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THE UNIVERSITY OF ALBERTA

PATTERNS OF NEWBORN WAKEFULNESS

by

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ABSTRACT

Inconsistencies exist in the literature regarding classification of neonatal waking behavior. Present classifications are inadequate, lacking in comprehensiveness and in adequate description necessary for replicability. The purpose of this study was to describe patterns of nighttime waking behavior of healthy full-term infants within a hospital nursery and to examine variables which may influence them.

Thirty-three waking episodes of 21 healthy full-term infants were videotaped at night in the nursery. An ethogram was developed and behavioral criteria identified for six stages of waking: *Asleep, Transition to Waking, Awake, Transition to Crying, Crying* and *Hard Crying*. These behavioral criteria were validated using discriminant analysis.

Four patterns of waking identified were slow arousal from sleep, rapid arousal from sleep, waking that ended in sleep and fluctuating rest/active periods. Differences in self-consoling and antecedent events were found within each pattern of waking and these varied within subject. The distinctiveness of each stage of waking was verified using discriminant analysis. Further, significant behaviors associated with each type of cry were identified. This study enables the assessment and documentation of infant behavior so that nursing interventions and their effectiveness may be evaluated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure PAGE

LIST OF PHOTOGRAPHIC PLATES

I. INTRODUCTION

While considerable information has been amassed about consistent patterns of sleep states in low risk infants, little is known about wakefulness and there have been few attempts to identify different waking states (Berg & Berg, 1987). This incongruency appears to be due to the lack of consistent electrophysiological data associated with waking states, resulting in reliance on behavioral observation and investigator interpretation (Becker & Thoman, 1983). Wakefulness has been determined solely on the basis of open eyes (Parmalee & Stern, 1972; Pretchl, 1974). Therefore, the purpose of this study was to describe the waking patterns of normal, low risk infants in a naturalistic setting.

Background Information

In addition to the inconsistent categorization of waking states in the literature, documentation of the waking patterns of low risk infants is inadequate. Desmond, Franklin, Vallbona, Hill, Plumb, Arnold and Watts's (1963) classification of waking patterns were determined by differences in physiological parameters and were limited to infants less than six hours of age. Emde, Swedberg and Suzuki (1975) observed infants under artificial conditions within the first ten hours of life using five preexisting behavioral categories (quiet sleep, active sleep, drowsy, wakefulness, crying). Wakefulness included alert-activity which is not part of a young infant's repertoire (Wolff, 1987). Wolff (1987) presented a single pattern of waking behavior, which summarized the waking behaviors of 20 infants under one month of age. Developmental differences in behavior (Irwin, 1932) and inclusion criteria requiring evidence of at least five minutes of alertness limit the value of this summary sequence. Another study described the patterns of two infants who were observed under artificial conditions (Pretchl, 1974). Finally, Thoman (1975), using the criteria of open eyes to determine wakefulness, calculated the transitional probabilities between 8 sleep-wake states. These calculations were based on data from short observation periods in a laboratory, which were not representative of behavior from one feeding to another.

A study of patterns of waking behavior in a caregiving environment would yield important information for nurses on at least four aspects of infant behavior. First, typical patterns or styles of waking would be documented. The relationship of particular behaviors such as fussing and crying, which have important implications for intervention, could be examined with reference to antecedent variables and subsequent behaviors. Second relationships between these patterns and infant, feeding and environmental variables could be examined for direct and indirect effects so that patterns based on these variables could be predicted. Third, the incidence of self-consoling behaviors could be documented. In addition, the relationship between self-consoling behaviors and other waking behaviors could be examined so that predictions of effectiveness of self-consoling could be possible. Fourth, extremes of waking activity could be documented and examined in relationship to infant, feeding and environmental variables. Thus, the potential outcomes of a study on patterns of wakefulness would provide useful information for nurses in practice and education as well as for nurse researchers.

Several subsequent nursing investigations become possible once this baseline of waking patterns is obtained. For example, when is the most appropriate time to initiate a feeding so that the outcome is a "good breast feeding experience"? When is the most appropriate time to initiate a feeding so that milk intake is optimized and minor discomforts such as regurgitation are reduced? When is the best time to initiate comforting measures? How is an "irritable" infant different from an average infant, and what interventions might be most suitable for this infant? Soothability can be investigated empirically. How does successful self-consoling relate to nighttime sleep-wake patterns and the incidence of colic symptoms? What differences in waking patterns and self-consolability exist between low risk infants and the high risk population? Knowledgable and effective nursing care can be advanced when questions such as these are investigated. Therefore, it is important for further nursing research in these areas that a baseline of waking patterns in low risk infants in a caregiving environment be sought.

Research Questions

This descriptive study addressed the following questions:

1. What are the typical patterns of nighttime waking behavior for the low risk newborn infant in a nursery environment?
2. What factors appear to influence these patterns of waking behavior?

Definition of Terms

Some of the terms used in this study are summarized in alphabetical order as follows:

Active Period of a Stage of Waking: This period was defined by certain behavioral criteria which was characteristic of that stage (see Table 8).

Behavioral Event: This was defined as a behavior that occurs so rapidly that an observer could just identify it and count its occurrence (Lehner, 1979).

Duration of a Stage of Waking: This figure was calculated from the onset of the behavioral events which characterized that stage to their cessation.

Loose Swaddling: This was identified when the infant's hands and arms were partially or completely uncovered by a restraining blanket.

Low Risk Infant: This was considered to be a healthy infant between 37 and 42 weeks gestation.

Pattern of Waking: This consisted of a temporal sequence of stages of waking which occurred between sleeping episodes.

Rest Period of a Stage of Waking: This period was a lower stage of waking which followed the active period of the stage of waking.

Restrictive Swaddling: This was identified when the infant's hands and arms were completely covered by a restraining blanket throughout the waking episode. Although arm movement was possible, the infant could not touch his face with his/her hands.

Secure Swaddling: This was identified when the infant's hands were partially or completely uncovered by a restraining blanket. The arms were generally held in a flexed position by the restraining blanket with the hands near the infant's face.

Stage of Waking: This consisted of one or more states of arousal called active and rest periods.

States of Arousal: These were defined as clusters of four or five behaviors occurring within a consistent pattern (Pretchl, 1974).

Waking Episode: This was defined as the period from initial stirring movements, which were preceded by sleep, to the initiation of intervention or until sleep resumed.

II. LITERATURE REVIEW

With the exception of infant vocalization (Aldrich, Sung & Knop, 1945a, 1945b, 1946; Gill, White & Anderson, 1984) and motility (Irwin, 1932; Thoman & Tynan, 1978), waking behavior has been studied primarily in terms of behavioral states (Berg & Berg, 1987). Many variations in criteria and numbers of categories of waking states and transitional states can be found in the literature (Pretchl, 1974; Wolff, 1987). Transitional states, which mark the passage from one state to another, involve greater variations of behavior as they are defined by one or two criteria versus the four or five criteria defining each behavioral state (Wolff, 1987). Some investigators label similar behavior as indeterminant and do not describe it further (Becker & Thoman, 1983; Keefe, 1986; Thoman, 1975) so that it is not possible to replicate that research.

Most observations of wakefulness have been done in two naturalistic settings: either in the home (Wolff, 1987) or in the low risk nursery (Aldrich, Sung & Knop, 1945a, 1945b, 1946; Bennett, 1971; Emde et al., 1975; DiPietro, Larson & Porges, 1987; Gaensbauer & Emde, 1973; Gill, White & Anderson, 1984; Irwin, 1932; Thoman & Tynan, 1978). As findings from studies done in naturalistic settings have more practical value for caregivers than those done in a laboratory setting, this review of the literature will be focused on descriptions of infant waking behavior based on systematic observation in naturalistic settings.

Due to developmental and neurological differences in behavior between full-term and premature infants (Booth, Leonard & Thoman, 1980; Pretchl, 1965), this review will be confined to the full-term infant. In addition, the effect of maternal intervention on certain aspects of waking behavior, such as visual alertness, have been studied (Korner

& Thoman, 1970). Since the purpose of this study is to focus on the description of waking behavior prior to intervention, such studies will not be reported in this review. In this chapter, the results of systematic observations of waking behavior will be described as well as the influence of infant, feeding and environmental variables. A summary of the salient aspects of waking behavior and influencing variables will follow.

Description of Wakefulness

A newborn infant spends approximately 16 to 17 hours in sleep, and the rest of the time in wakefulness (Parmalee & Stern, 1972). The first day of life is associated with increased periods of wakefulness (Wolff, 1987). After observing 20 low risk infants in the first week of life, Wolff (1987) found that the mean duration of sustained wakefulness, excluding the first 24 hours following birth, was 17.8 minutes (range 9-27 minutes).

Descriptions of waking behavior will be organized under the following sections: crying and fussing, drowsiness, alertness, other activity, and patterns of waking behavior. Most of the terminology for the description of waking behavior will be that used by Wolff (1987). This choice was based on three reasons. First, Wolff (1987) used descriptive labels such as drowsiness, alertness, crying and fussing, rather than functional labels which are subject to investigator bias (Lehner, 1979). Second, these terms are descriptive of similar behaviors seen in older infants and adults, for whom types of waking behavior are more easily distinguished and thus, defined (Parmalee & Stern, 1972). Finally, in contrast to numbers (eg., state I, state II, etc.) and other labels (eg. active awake, alert inactivity), this terminology is both familiar to and frequently used by nurses who care for infants and counsel new parents.

Crying and Fussing

Crying in the low risk infant has been described as a repetitive vocalization of five or more cycles and which may include silences between utterances lasting less than 3 seconds (Wolff, 1987). Crying was accompanied by either diffuse motor activity or a rigid posture with limbs in partial extension. The face was contorted into a cry grimace and the skin was flushed. Tears were seen as early as 24 hours of age. In a study of three post-operative infants, Côté (1987) found that frown and bilateral leg movement accompanied crying.

Gill et al. (1984) presented a more specific analysis of different types of crying based on earlier unpublished work by Anderson and Gill. This description categorized crying into four types: whimpering, fuss, cry and hard cry. The behavioral description of whimpering included soft cry of minimal duration, no facial reddening, slight cry grimace and some limb movement. The description for fuss included a moderately loud vocalization of short duration, slight facial reddening, moderately tense cry grimace and rapid limb movement. Cry was described as a loud vocalization of moderately long duration, accompanied by reddened facial skin, tense cry grimace and tense, jerky limb movement. A hard cry was described as a very loud, almost continuous vocalization, very red facial skin, very tense cry grimace and very tense limb movement. These descriptions were organized into a scoring system with values for severity of crying. At least some of the criteria, such as loudness of cry and facial appearance, require subjective judgments and thus, would be a source of invalidity in this scoring system.

In contrast to crying, fussing has received considerably less attention in the literature. Fussing is described as moaning or cry-like sounds separated by periods of silence which lasted at least three seconds (Wolff, 1987). The face is sometimes contorted into a pout or grimace. Fussing is most often seen prior to a bout of crying. Using this description, Wolff (1987) stated that his attempts to distinguish fussing from crying may be arbitrary, as it was sometimes difficult to distinguish it from crying. Côté (1987) described similar behavior in postoperative infants, which included slight frown, eyes shut and legs extended.

Little has been documented on the frequency or duration of crying episodes, probably due to the effect of the variation in timing of intervention (Karraker, 1986). Keefe (1987) described a higher frequency of crying at nighttime in low risk infants in the nursery as compared to a rooming-in environment. The duration of a crying episode in the nursery ranged from 1.5 to 27 minutes. In the rooming-in group, crying time lasted from 1.5 to 13 minutes.

Gill et al. (1984) described the characteristics of a single cry in 15 low risk infants less than two hours old. The mean for the longest continuous cry was 24.7 (± 8.7) seconds, and the shortest period of crying was 1.6 seconds. The closest that any infant came to crying continuously was 39.6 seconds. The mean time interval between episodes of crying was 2.2 (± 8.6) minutes (range: 6 seconds to 11.9 minutes).

Another aspect of crying and fussing of increasing importance is self-consoling behavior. Based on personal observations, Brazelton (1984) defined successful self-consoling as quietening following crying when accompanied by the following movements: hand to mouth movements, insertion of hand/fingers in mouth, sucking hand/finger(s). Two additional self-consoling movements have been described by Blackburn (1977a): changing position and attending to a nearby voice or face.

Only two reports of the relationship of such behavior to fussing or crying could be located. In one study of 12 low risk infants within the first month of life, the occurrence of the following behaviors were counted: mouthing/tonguing, hand to face, hand to mouth, hand suck and rooting to own hand (Wolff, 1987). With the exception of mouthing/tonguing, these behaviors were observed most frequently during fussing and crying as compared to other waking states. Gill et al.'s (1984) data for 1-2 hour old infants demonstrated more frequent tonguing, hand to mouth, hand passing mouth, rooting and empty sucking behaviors during vocalization, than did that of Wolff (1987) whose subjects were older. With the exception of hand to face and rooting to own hand, these behaviors were more common to fussing than crying. The relationship of these behaviors to quietening was not described by either investigator.

Drowsiness

The description of drowsy behavior has received little attention. Drowsiness has usually been observed in the transition from waking to sleep and from sleep to waking (Thoman, 1975). It has been partially defined in terms of the motor activity and respiratory rhythm seen in different sleep states (Wolff, 1987). Particularly for the clothed infant in a naturalistic setting, this may create difficulty when electrophysiological measurements are not available. Intermittent opening and closing of the eyes with associated unfocussed and dull appearance, was the second characteristic of drowsiness (Wolff, 1987). In a brightly lit environment, it would not be unusual to observe intermittent opening and closing of the eyes during other waking states. In three postoperative newborns, Côté (1987) observed a smooth forehead and slightly open eyes, though this may have been affected by the administration of analgesics.

Wolff (1987) found that the duration of drowsiness is highly variable between occurrences within each infant and among individuals. He did not observe any hand sucking during this state. Other self-consoling behaviors were more common than is observed in sleep, but less common than was observed during the other waking states. Of these behaviors, mouthing/tonguing is the most frequently seen.

Alertness

Alertness was described as a relaxed and stable posture with little or no spontaneous movement (Wolff, 1987) and smooth forehead (Côté, 1987). The eyes are open and have a bright and shiny appearance. While alert, the infant is sometimes observed to scan the environment, or to hold his attention on an object for brief periods. The average duration of an alert period was found to be the shortest among waking states (Pretchl, 1974). Wolff (1987) consistently observed alertness in infants less than a month old within 30 to 60 minutes following a feeding.

Other Activity

Most investigators described another cluster of behaviors unique to the very young infant (Parmelee & Stern, 1972; Pretchl, 1974; Wolff, 1987). These behaviors have been variously labeled as active awake or waking activity. Wolff (1987) described this cluster of behaviors as being characterized by bursts of spontaneous activity, varying in intensity and duration. The eyes are open but not focussed, and there is an occasional vocalization such as moaning or whimpering, which is not sustained. The face may be pinched into a grimace and flushed when the limbs are moving. According to Blackburn (1977b), the infant may become increasingly sensitive to disturbing stimuli during this state.

For a sample of 20 two-week old, low risk infants observed at home, the duration of this active waking behavior was very similar to that of fussing and crying (Becker & Thoman, 1983). Progressively, within the first 3 months of life, this behavior was seen to be accompanied by alertness (Wolff, 1987).

Variables Infuencing Behavior

Infant Variables

Infant variables which have received attention in behavioral studies include: age, the effect of circumcision, the effect of soiled diapers, the effect of prenatal events, and individual differences. Although, differences in nurses' perception of behavior and in contingency of care have been attributed to differences in sex (Bennett, 1971), the relationship between sex and differences in waking behavior (Parmalee & Stern, 1972; Pretchl, 1974; Wolff, 1987) or patterns of behavior (Desmond et al., 1963; Keefe, 1987; Thoman, 1975) is generally not statistically significant.

Non-reflex, waking behavior is considered to be under the control of central nervous system mechanisms (Berg & Berg, 1987; Pretchl, 1974). Therefore, some of the differences observed between different age groups of infants may be representative of postnatal developmental changes in maturation of the central nervous system (Berg & Berg, 1987). Desmond et al. (1963) documented three patterns of physiological and behavioral characteristics common to 61 low risk infants during their first 6 hours of life. The first pattern was most common. Immediately postnatal, alert exploratory behavior was described, followed by intense activity then sleep. In the second pattern, intense activity occurred after an interval of quiet activity or sleep. In the third pattern, alertness was brief and followed by sleep; movements were usually provoked by external stimuli.

The last two patterns were usually but not always associated with administration of maternal analgesia prior to delivery. These characteristics were interpreted in relation to the infant's recovery from the birth process. Pretchl (1974) ...ated further that the typical pattern of sleep-wake cycles was different for the first day of life as compared to those observed in utero and in premature infants, and in older infants. Brazelton (1961) observed a relative state of disorganization of behavior in infants less than than 24 to 48 hours of age and whose mothers had no medication in labour. In addition, Wolff (1987) found that the duration of waking states was shorter in the first week of life as compared to the following weeks.

The effect of circumcision on the sleep-wake behavior of low risk male infants was examined by Anders and Chalemian (1974) and Emde, Harmon, Metcalf, Koenig and Wagonfeld (1971). Anders and Chalemian (1974) found that there was significant increased wakefulness within the first hour following circumcision. This consisted mainly of fussing and crying behaviors. Emde et al. (1971) observed prolonged periods of quiet sleep within [illegible] hours after circumcision, but did not report waking behavior. However, it is possible that the pattern of waking behavior may be different for at least several hours following stressful events such as circumcision.

The effect of soiled diapers has traditionally been associated by parents and nurses with increased activity levels and fussing or crying (Wolff, 1969). This belief is fostered by the successful comforting of some crying infants when only their diapers have been changed. Through a series of experiments, Wolff (1969, 1987) concluded that the discomfort from soiled diapers was probably due to the cooling effect of moisture against the skin, rather than to the sensation of wetness.

Intranatal complications, such as general anaesthetics, abnormal deliveries and apgar scores less than 7, are also associated with depressed infant behavior (Dubignon, Campbell, Curtis and Partington, 1969; Kron, Stein and Goddard, 1966; Pretchl, 1974). The importance of maternal complications to subsequent infant behavior was summarized by Pretchl (1965):

> In addition to the aforementioned paranatal conditions [birth process], the fetus may have been exposed during its intra-uterine development to complications such as toxemia or infectious diseases of the mother, abnormalities of the placenta, etc., which may harm it. They may also complicate the difficult process of adaptation to the new environment at birth and, therefore, affect the behavior of the newly born infant. (pp. 77)

The effect of the extrauterine adaptation on clarity of behavioral cues appears to last for 24 to 48 hours, but may be prolonged for at least 3 or 4 days if maternal analgesia was administered (Brazelton, 1977). Analgesic drugs administered systematically and locally during labour and delivery have a depressant effect on the motor abilities of the neonate (Wiener, Hogg & Rosen, 1979) and on attention and social responsivity (Belsey et al., 1981). These effects may last up to 6 weeks post-delivery (Belsey et al., 1981; Tronick, Wise, Als, Adamson, Scanlon & Brazelton, 1976). Both the total dose and the duration of administration are important factors when assessing the effect of maternal analgesia on the infant (Scanlon, Brown, Wiess & Alper, 1974; Tronick, et al., 1976).

Several investigators have commented on the considerable amount of observed variation in waking behavior between individual infants (Desmond et al., 1963; Bennett, 1971; Irwin, 1932; Thoman, 1975). The major assumption of the Neonatal Assessment Scale, a widely used research tool, is that there are important individual differences in an infant's interactional abilites and behavior (Brazelton, 1984). Bennett (1971) observed the propensity of adults to talk about these differences in such terms as: "he's lazy, he sleeps a lot", "he's a smart baby, he looks at me", "she's a lovely baby, and has a nice personality", "he's irritable..." (pp. 323-327)

These judgements may be affected by the adult's perception of the physical characteristics as well as the typical pattern of behavior before and during interaction (Bennett, 1971; Karraker, 1986). However, an individual's typical patterns of waking behavior may be an early display of temperament, which has been conceptualized as a construct within the dimension of personality (Goldsmith, 1986). Temperament has been defined as constitutional differences in organic and motor reactivity and the infant's ability to enhance or inhibit reactivity (Derryberry & Rothbart, 1984). Although there is a diversity of theoretical views of temperament, there is no consensus that temperament is a stable characteristic in early infancy which could be measured (Derryberry & Rothbart, 1984; Goldsmith, 1986; Goldsmith & Rieser-Danner, 1986; Thoman, 1975).

Feeding Variables

Four aspects of feeding have been studied in relation to wakefulness. These are: the temporal relationship between waking behavior and feeding; the effect of type of feeding, the effect of scheduled feedings, and the effect of hypoglycemia.

Gaensbauer and Emde (1973) found that wakefulness in week-old infants typically preceded a feeding. In another study, infants less than one month old were more likely to cry 15 minutes before feeding than 15 minutes following feeding (Wolff, 1987). They rarely cried if a feeding was interrupted near the end. These infants were also alert and awake for prolonged periods during the first 30 to 60 minutes following a feeding. This alert period was followed by drowsiness in 21% of observed occasions.

The temporal relationship of feeding to self-consoling behavior was examined by Wolff (1959) for three infants under 5 days of age. Behaviors such as mouthing, tonguing, hand-mouth contact, and hand sucking occurred more frequently prior to feeding than following feeding. Spontaneous rooting, however, depended on the infant's state of responsiveness and not on the time which had elapsed since the last feeding. The effect of hunger on quietening was not addressed. However, some studies on comforting interventions have indicated that the effect of hunger on the consolability of the infant may not be significant (Kessen, Leutzendorff & Stoutsenberger, 1967; Korner & Thoman, 1972; Neeley, 1979; Triplett & Arneson, 1979).

Several investigators found that type of feeding may have an effect on waking behavior of low risk infants. Young breast-fed infants tend to wake up fussing or crying if they are disturbed while sleeping (Bell, 1966; Wolff, 1987). DiPietro et al. (1987) found that breast-fed infants who were disturbed when sleeping were significantly more irritable, more difficult to console and more difficult to alert than bottle-fed infants. The effect of breastfeeding on infant wakefulness may be aggravated by the limited supply and calorie content of colostrum during the first three or four postnatal days (Wood & Walker-Smith, 1981).

Gaensbauer and Emde (1973) studied the effect of scheduled feedings for a sample of 60 infants from 1 to 3 days of age. Breast-fed and bottle-fed infants who were demand-fed tended to wake up every 4 hours. Based on similar observations, several authors have concluded that an intrinsic sleep-wake rhythm peculiar to very young infants may have accounted for this behavior (Gaensbauer & Emde, 1973; Parmalee & Stern, 1972; Pretchl, 1974).

