain cry and the "badness" of her own infant's cry. In other words, mothers who rated their own infants' cry as sounding "bad" did not rate the standard cry as more aversiveness.

Table 13 presents the same intercorrelations divided according to colic versus control subgroups. It had been hypothesized that colic and control group mothers would not differ with respect to correlation across the cry measures. The inverse correlation between perception of pain cry and perception of own infants' cry was similar between the groups [$r = -.34$/colic ($p = .30$) and $r = -.51$/control]
TABLE 13
INTERCORRELATIONS AMONG SUBJECTIVE AND
OBJECTIVE CRY MEASURES OF THE TWO STUDY GROUPS

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. QUANTITY / QUESTIONNAIRE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td>.74**</td>
<td>.26</td>
<td>-.20</td>
</tr>
<tr>
<td>Control</td>
<td>-.11</td>
<td>-.61*</td>
<td>.00</td>
</tr>
<tr>
<td>2. QUANTITY / DIARY</td>
<td></td>
<td>.62*</td>
<td>-.30*</td>
</tr>
<tr>
<td>Colic</td>
<td>.21</td>
<td>.47</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. QUALITY - PAIN CRY</td>
<td></td>
<td></td>
<td>-.34</td>
</tr>
<tr>
<td>Colic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td>-.51***</td>
</tr>
<tr>
<td>4. QUALITY - OWN CRY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05, two-tailed
**p < .01, two-tailed
***p < .001, two-tailed

(\(p = .16\)); however, the correlations were not significant. Maternal perception of own infant cry "badness" was not significantly correlated to maternal estimation of cry quantity \(r = -.20/\text{colic and } r = .00/\text{control}\) or to infant cry quantity via diary \(r = -.30/\text{colic (p = .34) and } r = .47/\text{control (p = .17)}\). The colic group mothers differed from the mothers in the control group on degree of correlation between impression of cry quantity and cry quantity via diary \(r = .74/\text{colic (p = .006) and } r = -.11/\text{control (p = .73)}\).
suggesting that mothers of infants who cry excessively are better estimators of how much their infants cry than are mothers of infants who cry very little. Control group mothers whose infants hardly ever cried tended to be poorer estimators of quantity, but this correlation was not significant. For the colic group mothers only there was a significant correlation between how much their infant cried (quantity) via diary data and the "badness" quality of the pain cry ($r = .62$/colic, $p = .04$); the same correlation was not significant for control group mothers. This finding suggests that within the colic group, mothers of infants who cry more perceive the cry as more "bad"; within the control group this relationship does not hold.

In summary, since three of the six intercorrelations were substantial, the first question was partially supported. Mothers of colic infants differed from mothers of control infants on several correlations across the cry measures, suggesting that having a colicky infant does effect how mothers perceive a cry sound as well as their subjective impression of their own infant's cry quantity.

**QUESTION 2: DO COLIC/CONTROL MOTHERS DIFFER IN PSYCHOSOCIAL CHARACTERISTICS?**

Maternal prenatal, labor, and delivery variables were examined to address this question (Table 14). It was hypothesized that there would be differences between the two groups in terms of general
psychological well-being, with colic group mothers exhibiting more distress than mothers in the control group.

To test these hypotheses, analysis of the data entailed several steps. First, means and standard deviations of all psychosocial instruments were computed; differences between means were analyzed by use of Student's t test for independent groups. As discussed previously, colic dyads were "matched" with control dyads on four variables that were believed to be highly correlated with the dependent measure (maternal caregiving): maternal age, maternal parity, infant age and infant gender. The matching strategy employed in this descriptive study paralleled a stratified sampling plan one would employ in an experimental study, both undertaken to ensure fairly homogenous groups for comparison. In no way were the dyads related to one another; they did not refer one another, nor did they have any contact with each other. Independence was further implied when correlations of the scores of the paired dyads revealed low, nonsignificant correlations. Both paired and unpaired t-tests were computed on six comparisons as a further means of verifying independence; the same conclusions regarding hypotheses were reached regardless of the type of t-test. For the most part, the low correlation between matched dyads resulted in paired t-tests produced lower p values. Given this information, the investigator elected to conduct independent t-test in all hypothesis testing.

When variances were not homogeneous, a t-test for separate variances was computed; these t values are reported when appropriate.
Means were considered to be significantly different from one another if the p value was less than or equal to .05 (two-tailed). Power analysis ($a = .05$) is reported when means are different from one another but not significant at $p<.15$. When there were significant group differences in mean scores, magnitude scaling via point biserial correlations ($r_{pb}$) and Greek omega squared was performed to estimate the degree of difference between groups (Burns & Groves, 1987). The point biserial correlation ($r_{pb}$), the correlation of choice when one variable is dichotomous (i.e. group) and the other is interval (Glass & Stanley, 1970), illustrates the extent of the relationship between the group to which a colic dyad belongs and the dependent variable that the case exhibits (Hays, 1988, p.311). Omega squared estimates the proportion of variance accounted for in this particular sample. As such, it represents the strength of association between the independent and dependent variables (Hays, 1988).

A majority of the mothers in both groups reported at least some childcare experience; nine (75%) colic group mothers and 12 (100%) control group mothers. However, three (25%) colic mothers reported no experience with children prior to the study infants' birth. Three mothers (25%) in the colic group gained over 50 pounds as compared to one (8%) mother in the control group. Otherwise, there were no significant differences in pregnancy weight gain across the two groups. Reporting of cigarette smoking was also similar across the two groups, with five (42%) of the colic and four (33%) of the


<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
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<tr>
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<tr>
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<tr>
<td>Alot</td>
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<td>50</td>
</tr>
<tr>
<td>WEIGHT GAIN</td>
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<td></td>
</tr>
<tr>
<td>1-9</td>
<td>1</td>
<td>8.3</td>
</tr>
<tr>
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<td>25</td>
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<td>30-39</td>
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<td>25</td>
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<td>42</td>
</tr>
<tr>
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<td>58</td>
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<tr>
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<tr>
<td>Some</td>
<td>4</td>
<td>33.3</td>
</tr>
<tr>
<td>Daily</td>
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<tr>
<td>Epidural</td>
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<td>83</td>
</tr>
<tr>
<td>Other</td>
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</tr>
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</table>

control group mothers smoking during the pregnancy of the study infant. The majority of mothers of colic (n = 11, 92%) and all of
control group reported some sickness during their pregnancy. Only one colic mother reported having any problems during her pregnancy. Seven (58%) of colic and 10 (83%) of control group mothers reported having labor induced. A majority of mothers in both groups reported having some medication for pain relief during labor, the most common being epidural anesthesia.

Maternal perceptions of their delivery experience and how their infant compared to the "average infant" were also examined (Table 15). On a scale of 1 (least desirable) to 5 (most desirable), the

<table>
<thead>
<tr>
<th>TABLE 15</th>
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</thead>
</table>

MATERNAL PERCEPTIONS OF COLIC AND CONTROL GROUP INFANTS

<table>
<thead>
<tr>
<th>VARIABLE</th>
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<th>COLIC SD</th>
<th>CONTROL M</th>
<th>CONTROL SD</th>
<th>t</th>
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</thead>
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<tr>
<td>DELIVERY</td>
<td>2.3</td>
<td>1.3</td>
<td>2.1</td>
<td>1.2</td>
<td>0.33</td>
</tr>
<tr>
<td>AVERAGE INFANT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crying</td>
<td>3.0</td>
<td>0.4</td>
<td>2.8</td>
<td>0.5</td>
<td>1.39</td>
</tr>
<tr>
<td>Feeding</td>
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<td>0.8</td>
<td>3.8</td>
<td>0.5</td>
<td>-0.94</td>
</tr>
<tr>
<td>Sleeping</td>
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<td>0.9</td>
<td>3.3</td>
<td>0.7</td>
<td>1.05</td>
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<td>Predictability</td>
<td>3.4</td>
<td>0.7</td>
<td>3.2</td>
<td>0.8</td>
<td>0.81</td>
</tr>
<tr>
<td>OWN INFANT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crying</td>
<td>1.4</td>
<td>0.7</td>
<td>3.5</td>
<td>0.7</td>
<td>-7.60**</td>
</tr>
<tr>
<td>Feeding</td>
<td>2.9</td>
<td>1.2</td>
<td>4.3</td>
<td>0.8</td>
<td>-3.50*</td>
</tr>
<tr>
<td>Sleeping</td>
<td>2.4</td>
<td>1.2</td>
<td>4.1</td>
<td>0.7</td>
<td>-4.30**</td>
</tr>
<tr>
<td>Predictability</td>
<td>2.7</td>
<td>1.1</td>
<td>4.1</td>
<td>0.7</td>
<td>-3.88**</td>
</tr>
</tbody>
</table>

*a 1-a great deal, 5-none; lower number reflects more negative perception
*p<0.01, two-tailed, **p<0.001, two-tailed
mean perception score for colic mothers was 2.3, which suggests that the delivery as a whole was viewed slightly more negatively than positively. Likewise, mothers in the control group rated the experience on the average at 2.1. The mean difference between the two groups was not significant ($t_{22} = .33$, $p = .75$). Another question examined how much time the mother was with the infant after the delivery. The mean amount in minutes of time that control and colic group mothers reported being with their infant after delivery was 29 and 22, respectively, a difference that was not significant ($t_{21} = .60$, $p = .55$).

Mothers were asked to rate how much crying and how much difficulty the average infant had with feeding, sleeping, and settling down to a predictable pattern as compared to their own infants. The rating scale, an adaptation of Broussard's Neonatal Perception Inventory (Broussard, 1978), was from "none" (1) to "a great deal" (5), such that a higher score reflected a more problematic perception. There were no differences between the study mothers with respect to perception of the average or typical infants' crying quantity ($t_{22} = 1.39$, $p = .18$), feeding problems ($t_{17} = -.94$, $p = .36$), sleeping difficulties ($t_{20} = 1.1$, $p = .31$), or predictability in patterns ($t_{21} = .81$, $p = .43$).

Mean group differences regarding perceptions of own infant behaviors were all statistically significant. As expected, colic group mothers rated their infants as crying more ($t_{22} = -7.6$, $p = .001$), having more trouble feeding ($t_{19} = -3.3$, $p = .002$), having
more difficulty in sleeping (t[18] = -4.5, p = .001), and not settling in to a predictable pattern of eating and sleeping (t[18] = -3.88, p = .001) than did control group mothers. Conversely, when colic group mothers were asked if their baby fed well on the questionnaire, only 33 percent replied "no," as compared to none of the control mothers (Fisher's exact test = p < 0.09). With respect to maternal self-report of sleep problems, significant group differences did exist with eight (67%) of colic group mothers and one (8%) of control mothers replying that their infant slept "restlessly" (Fisher's exact test = p < 0.0009).

Responses to the question, "Do you believe babies should be picked up when they cry?" differed between the two groups, with more colic than control group mothers (n = 7, 58% and n = 3, 25%), respectively) responding "always" and more control than colic group mothers (n = 9, 75% and n = 5, 42%, respectively) responding "sometimes" [x2(3, N=24) = 1.54, p < .21]. None of the mothers responded "never" (Table 16).

Mothers reported their usual behavior during the day when their baby started to cry (Table 16). Most colic group mothers (n = 8, 67%) responded that they typically did something to prevent the crying from starting, followed by intervening immediately after the onset of crying (n = 3, 25%). Conversely, control group mothers either tried to prevent it (n = 4, 33%) or they responded immediately once it had started (n = 3, 25%). Of interest is that only one colic group mother (8%) as compared to five control group mothers (42%)
TABLE 16
MATERNAL REPORT OF RESPONSITIVITY TO CRYING

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>PICKING UP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Sometimes</td>
<td>5</td>
<td>42</td>
</tr>
</tbody>
</table>

X²(1, N-24) = 1.54, p<0.21

OF ACTIVITY WHEN CRYING STARTS |       |         |       |         |
Prevent it                      | 8     | 67      | 4     | 33      |
Immediate                       | 3     | 25      | 3     | 25      |
Delayed                         | 1     | 8       | 5     | 42      |

X²(2, N-24) = 4.0, p<.14

responded that they would "let the baby cry a little before soothing."

Maternal psychological functioning was assessed via two standard self-report instruments: the Profile of Mood States (POMS) (McNair et al., 1978) and the SCLR-90 (Derogatis, 1983). The POMS, designed to capture an individual's subjective feeling, affect and mood, has become a standard measure to assess six affective states: tension, depression, anger, vigor, fatigue and confusion.

As depicted in Table 17, mothers of infants with colic differed significantly from control mothers in that they were more tense (t[17] = 6.0, p = .00), depressed (t[14] = 4.58, p = .001), angry (t[17] = 3.31, p = .004), fatigued (t[22] = 4.62, p = .001) and
TABLE 17
MEANS, STANDARD DEVIATIONS, AND T-TESTS RESULTS OF MOTHERS' SCORES ON THE POMS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC M</th>
<th>COLIC SD</th>
<th>CONTROL M</th>
<th>CONTROL SD</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension</td>
<td>22.1</td>
<td>7.8</td>
<td>6.6</td>
<td>4.4</td>
<td>6.00*</td>
</tr>
<tr>
<td>Depression</td>
<td>26.2</td>
<td>15.1</td>
<td>5.2</td>
<td>5.2</td>
<td>4.58*</td>
</tr>
<tr>
<td>Anger</td>
<td>17.8</td>
<td>9.9</td>
<td>7.0</td>
<td>5.5</td>
<td>3.31*</td>
</tr>
<tr>
<td>Vigor</td>
<td>7.3</td>
<td>4.6</td>
<td>18.8</td>
<td>4.7</td>
<td>-6.09*</td>
</tr>
<tr>
<td>Fatigue</td>
<td>19.3</td>
<td>5.4</td>
<td>8.3</td>
<td>6.2</td>
<td>4.62*</td>
</tr>
<tr>
<td>Confusion</td>
<td>15.7</td>
<td>6.6</td>
<td>4.5</td>
<td>2.7</td>
<td>5.44*</td>
</tr>
<tr>
<td>TOTAL</td>
<td>108.4</td>
<td>37.9</td>
<td>50.4</td>
<td>22.1</td>
<td>4.58*</td>
</tr>
</tbody>
</table>

*p < .01, two-tailed

confused (t[15] = 5.44, p = .001). Mothers of colic infants were also less vigorous than were control group mothers (t[22] = -6.09, p = .001). In terms of overall affective status, colic group mothers' averaged 108.4 (SD = 37.9) for Total Mood Disturbance score, whereas control group mothers averaged 50.4 (SD = 22.1) (t[18] = 4.58, p = .001).

The second measure of psychological functioning, the SCL-R-90, provided information on nine individual psychological dimensions and three global indices. Of the three global indices, the GSI represents the best single indicator of depth of current distress,
while the PSDI is a pure intensity measure, in a sense "corrected" for number of symptoms. The PST is a count of the number of symptoms the patient reports as experiencing to any degree (Derogatis, 1978). Raw scores were converted to standardized T-scores with a mean of 50 and standard deviation of 10. The higher the score, the more distress felt by the subject.

All colic group mothers’ dimension and summary SCLR-90 score means were significantly higher than scores of control mothers at p<.05 (Table 18). Mothers of infants with colic had multidimensional psychological distress. The following mean dimension scores were significantly different: somatization—bodily function (t[22] = 3.11, p = .005), obsessive—compulsive—impulsive thoughts and actions (t[19] = 5.36, p = .001), interpersonal sensitivity—personal inadequacy or inferiority (t[22] = 3.53, p = .002), depression—dysphoric mood (t[19] = 6.06, p = .001), anxiety—nervousness and tension (t[20] = 5.69, p = .001), hostility—state of anger (t[22] = 2.65, p = .012), phobic anxiety—fear of specific person, place or object (t[17] = 3.22, p = .005), paranoid ideation—disordered mode of thinking (t[20] = 2.37, p = .023), and psychoticism—schizoid life style (t[15] = 3.7, p = .002). Also, number of symptoms (t[16] = 4.52, p = .004), intensity of symptoms (t[22] = 4.45, p = .001), and the depth of distress (t[19] = 4.51, p = .001) were significantly elevated in the colic group mothers as compared to control group mothers.
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC M</th>
<th>COLIC SD</th>
<th>CONTROL M</th>
<th>CONTROL SD</th>
<th>t</th>
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</thead>
<tbody>
<tr>
<td>Somatization</td>
<td>60.8</td>
<td>8.5</td>
<td>49.2</td>
<td>9.8</td>
<td>3.11*</td>
</tr>
<tr>
<td>Obsessive-compulsive</td>
<td>65.3</td>
<td>6.4</td>
<td>47.6</td>
<td>9.4</td>
<td>5.36*</td>
</tr>
<tr>
<td>Interpersonal sensitivity</td>
<td>63.8</td>
<td>10.1</td>
<td>49.9</td>
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<td>3.53*</td>
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<td>Depression</td>
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<td>7.4</td>
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<tr>
<td>Anxiety</td>
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<td>6.2</td>
<td>5.69*</td>
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<tr>
<td>Hostility</td>
<td>64.2</td>
<td>10.3</td>
<td>52.6</td>
<td>11.1</td>
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<td>Phobic anxiety</td>
<td>60.1</td>
<td>11.8</td>
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<tr>
<td>Paranoid</td>
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<td>11.2</td>
<td>45.7</td>
<td>8.1</td>
<td>2.47*</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>61.8</td>
<td>13.3</td>
<td>46.4</td>
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<td>3.70*</td>
</tr>
<tr>
<td>GSI*</td>
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<td>7.6</td>
<td>48.7</td>
<td>11.5</td>
<td>4.51*</td>
</tr>
<tr>
<td>PSDI*</td>
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<td>7.8</td>
<td>48.7</td>
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<td>4.45*</td>
</tr>
<tr>
<td>PST†</td>
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<td>5.3</td>
<td>47.8</td>
<td>10.5</td>
<td>4.52*</td>
</tr>
</tbody>
</table>

* Global Severity Index-depth of disorder  
* Positive Symptom Distress Index-intensity of symptoms  
† Positive Symptom Total-number of symptoms  
* p<0.02, two-tailed

Of significance is the cut off point between "nonpatient" and "clinical" samples. Derogatis (1983) has contended that individuals may have some sort of psychiatric disorder when either the GSI score T-score is greater than or equal to 63, or any three primary
dimension scores are greater than or equal to T-score 63. Mean GSI T-scores and four of the nine dimension T-scores of mothers of infants with colic were above this cut-off point, suggesting that the psychological distress was serious enough to warrant psychological assessment.

QUESTION 3: DO COLIC/CONTROL INFANTS DIFFER IN BIOBEHAVIORAL CHARACTERISTICS?

Data from maternal interview and self-report were used to answer this question. The hypotheses were:

1. There will be no differences between colic and control group infants on select prenatal or neonatal variables.

2. Colic infants will exhibit more fuss and/or cry behavior than control infants as measured via a 7-day maternal-maintained diary.

3. Colic infants will sleep less in a 24 period than will control infants as measured via a 7-day maternal-maintained diary.

4. Colic infants will be fed more frequently than will control infants as measured via a 7-day maternal-maintained diary.

Table 19 presents data regarding prenatal variables. Colic and control infants were equally likely to be described as very or moderately active in utero, with none of the mothers reporting fetal inactivity.

Only seven (58%) of the infants with colic and 11 (92%) of control group infants were born at term (38-42 weeks). Three (25%) infants in the colic group were born before 38 weeks gestational age,
and two (17%) were born after 42 weeks. The only control infant who was not born at term was born after 42 weeks.

Less than a third of the mothers in both groups (n = 2, 17%) reported that they had experienced problems during labor. All of the

<table>
<thead>
<tr>
<th>TABLE 19</th>
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<tbody>
<tr>
<td>PRENATAL VARIABLES OF THE INFANTS IN THE COLIC AND CONTROL GROUPS</td>
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<tr>
<td></td>
<td>n</td>
<td>%</td>
<td></td>
<td>n</td>
<td>%</td>
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<tr>
<td>UTERO ACTIVITY</td>
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<tr>
<td>Very</td>
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<td>42</td>
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<tr>
<td>&lt;38 weeks</td>
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<td>25</td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>38-42 weeks</td>
<td>7</td>
<td>58</td>
<td></td>
<td>11</td>
<td>92</td>
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<tr>
<td>&gt;42 weeks</td>
<td>2</td>
<td>17</td>
<td></td>
<td>1</td>
<td>8</td>
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<tr>
<td>LABOR COMPLICATIONS</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>17</td>
<td></td>
<td>2</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>10</td>
<td>83</td>
<td></td>
<td>10</td>
<td>83</td>
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<tr>
<td>DELIVERY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Vaginal</td>
<td>12</td>
<td>100</td>
<td></td>
<td>8</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Cesarean</td>
<td>0</td>
<td>0</td>
<td></td>
<td>4</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>PROBLEMS AFTER BIRTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>50</td>
<td></td>
<td>2</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6</td>
<td>50</td>
<td></td>
<td>10</td>
<td>83</td>
<td></td>
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<tr>
<td>ILLNESSES SINCE BIRTH</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td>5</td>
<td>42</td>
<td></td>
<td>6</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>7</td>
<td>58</td>
<td></td>
<td>6</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>GENDER</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7</td>
<td>58</td>
<td></td>
<td>5</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>42</td>
<td></td>
<td>7</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>
infants with colic (100%) and eight (67%) of the control infants were delivered vaginally. A larger proportion of the colic group infants (n = 6, 50%) experienced problems after birth as compared to control group infants (n = 2, 17%), but this difference was not significant \[X^2 (1, N=24) = 1.7, p = .19\]. The number of illnesses experienced by the infants since birth was similar across the two groups; five (42%) of colic group infants and six (50%) of control group infants had been ill at least once prior to participating in this study. Finally, infant gender was nearly equally divided, with seven (58%) and five (42%) being male in the colic and control groups, respectively \[X^2 (4, N=24) = 0.17, p<.68\].

Table 20 presents a comparison of infant biological variables. The mean age of infants with colic was 6.8 weeks (SD = 2.3) with a range of three to 12 weeks; the mean age of control group infants was 6.5 (SD = 2.3) with a range of four to 10 weeks (t[22] = .29, p = .78). Infants were similar in terms of birth weight and length, with mean weights being 3.3 kg for infants in the colic group (SD = .7, range 2.1 to 4.1) and 3.4 kg for control group infants (SD = .3, range 2.9-4.0). Birth length for colic group infants was 51.3 cm (SD = 2.3, range 47-55) and for control group infants was 50.9 cm (SD = 2.4, range 48-55). One and five-minute Apgars were also similar between the two groups, with the mean 1-minute Apgar scores being 7.3 (SD = 1.6) and 7.8 (SD = 1.1) for colic and control group infants, respectively (t[10] = -.66, p = .52). The mean of the 5-minute Apgar scores for the control group was slightly higher (8.8, SD = .5)
TABLE 20
MEANS, STANDARD DEVIATIONS, AND T-TEST RESULTS OF BIOLOGICAL VARIABLES IN COLIC AND CONTROL GROUP INFANTS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
<th></th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>AGE (weeks)</td>
<td>6.8</td>
<td>2.3</td>
<td>6.5</td>
<td>2.3</td>
<td>0.29</td>
</tr>
<tr>
<td>BIRTH WEIGHT (kg)</td>
<td>3.3</td>
<td>0.7</td>
<td>3.4</td>
<td>0.3</td>
<td>-0.79</td>
</tr>
<tr>
<td>BIRTH LENGTH (cm)</td>
<td>51.3</td>
<td>2.3</td>
<td>50.9</td>
<td>2.4</td>
<td>0.43</td>
</tr>
<tr>
<td>Apgar 1 minute</td>
<td>7.3</td>
<td>1.6</td>
<td>7.8</td>
<td>1.1</td>
<td>-0.66</td>
</tr>
<tr>
<td>Apgar 5 minute</td>
<td>7.5</td>
<td>2.7</td>
<td>8.8</td>
<td>0.5</td>
<td>-1.26</td>
</tr>
<tr>
<td>HEALTH CARE VISITS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scheduled</td>
<td>2.2</td>
<td>1.4</td>
<td>1.7</td>
<td>1.0</td>
<td>1.13</td>
</tr>
<tr>
<td>Unscheduled</td>
<td>1.3</td>
<td>2.8</td>
<td>0.5</td>
<td>0.7</td>
<td>1.01</td>
</tr>
<tr>
<td>Emergency</td>
<td>0.5</td>
<td>0.7</td>
<td>0.3</td>
<td>0.6</td>
<td>0.94</td>
</tr>
</tbody>
</table>

than that of the colic group (7.5, SD = 2.7), but this difference was not significant (t(8) = -1.26, p = .24).

To further operationalize infant biological status, health care utilization across the two groups was examined. It was hypothesized that the number of "scheduled" or well-baby visits would be similar across the two groups, but that the number of "unscheduled" or ill visits and emergency room visits would be different. There were mean differences between the two groups in the three categories, particularly unscheduled appointments, but these differences were not significant (t(12) = 1.01, p = .33) (Table 20). The higher number of
unscheduled visits in the infants with colic is due to one infant who was seen repeatedly by her pediatrician and a gastro-enterologist for excessive crying. Costs associated with uncovering a reason for this infant’s excessive crying exceeded $10,000.00. This case group infant was hospitalized twice for her extreme irritability; none of the control infants had been hospitalized prior to study enrollment.

**TABLE 21**

Means, standard deviations, and t-tests results of daily fussing, crying, feeding, and sleeping in colic and control group infants

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC M</th>
<th>SD</th>
<th>CONTROL M</th>
<th>SD</th>
<th>t*</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUSS (hours)</td>
<td>3.2</td>
<td>1.5</td>
<td>0.7</td>
<td>0.4</td>
<td>5.7</td>
<td>.022</td>
</tr>
<tr>
<td>CRY (hours)</td>
<td>2.2</td>
<td>1.3</td>
<td>0.5</td>
<td>0.5</td>
<td>4.3</td>
<td>.001</td>
</tr>
<tr>
<td>FUSS/CRY (hours)</td>
<td>5.3</td>
<td>1.3</td>
<td>1.1</td>
<td>0.7</td>
<td>9.7</td>
<td>.000</td>
</tr>
<tr>
<td>CRY EPISODES</td>
<td>4.4</td>
<td>1.4</td>
<td>0.9</td>
<td>0.7</td>
<td>7.7</td>
<td>.001</td>
</tr>
<tr>
<td>SOOTHABILITY (%)a</td>
<td>52.0</td>
<td>27.0</td>
<td>89.0</td>
<td>15.0</td>
<td>-4.2</td>
<td>.001</td>
</tr>
<tr>
<td>AWAKE (hours)b</td>
<td>11.0</td>
<td>3.4</td>
<td>9.1</td>
<td>2.1</td>
<td>1.7</td>
<td>.100</td>
</tr>
<tr>
<td>SLEEP (hours)</td>
<td>12.8</td>
<td>1.4</td>
<td>14.5</td>
<td>1.7</td>
<td>-2.7</td>
<td>.014</td>
</tr>
<tr>
<td>NIGHT AWAKENINGS</td>
<td>2.3</td>
<td>1.6</td>
<td>0.9</td>
<td>0.9</td>
<td>2.5</td>
<td>.022</td>
</tr>
<tr>
<td>FEEDINGS</td>
<td>6.4</td>
<td>1.2</td>
<td>6.6</td>
<td>1.2</td>
<td>-0.5</td>
<td>.647</td>
</tr>
</tbody>
</table>

a diary data  
b maternal report  
* two-tailed
Table 21 presents the data on general infant biological variables, derived via diary data and maternal self-report. As expected, colic group infants fussed ($t_{13} = 5.7, p = .001$) and cried ($t_{13} = 4.3, p = .001$) significantly more than control group infants. In addition, there was more variability in the colic group infants fuss/cry quantity. Infants with colic had more cry "episodes," which was defined as sustained crying for at least 30 minutes. Colicky infants cried on the average $4.4 \pm 1.4$ times per day, whereas control group infants averaged less than one episode per day, which was significant ($t_{17} = 7.7, p = .001$). Contrasts of colic and control infant diary entries are included in Appendix P.

Table 22 compares 24 hour-cry quantities obtained in other similar studies on infants with colic. A majority of the studies employed maternal-maintained diaries to assess fuss/cry quantity, and the infants were between three and seven weeks of age. Total daily cry quantity in infants with colic averaged 206 minutes per day, with a range of 156 to 376 minutes per day.

Mothers were asked to rate what percentage of time they were able to soothe their infant. Significant group differences existed ($t_{17} = -4.20, p = .0006$) in terms of perceptions of soothability, with mothers in the control group able to soothe their infants 89 percent of the time as compared to mothers of infants with colic reporting being able to soothe their infants only 52 percent of the time. Maternal perception of total time awake per day averaged 11.0
TABLE 22
CRY QUANTITY IN INFANTS WITH COLIC ACROSS STUDIES

<table>
<thead>
<tr>
<th>RESEARCHER</th>
<th>DESIGN</th>
<th>METHOD</th>
<th>MEAN AGE</th>
<th>CRYING (min/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinyerd (1991)</td>
<td>D</td>
<td>D</td>
<td>6.2</td>
<td>192</td>
</tr>
<tr>
<td>Wessel et al (1954)</td>
<td>D</td>
<td>D</td>
<td>3.5</td>
<td>180</td>
</tr>
<tr>
<td>Brazelton (1962)</td>
<td>D</td>
<td>D</td>
<td>6.0</td>
<td>240</td>
</tr>
<tr>
<td>Taubman (1984)</td>
<td>E</td>
<td>D</td>
<td>4.0</td>
<td>156</td>
</tr>
<tr>
<td>Danielsson &amp; Hwang (1985)</td>
<td>E</td>
<td>D</td>
<td>4.5</td>
<td>376</td>
</tr>
<tr>
<td>Wikander &amp; Wahlberg (1987)</td>
<td>D</td>
<td>D</td>
<td>7.0</td>
<td>210</td>
</tr>
<tr>
<td>Taubman (1988)</td>
<td>E</td>
<td>D</td>
<td>6.0</td>
<td>192</td>
</tr>
<tr>
<td>Humphry &amp; Hock (1990)</td>
<td>D</td>
<td>D</td>
<td>7.0</td>
<td>239</td>
</tr>
<tr>
<td>Barr et al. (1991)</td>
<td>E</td>
<td>D</td>
<td>3.0</td>
<td>201</td>
</tr>
</tbody>
</table>

*aD = descriptive, E = experimental
*bD = diary

hours for the colic group infants and 9.1 hours for the control infants, a mean difference of approximately 2 hours that was not significant (t[18] = 1.71, p = .10). Conversely, control group infants averaged more sleep per day (M = 14.5 hours, SD = 1.7, range= 12 - 17) as compared to infants in the colic group (M = 12.8, SD = 1.4, range=9.5 - 14.6), a difference that was significant (t[21] = -2.68, p = .01). In terms of night awakenings, infants with colic also woke an average of 2.3 times as compared to control group
infants waking an average of 0.9 times. This difference in means was significant ($t_{17} = 2.51, p = .022$). The mean number of feedings per day across the two groups was similar ($t_{22} = -0.46, p = .65$), with the colic group infants being fed an average of 6.4 (SD = 1.2, range 4.4 - 8.3) and the control group infants being fed an average of 6.6 (SD = 1.2, range 4.6 - 8.6).

In summary, the first hypothesis related to prenatal and neonatal variables was supported; there were no significant differences between the two groups of study infants with respect to uterine activity, gestational age, birth or postnatal problems or Apgar scores. The second hypothesis was also supported; colic infants exhibited significantly more fussing, crying, and combined fussing/crying behavior than did control infants. The third hypothesis was supported; colic infants exhibited less sleep in a 24-hour period than did control infants; they also had significantly more night awakenings than did control infants. Finally, since colic infants were not fed more frequently than were control infants, the data did not support the fourth hypothesis.

A more indepth examination was conducted on selected infant behaviors related to the three major biological variables of the study: crying, feeding, and sleeping behaviors. This analysis was apriori determined to be descriptive in nature only. Tables 23, 24, and 25 present the data.

As presented in Table 23, five (42%) colic and eight (67%) control group mothers perceived that their infants were most likely
TABLE 23
DESCRIPTION OF THE CRYING PATTERNS EXHIBITED
BY COLIC AND CONTROL GROUP INFANTS
AS PER MATERNAL REPORT

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>TIME OF DAY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>2</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>Afternoon</td>
<td>5</td>
<td>42</td>
<td>8</td>
</tr>
<tr>
<td>Evening</td>
<td>3</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Night</td>
<td>2</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>LONGEST CRYING EPISODE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2 minutes</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2 - 5 minutes</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>5 - 10 minutes</td>
<td>1</td>
<td>8.3</td>
<td>2</td>
</tr>
<tr>
<td>10 - 30 minutes</td>
<td>4</td>
<td>33.3</td>
<td>3</td>
</tr>
<tr>
<td>&gt; 30 minutes</td>
<td>7</td>
<td>58.4</td>
<td>1</td>
</tr>
<tr>
<td>AVERAGE CRYING EPISODE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2 minutes</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>2 - 5 minutes</td>
<td>1</td>
<td>8.3</td>
<td>2</td>
</tr>
<tr>
<td>5 - 10 minutes</td>
<td>1</td>
<td>8.3</td>
<td>1</td>
</tr>
<tr>
<td>10 - 30 minutes</td>
<td>6</td>
<td>50.0</td>
<td>1</td>
</tr>
<tr>
<td>&gt; 30 minutes</td>
<td>4</td>
<td>33.3</td>
<td>0</td>
</tr>
<tr>
<td>SINCE BIRTH CRYING HAS-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased</td>
<td>9</td>
<td>75</td>
<td>4</td>
</tr>
<tr>
<td>Not changed</td>
<td>1</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Decreased</td>
<td>2</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>CRY ONSET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudden</td>
<td>5</td>
<td>42</td>
<td>2</td>
</tr>
<tr>
<td>Builds up</td>
<td>7</td>
<td>58</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL TIME PER DAY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 hour</td>
<td>1</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>1 - 3 hours</td>
<td>3</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>3 - 5 hours</td>
<td>3</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 3 hours</td>
<td>5</td>
<td>42</td>
<td>0</td>
</tr>
</tbody>
</table>
to fuss and/or cry in the afternoon (12-6:00pm). Three (25%) of infants in both groups cried in the evening (6-12:00 midnight). Two (17%) colic and one (8%) control infants cried in the morning (6-12:00 noon). Night time crying (12-6:00am), the time of day when two (17%) of infants with colic were more likely to cry, was not reported by control mothers as a time their infants were most likely to cry. The two groups did not differ significantly in terms of time of day when most crying occurred.

Table 24 depicts actual diary data (as opposed to maternal report discussed above) on fuss/cry distribution in six hour time blocks. As illustrated, colicky infants fuzzed/cried more during the hours of 12:00 noon to 6:00 pm, whereas control infants cried more between 6:00pm and 12:00 midnight. Cry quantity of colicky infants was lowest from 12:00 midnight to 6:00 am (M = 0.5), which is the quantity of crying that was highest for control group infants between 6:00 pm and 12:00 midnight. As noted, differences in fuss/cry quantities were significant across all four time periods.

As expected, seven (58%) of the colic infants' mothers reported that the longest crying episodes were greater than 30 minutes. Conversely, the longest cry episode of the majority of infants in the control group infants (n = 8, 67%) tended to be less than 10 minutes. One control infant reportedly had at least one episode of crying that lasted longer than 30 minutes. These differences in longest cry episode were significant [X^2(4, N=24) = 11.0, p<.03]. Maternal report of average length of crying episodes were also significant
**TABLE 24**

COMPARISON OF FUSS/CRY HOURS PER TIME PERIOD

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6AM - 12 noon</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1.1</td>
<td>0.2</td>
<td>5.7*</td>
</tr>
<tr>
<td>SD</td>
<td>0.5</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.4 - 2.0</td>
<td>0.0 - 0.9</td>
<td></td>
</tr>
<tr>
<td><strong>12 noon - 6PM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1.9</td>
<td>0.4</td>
<td>9.6*</td>
</tr>
<tr>
<td>SD</td>
<td>0.5</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>1.3 - 2.8</td>
<td>0.1 - 0.8</td>
<td></td>
</tr>
<tr>
<td><strong>6PM - 12 midnight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>1.8</td>
<td>0.5</td>
<td>6.7*</td>
</tr>
<tr>
<td>SD</td>
<td>0.6</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>1.0 - 3.1</td>
<td>0.1 - 0.9</td>
<td></td>
</tr>
<tr>
<td><strong>12 midnight - 6AM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>0.5</td>
<td>0.1</td>
<td>3.32*</td>
</tr>
<tr>
<td>SD</td>
<td>0.4</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.0 - 1.3</td>
<td>0.0 - 0.3</td>
<td></td>
</tr>
</tbody>
</table>

* p < .005

different \(X^2(4, N=24) = 15.9, p < .003\). Ten (83%) colicky infants were reported to cry on the average a minimum of 10 minutes at one time; control infants cried an average of 0-5 minutes \(n=10, 83\%\).

Maternal perceptions of crying pattern since birth was significantly different between the two groups \(x^2(2, N=24) = 5.5, p < .06\). Most mothers in the colic group \(n=9, 75\%\) tended to report that their infants' crying had increased since birth, two \(17\%\) reported that it had decreased, and one \(8\%\) reported that it had not changed. Conversely, half \(50\%\) of control group mothers reported
that their infants' crying had not changed, four (33%) reported that it had increased, and two (17%) reported that it had decreased.

Most mothers in the colic (n = 7, 58%) and control (n = 10, 83%) groups reported that their infants' cry tended to start with fussing and build to crying. Five (42%) colicky infants and two (17%) control infants had sudden, quick onset crying.

As corroborated with diary data, infants with colic were reported by their mothers to cry significantly more in a 24-hour period than control group infants [$X^2 (3, N=24) = 15.6, p < .001$]. Eight (67%) colicky infants were reported to cry at least three hours per day, whereas no mothers in the control group reported cry quantities in this range. Control group infants tended to cry less than one hour per day (n = 10, 83%). Two infants (17%) in the colic group were reported to cry between one and three hours per day.

Diary data verified that mean daily fuss/cry time for each of these infants was at least two hours per day, as specified in the entry criteria.

Table 25 presents the data on feeding patterns. There were no differences between the two groups in terms of breast versus bottle feeding at study enrollment; three mothers (25%) in each group were breast-feeding. However, seven (58%) colic group mothers reported that they had originally breast-fed but had switched to bottle feeding for reasons related to their infants' colic. Four mothers believed or were told that their infants were probably sensitive to
TABLE 25

DESCRIPTION OF FEEDING PATTERNS
OF COLIC AND CONTROL GROUP INFANTS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td><strong>METHOD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breast</td>
<td>3</td>
<td>33</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Formula</td>
<td>9</td>
<td>67</td>
<td>9</td>
<td>75</td>
</tr>
<tr>
<td><strong>FORMULA (n = 9/group)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Similac&lt;sup&gt;R&lt;/sup&gt;</td>
<td>1</td>
<td>8</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Isomil&lt;sup&gt;R&lt;/sup&gt;</td>
<td>4</td>
<td>33</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Enfamil&lt;sup&gt;R&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Prosobee&lt;sup&gt;R&lt;/sup&gt;</td>
<td>2</td>
<td>17</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Other</td>
<td>2</td>
<td>17</td>
<td>2</td>
<td>17</td>
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<tr>
<td><strong>FEED WELL</strong></td>
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<td></td>
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<tr>
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<td>100</td>
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<tr>
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<td>33</td>
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<td>0</td>
</tr>
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<td><strong>BURP SPONTANEOUSLY</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9</td>
<td>75</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>25</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td><strong>REGURGITATE/EMESIS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>67</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>33</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td><strong>FINISH FEEDING (DAY)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soothe &amp; settle</td>
<td>4</td>
<td>33</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Play &amp; talk</td>
<td>5</td>
<td>42</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Sit &amp; watch</td>
<td>2</td>
<td>17</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td><strong>FINISH FEEDING (NIGHT)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soothe &amp; settle</td>
<td>9</td>
<td>75</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Play &amp; talk</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>17</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td><strong>AFTER FEEDING (DAY)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drowsy &amp; asleep</td>
<td>4</td>
<td>33.25</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Alert &amp; content</td>
<td>4</td>
<td>33.25</td>
<td>10</td>
<td>83</td>
</tr>
<tr>
<td>Ready for play</td>
<td>1</td>
<td>8.25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>8.25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Crying/fussing</td>
<td>1</td>
<td>17.0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
TABLE 25 (continued)

DESCRIPTION OF THE FEEDING PATTERNS
EXHIBITED BY COLIC AND CONTROL GROUP INFANTS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>AFTER FEEDING (NIGHT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drowsy &amp; asleep</td>
<td>2</td>
<td>17</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>Ready for play</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Crying/fussing</td>
<td>7</td>
<td>58</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

... (rest of the text)
groups reporting that their infants burped spontaneously, and 67 and 58 percents, respectively, reporting occasional emesis or regurgitation.

Mothers' behaviors after day (7:00am to 7:00pm) feedings were similar between the two groups, with most mothers playing and talking with their infants. Four (33%) colic group mothers as compared to one (8%) control group mother reported that they typically soothed and/or settled their infants. Following the night (7:00pm to 7:00am) feeding most colic (n - 9, 75%) and control (n - 6, 50%) mothers soothed and/or settled their infants. Two (17%) colic mothers were in the "other" category, which included walking and rocking before putting to bed. Five (42%) of the control group mothers also checked "other;" of these five, four mothers wrote in that they played with the infant early in the evening, and then put the baby to bed to sleep though the night. The other mother noted that she engaged in any one of the activities "depending on what the baby seems to need." Only one mother (8%) in both groups reported playing and talking with their infants following the night feeding.

Infant behaviors after day and night feedings were also examined. After a feeding during the day (7:00am-7:00pm), a majority of the control infants (n = 10, 83%) were alert/content; the other two (17%) were drowsy/asleep. Infants in the colic group also tended to be either drowsy/sleep (n = 4, 33%) or alert/content (n = 4, 33%) during the day. One infant (8%) was also reported to be ready for play and another infant (8%) tended to cry/fuss after most day
feedings. After a night feeding, 11 (92%) control group infants were drowsy/asleep, and one (8%) tended to cry/fuss. Conversely, seven (5%) of infants with colic tended to cry/fuss after a night feeding, two (17%) were drowsy, and one (8%) was ready for play. Two colic group mothers responded by checking every response (despite instructions to select only one), suggesting that their infants were impossible to classify within one category.

Infant sleep/awake patterns were also examined via maternal self-report. As depicted in Table 26, most infants in both groups (58% case and 42% control) slept in their cribs. Six (50%) of the control group infants, however, were still sleeping in a bassinet, as compared to only two (17%) of infants with colic. One infant in each group was reported to sleep in the parents’ bed. Of interest is that two infants with colic slept in either an infant seat or swing, sleep restlessly, as compared to one (8%) control group infants, a difference that was significant \[X^2(1, N=24) = 6.4, p < .01\].