Hypoglycemia, an abnormal condition of hunger, may be associated with either irritability or lethargy (Cowett & Stern, 1981). Irritability may serve to lower the infant's threshold for noxious stimuli, while the lethargic infant may have a higher threshold. Conditions associated with hypoglycemia are: asphyxia, pre-and post-maturity, small for gestational age, rhesus hemolytic disease, sepsis, cold stress and delayed feeding (Cowett & Stern, 1981).

Environmental Variables

A low risk nursery tends to have greater sources of stimulation such as light and sound levels, than a rooming-in environment (Keefe, 1987). The effect of the following environmental variables on wakefulness will be discussed: room temperature and sounds of other infants crying.

Cooling of the infant may increase irritability; while excessive heating of the infant may also be associated with "fussiness" or lethargy (Scopes, 1981). Wolff (1969) compared the effect of cool (78° F) and warm (85-90° F) environments on the total amount of crying of 10 infants, and found that infants in the cool environment cried more and slept less. Infants who have a lower body temperature may raise their state of arousal and become more responsive to noxious stimuli which would be sub-threshold during deep sleep (Wolff, 1969).

In a nursery of 20 infants, Aldrich et al. (1945a) observed that less than 20% of the total crying episodes were due only to one infant. This supports the possiblity that crying may disturb and wake other infants. This "group" crying may be aggravated by the limitations naturally imposed by the nurse's inability to respond to more than one infant at one time.

Summary

The sleep-wake cycle of low risk infants over 24 hours of age and within the first week of life, appears to be an intrinsic rhythm of approximately four hours. Although little has been done to investigate the typical patterns of waking behavior for low risk infants, some descriptions of duration of waking and frequency of self-consoling behaviors have been documented, as well as descriptions of waking behavior. These waking behaviors include crying and fussing, drowsiness, alertness, and other activity.

Far more is known about crying than about the other waking behaviors. A valid quantitative tool has not yet been developed to assess the quality of variation in vocalizing behavior, nor is this variation well documented. However, fussing could be distingushed from crying on the basis of the number and temporal spacing of cry-like sounds (Wolff, 1987).

As previously mentioned, the descriptions of drowsiness found in the literature have inherent problems for observational research in the low risk infant. For example, in a brightly lit nursery, drowsiness and alertness may be difficult to distinguish. In practice, drowsiness would be seen when the infant is either going to sleep or waking up, and does not require comforting. In a brightly lit nursery, alertness would be differentiated from drowsiness by the continued attempts to open the eyes while there is minimal activity. Rooting and yawning would be absent during alertness, but may be seen during drowsiness.

In addition to crying, fussing, drowsiness and alertness, there is another cluster of behaviors commonly observed in wakefulness. The description of this other waking activity can be easily confused with fussing when the infant is vocalizing. In practice, this waking activity is seen as abundant arm and body movements with eyes open or closed and occasional grunting.

Although the importance of self-consoling behavior in relation to quietening has been recognized, little has been documented about the occurrence of this behavior and its relationship to waking behavior. Successful quietening needs to be systematically examined before the label "self-consoling" can be given to specific motor activity.

Lastly, the influence of infant, feeding and environmental variables on infant behavior were discussed. Preliminary work has been done to investigate the relationships between the incidence or duration of waking behavior and these variables. However, little has been documented on the effect of these variables on the frequency of particular waking behaviors.

III. METHODS

In this chapter, the research method, study sample, data collection, data analysis, and ethical considerations are described. Methods for establishing interrater and intrarater reliability are also discussed.

Ethology

The research method incorporated within the design of this study is ethology. Ethology is the systematic method of observing and recording behavior, with minimal biases and expense, and then describing that behavior within context (Gould, 1982). There is no comprehensive ethogram of the newborn human infant to justify the use of other quantitative approaches in the study of waking behavior (Wolff, 1987). Since standard quantitative instruments are not available for the study of patterns of waking behavior, systematic observational techniques are necessary (Sackett, Ruppenthal & Giuck, 1978). Ethology prescribes a sequence of procedural guidelines aimed at systematic observation and analysis of behavior (Wolff, 1987). As a consequence, the data derived from ethological methods can provide a sound basis for future experimental studies on infant behavior and interventions.

The Study Sample

Convenience sampling was used to obtain 23 healthy, full term infants at two days of age from the Post-Partum Unit of the University of Alberta Hospitals. However, one infant (#19) did not wake during the observation period, and technical problems precluded the use of data gathered from a second infant (#17). Therefore a total of 21 infants comprised the final sample for analysis. A total of 40 waking episodes were filmed. Due to inadequate sound and/or visual data, only 33 waking episodes could be analysed. Repeated waking episodes were analysed for a total of seven infants.

Infants with the following problems were excluded from the study: dextrostik or blood sugar <2.5 mmols/l within 24 hours of commencement of data gathering; less than 37 weeks gestation or greater than 42 weeks gestation; small for gestational age; under phototherapy; and suspicion of sepsis.

Demographic characteristics

The sample consisted of ten male and eleven female infants. One infant was oriental and the others were caucasian. Gestational ages at birth ranged from 37 to 41weeks (Table 1). The majority of infants were delivered spontaneously. Four infants were delivered by forceps and two infants were born by cesarian section. Birth weight ranged from 2805 to 6105 grams (mean=3425 gms).

Maternal Analgesia

The mothers of five infants did not receive narcotic analgesics, epidural or general anaesthesia in labour (Table 2). One of these mothers received 200 mg Seconal orally 3.7 hours prior to delivery as well as a local injection of 1% Xylocaine in the second stage of labour. Another mother was also injected locally with 1% Xylocaine prior to delivery. While local analgesia is not considered to have an effect on infant behavior (Tronick, Wise, Als, Adamson, Scanlon & Brazelton, 1976), the barbiturate, Seconal, is known to cross the placental barrier (Brazelton, 1961).

Five mothers received epidural anesthesia (Table 2). Only one of these mothers received an epidural as the sole route for analgesia. She received a total of 9 mls of

Table 1. Demographic Characteristics of the Sample (n=21)

Characteristic	n	%
SEX		
Female	11	52.4
Male	10	47.6
GESTATIONAL AGE		
37 weeks	2	9.5
38 weeks	2	9.5
39 weeks	6	28.6
40 weeks	5	23.8
41 weeks	4	19.0
Not known	2	9.5
MODE OF DELIVERY		
Spontaneous vaginal delivery	15	71.4
Forceps delivery	4	19.0
Cesarian section	2	9.5

0.25% Marcaine via the epidural prior to delivery. The other four mothers received an intramuscular injection of a narcotic analgesic in addition to this epidural. One of these four mothers received 10 mg Morphine and 17 mls 0.25% Marcaine within four hours of delivery. Three of these mothers received 50-75 mg Demerol and 25 mg Phenergan, which was administered an average of seven hours prior to delivery (range=5.4-11.0 hours). The amount of 0.25% Marcain given per epidural for these three mothers ranged from 9 to 15 mls. Epidural anaesthesia with the agent, Marcaine, is not believed to have a significant effect on neonatal behavior (McGuinness, Merkow, Kennedy & Erenberg, 1978; Scanlon, Ostheimer, Lurie, Brown, Weiss & Alper, 1976).

A single dose of a narcotic analgesic without an epidural was administered to 10 mothers (Table 2). This consisted of 50-100 mg Demerol (mean = 62.5 mg) and 25 mg Phenergan and was administered an average of 2.3 hours prior to delivery (range=0.8-12.2 hours).

In summary, the mothers of 14 infants received a narcotic analgesic in labour. The average dose of Demerol for these mothers was 59.4 mg. Only one mother received a general anaesthetic (nitrous oxide) and she did not receive additional sedation. The categories of type of maternal analgesia which were examined in data analyses are listed in Table 2.

Condition at birth

The total length of labour for this sample averaged six hours (range=0.9-12.3 hours). Apgar scores averaged 7.6 at one minute (range=5-9) and 8.3 at five minutes (range=8-10). No infant required a narcotic antagonist during resuscitation.

Fifteen infants were born by spontaneous vaginal delivery and had no

Table 2. Incidence of Different Types of Analgesia Given in Labour (n=21)

Type of Maternal Analgesia	n	%
No epidural or narcotics	5	24.0
Epidural only	1	4.5
Narcotic analgesics only	10	48.0
Epidural & narcotics	4	19.0
General anesthesia only	1	4.5

Table 3. Types of Fetal Distress and Outcomes

INFANT #	TYPE OF DISTRESS	OUTCOMES		
		Mode of Delivery	Apgar[1]	Apgar[2]
4	fetal heart rate < 120	SVD[3]	5	8
10	fetal heart rate < 120	C/S[4]	9	10
11	meconium staining	SVD[3]	5	8
16	unknown	Forceps	9	9

[1] Apgar score at 1 minute.
[2] Apgar score at 5 minutes.
[3] Spontaneous vaginal delivery.
[4] Cesarian Section.

complications. One infant had fetal heart rate decelerations in the second stage of labour (Infant #4, Table 3). One infant had a low fetal heart rate and meconium stained liquor during the second stage of labour (Infant #11, Table 3). This infant was intubated at delivery to expedite tracheal suctioning and was admitted to the Neonatal Intensive Care Unit overnight for observation. Tachypnea quickly subsided following birth and no respiratory pathology was found.

Four infants were delivered by forceps. One infant had a low fetal heart rate during the second stage of labour and the cord was wrapped around the neck twice (Infant # 16, Table 3). The apgar score was 9 at one and five minutes.

Two infants were delivered by cesarian section. One infant had a low fetal heart rate following a deep transverse arrest (Infant #10, Table 3).

Two infants weighed less than 2900 grams at birth and one infant weighed 6105 grams. These two infants did not experience gestational complications and their blood sugars remained within normal range following birth. Gestational complications were experienced by seven mother-infant pairs (Table 4). Two mothers with gestational diabetes were well controlled by diet and their infants appeared healthy (Infants #4 and #12, Table 4).

One infant was circumcised in the first 12 hours of life and had no complications. At the time of the study, the circumcision was noted to be healing well by the nursing staff.

Feeding Characteristics

Three infants were formula-fed for all feedings. They slept between three and five hours between waking episodes while being observed. One infant was reported to "have

Table 4. Types of Gestational Complications and Outcomes

Infant #	Gestational Complications	Neonatal Outcomes
4	gestational diabetes positive direct coombs test	normal blood sugars bilirubin decreasing at time of study[1]
6	mild pre-eclampsia	birth weight 3710 gm apgars 9[2] and 9[3]
10	deep transverse arrest	apgars 9[2] and 10[3]
12	gestational diabetes raised diastolic pressure bleeding < 20 weeks	normal blood sugars apgars 7[2] and 9[3]
15	mild pre-eclampsia	birth weight 3000 gm apgars 9[2] and 9[3]

[1] Bilirubin level peaked in the morning at 194 mmol/l and no phototherapy was needed.
[2] Apgar score at 1 minute.
[3] Apgar score at 5 minutes.

Table 5. Incidence of Different Types of Feeding

METHOD OF FEEDING	# WAKING EPISODES	
	n	%
Breast fed only	18	55
Breast fed with supplements	5	15
Formula fed only	10	30
TOTAL	**33**	**100**

a lazy suck and needed continuous stimulation to keep sucking" during the night feeding. Fourteen infants were breast fed without supplements before one or more waking episodes (Table 5). They averaged 2.6 hours sleep between waking episodes (range=0.9-4.6 hours). Most breast fed infants were supplemented with formula during the night or received an entire feeding of formula (Table 5). Four infants were supplemented before one or more waking episodes. They averaged 2.7 hours sleep between waking episodes (range=0.7-3.6 hours). Five infants were given one feeding of formula during the night. They averaged 2.5 hours sleep between waking episodes (range=0.8-3.8 hours).

All infants voided and stooled at regular intervals, except for one infant who had not voided for over eight hours prior to the first waking episode of the night. This infant was breast fed with no supplements for every feeding and averaged 2.6 hours sleep between waking episodes (range=1.8-3.8 hours). There were no signs of dehydration upon examination.

Summary

Twenty one infants comprised the final sample. Most infants were born by spontaneous vaginal delivery between 39 and 41 weeks gestation. There was one atypical birth weight of 6105 grams. Despite gestational complications, all infants appeared healthy at two days of age. Five mothers did not receive either systemic analgesia or epidural.

Most infants were breast fed and were given supplements during the study. Five infants were formula-fed for one or more feedings. Infants who received formula slept longer than those who were only breast fed. The milk intake of one breast fed infant may have been low, as evidenced by infrequent elimination.

Data Collection

The Setting

Data were collected over five months, from March to July, 1988. Between one and four infants were studied during a 9-hour period per night, between 2200 and 0700 hours. During the study, all infants had a urine catcher applied as part of a routine screening program. The urine catcher was a soft plastic device with an adhesive backing and was applied after the first waking episode at night. It was typically removed after the second waking episode.

All infants were filmed in an empty hospital nursery, and were separated from the infants not participating in the study. The environmental conditions of this nursery were identical to the other nurseries. The lighting in the corridor and nurseries was dimmed during the night. Room temperature was measured twice each night, and averaged 22.8^{O}C in the nursery (range=20.5-24.0 ^{O}C).

Loud, repetitive and intermittent mechanical sounds were heard in the nursery during the study. A telelift track, used for the transport of specimens and requisitions, was located in the interstitial space above the nursery. These noises were most frequent between the hours of 2330-0130 and 0500-0600. There were also occasional sounds from the adjacent corridor from carts or cots being moved, infant crying and conversation. Occasionally, a parent or nurse came into the nursery during filming and conversations of varying lengths ensued. Infants who were asleep did not arouse with these sounds, but those who were awake were usually alert during the conversation.

Procedure

All infants remained in their mothers' rooms during the day. Mother returned their infants to the nursery between 2230 and 2330 hours before retiring to bed. Breast-fed infants usually went out to feed with their mothers during the night. Formula-fed infants were typically fed in the nursery by the nurse.

At the start of filming, the tightness of the infant's blanket around his body was recorded by the investigator as either loose, secure or restrictive (Table 5). Loose swaddling was identified when the infant's arms were partially or completely uncovered by his/her blanket. Only the hands were partially or completely uncovered in a securely swaddled infant. Restrictive swaddling was recognized when the infant's hands and arms remained covered despite apparent hand and arm activity. Loose swaddling was most commonly observed following a visit to the mother for feeding.

Room and axillary temperatures were recorded at the beginning of the night shift for infants who were observed prior to 0300 hours. Axillary temperatures were measured with the Ivac electronic thermometer (Model 2000). These temperatures were also recorded at the end of the night shift for infants who were filmed after 0300 hours. Axillary temperatures averaged 36.7°C during the night. Changes in body temperature during the night may reflect early emergence of a circadian-like rhythm (Deters, 1980). However, in this study, there was little difference between the mean axillary temperature at the beginning of the night and that at the end of the night (Table 7).

Nine infants were filmed using one video camera and 14 infants were filmed in groups of two. A power-boosted microphone was placed at the head of the cot. The video cameras on tripods were positioned approximately five feet from the cot. All infants were placed in the lateral right or left position, and the head of the cot was

Table 6. [illegible]dence of Different Types of Swaddling

TYPE OF SWADDLING	# WAKING EPISODES	
	n	%
Loose swaddling	18	55
Secure swaddling	14	42
Restrictive swaddling	1	3
TOTAL	**33**	**100**

Table 7. Room and Axillary Temperatures According to Time of Waking

Hour of the Night	Room Temperature (^{o}C)	Axillary Temperature (^{o}C)
2300 - 0300	mean = 22.5 range = 20.5 - 23.5 n = 18	mean = 36.7 range = 36.2 - 37.1 n = 18
0300 - 0700	mean = 23.0 range = 22.5 - 24 n = 13	mean = 36.6 range = 36.4 - 36.9 n = 12

elevated to facilitate filming. The video monitors and receivers were positioned behind the infant's cot, or, if two infants were being filmed, between cots. The investigator was stationed behind the cots and monitored the infants via the video monitor.

An attempt was made to film all stirring and waking movements. The first nine infants were filmed intermittantly. The video recorder was turned off during periods of no movements and turned on when the infant moved. This was reevaluated during the process of obtaining interrater reliability. Because of the lag time between turning the recorder on and recording data on film, there was potential loss of data. Consequently, for the remainder of the study, the recorder was run continuously, at slow speed (6 hr.) until stirring movements were observed, then at normal speed (2 hr.).

Environmental and historical data were recorded on the Data Record Sheet (Appendix A). Field notes were taken to record qualitative observations of events which may have affected the infants' behavior. These data were used to enhance the quality of data collected via videotapes and to develop alternative hypotheses for the observed behavior.

Data Analysis

There were five steps in the process of data analysis. First, a coding tool for recording the data was developed. Second, the one/zero sampling method was chosen to facilitate the use of the coding tool. Third, inter-rater reliablity was obtained before the films were coded. Inter- and intrarater reliablities were also determined at regular intervals during coding. Fourth, the waking episodes were examined for patterns of the stages of waking. Potential explanations for differences and similarities in these patterns were also examined. Fifth, nonparametric and parametric statistical analysis techniques were used to further examine the data and the relationships among variables.

Coding Tool

The first step in the data analysis was to record a detailed description of the filmed behavior of the first three subjects. This description, and subsequent films of two infants were analysed for stages of waking. A coding tool was drafted to facilitate recording of the stages and behavioral events (Table 8).

The behavioral events were further refined during the process of coding and recoding several films. This was a collaborative process involving several people who were either experienced or inexperienced with the subject area. The revised coding tool can be found in Appendix B. The behavioral events which were recorded on the coding tool are defined in Appendix C. These were explicitly defined in empirical terms in order to minimize error due to misinterpretation (Lehner, 1979). Stringent measures were taken to ensure that the behavioral events were also qualitatively different from each other.

Each film was coded under the same lighting and sound conditions. The investigator sat at a fixed distance from the monitor. A timer was used to time each tape segment. The procedure for coding was to view the tape segment three times. The eyes and forehead were coded on the first run; the mouth and vocalizations on the second run; and the head, limbs, body and other movements on the last run. The duration of each waking stage was recorded in seconds. This was calculated from the onset of the behavioral events which characterized that stage to their cessation and use of the timer improved the accuracy of this measurement.

Table 8. Behavioral Criteria Used in the Coding Procedure to Identify the Stages of Waking

Stage 0: ***Asleep***

Sleep began with eyes shut and relaxed, and no movement. It was characterized by frequent and prolonged periods of no movement with eyes shut. Limb and head movement occurred only 1-3 times per episode, and tended to be slow. Occasionally, eyes opened briefly 1-3 times without activity, and sclera were usually prominent.

Stage 1: ***Transition to Wakefulness***

This transitional stage was characterized by eyes shut with activity, and/or periods when the eyes opened and closed repeatedly with no activity. Activity consisted of at least head movement which occurred 4 or more consecutive times. Vocalization tended to be minimal. This stage began when either of these characteristics were first exhibited.

Stage 2: ***Awake***

This stage was initiated when the eyes opened, either beginning a period of alertness, or during activity. Rooting and hand mouth activity tended to be common. Vocalization consisted of grunting; and/or occasional whimpers.

Stage 3: ***Transition to Crying***

This transitional stage began with a fuss cry, and was characterized by this type of crying.

Stage 4: ***Crying***

This stage began with the first real cry that was longer and louder than the fuss cry.

Stage 5: ***Hard Crying***

This stage was initiated with a hard cry. Although reddening was seen during live observation, it was not decernible on videotape.

Sampling Method

One/zero sampling was the method used for recording the behavioral events from the videotapes. This sampling method has been described as recording the occurrence or non-occurrence of behavioral events during specified time intervals (Lehner, 1979). Occurrence means that the behavioral event has taken place at some time during the specified time interval. Time intervals were defined by the duration of an individual stage of waking during which the behavioral event was being sampled. Therefore, the time intervals varied between and among stages (mean=29 seconds; range=1-627 seconds).

Major advantages of this method of sampling was to facilitate consistency and accuracy when coding the behavioral events and to maximize the extent of completeness of the description of behavior within each stage. Two limitations inherent in one/zero sampling have been described by Colgan (1978) and Lehner (1979): both the relative frequencies and the durations of behavioral events may be misrepresented. Therefore, no conclusions could be made regarding the frequency or duration of the behavioral events within a stage.

Reliability

Since the onset of each waking stage was defined by the onset of characteristic behavioral events, the durations and frequencies of the stages could be reliably obtained if the behavioral events were accurately recorded. According to Lehner (1979), interrater reliability is a measure reflecting the accuracy of observation. Intrarater reliability, on the other hand, is a measure reflecting consistency or stability of observation (Lehner, 1979). Both measures of reliability were considered important for accurate and consistent recording of the behavioral events and stages.

According to Lehner (1979), an accuracy criterion can be established by using the consensus of several observers. Therefore, interrater reliability using three observers was obtained on coding the behavioral events, before commencing with the actual data coding (see Table 9). Following training with the coding sheet, these observers coded randomly selected videotapes for five 30-second trials using the coding procedure described earlier. Light (1971, pp. 368-369) described the formula used for the calculation of kappa when there are multiple observers.

Subsequently, interrater reliablity was determined between two raters at regular intervals (see Table 9). Thirty second segments of videotape were chosen at random. The formula for this kappa was described by Topf (1986, pp. 253-254).

Intrarater reliability was determined at regular intervals on the following procedures: interpretation of the stages from the behavioral data; recognition of the stages from the filmed data; and, recognition of the occurrence or non-occurrence of the behavioral events (Table 9). Forty trials were chosen at random. The formula for kappa used to calculate intrarater reliability is described by Topf (1986, pp. 253-254).

Analysis of Patterns

Following a complete description of the stages of waking behavior for each infant, the pattern of stages was examined. Each stage of waking appeared to have an active period and a rest period (column B of Table10). The active period was defined by certain behavioral criteria which emerged from the thick descriptions of the first three infants. The rest period was always a lower level of arousal, either peculiar to that stage (i.e., eyes opening and closing with little or no movement in the rest period of stage 1)

Table 9. Inter- and Intrarater Reliabilities on the Coding Tool

Type of Reliability	Kappa	Variance	Significance
CODING BEHAVIORAL EVENTS			
Interrater Reliability			
Before coding begun	0.87	0.0129	p<.0005
During coding process	0.75	0.0004	p<.0005
Intrarater Reliability	0.88	0.0002	p<.0005
CODING STAGES OF WAKING			
Intrarater Reliability			
Interpretation[1]	1.00	0.0000	p<.0005
Recognition[2]	0.78	0.0042	p<.0005

1 The stages were interpreted from previously coded behavioral events and were compared to the previously coded stages.

2 The stages were recoded from videotape and were compared to the previously coded stages.

or characteristic of the behavior of a lower stage. Alert behavior appeared to be a rest period within stage 2, as movement was minimal. However, only the rest period of stage 1, *Transition to Wakefulness*, was coded separately from the active period of stage 1 because they occasionally occurred at different times during waking; whereas, alertness always occurred immediately before or after the active period of stage 2.

The patterns of active and rest periods were examined for each stage of waking. For this purpose, the duration of a particular stage was defined as the onset of the first active period of one stage to the onset of the active period of a higher stage as described in Table 8; for example, transition of waking to awake (column C of Table 10).

A waking episode was defined as the observed stages of waking from its onset until intervenion was required or until sleep resumed. The onset of a waking episode began with initial stirring movements preceded by a period of sleep. Sleep was identified when there was no movement and the eyes were shut. The pattern of each waking episode was depicted as stages over time. Comparisons were made between the patterns of waking episodes "within subject" (n=7) and "between subject" (n=21). Similarities and differences were examined as well as their relationship to infant, feeding and environmental factors.

Statistical Analysis

Descriptive statistics were used to provide measures of central tendency and spread of the duration of the waking episodes and stages (Sackett et al., 1978). Relative frequencies of the stages in which individual behavioral events occurred, were calculated for each stage. For this purpose and for the following analyses, the active and rest phases were differentiated into stages (column A of Table 10).

Table 10. An Example of the Method of Identifying the Patterns of Waking From the Raw Data

A Raw Data		B Active/Rest Periods	C Pattern of Waking	
Level of Behavior[1]	Duration (sec)		Stage	Duration (sec)
1	58	active	1	112
0	6	rest		
1	48	active	1	
2	159	active	2	159
3	14	active	3	14
4	5	active	4	148
3	13	rest		
4	4	active		
2	3	rest		
4	12	active		
1	28	rest		
4	54	active		
1	29	rest	4	
5	14	active	5	14

[1] Level of behavior corresponds to the coded stages of waking in the raw data.

Stages of very short duration and jerky movements may be possible signs of behavioral disorganization in the infant (Als, 1982) and chi-square analysis was used to examine this association. Discriminant analysis was used to ascertain if these two variables were distinct from infant characteristics, alertness and self-consoling activity.

Discriminant analysis was also used to assess the validity of the coding tool developed in this study. The stages of waking were compared to ensure that each was significantly different from the others. These behavioral differences were further explored with a factor analysis. The stages of wakefulness were then compared to descriptions of waking behavior found in the literature.

Ethical Considerations

Ethical review for this project was received from the appropriate committees of the Faculty of Nursing at the University of Alberta and the University of Alberta Hospitals. Prior to data collection, written, informed consent was also obtained from both the obstetrician and pediatrician responsible for each mother and infant. Short inservice sessions were conducted with the night staff prior to the commencement of data collection in order to acquaint the nurses with the aims, rationale and procedures of this study.

Potential subjects were gathered in the evening after consultation with the nurse in charge of the ward. To obtain consent for infant participation in the study, the investigator visited the mother in her room around 2100 hours. Typically, the fathers were also present at this time. The study and procedures were described and the consent forms explained. Written, informed consent was then obtained (Appendices D and E). The mothers were visited a second time by the investigator in the morning to provide information on how their infant slept during the night. Upon request, a copy of the videotape of their infant was provided for the parents.

During the study, the infants were not left to cry longer than five minutes without appropriate intervention. However, when an infant displayed signs of physiological disturbance, such as color change or flailing arms, appropriate intervention was taken immediately.

A few infants did not wake up for their feeding as expected. If the infant had not been fed for five hours, the nurse was informed and the infant returned to the general nursery. Similarly, if the infant did not settle upon return to the study nursery, the nurse was informed and appropriate action taken.

IV. RESULTS

In this chapter, the patterns and stages of waking of 21 infants will be described. This description will include: variations in the patterns of stages, behavioral events in each stage, the relationship of selected behavioral events with different types of crying, and the effect of antecedent variables on selected behavioral events. The antecedent variables will include the birth, feeding and environmental characteristics related to the waking episodes. An analysis of the validity of the coding tool will follow.

When collecting and analyzing the data, duration was measured and reported in "seconds." However, for large integers, "minutes" or "hours" will be used in the text in order to facilitate the reader's interpretation of the results.

Patterns of the Stages of Waking

The patterns of waking for the 33 waking episodes are illustrated in Figures 1.1 to 1.13. Each illustration is a plot, over time, of the stages of waking for one waking episode. The criteria for identifiying the stages of waking are described in Table 8. Appendix F contains summaries of the frequency and duration of active and rest periods of each waking episode. This Appendix also contains a summary of self-consoling, sucking and jerky behavior for each episode.

Patterns "Within Subject"

During the data collection period, seven infants demonstrated two or more waking episodes. The unit of analysis is the infant. For each infant, patterns and behavioral characteristics of episodes were examined for consistencies and idiosynchroncies.

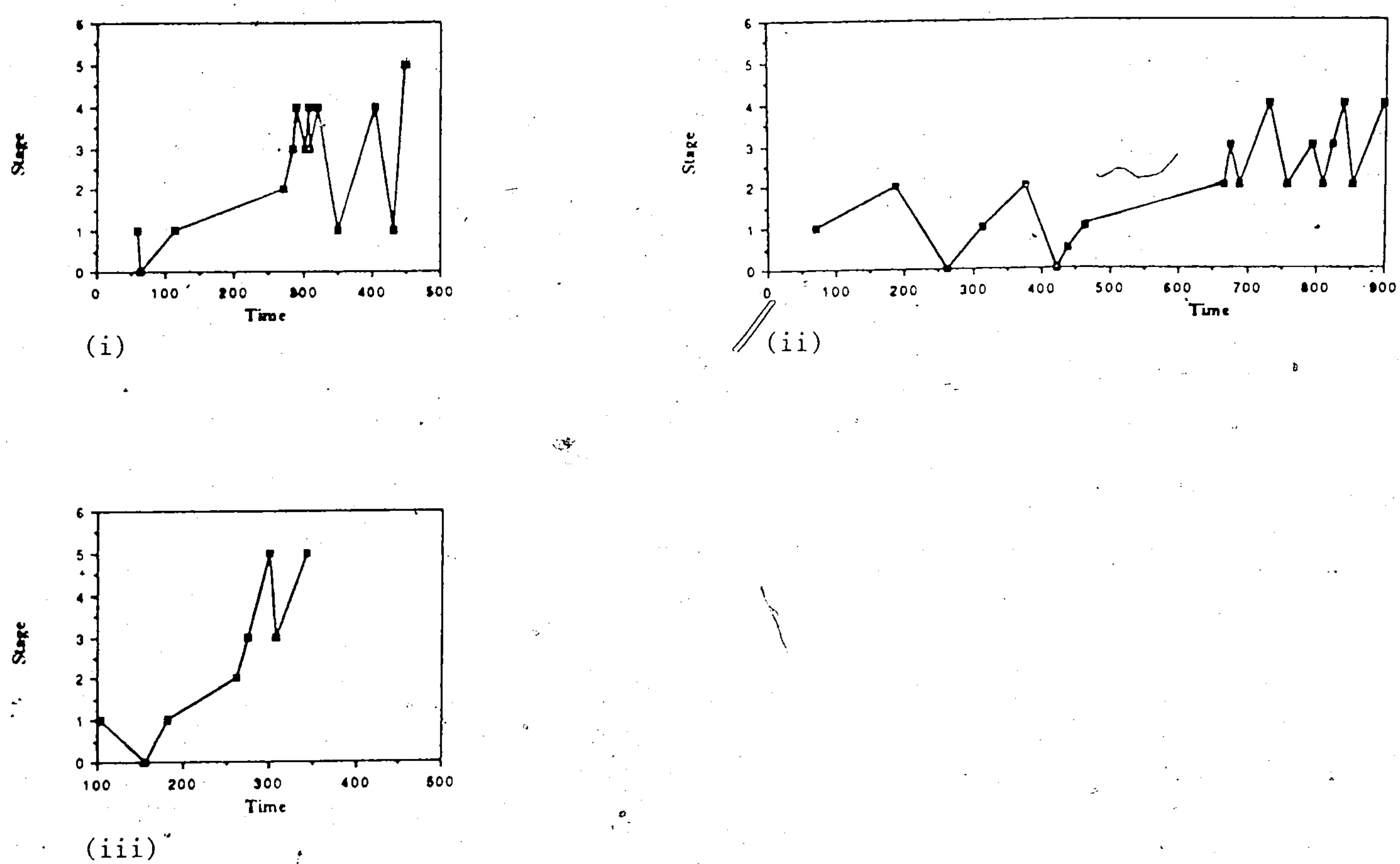


Figure 1.1. The Stages of Waking Over Time (seconds): Infant #1 (i) First (ii) Second and (iii) Third Waking Episodes

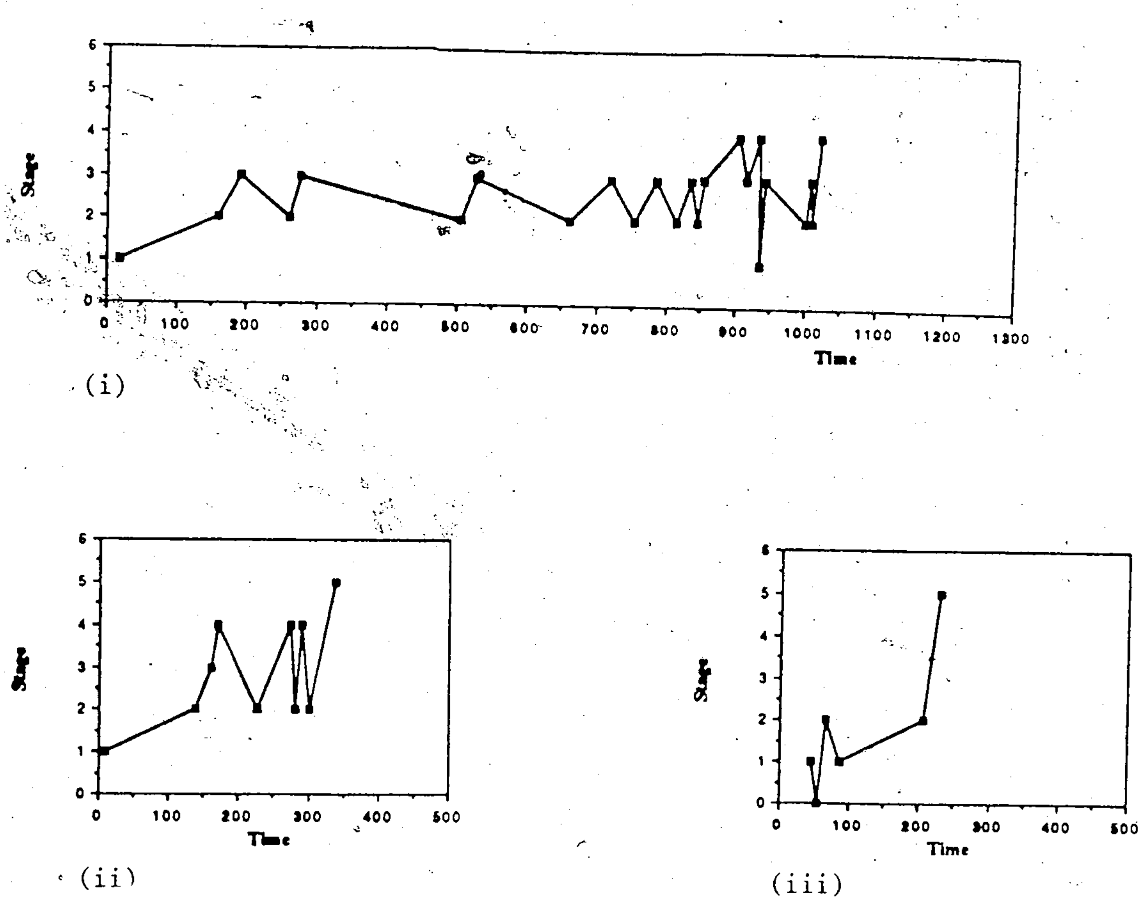


Figure 1.2. The Stages of Waking Over Time (seconds): Infant #2 (i) First (ii) Second and (iii) Third Waking Episodes

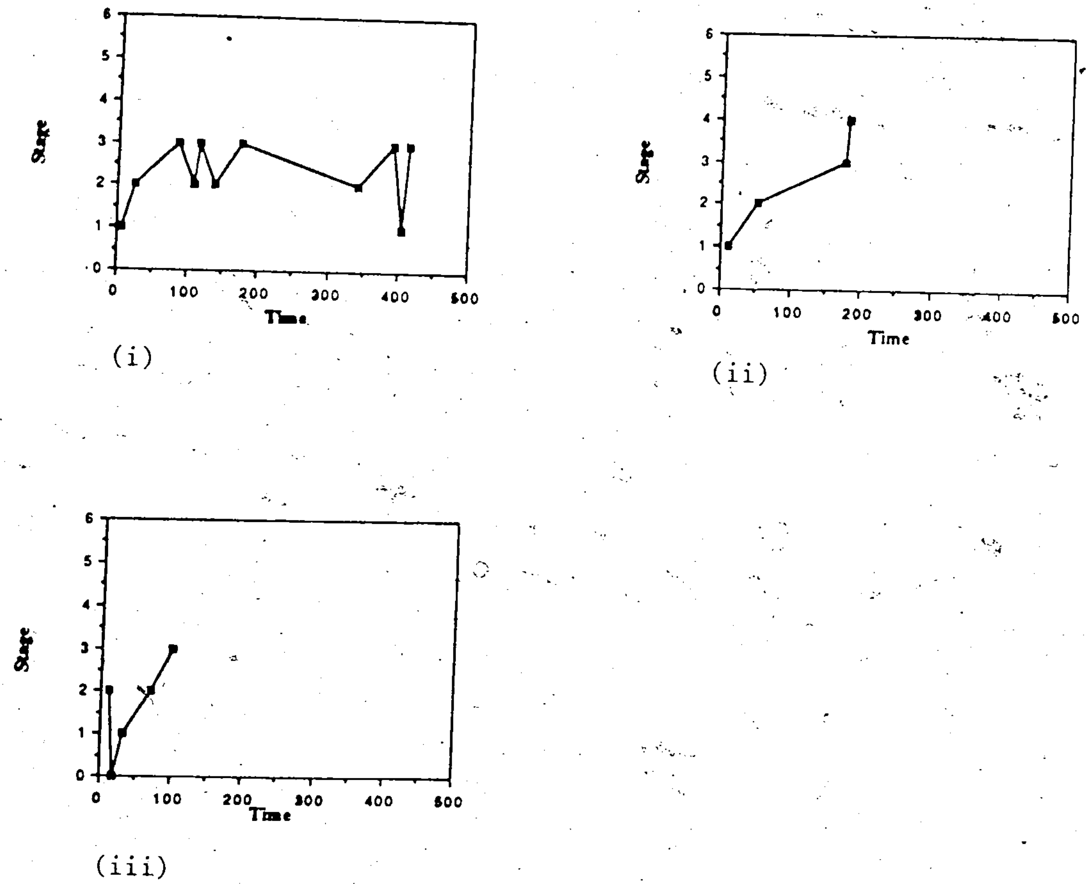


Figure 1.3. The Stages of Waking Over Time (seconds): Infant #3 (i) First (ii) Second and (iii) Third Waking Episodes

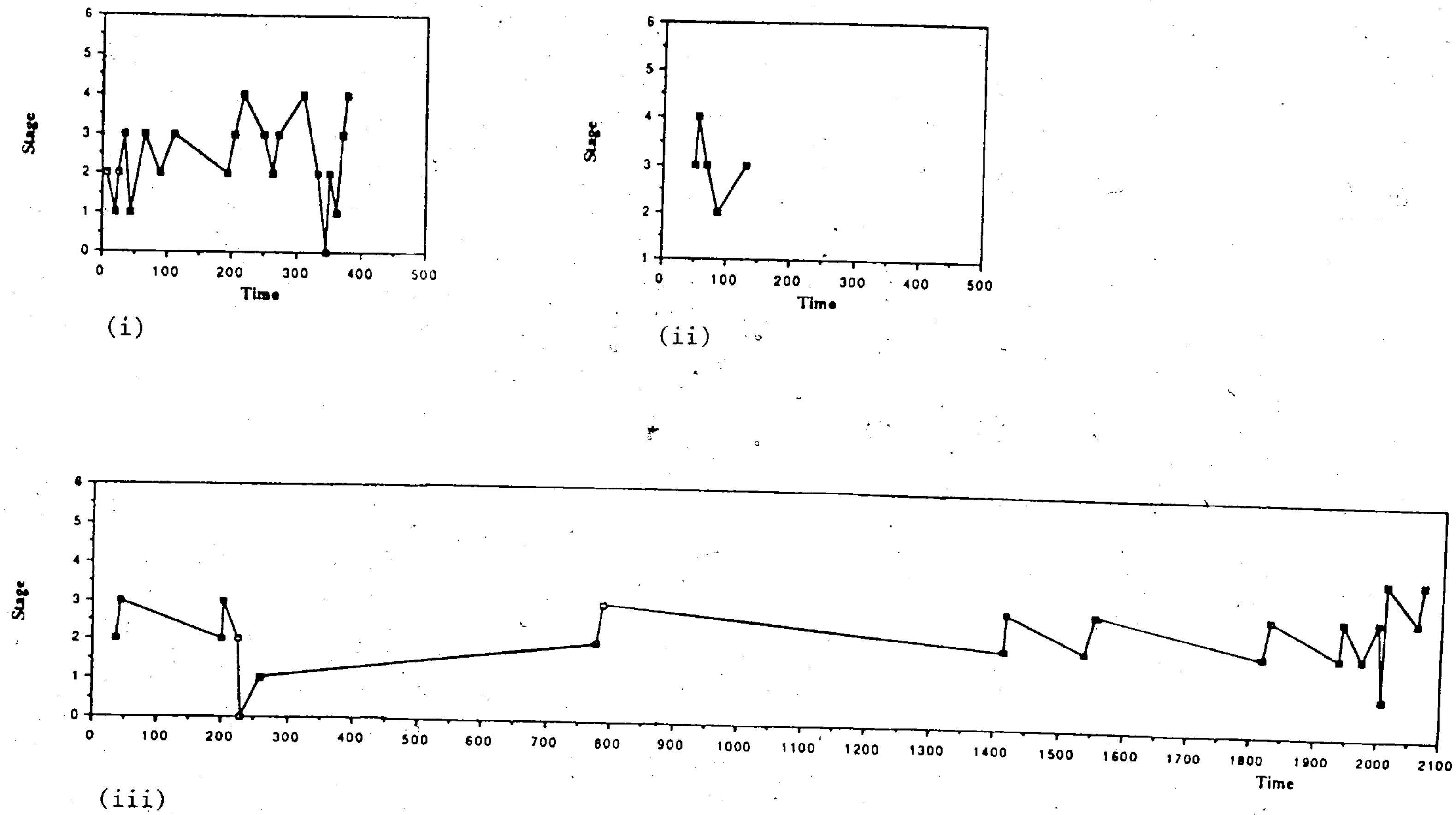


Figure 1.4. The Stages of Waking Over Time (seconds): Infant #4 (i) First (ii) Second and (iii) Third Waking Episodes

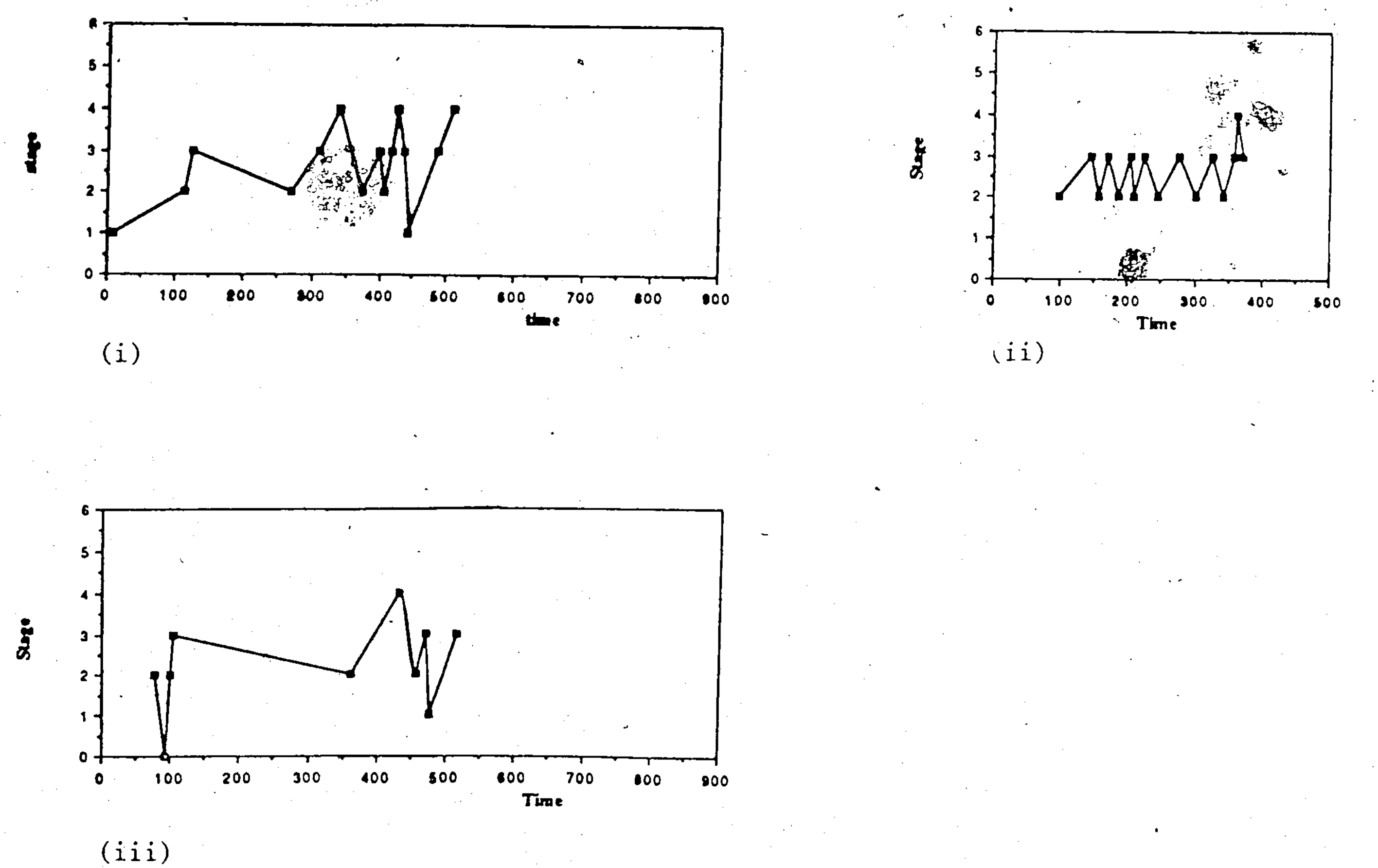
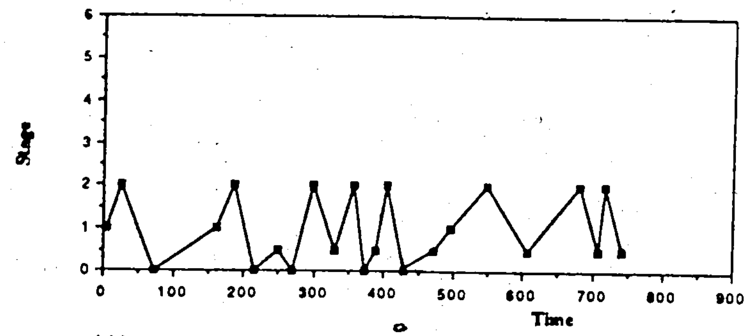
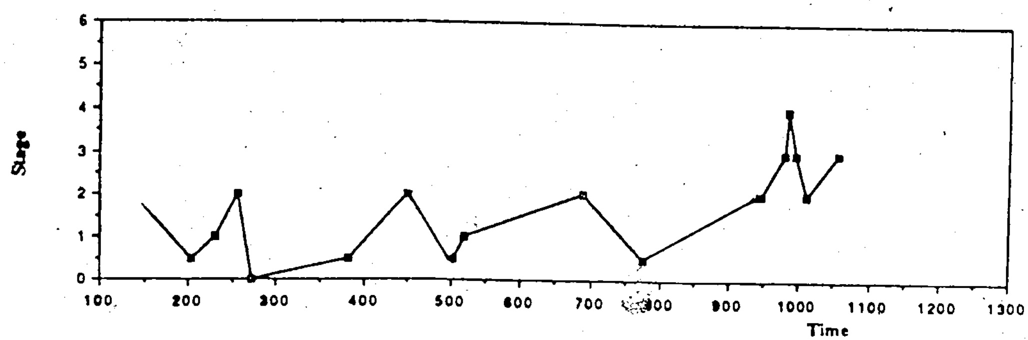