The longest period of awake time for control group infants was in either the afternoon (n = 5, 42%) or the morning (n = 4, 33%). Three (25%) control group infants had long awake times in the evenings. Conversely, a majority of the infants with colic had their longest awake time in either the evening (n = 5, 42%) or in the afternoon (n = 4, 33%). Two infants with colic (17%) infants were most awake in the morning and one (8%) was most awake in the night.

The typical time when most infants were content in the colic (n = 5, 42%) and control (n = 6, 50%) groups was the morning. The
TABLE 26
DESCRIPTION OF AWAKE/SLEEP PATTERNS
EXHIBITED BY COLIC AND CONTROL GROUP INFANTS

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>LOCATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crib</td>
<td>7</td>
<td>58</td>
</tr>
<tr>
<td>Bassinet</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Infant seat</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Bed</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Infant swing</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>TYPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restless</td>
<td>8</td>
<td>67</td>
</tr>
<tr>
<td>Quiet</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>LONGEST TIME AWAKE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Afternoon</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Evening</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Night</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>MOST CONTENT TIME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>Afternoon</td>
<td>4</td>
<td>33</td>
</tr>
<tr>
<td>Evening</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Night</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

second most content time was in the afternoon (33% colic and 25% control). One control mother reported that her infant was most content in the night.

In summary, colic infants did not differ from control infants on selected pre- and post-natal variables. Infants with colic were less soothable, fussed/cried more, had more cry episodes and night awakenings, and slept less than did control infants. There were no differences between the two groups in terms of feeding frequency.
QUESTION 4: CAN THE CRY OF THE INFANT WITH COLIC BE CATEGORIZED AS A DISTINCTIVE CRY TYPE VIA ACOUSTICAL ANALYSIS?

The audio-recordings of colicky and control infant cries were of such poor quality that acoustic properties could not be assessed via the computer analog system as originally planned. Therefore, this question was not addressed.

QUESTION 5: WHAT IS THE RELATIONSHIP BETWEEN PRESENCE/ABSENCE OF COLIC AND THE INFANT'S CAREGIVING ENVIRONMENT?

The hypotheses that were tested were:

1. The colic group dyads will have lower mean maternal, infant, and interaction scores on the NCAFS.
2. The colic group dyads will have lower mean total scores on the HOME.
3. The colic group dyads will have higher discrepancy scores on the FFFS.
4. The colic group dyads will have lower Family APGAR scores.

To test these hypotheses, analysis of the data entailed independent t-tests, power analysis and magnitude scaling.

All feedings were videotaped by a NCAFS-certified research nurse and later scored by a second NCAFS-certified research nurse who was masked to group membership. The second observer was initially trained to a level of .85 (total percent agreement) on the NCAFS and .90 (total percent agreement) on the HOME. Pairwise total agreement at the end of the study ranged from .75 to .92 on the NCAFS and .82
to .90 (total percent agreement) on the HOME. Pairwise total agreement at the end of the study ranged from .75 to .92 on the NCAFS and .82 to .89 on the HOME. While the utility of percent agreement as a measure of reliability has been questioned (Topf, 1986), it remains a popular method which most investigators use.

Table 27 compares the two groups on maternal subscale and summary NCAFS scores assessed by means of a Student's t-test. Colic group mothers (M = 8.6, SD = 1.8) scored significantly lower than control group mothers (M = 11.2, SD = 1.9) on the "Socioemotional Growth-Fostering" subscale (t[22] = -3.35, p = .003). Mothers of infants with colic tended be less likely to engage in social interaction (t[20] = 1.77, p = .09, 1-β = .51), use positive statements while talking to their infants (t[17] = 1.96, p = .07, 1-β = .60), and praise their infants' behavior during the feeding (t[20] = 1.99, p = .09, 1-β = .51). They also tended to be more likely to grimace or frown when making eye contact with their infants (t[20] = 1.77, p = .09, 1-β = .51). Most of these differences only approached significance at p < .05, and as indicated they also lacked sufficient power to correctly reject the null hypothesis.

On the three other maternal subscales, while there were mean group differences, they were not significant on the "Sensitivity to Cues" subscale (t[22] = - .68, p = .50), the "Response to Distress" subscale (t[19] = -1.03, p = .32), or the "Cognitive Growth-Fostering" subscale (t[22] = -1.54, p = .14). However, post-hoc analysis revealed low powered statistical tests for the "Response to
TABLE 27
MEANS, STANDARD DEVIATIONS, AND T-TEST RESULTS FOR NCAFS MATERNAL SUBSCALE AND SUMMARY SCORES

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC M</th>
<th>SD</th>
<th>CONTROL M</th>
<th>SD</th>
<th>t*</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity to cues</td>
<td>10.0</td>
<td>2.6</td>
<td>10.8</td>
<td>2.8</td>
<td>-0.68</td>
<td>.50</td>
</tr>
<tr>
<td>Response to distress</td>
<td>7.8</td>
<td>2.3</td>
<td>8.7</td>
<td>1.6</td>
<td>-1.03</td>
<td>.32</td>
</tr>
<tr>
<td>Socioemotional growth-fostering</td>
<td>8.6</td>
<td>1.8</td>
<td>11.2</td>
<td>1.9</td>
<td>-3.35</td>
<td>.003</td>
</tr>
<tr>
<td>Cognitive growth-fostering</td>
<td>5.3</td>
<td>1.7</td>
<td>6.4</td>
<td>1.8</td>
<td>-1.54</td>
<td>.14</td>
</tr>
<tr>
<td>TOTAL MOTHER</td>
<td>31.8</td>
<td>6.6</td>
<td>37.2</td>
<td>7.4</td>
<td>-1.89</td>
<td>.07</td>
</tr>
</tbody>
</table>

*two-tailed

Distress" subscale (1-β = .33) and for the "Cognitive Growth-Fostering" subscale (1-β = .45). Since the probability of committing a Type II error was high, a conclusion of no difference on the "Response to Distress" subscale is tentative.

As an exploratory strategy, individual items on the NCAFS were examined for mean differences. On the "Response to Distress" subscale, mothers of infants with colic tended to be more likely to make negative comments about their infants (t[22] = 1.91, p = .07, 1-β = .41) and to use abrupt or rough movements when responding to their infants' distress (t[22] = 2.35, p = .03). On the "Cognitive Growth-Fostering" subscale, mothers of infants with colic tended to be more
likely to provide their infants with objects of some type (e.g. fingers, utensils) during the feeding ($t[17] = 1.96, p = .07, 1-\beta = .60$), less likely to use "baby talk" ($t[22] = -3.32, p = .003$), more likely to interrupt their infants' feeding by removing or juggling the nipple ($t[22] = -2.68, p = .11, 1-\beta = .60$), and more likely to talk to their infants about something other than feeding ($t[17] = 1.96, p = .07, 1-\beta = .60$).

Total control group mothers' mean score on the four subscales ("total mother") combined was 37.2 (SD = 7.4) as compared to colic group mothers' mean score of 31.8 (SD = 6.6); this difference was not significant at $p = .07$ ($t[22] = -1.89$). Since the $p$ value approached significance, post-hoc analysis revealed that the power ($1-\beta$) at $p = .05$ was .58.

To estimate the magnitude of the group differences on "total mother" scores, point biserial was $r_{pb} = 0.37 (p = 0.07)$. To obtain a better estimate of proportion of variance accounted for by the group variable, omega-squared was calculated to be 0.10 (approximate power=0.33). Group membership accounted for approximately 10 percent of the variance in maternal summary scores in this sample.

Table 28 summarizes infant subscale and summary scores compared via Student's $t$-test for independent groups. Control group infants ($M = 12.6, SD = 1.7$) had higher scores on the "Clarity of Cues" subscale than did infants with colic ($M = 11.4, SD = 1.9$); control group infants also had higher scores on the "Responsivity to Parent" ($M = 7.6, SD = 1.6$) subscales as compared to colic group infants ($M = $
TABLE 28
MEANS, STANDARD DEVIATIONS, AND T-TEST RESULTS FOR 
NCAFS INFANT SUBSCALE AND INFANT SUMMARY SCORES 
AND TOTAL INTERACTION SCORE

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th></th>
<th>CONTROL</th>
<th></th>
<th>t*</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity of cues</td>
<td>11.4</td>
<td>1.9</td>
<td>12.6</td>
<td>1.7</td>
<td>-1.56</td>
<td>.13</td>
</tr>
<tr>
<td>Responsiveness to parent</td>
<td>6.4</td>
<td>1.8</td>
<td>7.6</td>
<td>1.6</td>
<td>-1.68</td>
<td>.11</td>
</tr>
<tr>
<td>TOTAL INFANT</td>
<td>17.8</td>
<td>3.2</td>
<td>20.2</td>
<td>2.9</td>
<td>-1.87</td>
<td>.07</td>
</tr>
<tr>
<td>TOTAL INTERACTION</td>
<td>49.6</td>
<td>7.1</td>
<td>57.3</td>
<td>9.7</td>
<td>-2.23</td>
<td>.04</td>
</tr>
</tbody>
</table>

*two-tailed

6.4, SD = 1.8). Only the "Responsivity to Parent" subscale approached significance (t[22df] = -1.68, p = .11). Individual items were examined for mean differences as an exploratory strategy. Infants with colic tended to be less likely to respond to social cues from their mothers (t[20] = 1.77, p = .09, 1-β = .54), to vocalize to their mothers during the feeding (t[20] = 1.77, p = .09, 1-β = .54), and to turn away or avert gaze from their mothers (t[22] = -1.66, p = .11, 1-β = .51).

Combined infant scores for the two subscales ("total infant") tended to be different (t[22df] = -1.87, p = .07), with control group infants having higher mean scores (M = 20.2, SD = 2.9) than infants with colic (M = 17.8, SD = 3.2). However, these differences were not
statistically significant. The power of this test to detect a significant difference at $\alpha = .05$ was .60. Therefore, caution is warranted in accepting the null hypothesis given the low power of the statistical test.

In terms of magnitude scaling, the correlation between group and the "total infant" score was $rpb = .37$ ($p = .07$). Omega squared calculations revealed that group membership accounted for approximately 9 percent of the variance in infant summary scores in this sample (approximate power = .30).

For the "total interaction" scores (see Table 27), control dyads had mean NCAFS total scores ($M = 57.3$, $SD = 9.7$) that were significantly higher ($t_{20df} = -2.23$, $p = .037$) than colic dyad mean scores ($M = 49.6$, $SD = 7.1$). The correlation between group and the total interaction score was $rpb = .43$ ($p = .36$). Omega squared was calculated to be .14 (approximate power = .47). As such, group membership accounted for approximately 14 percent of the variance in the NCAFS total score in this sample.

Of interest are some of the items on the NCAFS that did not differentiate the two study groups. Mothers of infants with colic did not differ from control mothers in terms of smiling and laughing during the feeding, making eye contact with their babies, or using gentle forms of touching during the feeding.

Table 29 summarizes means, standard deviations, and $t$-test results on the HOME assessment. While differences between means were observed on all six subscales, only one was significant. Control
dyads averaged 7.9 (SD = 1.4) on the "Emotional and verbal responsivity of mother" whereas colic dyads averaged 6.5 (SD = 2.0) ($t_{20df} = -2.00, p = .04$). Exploratory analysis of individual items revealed that colic mothers tended to praise their infants' behavior or qualities less ($t_{22} = 1.68, p = .11, 1-\beta = .51$), convey positive feeling when speaking to or of their infants ($t_{17} = 2.42, p = .03$), and show positive responses to praise of their infants by the

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Emotional and verbal responsivity of mother</td>
<td>6.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Avoidance of restriction and punishment</td>
<td>5.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Organization of environment</td>
<td>4.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Provision of appropriate play material</td>
<td>5.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Maternal involvement with child</td>
<td>3.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Opportunities for variety in daily stimulation</td>
<td>2.8</td>
<td>1.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>

*p < 0.05, two-tailed
research assistant ($t[17] = 1.96, p = .07$). Overall, control dyads scored significantly higher on the total HOME score using Student's $t$-test for independent groups ($t[22df] = -2.26, p = .03$). Control dyads averaged 31.3 (SD = 2.8) while the mean value for the colic dyads was 28.8 (SD = 2.8). The correlation between group and total HOME score was $r_{pb} = .43$ ($p = .034$). Omega-square calculation revealed that the group variable accounted for roughly 15 percent of the variance in the total HOME scale score in this sample ($power = .49$). Of interest from an exploratory standpoint were individual items on the HOME scale that did and did not differentiate the two study groups. Mothers of colicky infants tended to be more likely to overtly express annoyance with or hostility toward the infant ($t[22] = 7.42, p = .001$), to provide toys for music and literature ($t[17] = -1.96, p = .07, 1-\beta = .62$), and to have books available for their infants, despite their young age ($t[20] = -2.24, p = .04$). However, mothers of colicky infants tended to report less reading to their infants ($t[20] = 1.34, p = .19, 1-\beta = .41$) and also less structuring of play periods ($t[22] = 1.68, p = .11, 1-\beta = .51$). Fathers of colicky infants were more likely than control group fathers to participate in caregiving on a daily basis ($t[21] = 1.96, p = .07, 1-\beta = .62$). Colic and control dyads did not differ in terms of general organization of the environment; both groups of infants got out of the house on a regular basis, both had special places for their personal belongings, both were routinely cared for by a regular
substitute when the mother was away, and both lived in environments that were hazard free.

Mean scores for colic and control dyads on the FFFS subscales and the Family APGAR are presented in Table 30. While differences between means were observed on all four of the FFFS subscales, none of the differences were significant at \( p < .05 \). On the "discrepancy" subscale, case dyads averaged 11.7 (SD = 12.1) whereas control dyads averaged 4.3 (SD = 7.0) (\( t[10df] = 1.57, p = .15 \)). ["Discrepancy" scores are absolute scores calculated by summing the difference between 'how much is there' and 'how much should there be']. The extreme variability and small group sample sizes (colic = 8 and control = 11) suggested that statistical power may be too low to adequately test this hypothesis. Posthoc power analysis revealed 58 and 47 percent chances, respectively, of correctly rejecting the null hypothesis of no difference in "discrepancy" and "now" scores between the two groups (\( Q = .05 \)). ["Now" scores are absolute scores calculated by summaing scores on 'how much is there now']. Given such a low power, a conclusion of no significant group difference is tentative. The correlation between the group variable and the discrepancy score was \( r pb = -.38 \) (\( p = .11 \)).

On the Family APGAR, colic dyads averaged 11.7 (SD = 5.2) while the mean value for the control dyads averaged 16.2 (SD = 2.3). This difference was significant at \( p = .02 \) (\( t[14df] = -2.58 \)). The correlation between the group variable and the family APGAR score was \( r pb = .50 \) (\( p = .02 \)). Calculation of omega squared revealed that the
group variable roughly accounted for 20 percent of the variance in the family APGAR scores in this sample (approximate power = .65).

In summary of question five, hypothesis number one was partially supported; while colic group mothers and infants tended to have lower mean scores, these differences were not significant at p < .05. Again, caution is warranted in accepting the null hypothesis given the general low power of the statistical tests. For the total interaction scores, however, the null hypothesis was rejected at p < .05; colic mother-infant dyads had lower interaction scores than did control dyads.

On the HOME assessment, colic dyads had significantly lower scores than did the control dyads. Therefore, the null hypothesis was rejected at p = .03 and the second hypothesis was supported.

TABLE 30

MEANS, STANDARD DEVIATIONS, AND T-TEST RESULTS FOR FFFS AND FAMILY APGAR SCORES

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFFS (n = 19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How much now</td>
<td>93.6</td>
<td>15.7</td>
</tr>
<tr>
<td>How much should be</td>
<td>103.4</td>
<td>17.5</td>
</tr>
<tr>
<td>Discrepancy</td>
<td>11.7</td>
<td>12.1</td>
</tr>
<tr>
<td>How important</td>
<td>129.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Family APGAR (n = 22)</td>
<td>11.7</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*p = 0.02, two-tailed
The data failed to reject the null hypothesis of no difference between the two groups on FFFS discrepancy scores, although colic dyads tended to have higher discrepancies scores than control dyads. Given the low power to test this hypothesis, however, this finding must be viewed with caution.

Finally, colic dyads had significantly lower scores on the family APGAR as compared to control dyads; the null hypothesis was rejected at $p = .02$. Therefore, hypothesis four was supported.

QUESTION 6: WHAT IS THE RELATIONSHIP BETWEEN BASELINE MATERNAL CRY PERCEPTION AND THE INFANT'S CAREGIVING ENVIRONMENT?

Data from maternal perception of cry sound quality, maternal interview, maternal self-report, and mother-infant observation were used for this objective. The hypotheses were:

1. There will be no differences between colic and control mothers on perception of standard cry sound quality.

2. Mothers of colicky infants will perceive their own infants' cry as more aversive than control mothers perceive their own infants' cry.

3. There will be no correlation between maternal perception of standard cry sound quality and summary scores on the NCAFS, HOME, FFFS, Family Apgar.

4. There will be no correlation between maternal perception of own infant cry sound quality and summary scores on the NCAFS, HOME, FFFS, Family Apgar.

The first two hypotheses were tested using means, standard deviations, t-tests, power analysis and magnitude scaling. Pearson
Product Moment Correlations (PPMC) were computed to test hypotheses three and four.

At study entry, all mothers listened to the same two cry-recordings in standard order: first the cry of an infant with colic followed by a "pain-induced" cry-recording. Maternal baseline cry perception scores as derived from listening to these two cry segments are depicted in Table 31, with the higher values reflecting a more negative perception. After listening to the pain cry, while there were mean differences between the two groups across the four subscales, none of the differences were significant at $p < .05$.

Colic and control group mothers found the pain cry to be equally

| TABLE 31 |
| MEANS, STANDARD DEVIATIONS, AND T-TEST RESULTS OF MOTHERS' BASELINE CRY PERCEPTION SCORES |

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC</th>
<th>CONTROL</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>PAIN CRY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aversiveness</td>
<td>48.2</td>
<td>8.6</td>
<td>43.8</td>
</tr>
<tr>
<td>Affective</td>
<td>12.1</td>
<td>4.0</td>
<td>10.4</td>
</tr>
<tr>
<td>Caregiving</td>
<td>30.1</td>
<td>5.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Quality</td>
<td>47.2</td>
<td>7.2</td>
<td>41.5</td>
</tr>
</tbody>
</table>

| COLIC CRY    |       |         |     |      |     |
|--------------|-------|---------|-----|
| Aversiveness | 52.8  | 7.9     | 53.8| 8.8  | -0.29*|
| Affective    | 13.5  | 4.6     | 12.4| 4.4  | 0.60*|
| Caregiving   | 31.2  | 3.8     | 32.4| 7.0  | -0.53*|
| Quality      | 56.1  | 8.3     | 56.0| 6.1  | 0.03*|

*p > 0.10, two-tailed
aversive (t[21] = 1.1, p = .29), and they reported similar affective (t[17] = 1.17, p = .26) and caregiving (t[20] = -.29, p = .77) responses. Mothers' ratings of cry quality ("badness") of the pain cry using a series of nine semantic differential subscales were not different between the two groups (t[21] = 1.82, p = .08, 1-β = .56).

Likewise, there were no perceptual differences between the two groups of mothers after listening to the "colic" cry. Again, mothers found it be equally "bad" (t[18] = .03, p = .98) and aversive (t[21] = -.29, p = .77), and they reported similar affective (t[20] = .60, p = .56) and caregiving responses (t[17] = -.53, p = .60). These data support a previous observation with respect to the low correlation (r = .34) between "own infant" fuss/cry quantity and maternal perception of a standard pain cry. Neither group status nor cry quantity were related to maternal perception of the sound quality of a standard cry.

In general, the colic cry was perceived by the entire sample to be more aversive, as reflected in the higher aversiveness scale score (M colic = 53.3, M pain = 46.0) and the higher "badness" score (M colic = 56.0, M pain = 44.0). Mothers would not have altered their caregiving as a function of the cry sound as reflected on the "caregiving" subscale scores.

At the home visit, all mothers listened to and rated their own infants' cry that had been tape-recorded at the baseline visit. None of the mothers were told that this cry was their own infant, but a
surprising two (17%) mothers in both groups did not originally identify it as such.

Table 32 compares how mothers in the two groups rated their own infants' cry. Colic group mothers tended to rate their infants' cries as sounding more aversive than did control group mothers, and this difference was statistically significant ($t[14] = 3.3$, $p = .005$). In other words, colic group mothers tended to rate their infants' cry as being more grating, urgent, arousing, distressing, discomforting, piercing, aversive, and irritating than did control group mothers. Mothers in the colic group also reported being more angry, alarmed, and frustrated when listening to the cry than did control group mothers ($t[18] = 2.56$, $p = .02$). There were no group differences with respect to caregiving, with colic and control mothers equally likely to engage in some sort of caregiving activity

| TABLE 32 |
| MEANS, STANDARD DEVIATIONS, AND T-TEST RESULTS OF MOTHERS' PERCEPTIONS OF THEIR OWN INFANTS' CRIES |
|---|---|---|---|---|---|---|
| VARIABLE | COLIC | CONTROL | t | * | p |
| AVERSIVENESS | 46.3 10.4 | 28.1 13.8 | 3.30* | * | < .01, two-tailed |
| AFFECTIVE | 11.6 4.8 | 6.4 4.4 | 2.56* | * | p < .05 |
| CAREGIVING | 29.0 7.3 | 29.0 6.1 | 0.00 | | |
| QUALITY | 46.4 8.5 | 30.0 10.4 | 3.38* | * | < .01, two-tailed |
In terms of cry quality or "badness," colic group mothers tended to rate their infants' cry as sounding significantly more unpleasant, awful, bad, rugged, hard, heavy, active, fast, and sharp than did control mothers ($t_{15\text{df}} = 3.96, p = .001$). Appendix R provides an item-by-item comparison of mothers' perception scores after listening to their own infants' cry.