Figure 1.5. The Stages of Waking Over Time (seconds): Infant #5 (i) First (ii) Second and (iii) Third Waking Episodes

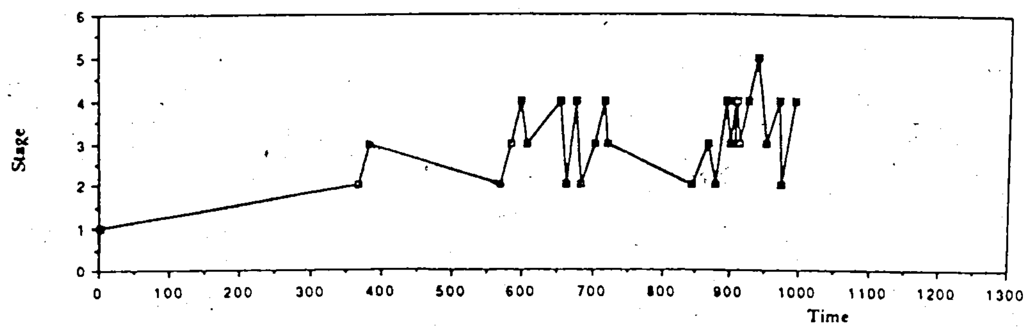


(i)

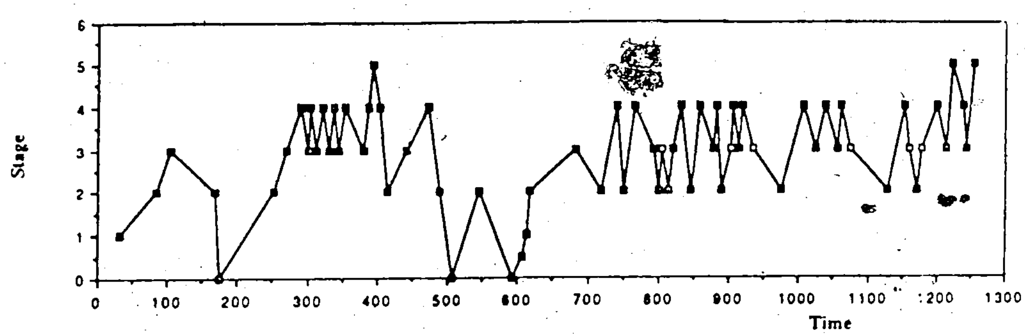


(ii)

Figure 1.6. The Stages of Waking Over Time (seconds): Infant #6 (i) First and (ii) Second Waking Episodes

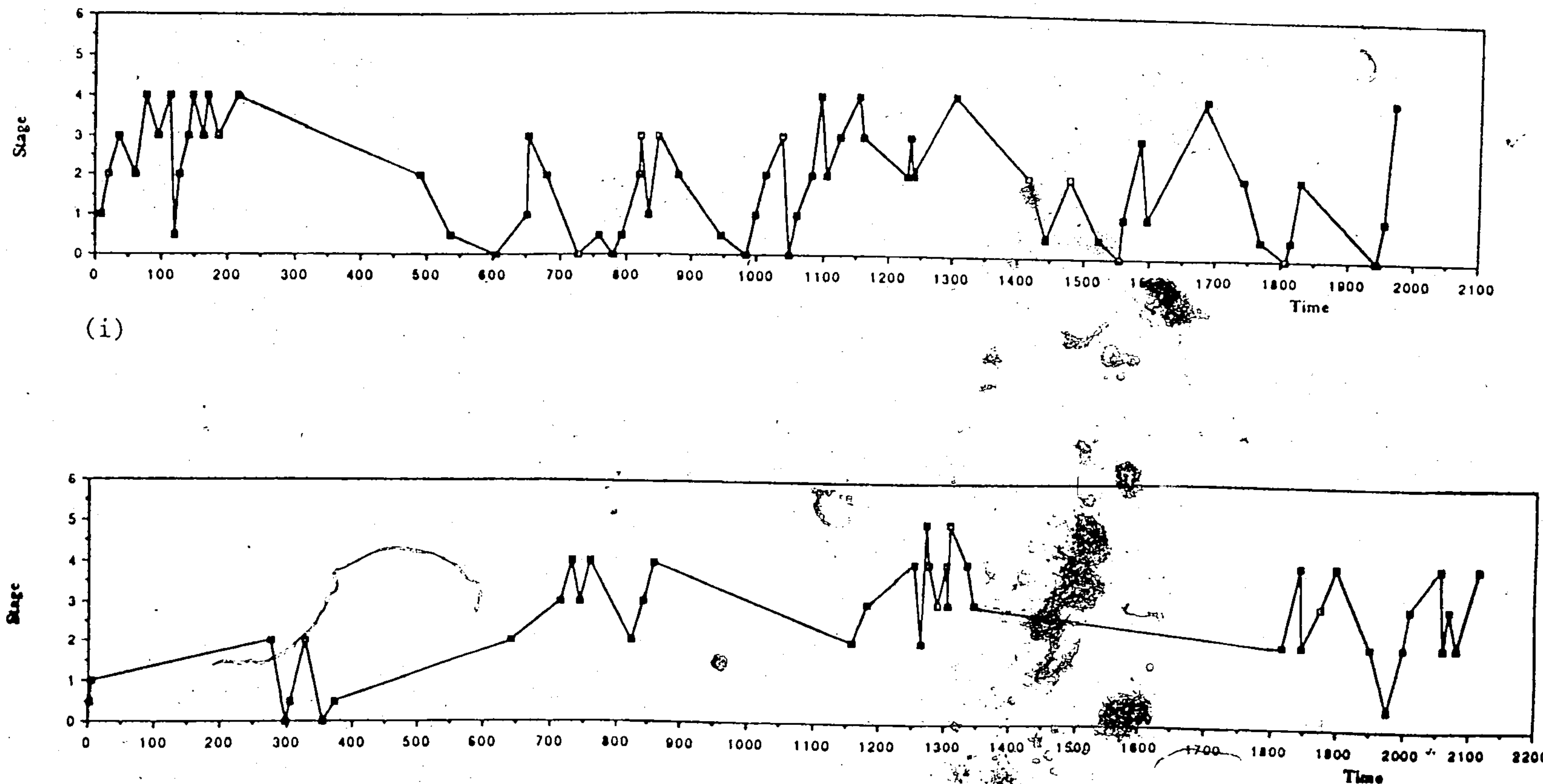


(i)



(ii)

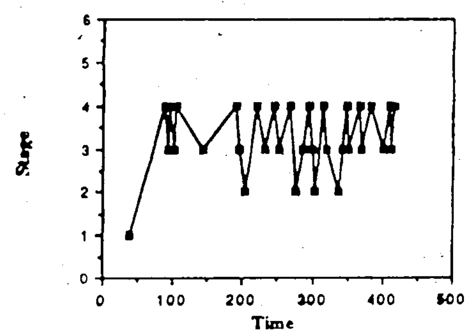
Figure 1.7. The Stages of Waking Over Time (seconds): Waking Episodes of Infants (i) #7 and (ii) #8



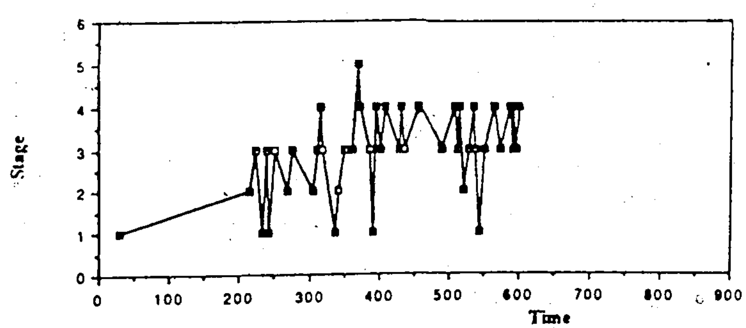
(i)

(ii)

Figure 1.8. The Stages of Waking Over Time (seconds): Waking Episodes of Infants (i) #9 and (ii) #10

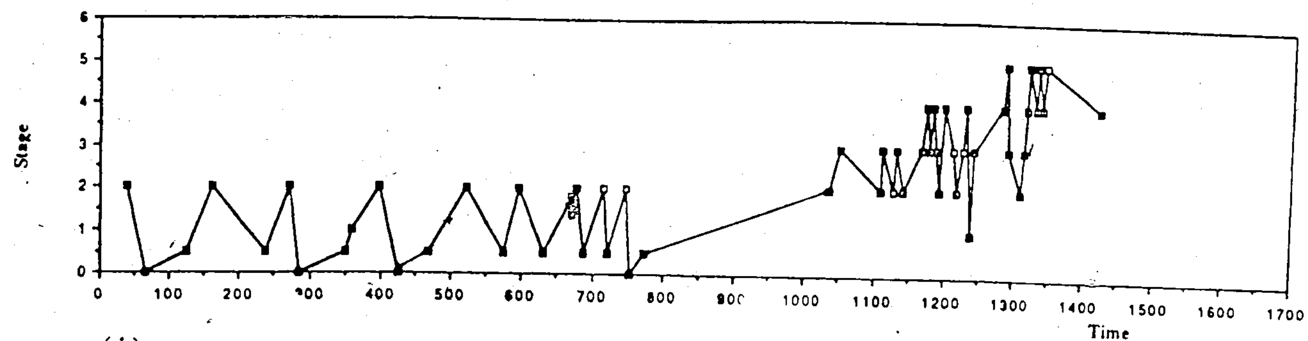


(i)

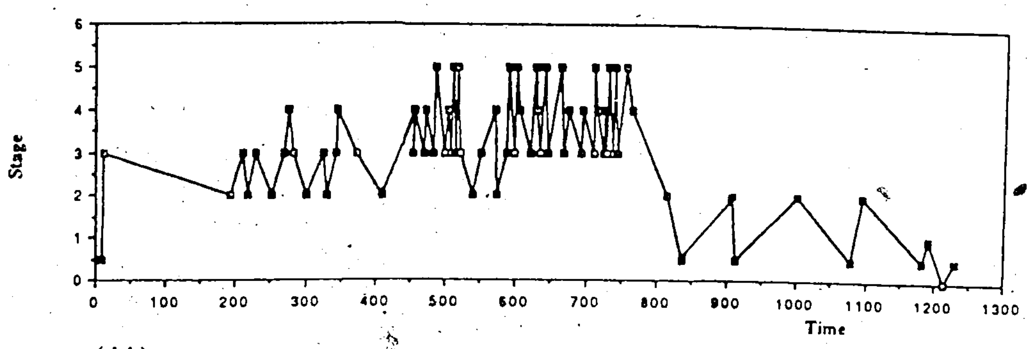


(ii)

Figure 1.9. The Stages of Waking Over Time (seconds): Infant #11 (i) First and (ii) Second Waking Episodes

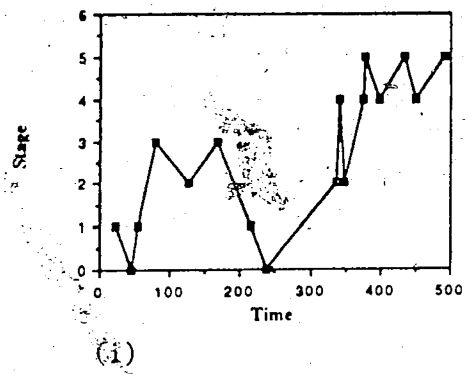


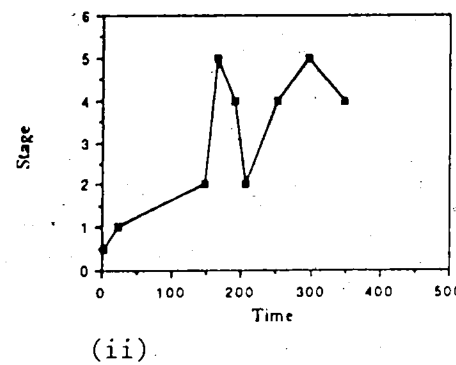
(i)



(ii)

Figure 1.10. The Stages of Waking Over Time (seconds): Waking Episodes of Infants (i) #12 and (ii) #13





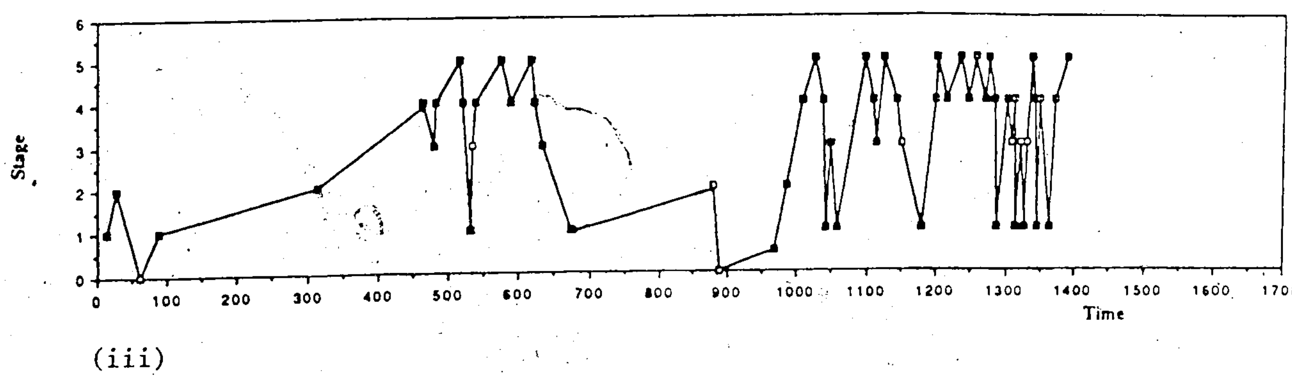


Figure 1.11. The Stages of Waking Over Time (seconds): Waking Episodes of Infants (i) #14 (ii) #15 and (iii) #16

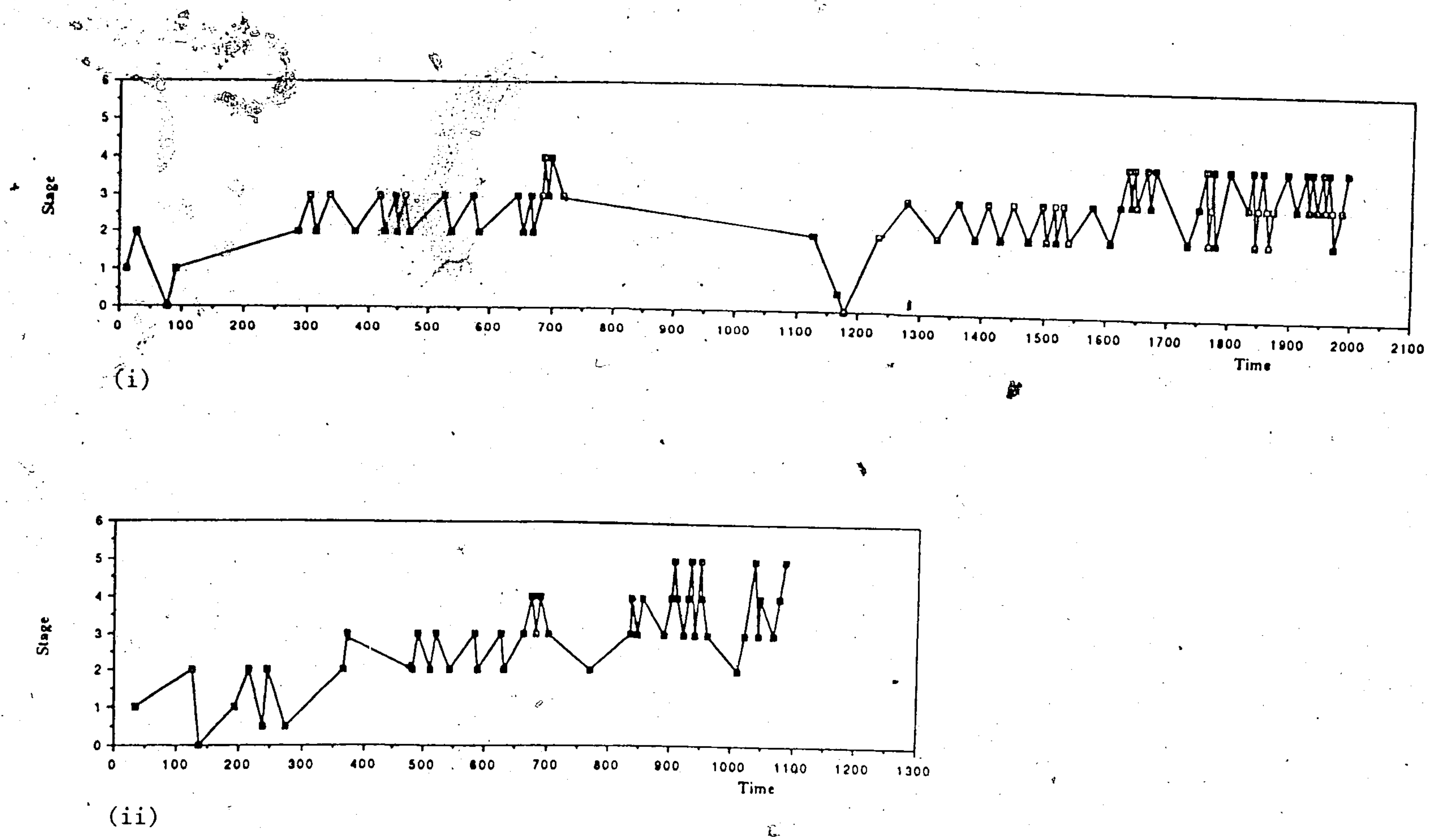


Figure 1.12. The Stages of Waking Over Time (seconds): Waking Episodes of Infants (i) #18 and (ii) #20

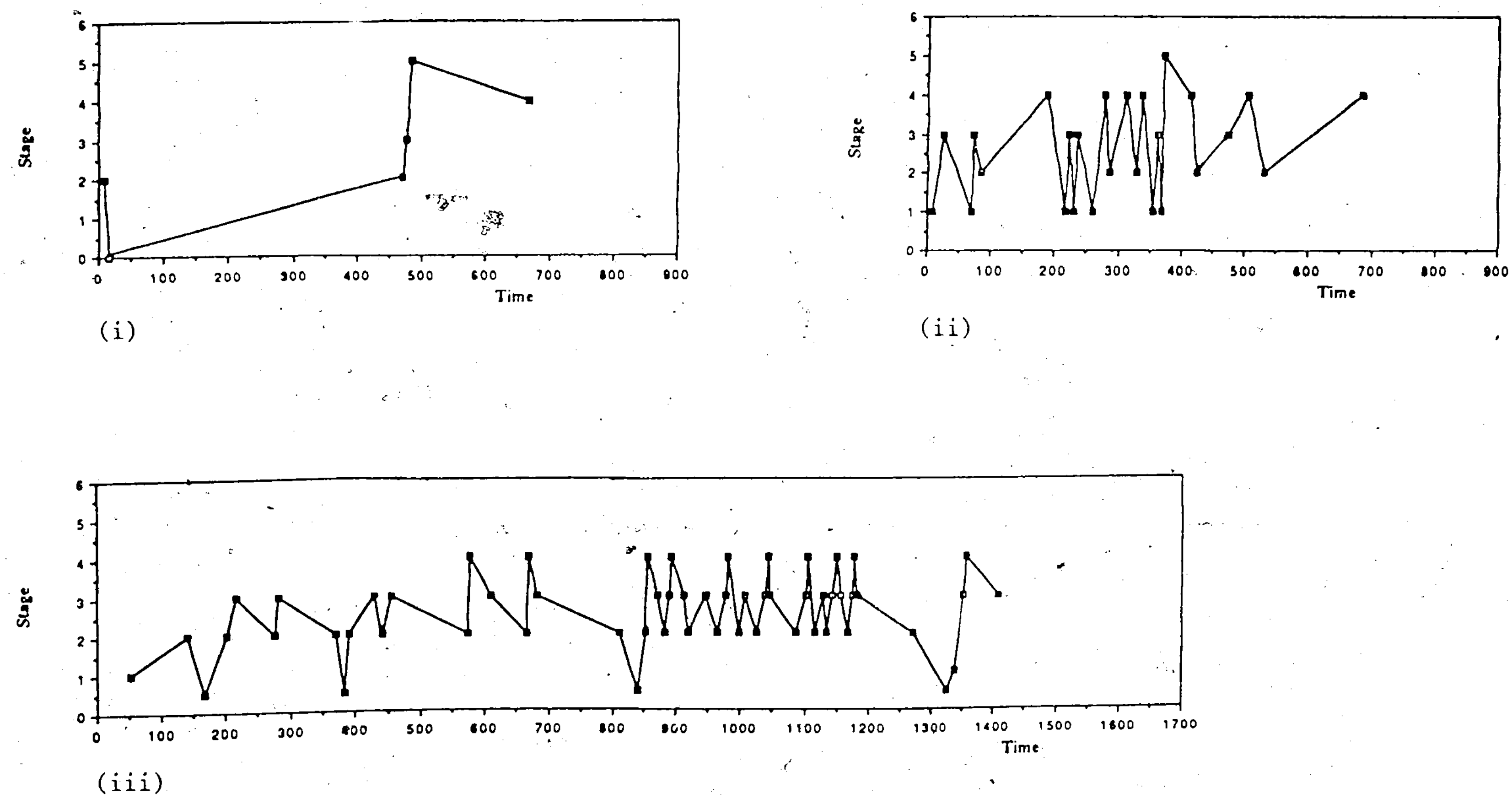


Figure 1.13. The Stages of Waking Over Time (seconds): Waking Episodes of Infants (i) #21 (ii) #22 and (iii) #23

Infant 1

Three waking episodes were observed. *Transition to Crying* was consistently short in all episodes (Appendix F). Hand-mouth activity occurred in 81% of rest/active periods, which was above the average for the sample (Table 11).

The first and third waking episodes had similar patterns (Figure 1.1). *Hard Crying* was reached within 7.2 minutes in episode one, and within 4.2 minutes in episode three (Appendix F). In addition, there were 30% more active periods as compared to rest periods. Although there were no differences in occurrence of hand-mouth activity and sucking, there were 50% more stages with jerky movements in episode three compared with episode one. Lowered body temperature in the third episode may have contributed to this disparity.

The pattern of the second waking episode appeared different from these episodes (Figure 1.1). Although episode two was longer than the others, *Hard Crying* did not occur. Fifteen percent more rest periods were observed as compared to active periods, and more self-consoling behavior occurred. In particular, sucking occurred in 50% more stages.

The only different antecedent variable between the first and third waking episodes and the second waking episode was type of feeding: the infant was breast-fed prior to the first and third waking episodes and formula-fed prior to the second. Rapidity of arousal may have been stimulated by a limited supply and/or calorie content of the breast milk.

Infant 2

Three waking episodes were observed. The first waking episode was characterized by longer duration, lack of *Hard Crying* and an equal number of rest and active periods.

Table 11. Summary of the Rest/Active Periods and Selected Behavioral Events for All Waking Episodes

Variables	n	Mean (%)	Range (%)
REST AND ACTIVE PERIODS			
Relative Frequency of Rest Periods	33	53.0	0-81.2
Relative Frequency of Active Periods	33	47.0	18.8-100
# Rest Periods > # Active Periods[1]	10	-	-
# Rest Periods < # Active Periods[1]	8	-	-
BEHAVIORAL EVENTS[2]			
Hand-Mouth Activity	32[3]	50.5	1.4-100
Sucking	33	17.4	0-75
Jerky Movements	33	47.9	9.1-100

1 This includes only those episodes where there was a 20% difference or greater between the relative frequency of rest periods and that of active periods.

2 These figures represent the relative frequency of stages during which the particular behavioral event occurred. Alert behavior was omitted because its occurrance was restricted to one stage.

3 One waking episode was not included because restrictive swaddling precluded hand-mouth activity.

The rapid transitions between rest and active periods in the last half of this episode were similar to the patterns of other two episodes. This change in the pattern of episode one coincided with the infant passing gas per rectum indicating possible abdominal discomfort. Hand-mouth activity occurred in more stages in this episode when compared to the other two episodes.

There was little variation between the patterns of the second and third waking episodes (Figure 1.2). *Hard Crying* was reached within a very short period of time (Appendix F) and few rest periods were observed. Little variation was noted in the amount of hand-mouth activity. In contrast to these two episodes, *Transition to Crying*, *Crying* and sucking were absent in the third episode and the crying in *Hard Crying* sounded like screaming.

After being picked up and rocked in the third waking episode, the infant burped loudly twice. Abdominal discomfort due to gas may have contributed to the rapid build-up of tension in the third waking episode. It is significant that the mother commented, " my breasts are still soft, so the milk hasn't come in yet." This infant voided infrequently and may have been slightly dehydrated, which, in turn, may have contributed to some of the differences in the patterns of waking.

Infant 3

Three waking episodes were observed. All episodes were interrupted by early intervention (i.e., waking interrupted before *Hard Crying* occurred), which created difficulties in evaluating variation among the patterns of waking. Hand-mouth activity occurred in most stages of all waking episodes. It is significant that his mother commented, "I gave him a soother so he wouldn't suck his fingers . . . he grabs at his mouth and scratches his face."

Total duration and the duration of *Transition to Crying* were longest in the first waking episode compared to the other two episodes (Figure 1.3). There also were more rest periods in the first episode, and alertness was observed. No alertness and more jerky movements were observed in the other two episodes (Appendix F).

The only consistent difference in antecedent variables was that a formula supplement was given prior to the first waking episode and not the other two episodes. Prior to the second waking episode, the nurse commented, "he's exhausted... he wouldn't take the breast without a nipple shield, so I don't think that he will last the hour." The interval between the last feeding and initial stirring was 1.1 hours for the second episode, and approximately 3 hours for the other episodes.

Infant 4

Four waking episodes were observed, but technical problems precluded coding of one episode. Early intervention in the second episode precluded extensive analysis of this pattern. The first waking episode was unique as extreme facial tension (frown, eyes tightly shut and grimace or mouth open square) was observed in almost every stage. Abdominal discomfort may have contributed to this tension as the infant consumed a large volume of milk prior to episode one (80 ml of formula), regurgitated after feeding and passed gas several times. A urine catcher was also worn during the first waking episode, and irritation from the rigid seams of the plastic catcher or from the adhesive backing, may have created additional discomfort.

There was considerable variation between the patterns of the first two waking episodes and the third episode (Figure 1.4). Total duration and the duration of *Transition to Crying* were longest in the third episode (Appendix F). There were long rest periods in this episode at the level of stage 2 and the level of arousal had decreased to stage 0 at times. In contrast, there were shorter rest periods in the first two episodes and level of arousal did not fall below stage 1. These differences may be related to the marked increase in self-consoling activity observed in the third episode (Appendix F).

Infant 5

Three waking episodes were observed. Early intervention interrupted all episodes. Antecedent variables included the use of a urine catcher (Figure 5). Alert behavior was conspicuously low or absent in all episodes (Appendix F). Jerky movements were consistently high and flailing was observed. Isolated arm and face movements were frequent. These characteristics may have been exaggerated by immaturity as the birth weight of this infant was below the average for the sample (2805 grams).

Transitions between rest/active periods were most frequent in the second waking episode compared to the other two episodes, and a level of arousal less than stage 2 was not achieved (Figure 1.5). Sucking was absent and hand-mouth activity (37.5%) was below the average for the sample (Table 11). In contrast, rest periods at the level of stages 0 and 1 were achieved in the first and third episodes, and the amount of self-consoling activity was above the average for the sample. Discomfort from wearing a urine catcher during the second waking episode may have contributed to these differences.

Infant 6

Two waking episodes were observed. Both episodes consisted of a long stage of *Awake* with frequent rest periods (Figure 1.6). The first waking episode ended in sleep and more frequent rest periods were observed (Appendix F). Alert behavior occurred only in the second episode. The first waking episode was preceded by "a lot" of handling from visitors. Approximately half of the milk consumed during the feeding prior to this waking episode was regurgitated and this infant's nighttime sleep was characterized by frequent episodes of abrupt movements. Regurgitation and prolonged periods of "active sleep" may be indications of unusual stress (Als, 1982; Anders & Chalemain, 1974). The infant's ability to handle stress may also have been compromised by the depressant effect of the morphine administered in labour (Brazelton, 1977). The infant had to be aroused for feeding and later, the nurse commented, "he had a lazy suck and needed constant stimulation to keep sucking."

Infant 11

Two waking episodes were observed. Similarities between the two waking episodes included: rapid transitions between rest and active periods; few stages with sucking and alert behavior; and almost all stages with jerky movements (Appendix F). Flailing was observed during *Transition to Crying*, *Crying* and *Hard Crying*. Frown or slight frown, kicking and squirming were observed in all stages of both episodes.

A few differences existed between the two episodes (Figure 1.9). These included rapid arousal in the first episode and greater proportion of rest periods and hand-mouth activity in the second episode. Discomfort in the first episode may have contributed to these differences as the axillary temperature was low (36.4°C) and sleep was shorter prior to this episode (difference=1.6 hours). The infant was breast-fed prior to both episodes.

Summary

Inconsistencies in the patterns of repeated waking episodes consisted of systematic variation of three aspects of waking behavior: patterns, active/rest periods, and behavioral events. Some of these trends may have been related to antecedent variables.

Consistencies "within subject" were found within two waking episodes per infant and included similarities in the amount of hand-mouth activity and jerky movements (n=5). Early intervention in the waking episodes of one infant precluded any conclusions of similarity.

Inconsistencies were found on some aspect of the patterns of two waking episodes for all infants (n=7). When three episodes were observed in the same infant, one pattern was always different from the patterns of the other two episodes (n=4). No such conclusion could be drawn for one infant, because of premature intervention. When two episodes were observed for one infant, one pattern was always different from the other (n=2). The major source of within subject variation was the rapidity of arousal from sleep (n=5). A more rapid arousal was related to rapid and frequent transitions among rest and active periods, greater relative frequency of active periods as compared to rest periods, decreased occurrence of self-consoling behaviors, and increased occurrence of jerky movements. Antecedent variables that may have contributed to this pattern included abdominal discomfort, presence of a urine catcher, hunger, and cooler skin temperature.

In conclusion, within subject variation of patterns of waking was common to all seven infants. Consistent trends were found in the patterns of rest and active periods and the amount of self-consoling activity and jerky movements. Although a proportion of an infant's response to internal and external environment may be unique to the individual or due to the surroundings, these findings suggest that considerable differences do exist "within subject" in the patterns of waking behavior.

Patterns "Between Episodes"

The unit of analysis for this description was the waking episode (n=33). In this section, the results of the analysis of the patterns "between episodes" will be described. The following types of patterns will be described: rapid arousal from sleep, slow arousal from sleep, episodes that ended in sleep, and episodes with wide discrepancies between the incidence of rest and active periods. Differences on three levels (periods, behavioral events and antecedent variables) will be examined for each type of pattern.

Early versus delayed intervention affected this analysis. Early intervention was defined as a deliberate interruption of the infant's pattern of waking by a caregiver before the infant reached *Hard Crying*. This included waking episodes that were interrupted before the infant reached *Crying*. Therefore, a considerable range of duration for these waking episodes was observed (Table 12). Delayed intervention was defined as a deliberate interruption of the infant's pattern of waking by a caregiver after the infant reached *Hard Crying*.

Rapid Arousal from Sleep

Differences in the rate at which the infant reached *Transition to Crying* or higher were seen. There were ten waking episodes during which an infant reached *Transition to Crying* (n=9) or *Crying* (n=1) within one minute (episodes one and two of infant #3, one, two and three of infant #4, one of infants #9, 11, 13, 14 and 22). This value is considerably lower than the average for the sample (Table 13). The relative frequency of active periods was 20% greater than that of rest periods in only two episodes. The opposite pattern occurred in three episodes. However, there were only two episodes that had a rest period in the stage(s) prior to the onset of *Transition to Crying* (episode one of infants #4 and 14).

Hand-mouth activity occurred in all episodes (mean=39.8% of stages) and was

Table 12. Duration (seconds) of All Waking Episodes According to the Timing of Intervention

Timing of Intervention	n	%	Mean Duration	Range
Early Intervention[1]	14	42.4	669.8	100-2071
Delayed Intervention[2]	16	48.5	853.1	228-2113
No Intervention[3]	3	9.1	1355.0	742-1968
Total	**33**	**100.0**	**843.1**	**100-2113**

[1] Intervention occurred before *Hard Crying* was attained.
[2] Intervention occurred after *Hard Crying* was attained.
[3] Waking episode ended in sleep and no intervention was required.

Table 13. Summary of Arousal Patterns for All Waking Episodes

Arousal Pattern	n	Mean (sec)	Range (sec)
TIME FROM INITIAL STIRRING			
To *Awake*	29	23.7	0-112
To *Transition to Crying*	28	205.8	8-1036
To *Crying*	26	487.9	38-1169
To *Hard Crying*	24	346.9	147-1282

considerably lower than the average for the sample (Table 11). Sucking occurred in six episodes (mean=13.2% of stages). The average for the sample was 17.4%. Jerky movement occurred in all episodes (mean=62.4% of stages) which was slightly higher than the average for the sample (Table 11).

Four antecedent variables were shared by two or more waking episodes. The majority of these episodes occurred between 2325 and 0130 hours and represented the infant's first feeding of the night (n=8). Seven of these episodes were preceded by breast feeding. Hunger may have contributed to this pattern as only one infant was given a supplement and milk intake may have been reduced by maternal fatigue (Wood & Walker-Smith, 1981). Infants were loosely swaddled in four episodes. Axillary temperature of the infants in two episodes was only 36.4^{o}C. Loose swaddling and cool skin temperature may have contributed to discomfort. Finally, the majority of episodes were from infants whose mother received narcotic analgesics during labour (n=9). The average dose of Demerol for these mothers was higher than the average for the sample (mean=70 mg; range= 50-100 mg). These infants (n=5) represented 36% of all infants whose mothers had received narcotics in labour (Table 2). In addition, one episode was from an infant whose mother had received a general anesthetic. Higher doses of maternal narcotic analgesics or general anaesthesia may have exaggerated the infants' responses to hunger and discomfort by depressing their ability to control their level of arousal or lowering their threshold of response.

Two infants went back to sleep following this pattern of arousal. Three episodes ended in *Hard Crying*. One episode was interrupted in *Crying* because that infant was flailing and the color very red. The characteristics and antecedent variables for patterns with rapid arousal from sleep are summarized below:

Characteristics

1. Time from stirring to *Transition to Crying* or *Crying* <1 minute.
1. Little difference between the number of rest and active periods.
2. No rest periods prior to *Transition to Crying*.
3. Decreased hand-mouth activity.
4. Increased jerky movements.
5. Waking ended in sleep (n=2).

Antecedent Variables

1. Higher doses of maternal narcotic analgesics.
2. Breast feeding with no supplement.
3. All episodes occurred between 2300 and 0130 hours.

Slow Arousal from Sleep

Three waking episodes had a pattern of slow arousal from stirring to *Crying* (episodes three of infant #4, two of infant #6 and one of infant #12). The modal time for these infants to reach *Crying* from stirring was 19 minutes (range=16 to 33 minutes), while the average for the sample was 8 minutes (Table 11). The relative frequencies of active periods and rest periods were similar within each episode. However, the rest periods in each episode tended to be longer. One infant reached *Transition to Crying* within 37 seconds (episode three of infant #4). In this episode, *Transition to Crying* consisted of prolonged rest periods and very short active periods.

Hand-mouth activity occurred in two episodes (mean=28.2% of stages), which was lower than the average for the sample (Table 11). Sucking occurred in all three episodes (mean=20.3% of stages), which was approximately 3% higher than the average for the sample (Table 11). Jerky movements occurred in all episodes (mean=30.1% of stages) and was approximately 18% lower than the average for the sample (Table 11).

Several antecedent variables may have contributed to slow arousal. Mothers of all infants received narcotic analgesics in labour but the average dose for two mothers was lower than that seen in the rapid arousal pattern (mean=50 mg Demerol). Axillary temperature averaged 36.8°C (range=36.7-36.8°C) and all infants were securely swaddled, which may have increased their comfort level. All infants were fed formula prior to waking indicating that they may have been less hungry. Several other factors may have influenced the behavior in episode one of infant #6. The infant had been handled "a lot" by visitors and had a "lazy suck" prior to this episode, indicating possible fatigue. The mother was given Morphine and an epidural in labour which may have depressed his motor abilities further.

The duration of "slow arousal" episodes averaged 25 minutes (1526 seconds), which was considerably longer than the average for the sample (Table 13). Two of the episodes were interrupted by early intervention. It is interesting to note that all episodes occurred later in the night when compared to those episodes with rapid arousal (0210, 0536 and 0548 hours). The characteristics and antecedent variables for patterns of slow arousal from sleep are summarized below:

Characteristics

1. Modal time from stirring to *Crying* or *Hard Crying*: 19 minutes.
2. Rest periods longer than active periods.
3. Decreased hand-mouth activity.
4. Decreased jerky movements.

Antecedent Variables

1. Secure swaddling.
2. Formula feeding.
3. Lower doses of maternal narcotic analgesics.
4. All episodes occurred after 0210 hours.

Episodes that Ended in Sleep

Three episodes ended in sleep (episode one of infants #6, 9 and 13). The average relative frequency of rest periods was 68.9% (range=60.9-80.0%). This was considerably higher than the average for the sample (Table 11). The average relative frequency of active periods was 31.1%, which was lower than the average for the sample (Table 11). The relative frequency of rest periods was greater than active periods for episodes ending in sleep.

Hand-mouth activity occurred in all episodes (mean=24.4% of stages), and was lower than the average for the sample (Table 11). Sucking occurred in each episode (mean=16.1% of stages) and was similar to the average for the sample (Table 12). Jerky movements also occurred in all episodes (mean= 37.8% of stages), but was 10% less than the average for the sample (Table 11).

Several antecedent variables may account for the outcome of these episodes. Two episodes were from infants whose mothers received narcotic analgesics. One mother was given 10 mg Morphine and an epidural, and the other received 50 mg Demerol. The third episode was from an infant whose mother had received a general anaesthetic. None of the infants wore a urine catcher, a possible source of discomfort for other infants. The axillary temperature was 36.9°C in the first two episodes and was 36.6°C in the third episode, indicating that the infants were probably comfortably warm. One episode was preceded by a feeding of formula while the other two infants were breast-fed by mothers with previous lactation experience. The interval between the last feeding and initial stirring averaged 3.3 hours for the breast fed infants (range=2.8-3.7 hours). This may indicate that these infants may have achieved greater satiation prior to waking.

All three infants had to be aroused for feeding. The characteristics and antecedent variables for patterns which ended in sleep are summarized below:

Characteristics

1. Rest periods more frequent than active periods.
2. Decreased number of active periods.

3. Decreased hand-mouth activity.
4. Decreased jerky movements.

Antecedent Variables

1. Maternal narcotic analgesics and a general anaesthetic.
2. Increased room and/or axillary temperatures.
3. Questionable large intake of milk from previous feeding.

Discrepancies Between Rest and Active Periods

Slightly more than half the sample of waking episodes included patterns in which there were wide discrepancies between the proportions of rest and active periods (Table 11). Since rest periods may represent the infant's successful attempts to conserve energy or reorganize behavior, factors that may have been related to these discrepancies were examined in closer detail.

Rest Periods Exceed Active Periods

Ten waking episodes had 20% or more rest periods than active periods (episode one of infants #6, 8, 9, 10, 11, 13, 16, 18, 22, 23). Two episodes were from different infants who had been observed [illegible] le waking episodes. Five episodes were interrupted by early interventi[illegible] des ended in sleep.

All or part of the patterns [illegible] rapid transitions between rest and active periods (Table 14). The majority of transitions occurred in *Crying* and/or *Hard Crying* (n=9). The highest stage achieved in one episode was *Awake* (episode one of infant #6). The majority of transitions in this episode occurred in *Awake*.

Hand-mouth activity occurred in nine episodes (mean=40.3%), which was approximately 10% lower than the average for the sample (Table 11). One infant's arms were restrained by restrictive swaddling. Sucking occurred in all episodes (mean=15.6%). However, in eight episodes, the relative frequency of stages with

Table 14. Comparison of the Number of Transitions Among All Waking Episodes and Two Groups

GROUPS	TRANSITIONS PER MINUTE	
	Mean[1]	Range
I. All Episodes (n=33)	1.8	0.4-4.4
II. # Rest Periods > # Active Periods (n=10)[2]	2.6	1.2-4.4
III. # Rest Periods < # Active Periods (n=8)[2]	1.4	0.4-2.4

[1] Calculated for each episode as the total number of active and rest periods minus one, then divided by the duration of the episode, then multiplied by 60. These were summed for all episodes and divided by the number of episodes.

[2] These groups include only those episodes where there was a 20% difference or more between the relative frequencies of rest and active periods.

sucking was 9.2%, which was lower than the average for the sample (Table 11). Jerky movements occurred in all episodes (mean=51.7%) and was similar to the average for the sample (Table 11).

Several antecedent variables were shared by two or more waking episodes. Most episodes were from infants whose mothers received narcotic analgesics or a general anaesthetic in labour (n=8), which may have contributed to central nervous system depression. Comfort and decreased hunger may also have influence these infants' patterns of waking. Five infants were securely swaddled and one was restrictively swaddled. Only two infants wore a urine catcher. Although seven infants were breast fed, the average time from the previous feeding to initial stirring was 3.1 hours (range=0.7-4.6 hours).

The characteristics and antecedent variables for patterns with increased rest periods are summarized below:

Characteristics

1. Number of rest periods were 20% or more greater than the number of active periods.
2. Rapid transitions between rest/active periods.
3. Slightly increased hand-mouth activity.
4. Decreased sucking.
5. Waking ended in sleep (n=2).

Antecedent Variables

1. Maternal narcotic analgesics, epidural and general anaesthetic.
2. Secure swaddling.
3. Average time since last feeding: 3.1 hours.
4. Breast feeding.
5. No urine catcher.

Active Periods Exceed Rest Periods

Eight waking episodes occurred with 20% or more active periods than rest periods (episodes one and three of infant #1, two and three of infant #2, one, two and three of infant #3, and one of infant #21). Seven of these episodes were from three infants who had been observed for multiple waking episodes, and none of their waking episodes included excess rest periods. Early intervention occurred in three episodes. The relative frequency of transitions between active/rest periods were below the average for the sample (Table 14), and they tended to occur during *Transition to Crying* or *Crying*.

Hand-mouth activity occurred in all episodes (mean=66.1%), which exceeded the average for the sample (Table 11). One episode was below average (episode one of infant #21). Sucking occurred in six episodes (mean=23.8%) and was similar to the average for the sample (Table 11). Jerky movements occurred in all episodes (mean= 32.8%) but was below the average for the sample (Table 11). Two episodes were above the average for the sample (episodes three of infant #1 and one of infant #21).

Examination of antecedent variables indicated that these infants may have experienced discomfort and greater hunger. In five episodes, the infants were loosely swaddled. A urine catcher was worn in five episodes. Seven episodes were preceded by breast feeding. A formula supplement was given in one case. The average time between the previous feeding and initial stirring was shorter than average (2.0 hours). Two of these cases included breast-fed infants who may have had insufficient milk intake for their needs. For example, one infant weighed 6105 grams and awoke within an hour after feeding. The other infant was breast fed with no supplements and had not voided for over 8 hours. Six episodes were from infants whose mothers received narcotic analgesics in labour which may have lowered their threshold of response to discomfort and hunger.

The characteristics and antecedent variables for patterns with increased active periods are summarized below:

Characteristics

1. Possible consistent trend "within subject."
2. Number of active periods were 20% or more greater than the number of rest periods.
3. Decreased transitions between rest/active periods.
4. Increased hand-mouth activity.
5. Decreased jerky movements.

Antecedent Variables

1. Maternal narcotic analgesics.
2. Loose swaddling.
3. Breast feeding.
4. Time since last feeding: 2 hours.
5. Urine catcher.