To address the relationship between maternal cry perception and the caregiving environment, PPMC were computed between the three cry perception scores (colic cry, pain cry, own cry) and the four measures of the caregiving environment (NCAFS, HOME, FFFS, Apgar). Table 33 presents the correlations.

Only seven of the 48 correlations (14%) were significant at a $p$-value of less than or equal to .10, which is slightly more than what one would expect to occur by chance (10%). Therefore, the data fail to reject the null hypothesis of no difference. As such, in this sample, mothers' perception of standard and own cry sounds did not impact the caregiving environment.

In summary, the data supported all four hypotheses. Mothers of infants who experience colic do not perceive the cry sound any different from mothers of infants who do not have colic. However, mothers of colicky infants tend to rate their own infants' cry as more aversive, as having more of a "bad" quality to it, and as generating more frustration and anger than did control mothers. PPM correlations between maternal cry perception scores (standard and own infant) and caregiving environment scores were nonsignificant. This
### TABLE 33

CORRELATIONS AMONG MATERNAL CRY PERCEPTION SCORES AND ENVIRONMENTAL CAREGIVING SCORES

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CAREGIVING ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NCAFS</td>
</tr>
<tr>
<td><strong>COLIC CRY SCORES</strong></td>
<td></td>
</tr>
<tr>
<td>Aversiveness</td>
<td>.30</td>
</tr>
<tr>
<td>Affective</td>
<td>.20</td>
</tr>
<tr>
<td>Caregiving</td>
<td>-.25</td>
</tr>
<tr>
<td>Quality</td>
<td>.19</td>
</tr>
<tr>
<td><strong>PAIN CRY SCORES</strong></td>
<td></td>
</tr>
<tr>
<td>Aversiveness</td>
<td>.04</td>
</tr>
<tr>
<td>Affective</td>
<td>-.23</td>
</tr>
<tr>
<td>Caregiving</td>
<td>-.23</td>
</tr>
<tr>
<td>Quality</td>
<td>-.41**</td>
</tr>
<tr>
<td><strong>OWN CRY SCORES</strong></td>
<td></td>
</tr>
<tr>
<td>Aversiveness</td>
<td>-.16</td>
</tr>
<tr>
<td>Affective</td>
<td>.00</td>
</tr>
<tr>
<td>Caregiving</td>
<td>-.12</td>
</tr>
<tr>
<td>Quality</td>
<td>-.12</td>
</tr>
</tbody>
</table>

*E < 0.10, two-tailed  
**E < 0.05, two-tailed

suggests that any caregiving differences observed between the two study groups is due to something other than maternal perceptual differences.

**QUESTION 7:** WHAT IS THE RELATIONSHIP BETWEEN INFANT CRY QUANTITY AND THE INFANT'S CAREGIVING ENVIRONMENT?

Data to address this question were derived from seven days of diary data, maternal interviews, maternal self-report, and
mother-infant feeding observations. The hypotheses that were tested were:

1. NCAFS maternal, infant, and total scores will vary as a function of cry quantity.
2. HOME subscale scores will vary as a function of cry quantity.
3. Family functioning "now" and "discrepancy" scores will vary as a function of cry quantity.
4. Family satisfaction scores will vary as a function of cry quantity.

Table 34 presents PPM correlations between the cry quantity measures and the NCAFS scale scores. There were very strong, positive correlations between the fussing behavior of infants with colic (as measured via diary data) and maternal summary scores ($r = .75, p < .01$) and the total interaction scores ($r = .70, p < .01$). In other words, in the colic subgroup, the more the infant fussed, the mother was more responsive and the interaction between the mother and the infant was more synchronous. These correlations did not hold true for the control subgroup or for the sample as a whole. Unlike fuss quantity, cry quantity as measured via diary data ("objective") correlated negatively with subscale scores for both the colic subgroup and the sample as a whole. The more infants with colic cried, the lower were total maternal scores ($r = -.55, p < .10$, $1.6 = .60$) and the lower were total scale scores ($r = -.65, p < .05$). Once again, these correlations were absent in the control subgroup.
TABLE 34
CORRELATIONS AMONG INFANT FUSS AND CRY QUANTITY AND NURSING CHILD ASSESSMENT FEEDING SCALE SUBSCALE SCORES

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Mom</th>
<th>Infant</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OBJECTIVE</strong> (diary)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUSS hrs/day:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td>.75***</td>
<td>.03</td>
<td>.70***</td>
</tr>
<tr>
<td>Control</td>
<td>.09</td>
<td>-.48</td>
<td>-.07</td>
</tr>
<tr>
<td>Total</td>
<td>.00</td>
<td>-.33</td>
<td>-.11</td>
</tr>
<tr>
<td>CRY hr/day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td>-.55*</td>
<td>-.32</td>
<td>-.65**</td>
</tr>
<tr>
<td>Control</td>
<td>-.11</td>
<td>-.53*</td>
<td>-.25</td>
</tr>
<tr>
<td>Total</td>
<td>-.51***</td>
<td>-.48***</td>
<td>-.57***</td>
</tr>
<tr>
<td><strong>SUBJECTIVE</strong> (questionnaire)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRY hrs/day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td>.19</td>
<td>.30</td>
<td>.30</td>
</tr>
<tr>
<td>Control</td>
<td>-.04</td>
<td>-.18</td>
<td>-.09</td>
</tr>
<tr>
<td>Total</td>
<td>-.36*</td>
<td>-.43**</td>
<td>-.44**</td>
</tr>
<tr>
<td>EPISODES per day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colic</td>
<td>.45</td>
<td>-.02</td>
<td>-.42</td>
</tr>
<tr>
<td>Control</td>
<td>.03</td>
<td>-.10</td>
<td>-.01</td>
</tr>
<tr>
<td>Total</td>
<td>-.33</td>
<td>-.19</td>
<td>-.33</td>
</tr>
</tbody>
</table>

*p < 0.10, two-tailed

However, for the total sample (N = 24), cry quantity was negatively correlated with total maternal score (ρ = -.51, p < .01), total infant score (ρ = -.48, p < .01), and with total scale score (ρ = -.57, p < .01). This low correlation on the infant subscale was the first substantial indication that cry quantity relates to the
infant's contribution to the interaction. There was also a significant negative correlation ($r = -.48, p < .02$) between combined infant fuss/cry quantity and total infant score. As such, infants who fuss/cried more received lower scores during the feeding and the mother-infant interaction was more dysfunctional.

Similar but lower correlations were observed between maternal perception of amount of infant crying ("subjective") and NCAFS scores across the entire sample. Again, there were negative correlations between maternal report of cry quantity and total maternal score ($rpb = -.36, p < .10, 1-.A-.35$), total infant score ($rpb = -.43, p < .05$), and total scale score ($rpb = -.44, p < .05$). There were no significant correlations in either of the subgroups.

Mothers also estimated number of episodes of crying per day. There were no correlations between number of cry episodes and NCAFS scores in either of the subgroups or in the entire sample. Fuss/cry frequency seems to have less of an impact on the mother, the infant, or the interaction than does fuss/cry duration.

Table 35 presents the correlations between infant cry quantity via diary and maternal self-report (questionnaire) and the HOME subscale scores. There were significant negative correlations with emotional and verbal responsivity of mother and quantity of crying as determined via diary ($r = -.50, p < .05$) and maternal self-report ($r = -.45, p < .05$). The more the infant cried, or was perceived to cry, the less responsive was the mother. There were also moderate
TABLE 35
CORRELATIONS AMONG INFANT CRY QUANTITY AND HOME SUBSCALE SCORES

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CRY/diary</th>
<th>CRY/quest.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotional &amp; verbal responsiveness of mother</td>
<td>-.50**</td>
<td>-.45**</td>
</tr>
<tr>
<td>Avoidance of restriction and punishment</td>
<td>-.22</td>
<td>.00</td>
</tr>
<tr>
<td>Organization of environment</td>
<td>-.11</td>
<td>.04</td>
</tr>
<tr>
<td>Provision of appropriate play material</td>
<td>.41*</td>
<td>.36*</td>
</tr>
<tr>
<td>Maternal involvement with child</td>
<td>-.10</td>
<td>-.10</td>
</tr>
<tr>
<td>Opportunities for variety in daily stimulation</td>
<td>-.09</td>
<td>-.07</td>
</tr>
<tr>
<td>TOTAL SCALE SCORE</td>
<td>-.34*</td>
<td>-.25</td>
</tr>
</tbody>
</table>

*p < 0.10, two-tailed
**p < 0.05, two-tailed

Positive correlations between diary ($r = .41, p < .10, 1-\beta = .52$) and self-report ($r = .36, p < .10, 1-\beta = .35$) and provision of appropriate play material, suggesting that the mother provided more toys to the infant when s/he cried more, although these correlations did not reach significance at $p < .05$. Of interest were the significant negative correlations between number of cry episodes per day ($r = -.46, p < .03$) and number of times awakened at night ($r = -.53, p <$
with total HOME scores. HOME scores were lower when the infant had more cry episodes per day and awoke more frequently at night.

In summary, these data suggest that when infant cry quantity and cry frequency is excessive, or when the infant awakens frequently at night, there is less support available to the infant for cognitive, social, and emotional development in the home environment as assessed via the HOME.

As depicted in Table 36, the fuss/cry quantities overall were moderately correlated with the FFFS discrepancy score and the Family APGAR. The strongest correlation was with cry quantity as measured via diary data and the FFFS discrepancy score ($r = .60, p < .01$). However, there was also a relationship between maternal report ("subjective") of cry quantity and FFFS discrepancy score ($r = .49, p < .05$). There was a moderate correlation ($r = .44, p < .07, 1 - \alpha = .62$) between number of crying episodes per day and FFFS discrepancy score; amount of daily infant fussing did not correlate with FFFS discrepancy score, but it did moderately correlate ($r = -.41, p < .07, 1 - \alpha = .53$) with current family functioning (FFFS now) score, although the later did not reach significance. These data suggest that the quantity and frequency of infant crying (but not fussing) via either objective or subjective measurement impact family functioning. Families of infants who cried excessively were perceived by the mothers as functioning further away from the ideal.
TABLE 36

CORRELATIONS AMONG INFANT FUSS AND CRY QUANTITY AND THE FFFS AND THE FAMILY APGAR SCORES

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>DISCREP*</th>
<th>NOWb</th>
<th>APGAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SUBJECTIVE</strong> (questionnaire)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRY hrs/day</td>
<td>.49**</td>
<td>-.24</td>
<td>-.40*</td>
</tr>
<tr>
<td>EPISODES per day</td>
<td>.44*</td>
<td>-.25</td>
<td>-.15</td>
</tr>
<tr>
<td><strong>OBJECTIVE</strong> (diary)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRY hr/day</td>
<td>.60***</td>
<td>-.28</td>
<td>-.44**</td>
</tr>
<tr>
<td>FUSS hrs/day</td>
<td>.27</td>
<td>-.41*</td>
<td>-.41*</td>
</tr>
</tbody>
</table>

*aFFFS discrepancy score
bFFFS "how much is there"  
*p < 0.07, two-tailed
**p < 0.05, two-tailed
***p < 0.01, two-tailed

There were also moderate negative correlations with Family APGAR scores and cry quantity as measured via self-report ("subjective") (r = -.40, p = .07, 1-β = .41) and diary ("objective") (r = -.44, p = .05). Amount of daily infant fussing was also related to Family APGAR scores (r = -.41, p = .07, 1-β = .53), such that the more the infant fussed, the lower was the APGAR scores, but this difference was not significant at p < .05.

In summary of Question 7, the first hypothesis was supported; maternal, infant, and total NCAFS scores varied as a function of infant fuss and cry quantity, but they were not related to cry frequency. Hypothesis two was partially supported as only two of the
six subscales were correlated with cry quantity. So while the total HOME score did not correlate with cry quantity, it was negatively correlated with number of night wakings and number of cry episodes. Hypothesis three was also only partially supported; only family "discrepancy" scores correlated with cry quantity. Number of hours of fussing per day negatively correlated to family "now" scores on the FFFS. Finally, the fourth hypothesis was supported; family satisfaction scores via the Family APGAR were significantly correlated with cry quantity.

As an exploratory strategy, infant fuss and cry quantity and frequency were also compared with several maternal psychological measures, as depicted in Table 37. As is evident, fuss and cry quantity (singularly and combined) and cry frequency were strongly correlated with maternal perception of how much crying her baby had done, how much trouble her baby had feeding, how much difficulty her baby had in sleeping, and how predictable her baby was. Similarly, fuss and cry quantity (singularly and combined) and cry frequency "episodes" were also highly related to maternal subscale scores on the POMS. The more the infant fussed and cried, the more tense (τ = .79, p < .05), depressed (τ = .66, p < .05), fatigued (τ = .77, p < .05), confused (τ = .78, p < .05) and less vigorous (τ = .78, p < .05) were the mothers. As expected, SCLR-90 subscale scores also highly correlated with cry quantity and frequency, with mothers of excessive criers reporting more somatization (τ = .46, p < .05), obsession (τ = .66, p < .05), interpersonal sensitivity (τ = .45, p
**TABLE 37**

CORRELATIONS AMONG INFANT FUSS AND CRY QUANTITY AND MATERNAL PSYCHOSOCIAL MEASURES

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>FUSS</th>
<th>CRY</th>
<th>COMB.*</th>
<th>EPISODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFANT DIFFICULTY WITH-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crying</td>
<td>-.62***</td>
<td>-.76***</td>
<td>-.84***</td>
<td>-.81***</td>
</tr>
<tr>
<td>Feeding</td>
<td>-.49**</td>
<td>-.43***</td>
<td>-.57**</td>
<td>-.46**</td>
</tr>
<tr>
<td>Sleeping</td>
<td>-.61***</td>
<td>-.64***</td>
<td>-.77***</td>
<td>-.76***</td>
</tr>
<tr>
<td>Pattern</td>
<td>-.75***</td>
<td>-.30</td>
<td>-.69***</td>
<td>-.61***</td>
</tr>
<tr>
<td>PROFILE OF MOOD STATES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tension</td>
<td>.61**</td>
<td>.67**</td>
<td>.79**</td>
<td>.83**</td>
</tr>
<tr>
<td>Depression</td>
<td>.48**</td>
<td>.61**</td>
<td>.66**</td>
<td>.71**</td>
</tr>
<tr>
<td>Anger</td>
<td>.39</td>
<td>.45**</td>
<td>.51**</td>
<td>.56**</td>
</tr>
<tr>
<td>Vigor</td>
<td>-.68**</td>
<td>-.57**</td>
<td>-.78**</td>
<td>-.69**</td>
</tr>
<tr>
<td>Fatigue</td>
<td>.69**</td>
<td>.54**</td>
<td>.77**</td>
<td>.79**</td>
</tr>
<tr>
<td>Confusion</td>
<td>.64**</td>
<td>.62**</td>
<td>.78**</td>
<td>.80**</td>
</tr>
<tr>
<td>Total</td>
<td>.53**</td>
<td>.59**</td>
<td>.69**</td>
<td>.75**</td>
</tr>
<tr>
<td>SCLR-90</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Somatization</td>
<td>.32</td>
<td>.44**</td>
<td>.46**</td>
<td>.47**</td>
</tr>
<tr>
<td>Obsessive</td>
<td>.62**</td>
<td>.41**</td>
<td>.66**</td>
<td>.64**</td>
</tr>
<tr>
<td>Interpersonal</td>
<td>.25</td>
<td>.51**</td>
<td>.45**</td>
<td>.53**</td>
</tr>
<tr>
<td>Depression</td>
<td>.56**</td>
<td>.56**</td>
<td>.70**</td>
<td>.68**</td>
</tr>
<tr>
<td>Anxiety</td>
<td>.48**</td>
<td>.68**</td>
<td>.70**</td>
<td>.70**</td>
</tr>
<tr>
<td>Hostility</td>
<td>.25</td>
<td>.35</td>
<td>.37</td>
<td>.38</td>
</tr>
<tr>
<td>Phobic Anxiety</td>
<td>.49**</td>
<td>.54**</td>
<td>.63**</td>
<td>.63**</td>
</tr>
<tr>
<td>Paranoid</td>
<td>.13</td>
<td>.39</td>
<td>.30</td>
<td>.36</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>.34</td>
<td>.51**</td>
<td>.51**</td>
<td>.54**</td>
</tr>
<tr>
<td>GSI TOTAL</td>
<td>.42**</td>
<td>.52**</td>
<td>.58**</td>
<td>.59**</td>
</tr>
</tbody>
</table>

* fuss and cry quantity combined

**p < 0.05, two-tailed,**

***p < 0.01, two-tailed

p < .05), depression (r = .70, p < .05), anxiety (r = .70, p < .05), phobic anxiety (r = .63, p < .05), and psychoticism (r = .51, p < .05).
QUESTION 8: WHAT IS THE RELATIONSHIP BETWEEN MATERNAL PSYCHOSOCIAL CHARACTERISTICS AND THE INFANT'S CAREGIVING ENVIRONMENT?

The hypotheses that were tested were:

1. NCAFS total scores will be inversely related to maternal mood state scores.
2. HOME total scores will be inversely related to maternal mood state scores.
3. Family functioning discrepancy scores will be positively correlated with maternal mood state scores.
4. Family APGAR scores will be inversely related to maternal mood state scores.

To test these hypotheses, PPM were computed between the two affective state measures (POMS and SCLR-90) and the four measures of the caregiving environment (NCAFS, HOME, FFFS, Apgar). Table 38 depicts the correlations.

Only one of 19 subscale scores on the maternal psychological measures was significantly related to the total NCAFS score at $p < .05$; mothers who had higher scores on the SCLR-90 Somatization subscale tended to have lower NCAFS interaction scores ($r = -0.45$, $p = 0.03$). Since having one significant correlation out of 19 is what one would expect to occur by chance (5%), the data fail to support rejection of the null hypothesis. Therefore, hypothesis one was rejected.

With respect to HOME scale correlations (hypothesis two), five of the six POMS subscale scores and the total mood disturbance score were negatively correlated with the total HOME scale score at $p < .10$. 
TABLE 38

CORRELATIONS AMONG MATERNAL PSYCHOLOGICAL CHARACTERISTICS
AND ENVIRONMENTAL CAREGIVING SCORES

<table>
<thead>
<tr>
<th>VARIABLES OF MOOD STATES</th>
<th>CAREGIVING ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NCAFS(^a)</td>
</tr>
<tr>
<td>Tension</td>
<td>-.38</td>
</tr>
<tr>
<td>Anxiety</td>
<td>-.31</td>
</tr>
<tr>
<td>Anger</td>
<td>-.24</td>
</tr>
<tr>
<td>Vigor</td>
<td>.30</td>
</tr>
<tr>
<td>Fatigue</td>
<td>-.12</td>
</tr>
<tr>
<td>Confusion</td>
<td>-.23</td>
</tr>
<tr>
<td>Total</td>
<td>-.27</td>
</tr>
</tbody>
</table>

SCLR-90

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CAREGIVING ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NCAFS(^a)</td>
</tr>
<tr>
<td>Somatization</td>
<td>-.45*</td>
</tr>
<tr>
<td>Obsessive</td>
<td>-.22</td>
</tr>
<tr>
<td>Interpersonal sensitivity</td>
<td>-.22</td>
</tr>
<tr>
<td>Depression</td>
<td>-.27</td>
</tr>
<tr>
<td>Anxiety</td>
<td>-.35</td>
</tr>
<tr>
<td>Hostility</td>
<td>-.14</td>
</tr>
<tr>
<td>Phobic anxiety</td>
<td>-.27</td>
</tr>
<tr>
<td>Paranoid ideation</td>
<td>-.30</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>-.35</td>
</tr>
<tr>
<td>GSI</td>
<td>-.31</td>
</tr>
<tr>
<td>PSDI</td>
<td>-.33</td>
</tr>
<tr>
<td>PST</td>
<td>-.27</td>
</tr>
</tbody>
</table>

\(^a\)total scale score \(^*\)=p < 0.05, two-tailed
\(^b\)discrepancy score \(^**\)=p < 0.01, two-tailed
\(^***\)=p < 0.001, two-tailed

The "vigor" POMS subscale was the only subscale that had a positive relationship with total HOME score, but that correlation was not significant (r = .21, p = .32). SCLR-90 subscale and total scores revealed a similar pattern; six of the nine subscales were inversely related to HOME total scores at p < .05; the subscales of
"hostility," "paranoid ideation," and "psychoticism" were not significantly correlated with the total HOME score. The three summary scores on the SCLR-90, the Global Severity Index (r = -.53, p < .01), Positive Symptom Distress Index (r = -.43, p < .05), and the Positive Symptom Total (r = -.51, p < .01), were all inversely related to total HOME scores. Thus, the data support rejection of the null hypothesis, since total HOME scores were in general inversely related to maternal psychological functioning as measured via the POMS and the SCLR-90.

The third column in Table 38 depicts the correlations between family functioning as assessed via the FFFS discrepancy score and maternal mood states. While all the correlations were in the hypothesized direction, only one out of 19 (5%) was significant at p<.05, which is what one would expect to occur by chance. As such, the data failed to support rejection of the null hypothesis, so hypothesis three was rejected.