Summary

This analysis involved descriptions of four patterns of waking behavior: rapid arousal from sleep, slow arousal from sleep, episodes that ended in sleep, and discrepancies between rest and active periods. Two characteristics distinguished rapid and slow arousal from the mean: time from stirring to crying and amount of jerky movements. These episodes differed in the following antecedent variables: type of feeding, dose of maternal narcotic analgesics and time of night in which they occurred.

Two characteristics distinguished episodes with discrepancies in amount of rest/active periods from the mean: the ratio of rest and active periods and the number of transitions between periods. Common antecedent events included the type of swaddling, the time since the last feeding and the presence of a urine catcher. Characteristics that varied among all four patterns included the relationship of rest and active periods and the amount of hand-mouth activity. The only common antecedent variables were those that may reflect the amount of milk intake in the feeding prior to waking.

Description of the Stages of Waking

The unit of analysis was the stage which was coded from the raw data (n=951). In this context, stages are equivalent to the active and rest periods reported earlier. There were no missing values for stages. Summaries of the total duration per waking episode for each stage are listed in Table 15. The relative frequencies of transition from one stage to another are listed in Table 16. For stages 0 to 2, arousal increased by one stage. For example, 59.3% of stage 2's were followed by stage 3. Only 13.3% of stage 2's were followed by stage 1. For stage 3, arousal increased or decreased by one stage with the same frequency. However, stages 4 and 5 tended to be followed by a lower level of arousal.

In this section, each stage will be described in terms of the observed behavioral events. Thirty-six behavioral events were coded for each stage. One percent of the values of the behavioral events were missing. The majority of the missing values involved movements of the limbs and mouth, which were obscured by the infant's wrappings or out of view of the camera. The relationship between stages and the behavioral events were examined by summary statistics and discriminant analysis. The probability of misclassification in discriminant analysis was increased by unequal covariance matrices, and non-normal distribution of variables.

Stage 0: *Asleep*

Forty-one occurrences of the *Asleep* stage were observed during the process of waking. Eyes shut and no movement were most commonly seen (Table 17). Head and arm movements occurred in short bursts. The extent of movement, such as the degree of flexion, and no movement were not recorded. Discriminant analysis, using direct-entry

Table 15. Summary of Total Duration (seconds) of the Stages of Waking Per Waking Episode

STAGE	WAKING EPISODES	DURATION		
	n	Mean[1]	Range	S.D.
0	20	57.35	4 - 373	83.65
1[2]	30	117.03	2 - 393	122.75
[illegible]	33	435.15	40 - 1889	418.71
[illegible]	30	156.47	6 - 690	143.14
4	28	124.18	3 - 387	107.51
5	16	43.31	4 - 237	56.88

[1] Calculated as the sum of the total duration of the stage observed within each waking episode divided by the number of waking episodes in which the stage occurred.
[2] Active and rest periods were handled as separate cases when they occurred in sequence.

Table 16. Relative Frequency of Transitional Periods Between the Stages of Waking

PREVIOUS	CURRENT						**Row**
	0	1[1]	2	3	4	5	**Total**
0	-	n=32	n=9	n=0	n=0	n=0	n=41
		78.0	**22.0**	**0.0**	**0.0**	**0.0**	100 %
1[1]	n=13	n=11	n=67	n=26	n=11	n=3	n=131
	9.9	**8.4**	**51.1**	**19.8**	**8.4**	**2.3**	99.9 %
2	n=27	n=32	-	n=143	n=35	n=4	n=241
	11.2	**13.3**		**59.3**	**14.5**	**1.7**	100 %
3	n=1	n=21	n=115	-	n=121	n=23	n=281
	0.3	**7.5**	**40.9**		**43.1**	**8.2**	100 %
4	n=0	n=21	n=41	n=105	-	n=22	n=189
	0.0	**11.1**	**21.7**	**55.6**		**11.6**	100 %
5	n=0	n=3	n=1	n=14	n=30	-	n=48
	0.0	**6.3**	**2.1**	**29.2**	**62.5**		100.1%

[1] For the purposes of this analysis, stage 1 combines the active and rest periods.

Table 17. *Asleep* (Stage 0): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=41)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Eyes Shut	40	97.6	-0.09	0.99	.002
Mouth Shut and Relaxed	32	78.0	-0.22	0.95	.000
Head Movement	12	29.3	0.71	1.00	.055
Arm Movement	10	24.4	0.32	0.75	.000
Mouth Movements	9	22.0	0.10	0.83	.000

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.

Plate 1. An Infant in the Stage of *Asleep*

of the most frequently occurring variables, revealed four significant behaviors: eyes shut, mouth shut and relaxed, arm movement and mouth movements. The standardized canonical discriminant function coefficients are listed in Table 17. This solution resulted in an eigenvalue of 0.38632, or accounted for 38.6% of the variance. Wilks' lambda was 0.7213328. A value of 0 indicates high discrimination, and a value of 1 occurs with zero discrimination. The prior probability of correct classification was 0.5, and 91.4% groups were correctly classified.

Stage 1: ***Transition to Wakefulness***

One-hundred-thirteen cases of stage 1 were observed. Behavioral events in the rest periods were unique to this stage and were analysed separately. There were 82 active periods of stage 1. Eyes shut, limb and body movements were observed in most stages (Table 18). Direct-entry discriminant analysis revealed seven significant variables: eyes shut, head movement, mouth shut and relaxed, hand-mouth activity, mouth movements, eyes open briefly and alert. The standardized canonical discriminant function coefficients are listed in Table 18. The eigenvalue was .44130 and Wilks' lambda was .693817. Prior probability was 0.5 and percent of correctly classified groups was 88.4%.

There were 50 cases of the rest period of stage 1. Eyes shut and open briefly with no vocalization occurred in most cases (Table 19). Direct-entry discriminant analysis revealed five significant variables: eyes shut, eyes open briefly, mouth shut and relaxed, head movement and vocalization. The standardized canonical discriminant function coefficients are listed in Table 19. The eigenvalue was .39552 and Wilks' lambda was .7166. Prior probability was 0.5 and percent of correctly classified groups was 91.4%.

Table 18. Active Periods of *Transition to Wakefulness* (Stage 1): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=82)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Eyes Shut	82	100.0	0.29	0.97	.000
Head Movement	81	98.8	0.22	0.99	.037
Arm Movement	73	89.0	0.13	1.00	.051
Squirming	60	73.2	0.01	1.00	.600
Mouth Shut and Relaxed	56	68.3	0.59	0.96	.000
Hand-mouth	57	69.5	0.17	0.97	.000
Slight Frown	52	63.4	0.11	1.00	.432
Mouth Movements	48	58.5	0.03	0.98	.000
Eyes Open Briefly	0	0.0	-0.93	0.85	.000
Alert	0	0.0	-0.36	0.99	.004

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.

Plate 2. An Infant in the Active Period of the stage of *Transition to Wakefulness*

Table 19. Rest Periods of *Transition to Wakefulness* (Stage 1): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=50)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Eyes Shut	50	100.0	-0.02	0.98	.000
Eyes Open Briefly	50	100.0	-0.49	0.97	.000
Mouth Shut and Relaxed	44	88.0	-0.20	0.93	.000
Head Movement	23	46.0	0.58	0.83	.000
Vocalization[3]	3	1.0	0.53	0.86	.000

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.
[3] This included grunting, occasional whimpering, fuss cry, moderately loud cry, loud cry and hard cry.

Plate 3. An Infant in the Rest Period of the Stage of *Transitional Wakefulness*

Stage 2: *Awake*

Two-hundred-forty cases of stage 2 were observed. Head and upper limb movement, eyes opening, and vocalization were most often observed (Table 20). Direct-entry discriminant analysis revealed the 13 significant variables (Table 20). The eigenvalue was 1.30252 and Wilks' lambda was 0.434307. Prior probability was 0.5 and percent of correctly classified groups was 90.7%.

Stage 3: *Transition to Crying*

Two-hundred-eighty seven cases of stage 3 were observed. Fuss cry, movement of head and all limbs, jerky movement and facial tension were observed most often (Table 21). Flailing was noted in five infants. Direct-entry discriminant analysis revealed 12 significant variables listed in Table 21, with their standardized canonical discriminant function coefficients. The eigenvalue was 22.57258 and Wilks' lambda was .04242. Prior probability was 0.5 and percent correctly classified groups was 99.1%.

Stage 4: *Crying*

One-hundred-ninety nine cases of stage 4 were observed. Facial tension, crying, jerky movement and body tension were observed most often (Table 22). Tears and flailing were observed in four infants. Direct-entry discriminant analysis revealed 12 significant variables (Table 22). The eigenvalue was 5.95735 and Wilks' lambda was .1437329. Prior probability was 0.5 and percent correctly classified groups was 97.5%.

Table 20. *Awake* (Stage 2): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=240)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Head Movement	231	96.2	0.07	0.99	.028
Eyes Shut	223	92.9	-0.06	0.93	.000
Eyes Open Briefly	212	88.3	0.42	0.90	.000
Arm Movement	204	85.0	0.15	0.99	.023
Squirming	182	75.8	0.00	0.99	.048
Mouth Movements	173	72.1	0.19	0.81	.000
Rooting	163	67.9	-0.07	0.95	.000
Mouth Shut and Relaxed	161	67.1	0.15	0.83	.000
Hand-mouth	134	55.8	0.12	0.94	.000
Eyes Tightly Shut	123	51.2	-0.25	0.95	.000
Grunting	119	49.6	0.39	0.75	.000
Occasional Whimper	113	47.1	0.27	0.83	.000
Alert	95	39.6	0.59	0.68	.000

1. Standardized canonical discriminant function coefficient.
2. Significance of univariate F-ratio.

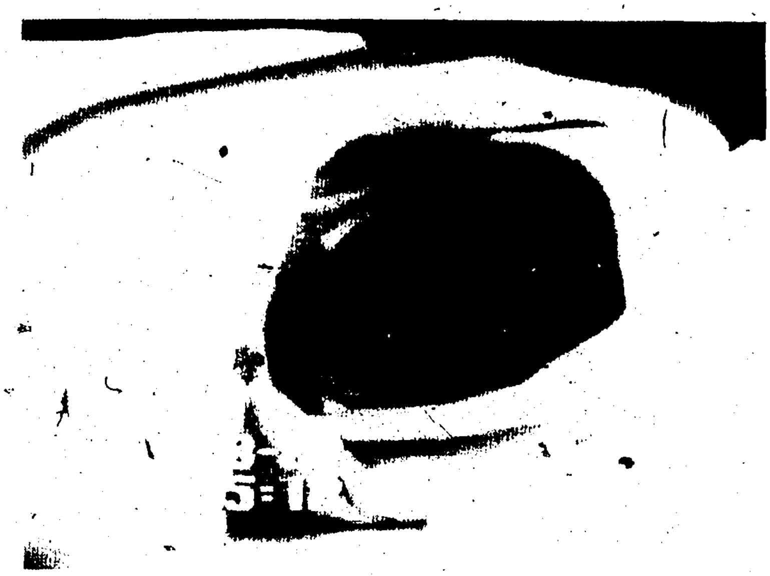


Plate 4. An Infant in the Stage of *Awake*

Table 21. *Transition to Crying* (Stage 3): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=287)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Fuss Cry	284	99.0	1.01	0.04	.000
Head Movement	284	99.0	0.02	0.97	.000
Arm Movement	271	94.1	0.03	0.96	.000
Slight Frown	244	85.0	-0.03	0.92	.000
Squirming	241	84.0	-0.08	0.96	.000
Eyes Tightly Shut	236	82.2	0.01	0.96	.000
Eyes Shut	227	79.1	0.01	0.99	.017
Eyes Open Briefly	211	73.5	-0.00	0.97	.000
Rooting	210	72.9	0.09	0.88	.000
Jerky Movement	207	72.1	-0.05	0.92	.000
Kicking	173	60.3	-0.01	0.97	.000
Grimace	167	58.2	-0.00	0.94	.000

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.

Plate 5. An Infant in the Stage of *Transition to Crying*

Table 22. *Crying* (Stage 4): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=199)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Eyes Tightly Shut	198	99.5	0.01	0.87	.000
Head Movement	195	98.0	0.01	0.98	.000
Frown	192	96.5	0.06	0.73	.000
Loud Cry	179	89.9	0.82	0.23	.000
Arm Movement	172	86.4	0.04	0.98	.000
Mouth Open and Square	168	84.4	0.10	0.65	.000
Moderately Loud Cry	152	76.4	0.62	0.33	.000
Squirming	143	71.9	0.03	1.00	.093
Jerky Movement	135	67.8	-0.01	0.97	.000
Body Tension	121	60.8	-0.19	0.84	.000
Kicking	121	60.8	-0.11	0.99	.000
Grimace	118	59.3	0.14	0.97	.000
Eyes Open Briefly	107	53.8	-0.01	0.99	.000

1 Standardized canonical discriminant function coefficient.
2 Significance of univariate F-ratio.

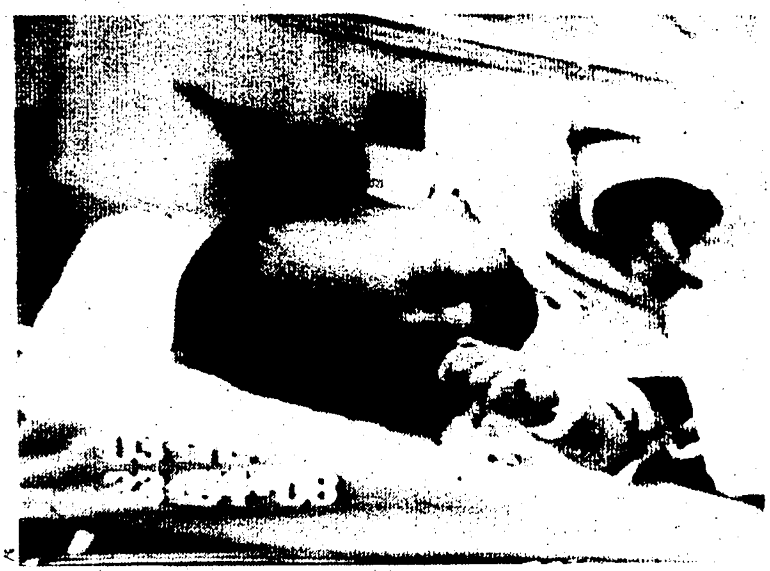


Plate 6. An Infant in the Stage of *Crying*, Loose Swaddling

Stage 5: *Hard Crying*

Fifty-two cases of stage 5 were observed. Hard crying, facial and body tension were observed most often (Table 23). Flailing was observed in two infants. Direct-entry discriminant analysis revealed five significant variables: hard cry, eyes tightly shut, frown, body tension and mouth open and square. The standardized canonical discriminant function coefficients are listed in Table 23. The eigenvalue was 4.79515 and Wilks' lambda was .172558. Prior probability was 0.5 and percent correctly classified groups was 98.9%.

Summary

This analysis involved summary statistics and discriminant analysis of the stages of waking. Waking episodes consisted mainly of *Awake* and *Transition to Crying*. *Awake* was the only stage to be observed in every episode. The direction of transitions between stages depended on the previous stage. Most transitions were one stage apart.

At least four significant behavioral events for each stage were identifed by discriminant analysis. Although the discriminant functions were not optimal, the misclassification rates were low. The best discrimination occurred in *Transition to Crying* (99.1%). The lowest percent of correctly classified grouped cases was in the active period of *Transition to Wakefulness* (88.4%). The strongest discriminators of each stage were those behaviors which were the least frequent. Eyes shut or tightly shut and movement were common to all stages. Eyes open was low or not seen in *Asleep*, active period of *Transition to Wakefulness* and *Hard Crying*.

Table 23. *Hard Crying* (Stage 5): Relative Frequency and Discriminant Scores of Associated Behavioral Events

BEHAVIORAL EVENT	STAGE (n=52)				
	n	%	Discriminant[1]	Wilks Lambda	Level of Significance[2]
Hard Cry	52	100.0	0.99	0.17	.000
Eyes Tightly Shut	52	100.0	0.01	0.97	.000
Frown	52	100.0	-0.01	0.93	.000
Head Movement	50	96.2	0.01	1.00	.274
Body Tension	50	96.2	0.09	0.84	.000
Mouth Open and Square	49	94.2	-0.04	0.89	.000

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.

Plate 7. An Infant in the Stage of *Hard Crying*

Description of Crying

Five types of crying were recorded: whimpering, fuss cry, moderately loud cry, loud cry and hard cry (Gill et al., 1984). The unit of analysis was the stage (n=951). Separate discriminant analyses with the following eight behavioral events was done for each type of cry: eyes tightly shut, slight frown, frown, grimace, pout, mouth open and square, body tension and jerky movements. The discriminant functions were not optimal because of unequal covariance matrices and non-normal distribution. The results will be presented in this section.

Whimpering

Occasional whimpering was observed mainly in stage 2, *Awake*. Each cry sound was typically short in duration and only one to three cries were heard successively. When whimpering occurred with each exhalation and more than three cries were heard successively, it was defined as fuss cry. Direct-entry discriminant analysis revealed four significant variables: slight frown, frown, mouth open and square, and body tension. This model correctly predicted 76% actual occurrences of stages with whimpering and 51.7% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 24. The eigenvalue was .07356 and Wilks' lambda was .9315. Prior probability was 0.5 and percent of correctly classified groups was 56.2%.

Fuss Cry

Fuss cry occurred mainly in stage 3, *Transition to Crying*. Individual differences in the quality of the cry were observed. A short, high-pitched cry with every breath was

Table 24. Discriminant Scores of Behavioral Events Observed in Whimpering Across All Stages

Behavioral Event	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Slight Frown	0.88	0.95	.000
Eyes tightly shut	0.12	1.00	.456
Grimace	0.02	1.00	.354
Mouth Open Square	-0.00	0.99	.007
Frown	-0.10	0.99	.021
Pout	-0.14	1.00	.876
Body Tension	-0.29	0.99	.001
Jerky Movements	-0.32	1.00	.054

1 Standardized canonical discriminant function coefficient.
2 Significance of univariate F-ratio.

heard most often. Moderately long, high-pitched sounds characterized the cries of five infants. Short and moderately loud, staccato sounds characterized the cries of three infants. Short and loud, staccato cries were heard from one infant. The most distinctive feature of this cry was its staccato quality.

Direct-entry discriminant analysis revealed six significant variables: eyes tightly shut, slight frown, grimace, pout, mouth open and square, and jerky movements. This model correctly predicted 73.4% actual occurrences of stages with fuss cry and 66.4% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 25. The eigenvalue was .22179 and Wilks' lambda was .81847. Prior probability was 0.5 and 68.5% groups were correctly classified.

Moderately Loud Cry

This type of cry was heard exclusively in stage 4, *Crying*. Short and moderately long cries of this type were heard. Moderately loud cries were usually heard in the same stage with loud cries. The distinctive feature of both types of cries was their rhythmical quality and distinguishing between them was difficult, particularly when only one type of cry occurred during *Crying*. Direct-entry discriminant analysis revealed seven significant variables: eyes tightly shut, frown, grimace, pout, mouth open and square, body tension, and jerky movements. This model correctly predicted 87.6% actual occurrences of stages with moderately loud cry and 78.4% actual non-occurrences. The standardized canonical discriminant function coefficients [illegible]sted in Table 26. The eigenvalue was .4281 and Wilks' lambda was .70023. Prior probability was 0.5 and 79.9% groups were correctly classified.

Table 25. Discriminant Scores of Behavioral Events Observed in Fuss Cry Across All Stages

Behavioral Event	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Jerky Movements	0.55	0.92	.000
Slight Frown	0.41	0.92	.000
Grimace	0.33	0.94	.000
Eyes tightly shut	0.25	0.96	.000
Pout	0.14	0.98	.000
Body Tension	0.04	1.00	.555
Mouth Open Square	-0.47	0.99	.024
Frown	-0.05	1.00	.096

1 Standardized canonical discriminant function coefficient.
2 Significance of univariate F-ratio.

Table 26. Discriminant Scores of Behavioral Events Observed in Moderately Loud Cry Across All Stages

Behavioral Event	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Mouth Open Square	0.72	0.72	.000
Frown	0.22	0.80	.000
Pout	0.18	0.96	.000
Body Tension	0.13	0.85	.000
Grimace	0.08	0.98	.000
Jerky Movements	0.02	0.98	.000
Eyes tightly shut	-0.03	0.91	.000
Slight Frown	-0.01	1.00	.715

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.

Loud Cry

This type of cry was heard exclusively in stage 4, *Crying*. Short and moderately long cries of this type were heard. Direct-entry discriminant analysis revealed the same significant variables found in moderately loud cry: eyes tightly shut, frown, grimace, pout, mouth open and square, body tension, and jerky movements. This model correctly predicted 90.5% actual occurrences of stages with loud cry and 82.7% actual non-occurrences. The standardized canonical discrimina function coefficients are listed in Table 27. The eigenvalue was .7851 and Wilks' lambda was .56019. Prior probability was 0.5 and 84.3% groups were correctly classified.

Hard Cry

This type of cry was heard mainly in stage 5, *Hard Crying*. The distinctive feature of this type of cry was its grating quality (like grinding pepper in a pepper mill), which was usually heard at the beginning of the first cry, and not necessarily on succeeding cries. Hard cries ranged from moderately long to long in duration and occurred singly or in rapid succession with loud cries. Two infants "gurgled" during hard crying. One infant's cry sounded like a scream.

Direct-entry discriminant analysis revealed six significant variables: eyes tightly shut, slight frown, frown, mouth open and square, body tension, and jerky movements. This model correctly predicted 90.2% actual occurrences of stages with loud cry and 83.9% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 28. The eigenvalue was .31585 and Wilks' lambda was .75996. Prior probability was 0.5 and 84.3% groups were correctly classified.

Table 27. Discriminant Scores of Behavioral Events Observed in Loud Cry Across All Stages

Behavioral Event	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Mouth Open Square	0.64	0.60	.000
Frown	0.29	0.71	.000
Body Tension	0.27	0.73	.000
Pout	0.10	0.96	.000
Jerky Movements	0.08	0.96	.000
Eyes tightly shut	-0.04	0.87	.000
Grimace	-0.04	0.98	.000
Slight Frown	0.02	1.00	.427

1 Standardized canonical discriminant function coefficient.
2 Significance of univariate F-ratio.

Table 28. Discriminant Scores of Behavioral Events Observed in Hard Cry Across All Stages

Behavioral Event	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Body Tension	0.65	0.83	.000
Eyes tightly shut	0.27	0.97	.000
Mouth Open Square	0.22	0.87	.000
Jerky Movements	0.13	0.99	.002
Frown	0.05	0.92	.000
Slight Frown	-0.37	0.96	.000
Grimace	-0.34	1.00	.144
Pout	-0.20	1.00	.377

[1] Standardized canonical discriminant function coefficient.
[2] Significance of univariate F-ratio.

Summary

h type of cry had one distinctive auditory feature. Whimpering was a short sound, fuss cry was staccato, moderately loud and loud cries were rhythmical and hard cries had a grating quality. Moderately loud and loud cries were difficult to distinguish during observation.

Discriminant analysis was used to predict the type of crying from eight behavioral events. These behavioral events occurred in the same stage as type of cry and did not necessarily occur simultaneously. As stated earlier, the probability of misclassification was increased because the discriminant functions were not optimal. The percent of correctly classifed grouped cases was best for loud cry (90.5%) and hard cry (90.2%), and lowest for whimpering (56.2%). At least four significant behaviors were found for each type of crying. The significant behaviors in moderately loud and loud cries were similar. Mouth open and square was common to all cries.

Effect of Selected Variables

In this section, the results of analysis of birth, feeding and environmental effects on self-consoling behaviors, alert behavior, jerky movements and rapid stage transitions will be reported. The unit of analysis was the stage (n=951). Summary statistics, chi-square, and direct-entry discriminant analysis techniques were used. The discriminant functions were not optimal due to unequal covariance matrices and non-normal distribution of variables.

Self-consoling Behavior

Three behavioral events were classified as self-consoling: sucking, hand-pass and hand-mouth activity. The relationships between self-consoling behaviors and alert behavior and jerky movements were examined by direct-entry discriminant analyses. Sucking was the only significant discriminator of alert behavior. The model of three self-consoling behaviors correctly predicted 46.2% actual occurrences of stages with alertness and 88.2% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 29. The eigenvalue for the analysis on alert behavior was .0929 and Wilks' lambda was .914998. Prior probability was 0.5 and percent of correctly classified grouped cases was 84.0%.

While there was a significant effect of all the self-consoling behaviors on jerky movements (Table 29), this model correctly predicted 42.1% actual occurrences of stages with jerky movements and 76.6% actual non-occurrences. The eigenvalue for the analysis on jerky movements was .05694 and Wilks' lambda was .94613. Prior probability was 0.5 and percent of correctly classified grouped case was 58.7% ($p<.0005$).

Hand-pass was observed in 14.2% of all stages. There was one missing case. Direct-entry discriminant analysis revealed five significant variables: type of maternal analgesia, type of feeding prior to waking, room temperature, axillary temperature and type of swaddling. This model correctly predicted 67.7% actual occurrences of stages with hand-pass activity and 67.0% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 30. The eigenvalue for this solution was .09471 and Wilks' lambda was .913486. Prior probability was 0.5 and percent of correctly classified grouped cases was 67.1%.

Hand-mouth activity was observed in 40.3% of all stages and 1.9% values were missing. Direct-entry discriminant analysis revealed five significant variables:

Table 29. Effect of Self-Consoling Behaviors on Alert Behavior and Jerky Movements

Behaviors	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
ALERT BEHAVIOR			
Sucking	1.04	0.91	.000
Hand-Mouth	-0.17	1.00	.171
Hand-Pass	0.06	1.00	.824
JERKY MOVEMENTS			
Sucking	-0.85	0.97	.000
Hand-Mouth	0.62	0.99	.001
Hand-Pass	0.34	0.99	.001

1 Standardized canonical discriminant function coefficients.
2 Significance of univariate F-ratio.

Table 30. Effect of Selected Birth, Feeding and Environmental Characteristics on Hand-Pass Activity in All Stages

CHARACTERISTICS	STAGES WITH HAND-PASS ACTIVITY		
	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Type of Maternal Analgesia	0.66	0.95	.000
Type of Swaddling	0.50	0.98	.000
Axillary Temperature	0.43	0.99	.006
Room Temperature	0.42	0.99	.005
Gestation	0.40	1.00	.803
Type of Feeding	0.06	0.995	.042
Time Since Last Feeding	0.01	1.00	.271

1 Standardized canonical discriminant function coefficients.
2 Significance of univariate F-ratio.

gestation, type of maternal analgesia, type of feeding prior to waking, time since last feeding, axillary temperature and type of swaddling. This model correctly predicted 65.0% actual occurrences of stages with hand-mouth activity and 60.2% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 31. The eigenvalue for this solution was .13871 and Wilks' lambda was .87818. Prior probability was 0.5 and percent of correctly classified grouped cases was 62.0%.

Sucking the tongue, hand, digit or blanket was observed in 14.9% of all stages and 0.8% of values were missing. Direct-entry discriminant analysis revealed three significant variables: time since last feeding, room temperature and axillary temperature. This model correctly predicted 55.3% actual occurrences of stages with sucking activity and 70.1% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 32. The eigenvalue for this solution was .04097 and Wilks' lambda was .960646. Prior probability was 0.5 and percent of correctly classified grouped cases was 68.2%.

Alert Behavior

Alert behavior occurred in the stage of *Awake*, and was observed in 10.1% of all stages or 39.8% of stages of *Awake*. One value was missing. Direct-entry discriminant analysis was not significant. Chi-square analysis between alert behavior and type of swaddling was significant (chi-square=15.6, df=1, p<.0005). Alert behavior increased with more restrictive swaddling (Table 33). Loose swaddling may have had the same effect as incorrect swaddling which may increase distress (Wolff, 1987) and therefore, decrease the infant's ability to control level of arousal.

Table 31. Effect of Selected Birth, Feeding and Environmental Characteristics on Hand-Mouth Activity in All Stages

CHARACTERISTICS	STAGES WITH HAND-MOUTH ACTIVITY		
	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Type of Maternal Analgesia	0.79	0.92	.000
Type of Swaddling	0.45	0.95	.000
Time Since Last Feeding	0.42	0.98	.000
Gestation	0.08	0.98	.000
Room Temperature	-0.10	0.99	.028
Axillary Temperature	-0.05	1.00	.184

[1] Standardized canonical discriminant function coefficients.
[2] Significance of univariate F-ratio.

Table 32. Effect of Selected Birth, Feeding and Environmental Characteristics on Sucking Activity in All Stages

CHARACTERISTICS	STAGES WITH SUCKING ACTIVITY		
	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Time Since Last Feeding	0.73	0.98	.000
Type of Swaddling	0.49	1.00	.603
Room Temperature	0.40	0.98	.000
Gestation	0.06	1.00	.083
Type of Feeding	0.04	1.00	.663
Axillary Temperature	-0.64	0.99	.011
Type of Maternal Analgesia	-0.13	1.00	.164

1 Standardized canonical discriminant function coefficients.
2 Significance of univariate F-ratio.

Table 33. Relationship Between Type of Swaddling and Frequency of Stages With Alert Behavior[1]

STAGES	TYPE OF SWADDLING		
	Loose	Secure	Restrictive[2]
ALERT DID NOT OCCUR			
n	428	393	33
Row %	93.4	87.3	78.6
ALERT OCCURRED			
n	30	57	9
Row %	6.6	12.7	21.4

[1] Chi-square=15.6 (df=1, p<.0005).
[2] Only one infant was swaddled restrictively which represented 3% of all stages.

Jerky Movements

Jerky movements were observed in 51.9% of all stages, and included flailing. Decreased jerky movements were more likely to be observed in short stages (Table 34). Direct-entry discriminant analysis revealed two significant variables: type of maternal analgesia and type of swaddling. This model correctly predicted 59.0% actual occurrences of stages with jerky movements and 63.5% actual non-occurrences. The standardized canonical discriminant function coefficients are listed in Table 35. The eigenvalue for this solution was .08550 and Wilks' lambda was .92124. Prior probability was 0.5 and percent of correctly classified grouped cases was 61.1%.

Stages of Short Duration

Stages which lasted 10 seconds or less were observed in 39.6% of all stages. Direct-entry discriminant analysis revealed four significant variables: type of maternal analgesia, gestation, axillary temperature and room temperature. This model correctly predicted 66.9% actual occurrences of short stages and 47.8% actual occurrences of longer stages. The standardized canonical discriminant function coefficients are listed in Table 36. The eigenvalue for this solution was .04135 and Wilks' lambda was .96029. Prior probability was 0.5 and percent of correctly classified grouped cases was 59.2%.

Summary

The effects of birth, feeding and environmental variables on the occurrence of selected behavioral events and stages of short duration were examined by discriminant analysis and chi-square. Again, the discriminant functions were not optimal.

Table 34. Relationship Between the Occurrence of Jerky Movements and Stages of Short Duration[1]

JERKY MOVEMENTS	DURATION OF STAGES	
	≤ 10 Seconds	> 10 Seconds
NO JERKY MOVEMENTS		
n	297	160
Row %	65.0	35.0
Colum . %	51.2	43.1
JERKY MOVEMENTS		
n	283	211
Row %	57.3	42.7
Column %	48.8	56.9

[1] Chi-square=5.6 (df=1, p=.018).

Table 35. Effect of Selected Birth, Feeding and Environmental Characteristics on the Occurrence of Jerky Movements

INFANT CHARACTERISTICS	STAGES WITH JERKY MOVEMENTS		
	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Type of Swaddling	1.01	0.96	.000
Gestation	0.76	0.99	.079
Type of Maternal Analgesics	0.29	0.99	.005

[1] Standardized canonical discriminant function coefficients.
[2] Significance of univariate F-ratio.

Table 36. Effect of Selected Birth, Feeding and Environmental Characteristics on Frequency of Stages ≤ 10 Seconds Duration

INFANT CHARACTERISTICS	STAGES ≤ 10 SECONDS DURATION		
	Discriminant[1]	Wilks' Lambda	Level of Significance[2]
Room Temperature	0.75	0.97	.000
Time Since Last Feeding	0.18	1.00	.088
Type of Maternal Analgesia	0.07	0.99	.004
Type of Feeding	-0.08	1.00	.312
Axillary Temperature	-0.21	0.99	.001
Gestation	-0.30	0.99	.017

1 Standardized canonical discriminant function coefficients.
2 Significance of univariate F-ratio.

Hand-mouth activity was the most common self-consoling behavior observed, and sucking was the least common. Axillary temperature was a common significant discriminator of all three self-consoling behaviors. Sucking was significantly related to alert behavior and all three self-consoling behaviors were significantly related to jerky movements. However, the low rates of correct prediction within these models suggest that variables other than sucking, hand-pass and hand-mouth may be more significant predictors of alertness and jerky movements. Type of swaddling and maternal analgesia wera significant discriminators of both alert behavior and jerky movements. Jerky movements were more common in longer stages (>10 seconds) supporting the notion that rapid stage transitions may accompany improved motor control or organization.

Validity of the Coding Tool

In this section, the results of discriminant and factor analyses on predicting the stages of waking will be reported. The unit of analysis was the stage. Both discriminant and factor analyses had limitations. The discriminant function was not optimal because of nonequal covariance matrices and non-normal distribution of variables. Factor analysis was limited by missing values and binary data.

Discriminant Analysis

To determine if the stages were distinct, discriminant analysis was performed. All behavioral events were entered into direct-entry discriminant analysis. Six functions were produced and all were significant. The eigenvalue for the first function was 23.67487 and Wilks' lambda was .0001118. These values decreased with each succeeding function. Prior probability for 6 stages of waking and the rest period of stage one was 0.14. Percent of correctly classified groups was 94.3%. The classification results are reported in Table 37.

Factor Analysis

Principal-components factor analysis with an oblique varimax rotation of the factor axes was used to explore the dimensions of community in the behavioral events. Variables with an eigenvalue greater than one and with correlations greater than 0.3 were retained in the initial analysis. Variables with values of 0.47 loaded on more than one factor, and were excluded in the final analysis.

Two factors were identified which consisted of variables with loadings of 0.31 or greater. Communality, an indication of the strength of the linear association among the variables, may range from 0 (low) to 1 (high). Communality of the variables in the final analysis ranged from 0.50 to 0.73. The two factors were named Crying and Waking Activity. The factor loadings are reported in Tables 38 and 39. The eigenvalue of Factor I was 3.8615 and accounted for 35.1% of total variance. The eigenvalue of Factor II was 2.56746 and accounted for 23.3% of total variance.

Summary

Discriminant analysis demonstrated a high prediction rate of the stages of waking based on the observed behavioral events. Five stages were correctly predicted by discriminant analysis with > 90% success. *Hard Crying* was correctly classified (100%). Asleep was correctly predicted at a rate of 81.3%. Factor analysis on the behavioral events identified two factors with significant loadings: Crying and Waking Activity.

Table 37. Classification Results of Predicted Group Membership of Stages of Waking Based on Discriminant Analysis

ACTUAL GROUP	PREDICTED GROUP MEMBERSHIP						
	0	1[1]	1[2]	2	3	4	5
0	26	3	0	0	0	0	3
	81.3	9.4					9.4 %
1[1]	0	40	0	1	0	0	1
		95.2		2.4			2.4 %
1[2]	1	0	58	0	0	0	0
	1.7		**98.3**				%
2	1	8	5	158	0	0	0
	0.6	4.7	2.9	**91.9**			%
3	0	0	0	1	209	0	0
				0.5	**99.5**		%
4	0	0	2	1	6	151	8
			1.2	0.6	3.6	**89.9**	4.8 %
5	0	0	0	0	0	0	44
							100 %

[1] Active period of stage 1.
[2] Rest period of stage 1.

Table 38. Factor I: Crying

Factor Loading	Behavioral Events
0.82	Mouth open and square
0.79	Frown
0.78	Loud cry
0.69	Body tension
0.68	Moderately loud cry
0.43	Arm movement [1]
0.43	Head Movement [1]
0.43	Kicking [1]
0.35	Squirming [1]
-0.58	Eyes shut [1]

[1] Loaded significantly on both Factors.

Table 39. Factor II: Waking Activity

Factor Loading	Behavioral Events
0.74	Squirming[1]
0.71	Rooting
0.69	Arm movement[1]
0.61	Head movement[1]
0.57	Kicking[1]
0.31	Eyes shut[1]

[1] Loaded significantly on both Factors.

V. DISCUSSION

This purpose of this study was to describe patterns of waking behavior of normal, low risk newborn infants in a naturalistic setting. Insight into the waking behavior of normal newborn infants would provide information to enable the nurse to provide the mother with more effective guidance related to newborn behavior. An ethological approach was used in this study because of the apparent inconsistency of information in the literature regarding neonatal waking behavior.

Waking behavior was categorized into six stages of waking. Repeated waking episodes demonstrated several consistent patterns within each subject. Examination of patterns between the waking episodes of all infants revealed four patterns of waking. Behavioral events were identified for each stage of waking by discriminant analysis. Types of crying were also explored and related to facial expression, movements and tension. Finally, the validity of the coding tool used in this study was investigated by discriminant and factor analyses. In this chapter, these findings will be discussed in light of the current state of knowledge on neonatal waking behavior. The method of study and implications for nursing practice and nursing research will also be discussed.

Evaluation of Methods

Ethology prescribes techniques aimed at complete description of behavior in the context in which it occurs. These techniques include the use of video, recording detailed descriptions of behavior, and analyzing the descriptions for patterns and trends. With this inductive approach, behavior can be examined without the confines of pre-existing theory. Thus, this approach was consistent with the purpose of this study.

Changes in behavior occurred rapidly when the infant was awake. Videotaping facilitated complete description of waking behavior. Loss of data and observer fatigue were minimized because the films could be replayed and sequences slowed or played frame by frame. Videotaping facilitated evaluation of interrater and intrarater reliabilities. Visual stimulation of the subjects was reduced by remote monitoring. Videotaping also shortened the data collection period as more than one infant could be filmed at one time, by using two cameras and recorders.

Real-life conditions were disrupted as little as possible during the study. The infants who were filmed were in a separate nursery from the other infants, due to the extra space needed for the video equipment. Lighting conditions were unchanged. The infants were returned to the other nursery for assessment and/or feedings so that there was no interference with mother-infant interaction.

Interrater and intrarater reliabilities were checked regularly throughout the study and were consistently high. The sample was not randomized and this was the major threat to external validity. Internal validity of the study was affected by sample size, early intervention when the infant cried, the quality of filmed data, the adequacy of the coding tool and sampling method, the imprecise measurement of vocalization and adequacy of measurement of room and axillary temperatures.

The small sample size was a threat to internal validity because variations in patterns of waking may not have been exhausted. There were only three examples of two patterns described in the findings: episodes that ended in sleep and slow arousal from sleep. Similarly the categories of birth variables were not saturated. For example, there was only one infant who was delivered by cesarian section. A larger sample size or a design with more tightly controlled antecedent variables (i.e., type of maternal analgesia) would facilitate interpretation of events.

Early intervention interrupted approximately half the waking episodes in the sample before the infant reached *Hard Crying*. Analyzing variation among the patterns of waking was limited by this missing data. The majority of these waking episodes occurred early in the study. Once this error was recognized, it was immediately rectifed for the remaining infants in the study.

The quality of the filmed data was affected by the type of camera used, the juxtaposition of the plastic wall of the infants' cots between camera and infant, and the adequacy of the camera view. The second camera used for filming was black and white and had a poor picture resolution which obscured visual detail. This created difficulities in coding small and quick movements such as slight frown. The quality of color was obscured when the infants were filmed through the plastic wall of their cots. Therefore, it was not possible to measure colour change during activity or crying. Another problem was encountered when behavior of the first seven subjects was filmed intermittently (i.e., sleep was not recorded). There was a short lag from the moment recording was initiated to the moment the behavior was recorded, resulting in potential loss of data. This was corrected as data collection proceeded. One percent of the behavioral data was missing due to inadequate view of the face, arms or lower trunk and limbs. This occurred when the blanket obscured the infant's face or arms and when the camera was positioned too close to the infant. Since most of the infant's body was swaddled, potential error in observation of body movement and kicking also existed. Data on seven waking episodes were lost due to improper operation of the video epuipment or battery failure of the microphone. Measures taken to minimize loss of data included an initial practice session using the equipment, frequent checks of the equipment's operation, and continuous audio-visual recording during observation.

The behavioral events were explicitly defined in empirical terms in order to minimize error due to misinterpretation (Lehner, 1979). However, based on observations made during coding, some additions could be made to the coding tool which would add to its comprehensiveness and facilitate analysis. Tears were occasionally observed in stages 4 and 5. Burps and spit-ups were observed and may represent signs of autonomic disturbance (Als, 1982). A category of no movement would help to capture variation in the amount of movement observed, particularly in stages 0-2. Self-clasp, which consisted of one hand holding the opposite hand or arm, was observed during waking and may be related to self-quieting.

One/zero sampling was a pre-requisite to establishing adequate reliability because the coding tool was detailed and several stages occurred in quick succession. However, no conclusions could be made about the frequency and duration of the behavioral events. Another aspect of sampling which affected internal validity was the method of determination of the onset of stage 3, *Transition to Crying*. Coding the onset of stage 3 began with the first sound of the fuss cry. However, facial tension usually preceded this first sound. Therefore, signs of facial tension which may be a part of stage 3 were coded in stage 2.

Type of cry was an important variable in the categorization of the stages of waking. Differences in pitch and duration were difficult to measure accurately and reliably without the use of sophisticated instrumentation. Maturation was an important threat to internal validity as the investigator's ability to distinguish among the types of crying improved with experience.

Room and axillary temperatures appeared to influence patterns of waking, self-consoling activity, the amount of alertness and jerky movements. Readings were only recorded twice each night. History was a threat to internal validity as the temperatures may have fluctuated between recordings. Therefore, the findings would be strengthened if room and axillary temperatures were recorded following each waking episode.

Patterns of Wakefulness

Several authors have emphasized the importance of individual differences in the behavior of infants (Als, 1982; Blackburn, 1977a; Brazelton, 1984; Gorski, Davidson & Brazelton, 1979). The findings from this study are unique in that consistencies between patterns of repeated waking episodes were identified. These consistencies varied between infants and included: duration of stages, frequency of transitions between rest and active periods, amount of self-consoling, amount of jerky movements, and amount of alert behavior. Within subject differences in rapidity of arousal were also observed. These inconsistencies could be related to differences in discomfort and type of feeding. Other authors also found that breast-fed infants tended to arouse more rapidly than formula-fed infants (Bell, 1966; DiPietro et al., 1987; Wolff, 1987). This effect may be due to the lower calorie content and limited supply of milk following birth (Wood & Walker-Smith, 1981).

As mentioned in the Introduction, patterns of waking activity have been documented in the literature (Desmond et al., 1963; Emde et al., 1975; Pretchl, 1974; Thoman, 1975; Wolff, 1987). However, important differences were noted to exist between previous findings and those from this study. Desmond et al.'s (1963) classification of waking patterns were determined by differences in physiological parameters and was limited to infants less than six hours of age. Emde et al. (1975) observed infants under artificial conditions within the first ten hours of life using five preexisting behavioral categories (quiet sleep, active sleep, drowsy, wakefulness, crying). Wakefulness included alert-activity which is not part of a young infant's repertoire (Wolff, 1987). In another study, two infants were observed after their sleep was deliberately interrupted and their subsequent behavior was described (Pretchl, 1974). Thoman (1975) examined transitions among states during brief observations of infants in a laboratory. Wolff (1987) presented a single pattern of waking behavior, which summarized the waking behaviors of 20 infants under one month of age.

Four patterns of waking were observed in the current study and were based on categories of behavior which were developed in context. The patterns were characterized by differences in durations and frequencies of rest/active periods, amount of self-consoling and jerky behavior, and outcome. These patterns appeared to be influenced by satiation following the last feeding, dose of maternal medication in labour, comfort, and swaddling. Infants who were breast-fed by primiparous mothers aroused more rapidly and had fewer rest periods. Some of the multiparous mothers commented on their "milk coming in" early, suggesting that previous lactation experience may have increased the volume of milk produced two days following birth. The effect of higher doses of maternal analgesics in labour in the rapid arousal group, may have diminished these infants' abilities to reorganize their behavior. This was further evidenced by decreased rest periods and is supported by the literature (Belsey et al., 1981; Brazelton, 1977; Tronick et al., 1977; Wiener et al., 1979). One infant whose mother received a general anaesthetic (and no additional sedation) did not exhibit rapid arousal from sleep nor increased jerky movement. This was contrary to what was expected (Dunn, 1977).

Rapid delivery following induction of anaesthesia and restrictive swaddling may have contributed to this discrepancy.

Infants who fell asleep after waking were warmer and possibly less hungry. These findings are supported by several authors (Bell, 1966; Scopes, 1981; Wolff, 1969, 1987). Comfort and warmth may be important soothing mechanisms which facilitate reorganization of behavior or actually promote sleep.

Infants with fewer rest periods were more likely to have been loosely swaddled. Swaddling has been implicated as a comforting mechanism (Moss & Solomons, 1979) and incorrect swaddling is associated with the opposite effect (Wolff, 1969). Infants with possible discomfort (eg. wearing a urine catcher or lowered axillary temperature) had rapid transitions between rest/active periods. In longer waking episodes, the rapidity of transitions increased as crying and fussing increased. The duration of crying and fussing may be inversely related to the infant's ability to reorganize which is supported by the literature (Als, 1982; Cole, 1985; Gorski, Davidson & Brazelton, 1979).