Family APGAR scores were negatively correlated with 15 out of the 19 (80%) maternal mood subscale scores at p<.05. On the POMS, mothers with lower Family APGAR scores had higher scores on the anger (r = -.79, p < .001), anxiety (r = -.73, p < .001), confusion (r = -.71, p < .001), and tension (r = -.61, p < .01) subscales. The total mood disturbance score on the POMS was also significantly correlated with total family APGAR score at r = -.74 (p < .001). On the SCLR-90, mothers with lower Family Apgar scores had higher interpersonal sensitivity (r = -.55, p < .01), depression (r = -.53,
p < .01), psychoticism (r = -.47, p < .05), and anxiety (r = -.47, p < .05) subscale scores. Family APGAR scores were also inversely related to Global Severity Index (r = -.43, p < .05), Positive Symptom Distress Index (r = -.51, p < .01), and Positive Symptom Total (r = -.46, p < .05) summary scores on the SCLR-90. The only subscale scores that were not related to Family APGAR scores were somatization, obsessive-compulsive, hostility, phobic anxiety and paranoid ideation. The data support rejection of the null hypothesis, since Family APGAR scores were in general inversely related to maternal mood states as measured via the POMS and the SCLR-90. Hence, hypothesis four was supported.

QUESTION 9: WHAT IS THE RELATIONSHIP BETWEEN INFANT BIOBEHAVIORAL CHARACTERISTICS AND THE INFANT’S CAREGIVING ENVIRONMENT?

The hypotheses that were tested were:

1. There will be no relationship between infant age/gender and caregiving environment scores.

2. There will be no relationship between number of feedings per day and caregiving environment scores.

3. There will be no relationship between total hours of sleep per day and caregiving environment scores.

4. There will be no relationship between mean number of night awakenings and caregiving environment scores.

5. There will be no relationship between infant soothability and caregiving environment scores.
To test these hypotheses, PPM were computed between the variables of age (in weeks), gender, number of feedings, hours of daily sleep, number of night awakenings, and maternal perception of infant soothability and the four measures of the caregiving environment (NCAFS, HOME, FFFS, Apgar). Table 39 depicts the correlations.

Aside from the two variables related to crying, quantity and frequency, in general there were no significant relationships between infant biobehavioral variables and caregiving environment scores. The variable "number of night awakenings," was the only infant variable that significantly correlated ($r = -.53$, $p < .01$) with any of the caregiving measures; as previously observed, total HOME scores were lower the more times the infant awoke in the middle of the night. And despite the fact that infants in the colic group slept less, amount of daily sleeping was not significantly related to any of the caregiving measures. Maternal perception of infant soothability tended to be moderately related to NCAFS ($r = .31$) and HOME summary scores ($r = .35$), but these correlations were not significant at $p < .05$.

There were some surprising correlations between gender and the caregiving measures that were not evident across the sample. Across the entire sample ($N = 24$), gender did not correlate with either NCAFS interaction scores ($r = .15$, $p = .48$), HOME total scores ($r = .18$, $p = .40$), FFFS discrepancy scores ($r = -.01$, $p = .97$), or Family APGAR scores ($r = -.09$, $p = .68$).
### Table 39
CORRELATIONS BETWEEN INFANT BIOBEHAVIORAL CHARACTERISTICS
AND ENVIRONMENTAL CAREGIVING SCORES

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>CAREGIVING</th>
<th>ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NCAFS&lt;sup&gt;a&lt;/sup&gt;</td>
<td>HOME&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>AGE</td>
<td>-.19</td>
<td>.13</td>
</tr>
<tr>
<td>GENDER</td>
<td>.15</td>
<td>.18</td>
</tr>
<tr>
<td>FEEDINGS/day</td>
<td>.24</td>
<td>.19</td>
</tr>
<tr>
<td>SLEEP/day</td>
<td>.28</td>
<td>.22</td>
</tr>
<tr>
<td>CRY EPISODES</td>
<td>-.51&lt;sup&gt;***&lt;/sup&gt;</td>
<td>-.43&lt;sup&gt;**&lt;/sup&gt;</td>
</tr>
<tr>
<td>CRY QUANTITY</td>
<td>-.57&lt;sup&gt;***&lt;/sup&gt;</td>
<td>-.34&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>NIGHT AWAKENINGS/day</td>
<td>-.31</td>
<td>-.53&lt;sup&gt;***&lt;/sup&gt;</td>
</tr>
<tr>
<td>SOOTHABILITY (%)</td>
<td>.31</td>
<td>.35&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>summary score  
<sup>b</sup>discrepancy score

***<sub>p < 0.01, two-tailed</sub>  
**<sub>p < 0.05, two-tailed</sub>  
*<sub>p < 0.10, two-tailed</sub>

In terms of mean group differences, in the colic subgroup, mothers of male infants tended to have significantly (t<sub>[6]</sub> = 2.28, p = .06) higher NCAFS scores (male = 35, female = 27) and the interaction scores tended (t<sub>[6]</sub> = 1.45, p = .19) to be higher for males who were colicky (male = 52, female = 46). In the control subgroup, differences were in the opposite direction. Mothers of female control infants tended to have significantly (t<sub>[8.0]</sub> = -1.87, p = .09) higher scores (female = 40, male = 33) and the total
interaction score also tended ($t[9] = -1.81, p = .10$) to be higher (female = 61, male = 52). Gender differences on infant summary scores in either subgroup were nonexistent.

Gender differences were also present on HOME subscale scores, with male infants scoring significantly lower ($t[21] = -2.48, p = .02$) on the "Maternal involvement with child" subscale than female infants (male = 3.2, female = 4.4). In the control subgroup, again there were similar differences on the "Maternal involvement with child" subscale, with male infants having significantly ($t[9] = -3.08, p = .01$) lower scores than female infants (male = 3.0, female = 4.9). The total HOME score was also significantly lower ($t[10] = -2.67, p = .02$) for male infants as compared to female infants (male = 2.9, female = 33). There were no gender differences on any of the HOME subscales in the colic subgroup.

Other than cry/fuss duration, most of the correlations were in the hypothesized direction, with only one out of 20 being significant at $p < .05$. Hypothesis one was only partially supported as there were some unexpected gender differences across the two groups on most of the care-giving measures. Infant age did not correlated with any of the caregiving measures. For hypothesis two through four, the data failed to support rejection of the null, so these were supported.

**QUESTION 10:** WHAT IS THE RELATIONSHIP BETWEEN MATERNAL PERCEPTION OF "OTHER INFANT" CRIED TO MATERNAL PERCEPTION OF "OWN INFANT" CRIES?
The hypotheses that were tested were:

1. There will be no relationship between maternal perception of own infant cry and perception of a colic cry.

2. There will be no relationship between maternal perception of own infant cry and perception of a pain cry.

To test these hypotheses, PPM were computed among the three semantic differential scales mothers completed after listening to a 30-second segment of her own infant's cry, the cry of an infant with colic, and the cry of an infant experiencing a painful procedure. Table 40 depicts the intercorrelations.

All of the correlations were low and only one approached significance; there was an inverse relationship of moderate magnitude between maternal perception of colic cry aversiveness and maternal perception of pain cry aversiveness (r = -.31, p = .16). The correlations between maternal perception of own infants' cry to the

**TABLE 40**

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) COLIC CRY</td>
<td>-.31*</td>
<td>.13</td>
</tr>
<tr>
<td>2) PAIN CRY</td>
<td>.20</td>
<td></td>
</tr>
<tr>
<td>3) OWN CRY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p = 0.16, two-tailed
two standard cries were low and not significant. As such, the data failed to reject the null hypotheses, so the hypotheses as stated were supported. How a mother perceived infant cry sounds in general was not related to how she perceived her own infant's cry sound.
DISCUSSION OF THE FINDINGS

The discussion is divided into several sections. The first section addresses the biobehavioral results between colic and control infants as it relates to reports in the literature. The second examines maternal psychosocial and family demographic characteristics of colic and control infants. Mother-infant interaction differences in context of the conceptual framework are presented in the third section. This discussion provides parameters to further describe infant colic.

INFANTS

Twelve infants with colic and 12 infants without colic participated in this matched, case-control study. Infants were matched on the variables of age (± 2 weeks) and gender. All infants were singletons, approximately seven weeks of age, and without acute or chronic illness at study entry.

Analysis of demographic variables revealed no significant differences between the two study groups in terms of maternal age, paternal age and socioeconomic status. Covington (1990) found in her study of 38 newborns with colic that fathers' education of colicky infants was significantly higher than those in the noncolic group; a finding she hinted may simply be sampling artifact. Educated fathers may be more likely to seek out professional advice for their infants' crying and hence more apt to be recruited into a clinical study.
In general, infants with colic did not differ in the newborn period from infants without colic. Other studies have suggested differences in birth weight (Bruce, 1961; Illingworth, 1954; Meyer & Thaler, 1971), but these findings were not supported in this study. Birth weight and length were nearly identical, and one and five minute APGARs were not significantly different from one another. While not significant, there were mean differences between the two groups in terms of gestational age, method of delivery, and problems after birth. Forty-two percent (n = 5) of infants with colic as compared to eight percent (n = 1) of infants without colic were born either prior to 38 weeks or after 42 weeks gestational age, and 50 percent (n = 6) of infants with colic as opposed to 17 percent (n = 2) of infants without colic reportedly had problems after birth. Further, all infants with colic were delivered vaginally, as compared to only eight (67%) control group infants. Rubin and Prendergast (1984) found an association between colic and intensity of the labor process. These combined results suggest that perinatal/birth stress associated with either prematurity or postmaturity and a difficult labor could be implicated in the presentation of colic, thereby supporting the position that colic is biologically-based. Or, since feeding and fussiness behavior in colicky infants are present at one week (Covington, 1990), colic may be present at birth, develop more fully after the newborn recovers from the birth process during the first week of life, and be in full bloom by two to three weeks of age (Covington). The universal features of colic, such as age of
presentation and resolution, associated infant behaviors of hypertonicity, unconsol-ability, consolidation of crying in the evening, and erratic day-to-day presentation, taken together offer some support to the contention that colic is innately determined.

The mean age of colic onset for the 12 infants with colic was 2.3 weeks, which is slightly higher than the 1.8 week onset age Paradise (1966) reported. Two of the three colic group mothers whose second-born infants were in the study reported that their firstborn infants had also been colicky; no second-born infants in the control group had older siblings who had been colicky. This observation lends support to the contention in the literature that infants with colic tend to have siblings with colic (Stahlberg, 1984; Taylor, 1957). While several studies have suggested that colic can last up to six months of age (Pinyerd, 1987; Rubin & Prendergast, 1984), in most infants colic subsides by 16 weeks of age (Illingworth, 1954). In this study, the mean age of resolution of the colic was 12.1 weeks, which is over one week less than Paradise’s (1966) mean of 13.6 weeks.

Contrary to popular belief, colicky spells were not necessarily confined to the evening hours. While 42 percent of colicky infants at study entry did cry the most between 6:00 pm and 12:00 midnight, 50 percent of the mothers reported that their infants’ crying was erratic each day. Mothers of two of the five infants whose crying was confined to the evening hours reported that at the onset of the colic the crying had been erratic in nature, but had gradually
changed to being consolidated into evening hours. It may be that the pattern of colicky crying is initially diffuse, but that as the infant gets older it tends to cluster into the evening hours, supporting a maturational theory of etiology. Hide and Guyer (1982) failed to find any significant pattern as to time of day for colic, other than that it was never most severe during the morning hours. In this study, the colicky infants as a group fussed/cried the most ($M = 1.9$ hours) in the afternoon (12:00 noon to 6:00 pm); however, the mean was 1.8 hours in the evening (6:00 pm to 12:00 midnight). The colicky infants fuss/cried the least ($M = 1.1$) in the morning (6:00 am to 12:00 noon). The general picture for these infants with colic was to cry off and on throughout the entire day. Colic does not simply represent a few hours of fussing and crying in the evening as is commonly perceived (Gillies, 1987).

During the physical examination, infants with colic generally exhibited clenching of the hands/fists, flexion of the elbows, increased motor activity, face flushing, and drawing of their arms up to their abdomens. These features, along with the fact that colic spells not only come and go, but sometimes occur after meals, suggest that the infant is experiencing waves of colonic spasms that might inflict pain upon the infant. Parents often seek professional advice based on the belief that their infant is in pain. Indeed, infants in pain are described as exhibiting thrashing frantic activity, back arching, color changes, and hyperextension of the arms and legs (Budreau & Kleiber, 1991), but these behaviors could constitute the
infant's generalized response to any type of stressor. While the gastrointestinal pain theory has been around for over 50 years, the scant empirical work has led to continued debate and discussion (Carey, 1984; Geertsma & Hyams, 1989). Practitioners who assume colic is gastrointestinal pain generally attribute colic to be of gastrointestinal origin; hence, pharmacological agents and formula modifications are frequently attempted.

In terms of pharmacological intervention, 10 of the 12 infants were on medication for colic, including Chloral Hydrate®, Phénobarbital®, and Mylicon®. Chloral hydrate® is one of the oldest and most frequently used sedative-hypnotic drugs in pediatrics. However, while it is a powerful drug that is effective in calming the infant, it has many undesirable side effects, primarily gastrointestinal tract irritation and undesired drowsiness. Further, if indeed colic is pain-associated, chloral hydrate has little to no analgesic activity. Phénobarbital®, an antispasmodic/barbiturate with generalized sedative effects, is difficult to titrate to achieve a desired sedative effect without significant general depression of the central nervous system. Another concern is that Phénobarbital®, like Chloral hydrate®, has no analgesic effect, and in low doses may actually increase pain perceptions and reactions (Harvey, 1985). How use of sedatives such as Chloral Hydrate® and Phénobarbital® affects long-term development (Gordin, 1990) and parent-infant interaction may be of concern.
Antiflatulents have emerged as a popular alternative agent and in this study nine of the 12 infants were on Mylicon®. The explanation as to the antiflatulent’s popularity relates to the presumption that colicky infants have excess gas production that is either causing or is a result of the excessive crying. Mylicon® and "colic drops" claim to work by dispersing and preventing the formation of gas pockets in the intestinal tract. The only study conducted on infants with colic to examine these possibilities found no excessive gas using radiologic studies (Jorup, 1942). The pharmacological data on efficacy of antiflatulents is contradictory; one study found Mylicon® to be ineffective (Hwang & Danielsson, 1985) and a second found it to be more effective than a placebo (Sethi & Sethi, 1988).

A second popular intervention is formula modification (Pinyerd & Zipf, 1987). Colic has been blamed on formula that is either too hot, too cold, too rich, too weak, or contains too much carbohydrate, too much fat, or too much protein (Illingworth, 1954). Empirical information about lactose and protein intolerance in colicky infants is both extensive and conflicting. Some studies have found no relationship between the consumption of milk-containing lactose and colic symptoms (Evans, Allardyce, Fergusson et al., 1981; Liebman, 1981), intestinal damage (Thomas, McGilligan, Eisenberg et al., 1987), or breath hydrogen production (Hyams, Geertsma, Etienne & Treema, 1989). Others have reported an increased breath-hydrogen excretion in colicky infants (Miller, McVeagh, Fleet et al., 1989; Moore, Robb & Davidson, 1988), and increased concentration of cow’s
milk protein in breast milk (Clyne & Kulczycki, 1991), and a reduction or extinction of colicky symptoms after being milk-free (Jakobsson & Lindberg, 1983; Lothe, Ivarsson & Lindberg, 1982; Lothe & Lindberg, 1989). Given the contradictory findings, the role of "special," milk- and protein-free formulas in the management of colic is unknown. Yet formula modifications continue to be one of the most popular approaches toward management (Pinyerd, 1987), with mothers in this study averaging at least 1.5 formula changes in the first six months of life. And most of these changes (n = 6 out of 9) were to soy formulas as prescribed by physicians, a troubling observation since the Committee on Nutrition of the American Academy of Pediatrics recommends that soy-protein formulas not be used "in the routine management of colic" (American Academy of Pediatrics, 1983).

Seven infants with colic who were originally breast-fed were on formula by the time they were seven weeks of age. Barr et al. (1989) examined the efficacy of switching from breast to bottle by comparing cry quantity, frequency, and patterns of infants who were solely breast-fed at seven weeks of age to infants who were initially breast-fed but had been switched to formula feeding by six weeks of age. They found no 24-hour differences in duration or frequency of crying/fussing. However, the crying of infants who had been changed to formula feeding tended to "even out" during the day, with proportionally less evening crying; in other words, these infants did exhibit a different distribution of fussing and crying through the day. This may help explain why following a change to formula feeding
there is often the perception of a reduction in total cry duration, which is not the case. It seems that a reduction in evening cry quantity generalizes to total daily cry quantity, perhaps because it occurs at the busiest time of day, thereby making it the most difficult to handle.

Related to type of feedings is number of feedings. Both under- and overfeeding have been cited as causes of colicky crying (Birdson, 1975). Some investigators have reported that colicky infants are overfed due to their behaviors which mimic hunger and the mothers' attempts to abate those behaviors (Bernal, 1972; Carey, 1985; Covington, 1990; Stewart et al., 1954; Wessel et al., 1954). Feeding is also often reported as a consolation technique, although mothers acknowledge that it is one of the least effective strategies. Further, mothers of colicky infants often report as problematic the fact that their infants feed too often (Covington, 1990). Contrary to these observations, this study found no difference in feeding frequency between infants with colic and without colic.

Some clinicians have noted that more irritable infants are fed solids at an earlier age by exhausted mothers in an attempt to quiet them. In this study, four infants with colic had been fed solids prior to seven weeks of age in attempt to diminish their crying. In the late thirties, early introduction of cereal was recommended as a treatment for colic (White, 1936). More recently, some investigators have contended that too early introduction of solid foods is resulting in colicky crying (Hide & Guyer, 1982), although the
available evidence does not support introduction of solids before six months as being either causally (Diecsher & Goers, 1954) or therapeutically (Barr et al., 1989) related to colic symptoms. As anticipated, infants with colic cried and fussied significantly more than control group infants. The mean amount of crying as per maternal-maintained diary was consistent with quantities reported by other investigators (see Table 22, page 134). If cry quantity as proposed by Wessel et al. (1954) was the sole diagnostic criterion, the infants assigned to the colic group in this study would have failed entry. Combined fuss and cry quantity in infants with colic, however, averaged 5.3 hours/day, well above the Wessel criterion. Conversely, combined fuss/cry quantity in the control infants did not meet Wessel et al. criteria. Humphry and Hock (1989) noted a similar pattern, and Barr and colleagues now combine fuss/cry quantity in their studies (Barr et al., 1989; Barr et al., 1991; Hunziker & Barr, 1988). Cry quantity was unrelated to gender, a finding supported by Humphry (1985).

Infant fussing, defined as "whining or crying off and on, associated with increased arm and leg activity," showed some interesting associations. In the colic subgroup only, there were very strong positive correlations between fuss quantity of infants with colic and maternal summary scores on the NCAFS and interaction scores on the NCAFS. These correlations were not present in the control group or for the sample as a whole, suggesting that when fuss quantity does go beyond a certain point, mothers become more
sensitive and responsive, resulting in a more positive and contingent interaction between her and her fussy infant.

Colicky infants in this study not only cried more, but they had more episodes of crying per day, defined as at least 30 minutes of sustained crying. Infants with colic exhibited lengthy, single episodes (up to six hours) as well as frequent short episodes (up to nine episodes per day). The crying in any one infant, while fairly constant in terms of daily duration, was quite variable in terms of daily presentation.

In this study, seven week-old infants in the control group fussed/cried an average of 1.1 ($\text{SD} = 0.7$) hours per day. Four to six week-old noncolicky infants have been reported to cry 1.0 hours per day (Taubman, 1984), 2.1 hours/day (Humphry & Hock, 1989), 2.2 hours/day (Hunziker and Barr, 1986), and 1.5 hours/day (Wikander & Wahlberg, 1987). As Taubman (1984) reported, colicky infants cried at three to four times more than did control infants.

In terms of maternal perception of crying, this study found a high correlation between maternal estimation of cry quantity and later cry quantity via diary recordings. Mothers seem to be reliable historians, such that when they bring their infants to the emergency room, physician's office, or clinic and report excessive infant crying of at least two to three hours per day, their complaint should be taken seriously. Twelve mother-infant dyads were referred to the study because of their "excessive" (three hours per day) crying but
did not meet the study entry criteria when diary data did not substantiate the mothers' report.

Of related interest was the incongruence between control group mothers' perception of cry quantity and cry quantity via diary. Mothers of control infants (who generally cried less than 60 minutes per day) were poor estimators of cry quantity. As such, there seems to be a certain cry quantity threshold beyond which the mother is a valid historian. This finding has important clinical implications; when a mother seeks professional advice for crying that is reportedly three hours per day, she is not to be viewed as an exaggerating, overanxious mother suffering from typical postpartum anxiety, but a mother who has a real complaint that needs to be addressed. The research implication is not quite as obvious; maternal subjective impression of cry quantity, while valid, may not be a reliable operationalization of cry quantity when the goal is to document quantity reduction following intervention. Thus, a more strict operationalization would be appropriate, such as in-home audio recordings or diary records.

Infants with colic exhibited different sleep-wake patterns from infants without colic. Parmelee (1964) and Traisman (1966) reported that total daily sleep duration in noncolic 6 to 8 week-old infants was between 14 and 18 hours, with the average being 16.0 hours per day. Colicky infants tended to spend more time in an awake/alert state (\(M = 11.0\) for colicky infants versus 9.1 for control infants) and less time in a sleep state (\(M = 14.5\) control infants versus 12.8
colicky infants) as reported by their mothers. Once asleep, the infants with colic had more night waking ($M = 2.3$ infants with colic and $0.9$ control infants). This observation supports Weissbluth and colleague's (1984) finding that infants with colic had shorter daily sleep durations and increased frequency of night awakenings. Humphry and Hock (1989) reported similar patterns, with colicky five week-old infants sleeping an average of 13.4 hours per day as compared to control infants who slept an average of 14.3 hours per day. Humphry (1985) also reported that the infant with colic tends to cry himself/herself to sleep more than the infant in the noncolic group. In terms of daily awake (non-crying) time, Humphry reported that control infants averaged more time in a quiet/alert state than did infants with colic.

While infants with colic in general had lower interaction scores on the NCAFS, the differences between the two groups in terms of responsiveness and cue clarity was not significant. Based on the literature and personal experience, it had been expected that colicky infant would have contributed to the disruption of interaction synchrony by virtue of their inability to give clear cues to their mothers, and by their inability to be consoled for any extended period of time. Shaw (1977) reported that 9-14 month-old infants who had cried excessively as newborns looked at, smiled at, and vocalized to their mothers significantly less than did infants in the control group during a 30-minute play session. Wikander & Wahlberg (1987) reported that colicky infants showed "dissatisfaction more
frequently" during a feeding session than did the noncolicky infants. In the investigator's study, however, colicky infants failed to exhibit less clear cues. In fact, infants with colic tended to be less likely to turn away or avert gaze from their mothers. This finding is in sharp contrast to the observation that infants with colic tended to spend more time looking away from the mother during a 5-minute "play observation" when compared to control infants (Humphry, 1985).

During the feeding, colicky infants tended to fuss periodically and seemed to be more difficult feeders. On a positive note, however, colicky infants did not differ from controls in terms of smiles and laughs, and they were more responsive to their mothers game-playing during the feeding than were control infants. This finding is similar to what Campbell (1979) found; while difficult infants had significantly higher crying duration and episodes, they were not different from controls in terms of time spent vocalizing, smiling, or engaging with toys.

As discussed previously, infants with colic differed from infants without colic in terms of amount of time spent awake and asleep. In the present study, based on maternal report, colicky infants spent more time in an awake state than did controls. Derived from diary data, Humphry (1985) found that control infants spent more time than infants with colic in a quiet state. The amount of time the colicky infant is awake is important to the mother-infant interaction, particularly when a large proportion of the day is spent
crying; if the infant spends a great deal of time either fussing or crying, he/she would consequently be less available to the mother and therefore have less opportunity to interact.

Several interpretations of these inconsistencies are possible; first, it could be that the NCAFS instrument is insensitive to individual differences in the young infant. As such, any differences in cue clarity would not be evident. Second, it may be that the timing of the feeding could explain inconsistency across studies. As mentioned, in the present study, day time feeding interactions as opposed to night time feedings were videotaped; other studies may have observed mother-infant interaction during an evening colic spell. Most mothers in the present study verbalized that the videotaped feedings were not typical of the infant's behavior during a "bad" feeding. It may be that colicky infants who cry excessively as neonates do not exhibit behavioral differences until a later age as a function of their physical and motor immaturity. With respect to the discrepancies on daily awake time, these may be due more to measurement error than actual sample differences. It is likely that fatigued, anxious, and depressed mothers do not reliably report awake quantity; mothers of infants who fuss and/or cry on and off all day may not differentiate fuss/cry state from alert state and therefore would tend to overestimate awake quantity. Finally, in terms of the cue clarity differences, it is equally plausible that infants with colic, other than the excessive crying, do not differ behaviorally from noncolic infants. This later explanation is consistent with the
viewpoint that colic is crying at the upper end of the continuum of normal crying, rather than being a syndrome of behavioral features that includes crying in its presentation.

MOTHER

Almost twenty years ago, the infant's potent effect on the caregiver was acknowledged (Lewis & Rosenblum, 1974), to the point that the nature of parental behavior was believed to be largely a function of the infant's characteristics (Thoman, 1975). Recently, Belsky and colleagues (1984) found that the mother played a relatively larger role in establishing the nature of the early interaction than the infant. The young infant is dependent upon her to create the early environment where first sensorimotor learning takes place. In short, the mother defines the type of environment that the young infant experiences.

As the primary caregiver, the mother brings certain demographic, social, and intrinsic qualities that will influence how she responds to her infant. Variables such as parity, age, education, race, social support, previous childcare experience, and culture have been implicated as influential in how a mother responds to her infant. Education and age repeatedly emerge as two strong predictors of mother-infant interaction patterns and infant developmental outcomes (Barnard et al., 1989). In this study, there were strong correlations between these two variables and maternal behavior, socioemotional and cognitive support available in the home, and the
nature of the mother-infant interaction. Older, educated mothers exhibited more responsive behaviors as well as higher interaction scores with their infants. However, when their infants had colic, they too were affected such that interaction and behavioral scores were significantly lower as compared to matched mothers of noncolic infants.

One maternal attribute that has been debated since Bell and Ainsworth's (1972) seminal study on attachment and maternal responsiveness to crying is maternal responsiveness to infant crying. The results of that classic study suggested that a rapid response to crying in the first three months of life led to reduced amounts of crying in subsequent quarters. Conversely, one cross-cultural study of Bedouin infants by Landau (1982) suggested just the opposite; infants who received prompt response to crying subsequently cried more than infants who had received a delayed response.

In the present study, while none of the mothers believed that babies should never be picked up when crying, there were group differences in terms of maternal report of behavior when her infant cries. Unlike control mothers, mothers of colicky infants attempted to prevent the crying from starting in the first place; but if unsuccessful in prevention, these mothers "always" picked up their infants when they started crying. In short, mothers of colicky infants tended to be "rapid responders." Control mothers, on the other hand, tended to "let the baby cry a little before soothing;" and their response to crying was less urgent, as reflected in their
tendency to "only pick [their infant] up some of the time." Control mothers, with their "wait and see" attitude, tended to be "delayed responders." This finding supports what Hubbard and van Ijzendoorn (1987) found in their replication of the Bell and Ainsworth study; mothers of normal infants tend to delay responding to crying 40 to 50 percent of the time. The study design prohibits clarification as to whether colic mothers had become less responsive at seven weeks because their colicky infants cried despite efforts at soothing, or whether the infants cried all the time because their mothers were less responsive. However, it is clear that at seven weeks of age mothers of infants with colic report a response pattern that is immediate.

Several mothers of colicky infants in the present study commented about their infants' boredom, describing their infants as "children inside babies bodies." Thompson and colleagues (Thompson et al., 1986) reported that parents and health care professionals described the once-colicky child as "more intelligent" and accomplishing major developmental tasks at an earlier age than normal.

Some of the NCAFS and HOME differences observed in this study may offer some explanation of the colic-cognition connection. While mothers of infants with colic generally scored lower on the cognitive growth-fostering subscale, they were more likely to provide their infants with objects to explore during the feeding, more likely to talk to their infants about something other than the feeding during
the feeding, and more likely to provide toys and books for music and literature. In less than seven weeks, these mothers had learned that in order to maintain a quiet-alert state, or to prevent a crying episode, they needed at their disposal an assortment of objects (both animate and inanimate) and activities that served to divert their infants. Stewart and colleagues (Stewart, et al., 1954) also reported that mothers of excessively crying infants demonstrated more activity aimed at the infant even though they were not able to console the infant. Stimulation of this type contributes to infant learning about their world.

On the other hand, it is more commonly believed that crying that is excessive will ultimately deplete the mother's energies, ultimately overtaxing her ability to provide consistent and responsive care. Indeed mothers of infants with colic (as compared to control mothers) had multidimensional psychological distress; they reported more bodily dysfunction, fears, disordered thinking, impulsive thoughts and actions, and they had stronger feelings of personal inadequacy or inferiority. As compared to the controls and standardized samples, they were significantly more depressed, anxious, fatigued and hostile. These results, while supportive, go beyond Humphry and Hock's (1989) observation that parenting an infant with colic was "stressful." And this distress is beyond that which normally accompanies postpartum healing and adjustment (Tulman & Fawcett, 1988; Gardner, 1991). In the present study, most mothers of colicky infants had such extreme test scores on the SCLR-90 and POMS
that further psychological assessment would have been indicated outside of a study context. In the presence of other at-risk factors, it is under these circumstances that one would expect to see such adverse outcomes as dysfunctional parenting and even infant abuse.

These findings verify both clinical and anecdotal claims; mothers of infants who cry excessively have been described as depressed (Smith, 1981), exhausted (Jones, 1983; Menahem, 1978), angry (Waldman & Sarsgard, 1983) and resentful (Swaffield, 1984). Thompson et al. (1986) appropriately characterize the mother's response to the crying infant as "parent colic", a biopsychological response characterized by crying, fatigue, guilt, depression, and resentment of the infant. Such a response would result in a mother who is less emotionally available for her infant. Unless, as implied above, when the mother reaches this state, the father or another "fresh" caregiver is able to intervene while the mother distances herself from the situation. In turn, when the father falls victim to parent colic, the mother is ready to again resume the caregiver role. Could this cycle of shared parenting explain positive developmental outcomes in infants with colic? As evident, longitudinal studies are needed to better understand the complex relationships between early infant behaviors, parental emotions, and the caregiver-infant relationship.

In addition to maternal affective differences, mothers of infants with colic also differed behaviorally from mothers of infants
without colic. And in fact, these behavioral differences as assessed via the NCAFS and HOME subscales and individual items, were highly correlated with maternal self-report of responsivity to crying. Specifically, mothers of infants with colic were less likely to engage in social interaction, use positive statements while talking to their infants, convey positive feeling when speaking about their infants, and praise their infants’ behavior. They were also more likely to grimace or frown when making eye contact with their infants, express annoyance with or hostility toward the infant, interrupt their infants’ feeding by removing or juggling the nipple, use abrupt or rough movements when responding to their infants’ distress, and make negative comments about their infants. These findings parallel those Campbell (1979) reported with infant-mother dyads when the infant was temperamentally difficult. Mothers of difficult infants vocalized to them less, engaged in less mutual vocalization, were less responsive to their infant’s cries, and spent more time away from their infants. However, Humphry (1985) found no significant differences between colic and noncolic mothers in terms of inhibiting behaviors such as negative comments and looking away from the baby, which was observed in this study. These behaviors exemplify the love-hate feelings colicky mothers experience.

Field (1982) found that some mothers of difficult infants tend to work harder at feeding their infants than mothers of quiet infants in that they exaggerated their responses to them, caressed them more, and even poked at them. Field has suggested that the mother, in
trying too hard, may have overlooked the infant's signal ("gaze aversion") to disengage or break from the interaction. Nurse caregivers of irritable newborns were observed to soothe irritable infants more, although the amount of overall contact during washing and diapering did not differ as a function of irritability (Breitmayer & Ricciuti, 1988).

The only other study that examined maternal behavior towards her colicky infant within context of feeding (Wikander & Wahlberg, 1987) reported that maternal smiles and laughs towards their infants were less frequent when the infant had colic. The present study did not support these latter findings; mothers of colicky infants did not differ from noncolic mothers in terms of smiling and laughing during the feeding. There were also no differences between the mothers in terms of making eye contact with their babies, using of gentle forms of touch during the feeding, and in their ability to read their infants' cues. Again, Humphry reported parallel findings; mothers of colic and noncolic infants displayed similar abilities to read their infants' cues, despite the fact that their infants spent more time looking away from them during a play task.

Finally, this study demonstrated that mothers of infants with colic are reliable estimators of their infants' cry quantity. Correlations between 7-day diary data and maternal estimation of average daily cry quantity were high. Further, mothers of infants with colic rated their infants' cry as qualitatively different as compared to control mothers' ratings of their infants' cries.
Colicky cries were rated as more arousing, irritating, distressing, grating, aversive, urgent, unpleasant, awful and bad, a finding similar to what Lester et al. (in press) reported. Lester and colleagues also demonstrated acoustically that the cry of the infant with colic had a 25 percent higher fundamental frequency (perceived pitch), a 30 percent increase in pitch variability, and more than twice as much dysphonation or turbulence. Taken in the context then of mothers ratings of their colicky infants' cries, it seems that mothers do indeed perceive these differences in acoustic characteristics. These findings suggest that the cry of the infant with colic does sound different to the human ear.

Mothers of colicky infants did not differ from control mothers in terms of cry quality perception of two standard cries, suggesting that they were not innately more "turned off" by the cry sound. However, physiological responses to cry sounds, a popular approach to understanding maternal perception and response in the laboratory, were not included to validate this observation. Of importance is the lack of correlation with standard cry perception and maternal behavior. How the mother perceived a standard cry sound was unrelated to her NCAFS and HOME scores. Further, mothers' reported caretaking activities did not differ as a function of cry sound perception. However, mothers of colicky infants who perceived their infants cries to sound more "negatively" did have lower responsivity and social-emotional-cognitive growth-fostering support scores, and their interactions with their infants reflected a less synchronized
exchange. In reality, these correlations are more likely more a function of cry quantity, which was highly correlated to maternal cry perception scores given the fact that colicky infants by definition were to cry excessively and have pain-sounding cries.

This study employed the NCAFS scale (Barnard, 1978b) to assess mother-infant interaction during a feeding. As noted by Farel and colleagues (Farel, Freeman, Keenan & Huber, 1991), mothers communicate many things to their infants by the way they present food. Lowenberg (1974) conjectures that the child first learns about love at feeding time. Parents play a critical role in guiding appropriate feeding patterns because food habits begin to be formed from the day of an infants' birth. Thus interaction between mother and infant around feeding is as important in the first year of life as it is in later years.

For these reasons, examination of the mother-infant interaction during a "typical" feeding was undertaken to describe maternal and infant behavioral patterns when the infant had colic. Since observations were scheduled during the day, NCAFS scores do not capture feedings at the height of the colicky infants' irritability. In fact, most mothers commented as such, reminding us that while we were capturing a typical day feeding, the feeding was not typical of feedings during the colic episode. Indeed, NCAFS results verified this contention. Although they tended to more clearly signal tension prior to the feeding, colicky infants did not display any more state changes during the feeding than did control infants. While a colicky
episode was missed and a "better" interaction was observed, it is interesting to note that even this "non-colic" feeding interaction revealed a less than optimal exchange between the mother and the colicky infant. This observation suggests that either there is a "carry over" or persistent affect of the colic, or there is an underlying disturbance in the interaction that is independent of the colic itself.

To obtain an overall picture of the colicky infant-mother dyad, NCAFS subscale and summary means were compared to the standardized sample (Barnard, 1978b), failure to thrive (FTT) infants (Lobo & Barnard, in press), infants with cardiac defects (Lobo, in press), preterm infants (Barnard & Bee, 1981), infants of adolescent mothers (Ruff, 1987), and to 8 month-old high-risk infants Farel, Freeman, Keenan & Huber, 1991) (see Appendix S). Mean maternal scores of the colic group in the present study were lowest of the six groups (31.2). Control infants scores (37.2) were similar to Barnard's sample (37.7). Mean infant summary scores were lowest in the premature (9.4) and FTT (10.8) groups. Infants with colic had higher mean scores (17.8) than the standard sample (14.2), but were less than the adolescent (14.5) and high-risk infants (19.4). With respect to mean scores for the interaction as a whole, premature (42.0) and FTT (44.0) infant-mother dyads exhibited the lowest scores, followed by the colic infant-mother dyads at 49.6. The highest interaction scores were observed in the high-risk 8 month olds (57.7).
This study supported the conceptual framework originally proposed at the outset; colic stresses the mother-infant interaction. Colicky infants and their mothers scored significantly lower on the NCAFS than did control infants and mothers, suggesting that the interaction lacked reciprocity. Infant data suggested that the colicky infant's cues were not necessarily confusing or ambiguous, but that colic presented such problems in the basic caregiving requirements that eventually the mother's adaptive capacities were stressed. While the infant's crying signals to her to do something, the mother is unable to alleviate the distress for any great length of time when the infant has colic. Indeed, mothers of colicky infants in this study reported being able to soothe their infants only 52 percent of the time, as compared to control mothers being able to console their infants 89 percent of the time. Eventually the mother's response to her infant was affected such that the result is a stressed mother-infant dyad with the distress of one being transmitted to the other (Hewson et al, 1987).

In summary, a two-group, comparison design was used to examine the impact of excessive infant crying on the caregiving environment. Twelve infants with colic and their mothers were matched to 12 infants without colic and their mothers. Using interview, self-report, and observational methods, data was collected on infant, maternal, family, and mother-infant variables. Infants with colic cried significantly more, slept less, and woke more frequently during the night. The cries of colicky infants were also judged to be more
aversive-sounding than did the cries of the noncolic infants. No statistically significant differences were noted on select prenatal, birth, or feeding variables, other than the fact that infants with colic who were originally breast-fed were likely to be switched to formula by the time they were seven weeks of age. Mothers of infants with colic exhibited significantly more psychological distress than did mothers of noncolic infants. Family APGAR scores were significantly lower when the infant had colic, suggesting less maternal satisfaction with family relationships. Mothers of colicky infants did not exhibit any perceptual differences in terms of standard cry sound aversiveness. Colic was found to impact the mother-infant interaction during a feeding session as colicky infants and their mothers scored significantly lower on the NCAFS than did control infants.
CHAPTER V
SUMMARY

Colic, excessive crying in an otherwise healthy infant, afflicts up to 30 percent of all newborns. The motivation to better understand the condition relates to the hypothesized environmental consequences such as infant abuse, dysfunctional parenting, and a disturbed mother-infant relationship after the colic has ended. The purpose of this study was to examine the caregiving environment when the infant had colic. In particular, the mother-infant interaction during a feeding session, the social-emotional support available in the home, and maternal perception of family functioning were examined. The relationship of various infant, maternal, and family psychodemographic variables to infant colic was also explored. Research questions guided the study of a group of mothers who had infants with colic versus a group of mothers who had infants without colic.

In general, infants with colic did not differ prenatally from infants without colic; birth weight, length, and 1- and 5-minute AFGARs were nearly identical between the two groups. While feeding frequency did not differ, there were differences in feeding choices, with proportionally more mothers of infants with colic switching from breast to bottle feeding by the time the infant was six weeks old.
Onset of colic symptoms averaged 2.3 weeks and average resolution was 12.8 weeks. Infants with colic spent more time in an awake/alert state, slept less, and woke more frequently in the night. They also fuss/cried more, averaging 5.3 (SD = 1.3) hours/day with single episodes lasting up to six hours. The crying in any one infant, while fairly constant in terms of daily duration was quite variable in terms of daily presentation. Some infants displayed an erratic pattern and others tended to exhibit consolidated crying spells in the evening. Control infants fuss/cried an average of 1.1 (SD = 0.7) hours/day.

Mothers of infants with colic reported severe psychological distress; they were significantly more tense, anxious, fatigued, angry, and depressed than were mother of control infants. The fact that mothers were not statistically different in terms of age, education, marital status, socioeconomic status, and parity rules out rival explanations for the observed differences in maternal distress. There were no differences between mothers on perception of a standard "colic" cry in terms of quality, but the cries of study infants who were colicky were rated by their mothers as more arousing, irritating, distressing, grating, aversive, urgent, unpleasant, awful and bad. On the NCAFS, colic mothers tended to score lower than control mothers, reflecting that they were less likely to engage in social interaction with their infants, were less likely to use "baby talk," and were more likely to use abrupt movements during the interaction. The interaction between colicky infants and their mothers revealed a
less synchronous, give-and-take dialogue between the two; colic dyads had significantly lower interaction scores. HOME scores were significantly lower in the colic group, suggesting less socio-emotional support in the homes of infants with colic. Of interest was the nonsignificant correlation between HOME score and diary quantity but that HOME scores were lower when the infant had more cry episodes per day and awoke more frequently at night. Specifically on the HOME, mothers of colicky infants displayed more hostility toward their infants, were less likely to praise their infants' qualities, yet they had more toys and books available.

Maternal perception of family satisfaction was also significantly lower in the colic group as reflected by family APGAR scores. Maternal perception of cry sound quality, infant gender, and infant age were unrelated to caregiving scores across the entire sample. This is the first study that employs direct observation to document the extreme mother-infant and family stress experienced when an infant exhibits colic. Early detection and close follow up are recommended to circumvent permanent disruption in the parent-infant relationship.

LIMITATIONS OF THE STUDY

Several limitations warrant discussion. To begin with, a major objective of the study was to examine acoustic characteristics of colic cries and relate these variables to other infant, maternal, and caregiving measures. Tape and recorder quality did not permit
acoustic analysis of the cry sounds. Specifically, the cry recordings all contained a continuous low frequency sound that prohibited summary analyses of the higher frequency cry sound on the computer analog system as had been planned. However, future technological devices may have the capacity to "erase" this noise but allow for cry sound analyses (Bauer, personal communication). As such, the tapes will be retained indefinitely for later secondary analysis. Future naturalistic studies will have to consider setting and equipment limitations on the production of high quality tapes.

A second limitation relates to instrument error, particularly observer bias and interrater reliability. It was initially planned that all NCAST and HOME observations/interviews would be video-taped for later reliability determinations. Scoring was to be done onsite by the research assistant who conducted the home visit. Midstudy interrater reliability checks revealed a strong observer bias as well as an obvious unblinding of group membership. At that time, a second research assistant blind to group membership was enlisted to score all videotapes. While initial observer reliability was at least .85, rater decline was a problem at the conclusion of the study. As in all field studies, aggressive strategies need to be pursued to prevent interrater reliability decline.

Many of the comparisons revealed mean group differences that approached but did not reach the significance level of the study ($p < .05$). In many instances post hoc analysis revealed too low statistical power to correctly reject the null hypothesis if in fact
a difference existed. Either the study design lacked the power to
detect real differences, or the differences observed were due to
random chance. This limitation was expected given that the purpose
of this exploratory study was to pilot methods and procedures for a
larger study. A larger study with adequate power is planned to
better address this issue.

Another limitation that must be recognized is the cross-
sectional, correlational nature of the study. Without prospective
enrollment of mother-infant dyads at birth, no conclusions can be
drawn as to the psychological status of the mothers prior to study
entry. It may be that mothers of infants with colic were
psychologically distressed even before the onset of their infants' colic. As such, any relationships identified must be interpreted as
correlational rather than causal.

A final limitation relates to the use of multiple univariate
(t) tests. While justifiable given the exploratory nature of this
investigation, there remains the potential for erroneous (Type I)
significant p values. Future studies that entail multiple
comparisons will incorporate the appropriate correction factors.

IMPLICATIONS FOR FUTURE RESEARCH

This study demonstrated that mothers of infants with colic are
able to maintain a seven-day diary of infant sleep, fuss/cry, and
feeding behaviors. It also demonstrated that home visits, which are
critical to ecological validity, are feasible with this population of
mothers. Mothers were comfortable with videotaping of feeding session scheduled at a time when the infant normally eats. Equipment failures, compliance failures, and attrition problems were minimal. These observations supports the feasibility of future studies that may involve night and/or multiple feeding assessments. Analysis of tape-recorded cries, however, need to be conducted in a sound-proof room with high quality tapes and recorders. Strategies for securing spontaneous cry recordings from infants who do not cry except when they are hungry will need to be defined. Since a majority of both groups of infants had "fussy spells" in the evening, it may be more feasible to conduct future comparisons on these cry characteristics as opposed to a "spontaneous" cry as was attempted in this investigation.

Related to specific cry comparisons is the more general issue of who are appropriate controls to employ as comparisons when studying infants with colic and their families. Typical mothers of "healthy" infants may not be comparable given the severe psychological distress exhibited by mothers of infants with colic along with the family stress that is experienced. Perhaps a more appropriate control group would be families of other "high risk" infants, such as when the infant is born prematurely, or when the infant has a known health problem, such as otitis media. A future study that involves a larger sample size along with multiple comparison groups would advance our knowledge about the immediate effects of colic on the family system. Given the magnitude of
differences and the variability observed in this study, power analysis suggests that future studies should have 28-34 mother-infant dyads per group.

Future studies should plan to examine fathers' perceptions, behaviors and stress levels. In the present study, one item on the HOME suggested that fathers of infants with colic were more involved in daily caregiving. Also, in light of the severe psychological distress exhibited by mothers of colicky infants, it would be important to discover if fathers exhibited similar levels of distress on the POMS and the SCLR-90. Also of importance would be how fathers interact with their infants when they have colic, possibly during a specific caregiving task such as diapering or feeding.

While mother-infant interaction patterns differed when the infant was colicky, this study did not provide any answers as to maternal psychological status, the interaction patterns, parenting effects, or child outcomes after the colic had ended. Future studies may incorporate prospective, longitudinal designs to delineate the consequences of early mother-infant distress.

Another issue relates to the fact that several (n = 5) infants with colic who were initially enrolled in the study failed to meet the entry criteria of at least 2 hours of crying per day for at least five days. Of significance is that at enrollment, all of these infants' history and physical findings verified that they were indeed "colicky." When the home visit was made, after seven days of diary collection, these mothers reported that their infants were "better."
Several explanation are conceivable. First, the mothers may have initially overestimated the quantity of their infants' crying; intermittent crying for six hours at a time may result in a perception of "he's crying all the time!" Second, since colic is a self-limiting condition, these infants may have indeed "grown out" of colic in the week following enrollment. And third, some aspect of study participation may have either altered the mothers' perception of their infants' crying, or altered the mothers' behaviors towards their infants such that the end result was a reduction in crying.

Given the mothers' general dissatisfaction with health care provider support at the time of study entry along with their extreme psychological distress suggests that the latter possibility may be viable. In particular, maternal diary maintenance may have unintentionally precipitated a change in their behavior, resulting in a reduction in daily infant crying. For example, one mother discovered that her infant had "better" days when they stayed at home and followed a routine; his worst evenings coincided with days she took him with her to run errands. Collins and colleagues (Collins, Given & Berry, 1989) illustrated how being a research participant can impact study outcomes. More specifically, Taubman (1984, 1988) has demonstrated a reduction in infant crying following parental counseling on infant handling and soothing. While the colic does not necessarily go away, the parents are taught ways to live with it. Unfortunately, the cross-sectional design employed in this study makes interpretation of this observation difficult. Longitudinal intervention trials are
needed to further examine the role of "interaction coaching" when the infant has colic.

Finally, from a clinical standpoint, two aspects of the study are recognized as practical intervention tools. Maternal monitoring of infant behavioral patterns via a diary was found to be an effective means of assisting the mother to understand her baby's unique behaviors. Secondly, many mothers expressed relief and gratitude about having available to them someone to talk to who really understands colic. Both of these strategies are appropriate for nurses who provide health care to early postpartum families.
APPENDIX A

Human Subjects’ Committee Approvals
MEMORANDUM

From: Vincent V. Hamparian, PhD
Chairperson, Human Subjects Research Committee

To: Belinda Pinyerd, RN

Date: December 6, 1990

Re: EXPEDITED APPROVAL OF REVISIONS TO PROTOCOL: MULTIPLE MEASURES OF INFANT CRYING: A PILOT STUDY - RETITLED: AN EXPLORATORY INVESTIGATION ON THE IMPACT OF EXCESSIVE INFANT CRYING ON THE CAREGIVING ENVIRONMENT

Protocol No.: 89H5053

The revised title and signature page, the increase in crying records (2), and the addition of two group practices as referral sites, have been approved by expedited review.

VVM/bes
Research Involving Human Subjects

ACTION OF THE REVIEW COMMITTEE

With regard to the employment of human subjects in the proposed research protocol:

91B0005 AN EXPLORATORY INVESTIGATION ON THE IMPACT OF EXCESSIVE INFANT CRYING ON THE CAREGIVING ENVIRONMENT, Edna M. Menke, Belinda J. Finney, Family and Community

THE BEHAVIORAL AND SOCIAL SCIENCES REVIEW COMMITTEE HAS TAKEN THE FOLLOWING ACTION:

___ APPROVED
___ DISAPPROVED
X APPROVED WITH CONDITIONS* 
___ WAIVER OF WRITTEN CONSENT GRANTED

* Conditions stated by the Committee have been met by the Investigator and, therefore, the protocol is APPROVED.

It is the responsibility of the principal investigator to retain a copy of each signed consent form for at least four (4) years beyond the termination of the subject's participation in the proposed activity. Should the principal investigator leave the University, signed consent forms are to be transferred to the Human Subjects Review Committee for the required retention period. This application has been approved for the period of one year. You are reminded that you must promptly report any problems to the Review Committee, and that no procedural changes may be made without prior review and approval. You are also reminded that the identity of the research participants must be kept confidential.

Date: January 11, 1991  
Signed:  
(Chairperson)

HS-025B (Rev. 3/85)
II. A. GENERAL INFORMATION:

1. Legal name and birthdate of subject:
   
   (Legal name) (Date of Birth)

2. Full title of study to be approved:
   
   An Exploratory Investigation of the Impact of Excessive Infant Crying on the Caregiving Environment

3. Expected duration of subject's participation in the study:
   
   Seven days.

4. Principal Investigator of Study:
   
   Belinda J. Pinyerd, RNC, MS
   Head Nurse, Clinical Study Center
   Columbus Children's Hospital

5. If applicable, FDA Investigational New Drug (IND)/Investigational Device (IDE) number:
   
   Not applicable.

6a. Experimental product(s)/procedure(s) to be used that are NOT part of standard practice:

   1) Seven-day diary maintenance of infant sleeping, feeding, and crying behaviors.

   2) Audio tape-recordings of infant's crying by mother during a "fussy spell" in the evening.

   3) Video-taping the baby feeding.

6b. How they are to be used:

   Quantification and qualification of my baby's behaviors (sleeping, feeding, crying).

7. Approved or accepted products to be used which entail some risk to the subject:

   Interviewing, videotaping, and home visit may cause some apprehension in mother.

Page 1 of 4
II. B. SPECIFIC INFORMATION:

1. Purpose of Study:

The purpose of this research is to begin to understand factors that impact parental response to infant cries. Crying represents one way which the infant affects the pattern of caregiving provided by parents. We are interested in examining how specific features of the cry itself impact maternal perception of interaction with the infant. This information will ultimately be used to define and test intervention strategies to be employed by health care providers in assisting parents' efforts at soothing and comforting.

I understand that first I will fill out several questionnaires about myself and my baby. Then I will listen to 3 cry recordings and fill out forms about how they sounded. Next I will maintain a daily diary of my baby's behavior (sleep, cry/fussy, and feeding) for seven days. I will also obtain 3 audiotapes of my baby's cry during evening "fussy" periods. After seven days, I understand that a registered nurse will come to our home at a time convenient for us. At that time she will interview me on what a typical day in our home is like. She will also videotape me feeding my baby a bottle. Again I will listen to 3 cry recordings and fill out forms about how they sounded.

2. Appropriate alternative treatment:

This is not a treatment.

3. Possible risks:

The possible risk of slight anxiety during the videotaping of me feeding my baby has been explained to me.

Inconvenience related to diary maintenance and audiotaping have also been explained to me.

4. Possible benefits:

The immediate benefits are: 1) The opportunity to talk with a registered nurse about my baby's behaviors, and 2) a 2 week supply of diapers.

5. Methods used to maintain confidentiality:

I understand that I and my baby will be identified by gender only or a code number in any information that might be published. All of our written documents (diary and questionnaire), audiotapes, videotapes, consent forms, etc. will not be destroyed at the conclusion of the study but will be kept in a locked file cabinet in the Clinical Study Center (CSC) at Children's Hospital. In no case will our or anyone else's identity related to this project be disclosed.

I give my permission for the audio and video tapes to be kept for future use.

______________________________
(Signature)
6. Describe possible additional costs to the subject or third-party payer that might result from participation in this study.

I understand that neither I or my insurance will be charged for anything done solely for this study. The cost of my visit to Children's Hospital at the time of my recruitment as well as any medical therapy instituted at that time will be my responsibility.

7. Others

For further explanation and for any questions concerning my rights or possible research-related injuries, I have been informed to contact the Director of Risk Management at (614) 461-2557.
CONSENT TO RESEARCH TREATMENT OR PROCEDURES

I. FULL TITLE OF STUDY: An Exploratory Investigation on the Impact of Excessive Infant Crying on the Caregiving Environment

II. INFORMATIVE STATEMENTS AND SIGNATURES:

The information has been explained to me and I understand it. Any further questions I may have in regard to this study will be answered by:

Belinda J. Pinyerd, RN, MS (614) 461-2341

PRINCIPAL INVESTIGATOR OR AUTHORIZED REPRESENTATIVE

I understand that I am not giving up my child's/my legal rights. I consent to enroll my child/myself in this study.

III. CONSENT SIGNATURES:

WRITTEN CONSENT

I have had the study explained to me and I agree to participate.

Date: ___________________________ Date: ___________________________

PARENT/LEGAL GUARDIAN

PARENT/LEGAL GUARDIAN

PATIENT ASSENT

WITNESS

PERSON OBTAINING CONSENT

ORAL CONSENT - If Applicable

Date: ___________________________

PATIENT ASSENT

PARENT/LEGAL GUARDIAN

WITNESS

PERSON OBTAINING CONSENT

I certify that I have explained the research, its purposes, and procedures to the subject or his/her representative or both before requesting the subject or representative to sign.

Signed: ___________________________

PRINCIPAL INVESTIGATOR OR AUTHORIZED AGENT

INVESTIGATOR: If this study involves investigational drugs, send copy to the Pharmacy. This must accompany the drug order or no drugs will be dispensed.
APPENDIX C

Brochure and Sign
You will be reimbursed for participating in the study.

**BENEFITS**
- Free physical exam
- Free cry analysis
- Free videotape

**SOME FACTS**
- For ages 2-7 weeks
- Safe - noninvasive
- Duration: 1 week

**PROCEDURES**
- Daily diary
- Questionnaires
- Feeding observation
- Interview

**SUPPORT**
- Funded in part by Children's Hospital Research Foundation
- Children's Hospital Review Board

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**THE CRYING BABY STUDY**
700 Children's Drive
Columbus, Ohio 43205
(614) 461-2341
We need infants to help study infant crying . . .

All babies cry and some cry more than others. Usually the parents can soothe or quiet the crying infant. Colic is a term that describes long periods of unexplainable crying or extreme fussiness in the young infant. While not life threatening, it is a common problem that affects the entire family.

To better understand infant crying, you and your baby are needed. The study entails no invasive procedures and no known risks. You will receive reimbursement for your participation.

We are studying factors that impact parental response to infant cries. Crying is one way the infant affects the care it receives from parents and other caregivers. We are particularly interested in how specific factors of the cry itself effect mothers' perception of and interaction with their infants.

After all your questions have been answered to your satisfaction, you will be requested to sign a form that validates your consent to participate. We assure confidentiality, safety, and privacy.

On your first visit to Children's Hospital Clinical Study Center, you will be interviewed by one of the project members and you will fill out several questionnaires (total time = 45 minutes).

Following this, we will teach you how to: 1) maintain a daily diary on your baby's feeding, sleeping, and crying behaviors, and 2) audio-record your baby's evening cry. We will provide the diaries, recorder, and tape for you. Over the next seven days you will maintain the diary. You will also record one "fuss cry" using the tape-recorder.

In approximately 7 days we will come to your home during the day at a predesignated time (preferably when the baby is hungry). At that time we will first videorecord you feeding your baby. At the conclusion of the feeding, we will interview you on what a "typical day" with your baby is like. This final visit will last approximately 60 - 90 minutes.

Your feeding session and cry recordings will be analyzed by a team of specialists in the area of infant behavior. Again, we assure confidentiality.

Within 6 months of your participation, we will send you a summary of your baby's cry analysis including how s/he compares to our entire group of babies along certain quality and quantity dimensions.

For more Information on the CRYING BABY STUDY

Please Call:
Belinda J. Pinyerd, RNC, MS
Principal Investigator
Registered Nurse in Ohio

Member:
American Nurses' Association
Assoc. for the Care of Children in Hospitals
Midwest Nursing Research Society

Certified:
Pediatric Nursing
Parent-Child Assessment

Location:
Children's Hospital,
Columbus, Ohio
461-2341
Crying: What Should I Do?

CONTACT: Adrienne Petersen, R.N. or Alexis Williams-Grier at beeper 144-745 or ext. 2341
APPENDIX D

Demographic Data Form
INSTRUCTIONS: Please provide the following information by checking (✓) the appropriate answer or filling in the blank space. ALL INFORMATION WILL BE KEPT STRICTLY CONFIDENTIAL.

I. FAMILY

1. Are you - (Check one)
   
   ✓ NOW MARRIED (INCLUDING COMMON-LAW MARRIAGE)
   □ WIDOWED
   □ DIVORCED
   □ SEPARATED
   □ NEVER MARRIED

2. Including yourself and your baby, how many people are currently living in your household? ______

3. Including this baby, how many children live in the home? ________ What are their ages? ________

4. What is your ethnic group? (Check one)
   
   ✓ CAUCASIAN
   □ BLACK
   □ HISPANIC
   □ ASIAN
   □ OTHER (SPECIFY: ____________________)

5. What is your religion, if any? (Check one)
   
   ✓ PROTESTANT
   □ CATHOLIC
   □ JEWISH
   □ NONE
   □ OTHER (SPECIFY: ____________________)

6. Where do you live? (Check one)
   
   ✓ HOUSE
   □ APARTMENT
   □ OTHER

7. What is your annual household income before taxes? (Check one)
   
   ✓ less than $5,000
   □ $5,000 - $9,999
   □ $10,000 - $14,999
   □ $15,000 - $19,999
   □ $20,000 - $24,999
   □ $25,000 - $29,999
   □ $30,000 - $40,000
   □ $40,000 - $69,999
   □ $70,000 - $99,999
   □ $100,000 - $199,999
   □ $200,000 - $299,999
   □ $300,000 - $499,999
   □ $500,000 - $699,999
   □ $700,000 - $999,999
   □ $1,000,000 or more
II. MOTHER

8. What is your age? ________ years at last birthday

9. Are you planning on returning to work? (Check one)
   ___ YES
   ___ NO
   ___ MAYBE, NOT SURE YET

10. Before the baby, what was your occupation? (Check one)
   ___ PROFESSIONAL WITH ADVANCED DEGREE
   ___ TEACHER, COUNSELOR, SOCIAL WORKER, NURSE
   ___ MANAGER, ADMINISTRATOR
   ___ SALES, CLERICAL, SECRETARIAL WORKER
   ___ TECHNICIAN, SKILLED WORKER
   ___ SEMISKILLED OR UNSKILLED WORKER
   ___ ARTIST, WRITER
   ___ HOMEMAKER
   ___ UNEMPLOYED - SEEKING WORK
   ___ OTHER: _______________________________

   JOB TITLE: ________________________________

11. What is the highest level of education you have attained? (Check one)
    ___ LESS THAN HIGH SCHOOL
    ___ HIGH SCHOOL DIPLOMA (OR EQUIVALENT)
    ___ ASSOCIATE, 2-YEAR, JUNIOR COLLEGE DEGREE
    ___ BACHELOR’S DEGREE
    ___ MASTER’S DEGREE
    ___ DOCTORATE
    ___ PROFESSIONAL (MD, JD, DDS, ETC.)
    ___ OTHER: _______________________________

12. Prior to this baby, how much experience did you have caring for infants? (check one)
    ___ NONE
    ___ SOME, WITH FRIENDS/RELATIVES INFANTS
    ___ ALOT, WITH FRIENDS/RELATIVES INFANTS

13. Which of the following statements best describes the planning of this pregnancy? (check one)
    ___ I MADE A DEFINITE DECISION - TRIED TO GET PREGNANT AS SOON AS POSSIBLE
    ___ I WASN’T USING CONTRACEPTIVES - THOUGHT I WOULD JUST "LET IT HAPPEN"
    ___ I WAS USING CONTRACEPTIVES AND DIDN’T EXPECT I WOULD GET PREGNANT
    ___ I WASN’T USING CONTRACEPTIVES AND DIDN’T EXPECT IT TO HAPPEN
    ___ OTHER (explain: _______________________________
14. Did you smoke cigarettes while you were pregnant? (check one)
   ______ YES
   ______ NO

15. Which did you prefer? (check one)
   ______ VERY MUCH WANTED BOY
   ______ PREFER BOY, GIRL OKAY
   ______ NO PREFERENCE
   ______ PREFER GIRL, BOY OKAY
   ______ VERY MUCH WANTED GIRL

16. How sick (nauseated and/or vomiting) were you?
    (check one in each column)
    1st trimester   2nd trimester   3rd trimester
    ______ NOT AT ALL      ______ NOT AT ALL      ______ NOT AT ALL
    ______ SOME          ______ SOME          ______ SOME
    ______ DAILY        ______ DAILY        ______ DAILY

17. How much weight did you gain while you were pregnant?
    (Check one)
    ______ LOST WEIGHT OR DID NOT GAIN ANY
    ______ 1 - 9 POUNDS
    ______ 10 - 19 POUNDS
    ______ 20 - 29 POUNDS
    ______ 30 - 39 POUNDS
    ______ 40 - 49 POUNDS
    ______ GREATER THAN 50

18. Did you work while you were pregnant? (Check one)
    ______ YES, FULL TIME
    ______ YES, PART TIME
    ______ NO

19. In your opinion, how active was your baby in utero? (Check one)
    ______ VERY ACTIVE
    ______ MODERATELY ACTIVE
    ______ SLIGHTLY ACTIVE
    ______ INACTIVE

20. Did your baby experience any problems during late pregnancy?
    (Check one)
    ______ NO
    ______ YES (explain: ____________________________________________)

21. Was your delivery (Check one) -
    ______ ON TIME (within 2 weeks of estimated due date)
    ______ EARLY (greater than 2 weeks before the estimated due date)
    ______ LATE (greater than 2 weeks after the estimated due date)
22. Was labor induced?

___ NO
___ YES (Please specify: ____________________________)

23. During labor, what (if any) methods for pain relief did you receive? (Check all that apply)

___ DEMEROL
___ EPIDURAL ANESTHESIA
___ PUDENDOL BLOCKADE
___ OTHER: ____________________________

24. Did your baby experience any complications during delivery? (Check one)

___ NO
___ YES (Explain: ____________________________)

25. How long were you and your baby together after delivery? (Fill in)

___ MINUTES

26. On a scale from 1 ("very") to 5 ("not at all"), how positive was the delivery of your baby for you? (Fill in)

___ (write in number from one to five)

III. FATHER

27. What is the baby's father's age? ________ years at last birthday

28. Baby's father works - (Check one)

___ FULL TIME
___ PART TIME
___ DOES NOT WORK

29. What is the baby's father's occupation?

___ PROFESSIONAL WITH ADVANCED DEGREE
___ TEACHER, COUNSELOR, SOCIAL WORKER, NURSE
___ MANAGER, ADMINISTRATOR
___ SALES, CLERICAL, SECRETARIAL WORKER
___ TECHNICIAN, SKILLED WORKER
___ SEMISKILLED OR UNSKilled WORKER
___ ARTIST, WRITER
___ HOMEMAKER
___ UNEMPLOYED - SEEKING WORK
___ OTHER: ____________________________

JOB TITLE: ____________________________
30. What is the highest level of education the baby's father has attained? (Check one)

- LESS THAN HIGH SCHOOL
- HIGH SCHOOL DIPLOMA (OR EQUIVALENT)
- ASSOCIATE, 2-YEAR, JUNIOR COLLEGE DEGREE
- BACHELOR'S DEGREE
- MASTER'S DEGREE
- DOCTORATE
- PROFESSIONAL (MD, JD, DDS, ETC.)
- OTHER: ____________________________

IV. BABY

31. Sex (circle): Male  Female

32. Date of birth: ____/____/____

33. Weight at birth: _________ pounds

34. Length at birth: _________ inches

35. Delivery was - (Check all that apply)

- VAGINAL
- CAESAREAN SECTION
- WITH PROBLEMS (DESCRIBE: ____________________________)

36. What were the baby’s APGAR scores? (fill in or check)

   a. ____ 1 MIN       DON'T KNOW
   b. ____ 5 MIN       DON'T KNOW

37. Did the baby have any problems right after birth? (Check one)

- NO
- YES (DESCRIBE: ____________________________)

38. Has your baby been sick since home from the hospital? (Check one)

- NO
- YES (DESCRIBE: ____________________________)

39. Since birth, how many times have you been to the clinic/doctor for a scheduled visit? (Fill in) ____ TIMES

40. Since birth, how many times have you been to the clinic/doctor for an unscheduled visit? (Fill in) ____ TIMES

41. Since birth, how many times have you been to the emergency room? (Fill in) ____ TIMES

THANK YOU VERY MUCH FOR YOUR PARTICIPATION
INSTRUCTIONS: Please provide the following information on your baby's behavior by checking ( ) the appropriate answer or filling in the blank space. ALL INFORMATION WILL BE KEPT STRICTLY CONFIDENTIAL.

I. FEEDING

1. What are you feeding your baby? (Check one)
   - ____ BREAST
   - ____ FORMULA (TYPE: ______________________)

2. In your opinion, does your baby feed well? (Check one)
   - ____ NO (If no, why? ____________________________ )
   - ____ YES

3. Is your baby taking anything besides formula? (Check one)
   - ____ NO
   - ____ YES (SPECIFY: ____________________________) 

4. Does your baby burp spontaneously? (Check one)
   - ____ NO
   - ____ YES

5. Does your baby spit up or vomit? (Check one)
   - ____ NO
   - ____ YES

6. During the day (7am-7pm), what do you do most often after the baby has finished feeding? (Check one)
   - ____ SOOTHE AND TRY TO SETTLE HIM/HER
   - ____ PLAY AND TALK WITH HIM/HER
   - ____ HAVE THE BABY SIT AND WATCH HOUSEHOLD ACTIVITY
   - ____ OTHER (SPECIFY: ____________________________)

7. During the night (7pm-7am), what do you do most often after the baby has finished feeding? (Check one)
   - ____ SOOTHE AND TRY TO SETTLE HIM/HER
   - ____ PLAY AND TALK WITH HIM/HER
   - ____ HAVE THE BABY SIT AND WATCH HOUSEHOLD ACTIVITY
   - ____ OTHER (SPECIFY: ____________________________)
8. During the day (7am-7pm), after a feeding is the baby usually — (Check one)
   __ DROWSY OR ASLEEP
   __ ALERT AND CONTENT
   __ READY FOR PLAY
   __ CRYING AND/OR FUSSING
   __ OTHER (SPECIFY: _____________________________________)

9. During the night (7pm-7am), after a feeding is the baby usually — (Check one)
   __ DROWSY OR ASLEEP
   __ ALERT AND CONTENT
   __ READY FOR PLAY
   __ CRYING AND/OR FUSSING
   __ OTHER (SPECIFY: _____________________________________)

10. Any other comments about your baby's feeding you would like us to know?

   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

II. SLEEPING

11. During a 24 hour period, approximately how many HOURS is your baby awake? (Fill in)
    __ HOURS AWAKE

12. At what time of day is the baby most "content", or awake and alert with no fussing or crying? (Check one)
    __ MORNING
    __ AFTERNOON
    __ EVENING
    __ NIGHT

13. How long is the longest stretch of time that your baby is CONTINUOUSLY awake? (Check one)
    __ HOURS

14. When does the longest awake time usually occur? (Check one)
    __ MORNING
    __ AFTERNOON
    __ EVENING
    __ NIGHT
15. How does your baby sleep? (Check one)
   _____ RESTLESSLY
   _____ QUIETLY

16. Where does your baby usually sleep? (Check one)
   _____ CRIB
   _____ INFANT SEAT
   _____ BASSINET
   _____ BED WITH ME
   _____ INFANT SWING
   _____ OTHER

17. On the average, how many times per night does your baby awaken crying? (Fill in)
   _____ TIMES

III. CRYING

18. Do you believe babies should be picked up when they cry? (Check one)
   _____ ALWAYS
   _____ SOMETIMES
   _____ Seldom

19. During the day, if you think your baby is going to start crying, what do you USUALLY do? (Check one)
   _____ DO SOMETHING TO PREVENT IT BEFORE IT STARTS
   _____ WAIT UNTIL CRYING BEGINS, THEN DO SOMETHING IMMEDIATELY
   _____ LET THE BABY CRY A LITTLE BEFORE TRYING TO SOOTHE

20. Overall, what proportion or percentage of time are you able to soothe your baby and stop his/her crying? (Fill in)
   _____ PERCENT (%) OF THE TIME

21. Approximately how many times per day does your baby cry? (Fill in) _____ TIMES

22. Is there a particular time of day your baby is most likely to fuss and cry? (Check one)
   _____ MORNING
   _____ AFTERNOON
   _____ EVENING
   _____ NIGHT

23. What are the specific hours in which your baby usually cries? (Fill in)
   ______ AM / PM TO _______ AM / PM
   (CIRCLE) _______ (CIRCLE)
24. How long does the single longest crying episode last each day? (Check one)
   _____ LESS THAN 2 MINUTES
   _____ 2 TO 5 MINUTES
   _____ 5 TO 10 MINUTES
   _____ 10 TO 30 MINUTES
   _____ LONGER THAN 30 MINUTES

25. How long does the average crying episode last? (Check one)
   _____ LESS THAN 2 MINUTES
   _____ 2 TO 5 MINUTES
   _____ 5 TO 10 MINUTES
   _____ 10 TO 30 MINUTES
   _____ LONGER THAN 30 MINUTES

26. Since birth, has the amount of time your baby spends crying - (Check one)
   _____ INCREASED
   _____ NOT CHANGED
   _____ DECREASED

27. When your baby starts to cry, does the crying usually - (Check one)
   _____ START SUDDENLY
   _____ START WITH FUSSING, AND BUILD TO CRYING

28. As you can best estimate, what is the total amount of time your baby cries each day? (Check one)
   _____ LESS THAN 1 HOUR
   _____ MORE THAN 1 HOUR, BUT LESS THAN 3 HOURS
   _____ MORE THAN 3 HOURS, BUT LESS THAN 5 HOURS
   _____ MORE THAN 5 HOURS

29. How many days per week does your baby cry for a total of 3 hours or more? (Fill in)
   _____ TIMES

30. How has your baby's crying affected you and your family? (Describe)

31. What or who has helped you cope? (Describe)

32. Is there anything else you would like us to know about your baby's crying?
APPENDIX F

Profile of Mood States
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APPENDIX G

SCLR-90
APPENDIX H

Rating Scale Judgements
INSTRUCTIONS: We have tape-recorded 3 cries from 3 different babies. After listening to EACH cry, you are to rate each one along the following 29 attributes. Circle the number that best reflects your response. You will be given adequate time between each cry to fill out the scales, so sit back and relax!

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 How GRATING did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.2 How URGENT did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.3 How SICK did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.4 How AROUSING did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.5 How DISTRESSING did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.6 How DISCOMFORTING did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.7 How PIERCING did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.8 How AVERSIVE did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>A.9 How IRRITATING did the cry sound?</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>Question</td>
<td>Scale</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>A.10 How SPOILED did the cry sound?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>B.11 How ANGRY do you feel in response to the cry?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>B.12 How ALARMED do you feel in response to the cry?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>B.13 How FRUSTRATED do you feel in response to the cry?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.14 How likely would you be to engage in FEEDING this infant?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.15 How likely would you be to engage in PLAYING WITH this infant?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.16 How likely would you be to ROCK OR WALK with this infant?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.17 How likely would you be to engage in CHANGING this baby's diaper?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.18 How likely would be to GIVE A PACIFIER to this baby?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.19 How likely would you be to CHECK TO SEE IF THIS BABY IS IN PAIN?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
<tr>
<td><strong>C.20 How likely would you be to PUT THE BABY TO BED?</strong></td>
<td><img src="image" alt="Scale" /></td>
</tr>
</tbody>
</table>
Below you will find NINE word PAIRS that describe various dimensions of an infant's cry. Please mark each line by CIRCLING the number that best describes how the cry sounds to you. For example, if you feel the cry sound more strong than weak, the line is to be marked as follows:

<table>
<thead>
<tr>
<th>STRONG</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>WEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLEASANT</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>UNPLEASANT</td>
</tr>
<tr>
<td>NICE</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>AWFUL</td>
</tr>
<tr>
<td>GOOD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>BAD</td>
</tr>
<tr>
<td>RUGGED</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>DELICATE</td>
</tr>
<tr>
<td>HARD</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>SOFT</td>
</tr>
<tr>
<td>HEAVY</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>LIGHT</td>
</tr>
<tr>
<td>ACTIVE</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>PASSIVE</td>
</tr>
<tr>
<td>FAST</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>SLOW</td>
</tr>
<tr>
<td>SHARP</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>DULL</td>
</tr>
</tbody>
</table>
APPENDIX I

Activity Record
CRYING BABY STUDY:
ACTIVITY RECORD

INSTRUCTIONS: This record of your baby’s day is designed for you to record selected baby behaviors over a 24-hour period. As you will see below, one whole day is represented by one bar consisting of ruler-like parts. Each long bar is 60 minutes, with further subdivisions representing 15-minute intervals.

Each baby behavior you will record is represented by a different type of symbol. Each time your baby exhibits that behavior, note it on the record with the corresponding symbol. Behaviors are to be recorded as follows:

- **Sleeping**
  
  1:00 to 2:00
  
  (= 90 minutes sleeping)

- **Crying**
  
  1:00 to 2:00
  
  (= 60 minutes crying)

- **Fussing**
  
  1:00 to 2:00
  
  (= 30 minutes fussing)

WHEN YOU RECORD YOUR BABY’S CRY, MAKE A NOTATION ON DIARY LIKE THIS:

1:00 to 2:00
When your baby is FEEDING, indicate with a circle around an "F" (formula) "B" (breast) or "S" (solid) when you begin the feeding:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00</td>
<td>2:00</td>
</tr>
</tbody>
</table>

To avoid any confusion, following are the definitions of the specific baby behaviors you are to record:

SLEEPING: sound state of rest, eyes closed, may occasionally wake up and whimper or cry, but falls back asleep.

FUSSY: alert, increased arm and leg activity, either whining or crying off and on.

CRYING: alert, more arm and leg activity; crying.

FEEDING: breast or bottle feeding of at least 3 minute duration.

Finally, each day, we would like you to note the number of episodes of the following:

- Vomiting
- Loose stool
- Spitting up
- Fever

Before you begin, let's try an example. In the space below, mark 45 minutes of sleeping:

|   |   |   |   |   |

That's all there is to it!

For the next _____ days, maintain the record as you've been instructed. For ease in completion, there is only one day on each page.

Have fun and good luck!
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Sleeping  Fussing  Crying  Feeding

AM

PM

Indicate number of episodes observed today:

Vomiting _______ Regurgitation _______
Loose stool _______ Fever _______

WHEN YOU RECORD YOUR BABY'S CRY, MAKE A NOTATION ON DIARY LIKE THIS:

Vennila
Day 1: ___/____/___

NOTES
COLIC SYMPTOM CHECKLIST/R

INSTRUCTIONS: The purpose of this checklist is to determine if an infant shows the symptoms of colic. This determination is made on the basis of: 1) history of crying from the maternal interview (CSC), 2) clinical examination of the infant (CSC) and, 3) direct observation of maternal attempts at consoling the infant (home visit).

First, the mother is interviewed to determine if the infant meets the 3 characteristics of excessive crying defined as crying for at least 1) 3 hours a day, 2) 3 days a week and 3) for 3 weeks. Next, the infant is examined for physical signs associated with hypertonia. During the exam, the characteristics of the cry including quality of onset and sound are scored. Finally, a consolability score is derived from direct observation of mother and infant.

I. INTERVIEW: Does the infant meet criteria of "excessive crying" via maternal interview? (see question 3 on maternal interview).

_____ YES
_____ NO

II. PHYSICAL EXAMINATION:

A. Physical Signs Associated with Hypertonia (check ( ) all that are observed):

- Tense abdomen
- Legs drawn up, momentarily extended
- Arm muscles hypertonic; score tone 1-4+
- Leg muscles hypertonic; score tone 1-4+
- Back arched
- Hands/fists clenched
- Increased motor activity
- Increased bowel sounds
- Face flushed
- Elbows flexed
- Breath holding
- Feet cold
- Cirumoral pallor

TOTAL SCORE (number checked)
(Criteria for colic = > 7)
B. Cry Sound

1) High pitched cry

High pitch is heard throughout the cry. There may be abrupt and dramatic pitch shifts from lower to upper registers and extreme variability in pitch, but high pitch predominates. The cry has a piercing, screeching quality of and may sound more like a scream than a cry. The cry is distinctly unpleasant and annoying to listen to and may seem abnormal.

___ YES
___ NO

2) Paroxysmal cry onset

The cry shows a rapid, abrupt, or immediate onset; there is virtually no build-up to the cry but more of an on/off quality. Cry onset appears as an unpredictable, extreme reaction with no warning, and may have the quality of an attack or spell. The infant may appear frantic, out of control and/or in pain.

___ YES
___ NO

3) Pain sounding

This is a distinctive pain cry in which there are periods during which the infant clearly sounds as if it is experiencing pain. The pain cry has a rapid, almost immediate onset, with periods of elongated cry utterances followed by long periods of inspiration that sound like breath holding. High pitch and turbulence are audible during the elongated cry utterances. Turbulence is also characteristic of the rest of the cry phonations. The pain cry is also loud, intense and arrhythmic.

___ YES
___ NO
III. CONSOLABILITY: (strategies used by mother to console infant during home observation)

A. When the infant fusses or cries, check (√) all of the behaviors employed to soothe the baby:

1. leave alone  
2. talk to  
3. prone  
4. pat  
5. stroke  
6. massage  
7. pacifier  
8. bottle  
9. nurse  
10. change diaper  
11. hold in arm  
12. hold on shoulder  
13. hold upright  
14. rock  
15. bounce  
16. walk with  
17. mechanical aids (swaddle, swing, vibrator, car ride, etc.)

B. Check the ONE item that best reflects extent to which infant is soothed.

✓ Infant quiets by itself, #1 above.  
✓ Mother talking is sufficient to quiet infant, #2 above.  
✓ Talking and touching activities (any of items 3-6 above) are sufficient to quiet infant.  
✓ Mother uses pacifier, feeding or changing (7-10 above) to quiet infant.  
✓ Infant needs to be picked-up, (any of items 11-16 above) in order to quiet.  
✓ Infant can only be quieted with use of mechanical aids (item 17 above).  
✓ Infant is unsettled, irritable, and fussy throughout the observation period. Mother is always engaged in some consoling activities but the crying can be controlled.  
✓ Infant is inconsolable and cries throughout the observation period regardless of maternal interventions. In addition to above, infant resists attempts at soothing; arches back, fights, struggles, screams and appears frantic.

Difficult (score > 5)  
Easy (score < 5)
SCORE:

(1) Infant meets criteria for excessive crying (crying for at least 1) 3 hours a day, 2) 3 days a week, and 3) for 3 weeks.

(2) Cry sound is high pitched.

(3) Cry sound is pain cry.

(4) Infant shows physical signs associated with hypertonia.

(5) Infant is difficult to console.

DECISION RULE

INFANT IS ASSIGNED TO COLIC GROUP IF:

(1) #1 is "YES"

(2) 2 or 3 is marked "YES"

(3) YES is marked for either 4 or 5
APPENDIX K

Semi-Structured Interview Guide
INSTRUCTIONS: Please provide the following information by either circling, checking ( ), or filling in the blank space. ALL INFORMATION WILL BE KEPT STRICTLY CONFIDENTIAL.

1. INFANT
   
   1. When did the colic start? __________ (weeks)

   2. How did you decide it was colic ("how did you know"?), or did someone else tell you it was colic?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

   3. About how many hours does your baby cry per day? ________

   How many days does your baby cry this much? ________

   How many weeks? ________

   4. How does one of these episodes begin? What seems to set it off?

   (Circle any that are mentioned)

   SUDDEN  UNPREDICTABLE  FIT  SPELL
   VIOLENT  RHYTHMIC  ATTACK

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

   5. When do these episodes usually occur?

   (probe: do they occur at a specific time each day, or does it vary widely?)

   __________________________________________________________
6. During one of these episodes, how does the cry sound? (Probe: does it seem different from other cries? If so, how is it different?) Circle any of the following that are mentioned:

HIGH-PITCHED  SHRILL  IN PAIN
TOP OF LUNGS  NOISY  LOUD

7. Can you describe your baby's behavior during one of these episodes? (Circle all that are mentioned)

STOMACH HARD, TIGHT  LEGS EXTENDED  GAS
FISTS CLENCHED  MUSCLES TIGHT  RED FACE
KNEES UP  ARCHED BACK  COLD FEET
STOMACH SOUNDS  ARMS FLAILING  BREATH HOLDING
ANGRY  ACTIVE  INCONSOLABLE

8. What seems to help your baby during one of these episodes? (Circle all that are mentioned)

FEEDING  HOLDING  CAR RIDE  PACIFIER
CHANGING  WALKING  SWING  ROCKING

9. How consolable or easy to soothe is your baby? (Probe: Does the baby resist, struggle, arch back, get angry?)


10. Is anything more effective than others in calming your baby?


11. Have you tried any specific medication for colic? ___yes ___no

If yes, what?____________________________________

Did it help?_____________________________________

12. Did you try changing formula? ___yes ___no

If yes, how many times?____________________________

From what to what?________________________________

Did that help?___________________________________

13. There are a lot of theories as to why some babies cry more than others. What do you think is the reason behind your baby's crying episodes?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

14. Is there anything else we haven't mentioned about colic you would like us to know?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
II. FAMILY: Circle if parents +/or siblings were affected.

<table>
<thead>
<tr>
<th>Parents</th>
<th>Siblings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
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<td>Y / N</td>
<td>Y / N</td>
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<td>Y / N</td>
<td>Y / N</td>
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<td>Y / N</td>
<td>Y / N</td>
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<td>Y / N</td>
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<tr>
<td>Y / N</td>
<td>Y / N</td>
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<tr>
<td>Y / N</td>
<td>Y / N</td>
</tr>
<tr>
<td>Y / N</td>
<td>Y / N</td>
</tr>
</tbody>
</table>

"Colic" as infant
Excessive crying as infant
Sleep problems as infant
Crohn's disease, ulcerative colitis
Irritable Colon, "colitis"
Chronic diarrhea or constipation
Peptic Ulcer Disease
Recurrent abdominal pain
Other gastrointestinal diseases
Asthma, hay fever
Food allergy or intolerance
Eczema, atopic dermatitis
Other chronic illness (diabetes, cancer, etc.)

THANK YOU VERY MUCH!
APPENDIX L

Nursing Child Assessment Feeding Scale
PLEASE NOTE

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267-270
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APPENDIX M

Home Observation for Measurement of the Environment
APPENDIX N

Feetham Family Functioning Scale
APPENDIX O

Family APGAR
APPENDIX P

Colic Infant Diary Entries
<table>
<thead>
<tr>
<th>Time</th>
<th>Sleep</th>
<th>Fussing</th>
<th>Crying</th>
<th>Feeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noon</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:00</td>
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<td></td>
<td></td>
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</tr>
<tr>
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<td>6:00</td>
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<tr>
<td>7:00</td>
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<td></td>
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<tr>
<td>8:00</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midnight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1:00</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3:00</td>
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<td></td>
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</tr>
<tr>
<td>4:00</td>
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<td>5:00</td>
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<tr>
<td>6:00</td>
<td></td>
<td></td>
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<tr>
<td>7:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Breast/Formula

- Wake
- Feeding
- Crying
Sleeping  |  Fussing  |  Crying  |  Feeding
Breast/Formula

Noon
12:00  |  1:00  |  2:00

12:00  |  1:00  |  2:00

3:00  |  4:00  |  5:00

Midnight
12:00  |  1:00  |  2:00

3:00  |  4:00  |  5:00

6:00  |  7:00  |  8:00

9:00  |  10:00  |  11:00
APPENDIX Q

Control diary entry
APPENDIX R

Mothers' Cry Perception Scores on Own Infants' Cries

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## COLIC AND CONTROL MOTHERS' CRY PERCEPTION

**SCORES OF OWN INFANT CRY SOUNDS**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>COLIC M</th>
<th>COLIC SD</th>
<th>CONTROL M</th>
<th>CONTROL SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grating</td>
<td>5.2</td>
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NCAFS Subscale and Summary Scores in Colic Group and Control Groups, Reference Groups, and Four Comparison Groups

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a Barnard, K.E. (1978)
b Ruff, C.C. (1987)
d Lobo, M. (in press)
e Lobo, M. and Barnard, K.E. (in press)
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