Stages of Waking

The description of each stage of waking, tested by discriminant analysis, provides a beginning ethogram of waking behavior of normal newborn infants. Ethograms of infants have been described by others (Côté 1987; Givens, 1977 & 1978; Izard, 1983; Wolff, 1987), but important differences exist in the characteristics of the samples and the target behaviors that were studied. For example, Côté (1987) described distressed behaviors of high risk infants following surgery. Givens (1977, 1978) described social behaviors of infants less than a year old observed during interaction. Wolff (1987) provided a detailed description of states and transitional states of infants under three months old. Izard (1983) described the facial expressions of infants in great detail. The behavior of infants less than one week old have less clear cut behavioral cues than older infants (Brazelton, 1977; Pretchl, 1965) and social interaction is minimal in a busy hospital nursery. The findings from this study support the fact that facial expressions by themselves would be insufficient to complete an ethogram of newborn behavior and that other aspects of behavior are both needed and useful to obtain a complete picture of waking behavior.

Six stages of waking were found which consisted of one or more states of arousal or active/rest periods. As many as eight waking states have been described (Anderson et al., 1981; High & Gorski, 1985). However, a classification of five or six states has greater validity and utility than more elaborate ones (High & Gorski, 1985; Wolff & Ferber, 1979). The idea of rest periods is missing when waking is conceptualized as states of arousal. Within a stage of waking, the infant's activity crested in an active period and subsided during a rest period. This rhythm of movement was characteristic of wakefulness, even in patterns of rapid arousal, and may have an adaptive function indicating reorganization of behavior.

While it is common practice to define wakefulness as "eyes open", discriminant analysis of the stages of waking indicated that "eyes shut" or "tightly shut" were significant behaviors for all stages, while "eyes open briefly" was significant for only four stages. "Eyes open briefly" was observed in 100% of the stages of *Awake*, 73.5% of *Transition to Crying* and 53.8% of *Crying*, and in 100% of the rest periods of *Transition to Wakefulness*. The relative importance of "eyes open briefly" compared to other behaviors was only high in the rest period of *Transition to Wakefulness* and in

Awake. One reason to account for the stress placed on "eyes open" in the literature on wakefulness is that most of the observations are made on the spot, by one or two judges which creates difficulty when observing rapid changes in behavior.

The findings indicated that the characteristics of vocalization were significant indicators of type of stage. Distinguishing waking states on the basis of types of cry is not common practice. High and Gorski (1985) describe three waking states in premature infants with the following types of cry: unsustained cry in "Mild Fussiness", sustained cry ≤ 15 seconds in "Active Fuss with Cry", and sustained cry >15 seconds in "Crying". Anderson et al. (1981) also describe three waking states on the basis of type of cry: audible or silent cry with very prolonged exhalation in "Hard Crying", audible or silent cry with prolonged exhalation in "Crying" and whimper with slightly prolonged exhalation in "Fussing". In the current study, vocalization was rare or absent in *Transition to Crying* and *Asleep*. Grunting and occasional whimpers each occurred in 50% of the stages of *Awake*. Fuss cry was heard in 99% of *Transition to Crying* (1% missing values). Moderately loud or loud cries were heard in all stages of *Crying*. Hard crying was heard in all stages of *Hard Crying*.

Transition among the stages of waking was as expected. The most common transitions from stages 0 to 2 were to one stage higher in arousal. The most common transitions from stage 3 were either to one stage higher or lower in arousal. The most common transitions from stages 4 and 5 were to one stage lower in arousal. These findings are supported by those of Thoman (1975) who examined transitional probabilities among states of arousal.

Asleep occurred in 60.6% of all waking episodes and always represented a rest period. The occurrence of a sleep state within a pattern of waking has not been widely acknowledged, probably as a result of the observational methods so frequently used. "Eyes shut" and "mouth shut and relaxed" with occasional brief movement were characteristic of this stage.

Transition to Wakefulness occurred in 90.9% of all waking episodes. The rest period of this stage has been described as "Drowsiness" (Brazelton, 1984; Thoman, 1975; Wolff, 1987) and is not believed to be a true state due to the wide variablity of observed behavior. Discriminant analysis indicated that this may not be the case as the rest period of *Transition to Wakefulness* was correctly predicted 98.3% from the coded behavioral events. Coding from videotapes versus live coding may have resulted in greater accuracy of recognition of this state. Eyes shut and open briefly were seen in every rest period of this stage. Head movement was common but brief. The active period of *Transition to Wakefulness* has received less attention as a state of wakefulness or impending wakefulness. Anderson et al. (1981) label the typical behaviors of this stage as "Very Active Sleep" because the eyes are closed.

Awake occurred in all waking episodes. This stage consists of two states, commonly described as "Active Awake" and "Alert" (Brazelton, 1984; High & Gorski, 1985; Parmalee & Stern, 1972; Pretchl, 1974; Wolff, 1987). Alertness was observed in 39.8% of all stages of *Awake*, and represented a rest period within stage 2. No differences in the amount of alert behavior were found among the four patterns of waking.

Transition to Crying occurred in 90.9% of all waking episodes and consisted of fuss cry, facial tension, motor activity and jerky movements. Anderson et al. (1981) did not include facial or motor activity in their definition of the state of "Fussing." Wolff (1987) described fussing in terms of vocalization and facial expression, commenting that it was difficult to distinguish between fussing and crying. Discriminant analysis demonstrated a high rate of correct prediction of *Transition to Crying* based on a wider variety of behavioral events.

Crying occurred in 84.8% of all waking episodes and consisted of moderately loud and loud cries, facial tension, movement, jerky movement and body tension. When the crying sounds were short and loud, this stage was difficult to distinguish from *Transition to Crying*. The description of *Crying* in these findings is more inclusive than previous descriptions (Anderson et al., 1981; Brazelton, 1984; Wolff, 1987). Although, the occurrence of *Crying* was affected by early intervention, there were some longer waking episodes during which crying never occurred, suggesting that some infants may rarely vocalize beyond the fuss cry. This possibility has not been documented in the past, and needs further investigation over a longer time period and with a larger sample.

Hard Crying occurred in 48.5% of all waking episodes and consisted of hard crying, extreme facial tension (eyes tightly shut, frown, and open, square mouth) and brief head movement. Although the percent of occurrence was affected by early intervention in this study, *Hard Crying* is rarely distinguished from other crying states in the literature. Anderson et al. (1981) describe this state in terms of extreme tension, facial redness and type of crying.

Types of Cries

Gill et al. (1984) described four types of crying (and no crying) on the Cry Scale in terms of grimace, facial reddening, vocalization characteristics and limb movement. Grimace was described cry grimace as a twisted, wrinkled or distorted face which is observed during crying (Gill, 1982). In the current study, the condition of the brows, eye lids and mouth were coded separately. Limitations of the method of study prevented analysis of the infants' color and precise measurement of the auditory characteristics of the types of cries. Although the accuracy of recognition of the types of cries improved with experience, it was affected by the variation of sounds that required categorization. Analysis of the behavioral events which occurred with each type of cry was further limited by one/zero sampling. Degree of rapidness of movement was not graded, but was coded as jerky movement when movement was abrupt or sudden. The rate of misclassification by discriminant analysis may have been increased by the violation of the required assumptions of equal covariance matrices and the non-normal distribution of variables.

The category of "no crying" in the Cry Scale includes no grimace, no vocalization and relaxed and fluid movement (Gill et al., 1984). The findings of the current study indicate that slight frown, which may be a form of slight grimace, does occur frequently without crying in *Transition to Wakefulness*. In addition, grunting was a common vocalization other than crying and observed in stages 0 to 2.

In the Cry Scale, slight grimace was an indicator of whimpering (Gill et al., 1984). Gill (1982) included open and closed eyes. The strongest discriminant of whimpering in the current study was slight frown. This type of cry occurred in *Awake*, during which the eyes were opened and shut.

The significant discriminators of fuss cry were eyes tightly shut, slight frown, grimace, pout, and jerky movements. Description of the facial expression of "fuss cry" in the Cry Scale is less detailed, but compatible with the increasing facial tension observed in the current study. However, the intensity of vocalization observed during fuss cry varied among infants and was not always moderately loud as described in the Cry Scale, though its nature was always staccato as described by Kersher (1982) and Wolff (1987).

Rhythmic moderately loud and loud crying were heard in *Crying*. Occasionally, only one type of cry was heard. The strongest discriminants of moderately loud crying were frown, mouth open and square, pout, and body tension. Grimace and jerky movements had a significant but weaker contribution to moderately loud crying. These characteristics are also found in "crying" in the Cry Scale and define loud crying. The strongest discriminators of loud crying in the current study were frown, mouth open square and body tension. A pout and jerky movements had a significant but weaker contribution to loud crying. In practice, it would be difficult to distinguish between moderately loud crying and loud crying using behavioral criteria and without sophisticated instrumentation to measure the auditory characteristics.

The significant discriminants of hard crying were eyes tightly shut, frown, mouth and open square, body tension and jerky movements. Slight frown was less likely to occur in the same stage as hard crying. Although these behaviors are like those of "ha crying" in the Cry Scale, they are also similar to those observed in moderately loud and loud crying. In practice, the quality of hard cry (i.e., initial grating sound similar to grinding pepper in a pepper mill) may be the most important distinguishing feature.

Effect of Antecedent Variables on Behavior

There has been considerable interest in the health care field in the concept of organization as a means of explaining the dynamics of infant behavior (Als, 1982; Brazelton, 1984; Cole, 1985; Gorski, Davidson & Brazelton, 1979). Reorganization is the process of regaining control over autonomic and motor behavior (Als, 1982; Brazelton, 1984). Loss of control may be evidenced by flailing and color changes (Als, 1982; Brazelton, 1984). Self-consoling behavior is thought to be an important strategy for reorganization (Blackburn, 1977a). Good organization may be necessary for the infant to demonstrate alert behavior (Brazelton, 1984). In the current study, flailing was coded as jerky movements and color could not be determined from videotape. Three self-consoling behaviors were recorded: hand-mouth, hand-pass and sucking. Effectiveness of self-consoling strategies has not been documented in previous studies. In the current study, the occurrence of these behaviors and the influence of birth, feeding and environmental variables were examined. Interpretation of the findings is limited by non-random sampling of the subjects and by one/zero sampling of the behavioral events.

The strongest discriminator of alert behavior was sucking. Hand-mouth and hand-pass were not significant. Sucking was observed most often during *Awake*, whereas hand-mouth and hand-pass were also common in other stages. This may partially account for the significant relationship between sucking and alert behavior. These findings support the notion that sucking is a strategy to promote alertness and consequently, organization of behavior (Birns, Blank & Bridger, 1966; Field & Goldson, 1984; Neeley, 1979). The strongest discriminators of sucking were room temperature and time since last feeding, suggesting that a cool room and a longer time since last feeding may increase the occurrence of spontaneous sucking. The rates of correct prediction of actual occurrences of sucking and alertness were less than 56% and require further investigation with a randomized sample.

The relationship between type of swaddling and alert behavior was significant. Infants who were more securely swaddled had more alert behavior than those who were loosely swaddled. However, the findings also indicated that infants who were more securely swaddled had more jerky movements than those who were loosely swaddled. Understanding the relationship between type of swaddling and behavioral organization would improve with a more tightly controlled investigation or with a larger sample size.

Hand-mouth and hand-pass were directly related to the occurrence of jerky movements whereas sucking was inversely related. The findings also indicated that infants whose mothers did not receive analgesics were less likely to exhibit as much hand-pass, hand-mouth and jerky movements, compared with infants whose mothers received analgesics. However, the number of mothers not receiving analgesia in labour was small (i.e., only five). Hand-mouth and hand-pass may represent unsuccessful attempts at reorganization of behavior as evidenced by their association with jerky movements. However, the rates of correct prediction of actual occurrences of jerky movements based on models of self-consoling behavior and antecedent variables were $\leq$ [illegible]% so that these results require further investigation.

Rapid state transitions have been implicated as signs of behavioral disorganization (Brazelton, 1984). No conclusive evidence for this could be found in the current study. Jerky movements were more likely to be absent in very short stages compared to longer stages. This may indicate that rapid stage transitions may be a strategy towards behavioral reorganization. This should be further investigated with a more tightly controlled study design.

Validity of the Coding Tool

Validity studies on ethograms of infant behavior are rare. The coding tool used in the current study consisted of behavioral events which were initially identified by a systematic literature review and by a detailed description of the behavior of three infants. The coding tool was further refined during the process of obtaining interrater reliablity before actual coding began. Discriminant analysis of the coded behaviors demonstrated a high rate of correct prediction of the stages of waking. Although discriminant analysis demonstrated content validity of the coding tool, factor analysis of the coded behaviors was less convincing. In factor analysis two factors were identified: Crying and Waking Activity. The first factor had significant loadings on the same variables which were strong discriminators of the stage, *Crying*. Although the second factor did not correspond to a specific stage, it did include some movements which were significant for all stages. The fact that only two factors were demonstrated with factor analysis may have been influenced by the limitations of the binary nature of the variables.

Implications for Nursing Practice

The findings of this study have implications for three important areas of nursing practice: assessment, intervention and evaluation. Knowledge of waking behavior and factors that influence behavior will facilitate accurate assessment of the needs and interactive abilities of the normal newborn infant. Four patterns of waking were identified as well as the factors, such as discomfort and hunger, which influence them. Sucking may be an important self-consoling strategy as evidence by increased alert behavior. The terminology used to label waking behaviors and vocalization in the coding tool will facilitate accurate recording and communication of assessment of infant behavior. Accurate assessment will also provide a sound basis for teaching new parents about their infant's verbal and non-verbal communication.

Knowledge of factors which may influence behavior will facilitate improved decision-making and nursing interventions, particularly in a busy nursery. Infants with increased jerky movements may need to be swaddled more tightly. Infants who were breast-fed were loosely swaddled on return to the nursery. Parents need to be taught how to swaddle their infants snuggly as early as possible to facilitate organization of behavior of their infant. The discomfort from wearing a urine catcher may play a role in the infant's inability to lower his level of arousal. Consequently, this infant may require earlier intervention. Increased hand-mouth and hand-pass activity without sucking may indicate unsuccessful attempts at self-consoling. Teaching parents to guide the infant's hand or digit to his mouth to encourage sucking may be helpful in improving self-consoling. Feedback from one breast-feeding mother indicated that infant feeding may improve if feeding is delayed until fuss cry is heard. Parents can be taught to recognize this cry by its staccato quality. However, this suggestion needs to be tested in future work.

Knowledge of infant behavior will also facilitate accurate evaluation of nursing interventions. Increased knowledge and the use of a standardized vocabulary will enhance the interaction of nurses with other health professionals and the public, and promote the professional image of nurses.

Implications for Nursing Research

This descriptive study provides nursing researchers with a baseline for subsequent investigations of infant waking behavior and the factors which influence it. Further investigation of waking behavior with a larger randomized sample and conducted over a longer period of time would expand our understanding of patterns of waking behavior and the influence of antecedent variables. Comments made by nurses during this study indicate the potential influence of ethnic differences on infant waking patterns. This has not been investigated in the past, nor was it incorporated in the current study.

The findings from this study indicate that maternal analgesics in labour may influence the infant's ability to self-console and ability to control their level of arousal. Therefore the need for investigation of alternate methods of pain relief in labour is an important area for nursing research.

The identification of patterns and stages of waking in this study will facilitate investigation into optimal feeding practices for the care of newborn infants. For example, when is the most appropriate time to initiate a feeding so that the outcome is a "good breast feeding experience?" When is the most appropriate time to initiate a feeding so that milk intake is maximized?

The findings from this study provide a baseline for investigation into several areas. For example, how do nighttime patterns of waking differ from daytime patterns? Efficient and effective methods for improving self-consoling abilities and for soothing infants in different settings can be investigated (e.g. type of swaddling). A longitudinal study of self-consoling, waking behavior and antecedent variables can increase our understanding of developmental needs relating to sleep disorders and colic. A comparative study on self-consoling behaviors of low-risk and high-risk populations can increase our insight into the special needs of these infants. The role of self-clasp as a self-consoling behavior needs further investigation. The effect of room and axillary temperatures on patterns of waking is another important area for investigation. The Cry Scale (Gill et al., 1984) can be redesigned and validity studies conducted to improve this research tool.

Summary

Normative data on the typical patterns of nighttime waking behavior of healthy full-term infants in a naturalisitic setting have been documented through this study. The influence of antecedent variables on these patterns and on self-consoling was examined and different types of cries were described.

Thirty-three waking episodes from 21 two-day old infants were videotaped and analyzed. Using ethological methods, a coding tool based on six stages of waking was developed from detailed descriptions of the waking behavior of the first few subjects. The behavioral events were coded using the one/zero sampling method. High intrarater and interrater reliabilities were established and maintained throughout the coding process. Descriptive statistics helped to describe the patterns "within subject" and "between waking episodes." Summary statistics and discriminant analysis were used to analyze the stages of waking, self-consoling and types of cries. Discriminant and factor analyses were used to examine the validity of the coding tool. Discriminant analysis was limited by nonequal covariance matrices and non-normal distribution of variables, while factor analysis was limited by binary measurement of the variables and missing values.

Generalizability of the findings of this study is limited by non-randomization of the sample. Sources of threats to internal validity included small sample size, poor quality of some filmed data, some behavioral events which were not coded, one/zero sampling method when coding events in long stages, imprecise measurement of vocalization and inadequate frequency of measurement of room and axillary temperatures. Content validity of the coding tool was demonstrated by discriminant analysis.

The findings from this study are unique in documenting variations among patterns of repeated waking episodes. Inconsistencies, which consisted mainly of differences in rapidity of arousal, could be related to differences in discomfort and hunger. The findings from this study are also unique in that different patterns of waking in infants over 24 hours of age were identified. Four patterns were observed: rapid arousal from sleep, slow arousal from sleep, episodes that ended in sleep and discrepancies in the ratio of rest/active periods. These patterns were distinguished at several levels: rest/active periods, typical behavioral events, antecedent variables and outcome.

The findings from this study are also unique in that stages of waking consisting of one or more states of arousal were identified. Conceptualizing waking behavior in terms of stages rather than states led to the concept of rest and active periods as ways of assessing the organizational attempts of the newborn infant. In addition, categorization of waking into stages versus states is a means of achieving heuristic validity and utility, yet also retaining the comprehensiveness of the complex classifications of states. The findings also indicate that the emphasis in the "state" literature which is placed on "eyes open" when defining wakefulness is not appropriate for healthy newborn infants. Type of vocalization was also found to be an important indicator of type of stage, and may be an important cue for nursing intervention. Type of vocalization has received little emphasis in current classifications of states of arousal.

Types of cries and related behavioral events were examined by discriminant analysis and provided useful information to evaluate the Cry Scale (Gill et al., 1984). Facial tension consisted of changes in the brows, the eye lids and the mouth which were explicitly defined in the current study; whereas, the category "Grimace" in the Cry Scale was not explicitly defined and may be misinterpreted. Each type of cry was defined in the current study by its particular quality (short, staccato, rhythmical and grating); whereas, in the Cry Scale, "Vocalization Duration" and "Vocalization Intensity" consisted of characteristics which could not be measured objectively without additional instrumentation. Body tension and jerky movements were explicitly defined in the current study but only their occurrence or non-occurrence was measured; whereas, in the Cry Scale, "Limb Movements" are rated according to subtle gradations in rapidity or tension, which cannot be measured objectively solely by observational techniques.

This study is also unique in evaluating self-consoling behavior. Increased sucking was related to increased alert behavior and decreased jerky movements; whereas, increased hand-mouth and hand-pass were related to increased jerky movements. Increased alert behavior was also observed when infants were securely or restrictively swaddled, compared to loosely swaddled. Increased hand-mouth, hand-pass and jerky movements were observed in infants whose mothers had received analgesics during labour.

In conclusion, the findings from this study have important implications on several aspects of nursing practice and nursing research. Knowledge of waking behavior will facilitate accurate assessment, management and evaluation of nursing care of the newborn infant and his family. The findings from this study provide baseline data for studies on nursing interventions, such as timing of feeding and soothing infants, and have led to the generation of questions for further nursing research, such as alternatives in pain management in labour.

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APPENDIX A

DATA RECORD SHEET

DATA RECORD SHEET

I.D. Code__________ Male / Female
Born________________________
Age at time of study _______ hours

Birth Weight__________ grams
Gravida_____ Para_____
Gestation______ weeks

Type of Delivery _________________ **Length of labour**__________________

Type of feeding: bottle ____
breast ____
suppl. __________________

2300: Axilla Temperature: ________ °C
Nursery Temperature: ________ °C

0600: Axilla temperature: _______ °C
Nursery temperature: _______ °C

Apgars ______ @ 1minute
______ @ 5 minutes

Pregnancy History:
Risk Score: _____

____
____
____
____

Maternal Analgesia:

Drug	Route	Dosage	Frequency	Duration	Last Dose

Running Record: (Feeding, Soiled Diapers, Comments)
Hour Events

APPENDIX B

CODING TOOL

CODING TOOL

Time Start

eyes shut
eyes tightly shut
eyes open briefly
alert
slight frown
frown

mouth shut
mouth movements
smile
lips pursed
rooting
mouth searching
sucking
grimace
pout
open square
sigh
yawn
sneeze
hiccough
grunting
occ whimper
fuss cry
mod loud cry
loud cry
hard cry

head
slight hand
hand mouth
hand pass
arm movement
kicking
squirming
startle
body tension
jerky movement

Time End

Duration

Stage

APPENDIX C

DEFINITIONS OF BEHAVIORAL EVENTS

DEFINITIONS OF BEHAVIORAL EVENTS

Eyes and Forehead:

eyes shut: eyes closed and relaxed.

eyes tightly shut: eye lids clenched together.

open briefly: eyes open at times (when eyes are shut more than they are open).

alert: eyes open and looking, with little or no movement.

slight frown: nasal root bulge only.

frown: nasal root bulge with furrows as seen during crying.

Mouth and Vocalization:

mouth shut: mouth closed and relaxed.

mouth movements: opening and closing of mouth, mouthing, tongue protrusion.

smile: mouth open or closed and corners of mouth pulled back and slightly up.

lips pursed: mouth open or closed, corners drawn together.

rooting: a turning of the head with the mouth open.

mouth searching: mouth open and rubbing against object, such as hand or linen.

sucking: individual patterns of pauses and bursts via tongue and cheek movements which create suction and expression forces in the oral cavity drawing an object, such as a hand, finger or linen, into the oral cavity (this can also occur with no object being drawn into the oral cavity or with the tongue as an object).

grimace: mouth slightly open, tense, and corners retracted straight back.

pout: corners of mouth drawn downward and outward, with mouth open or closed; chin may push up center of lower lip.

open square: mouth angular and squarish.

sigh: deep inhalation followed by deep exhalation.

yawn: nasal root bulge, eyes tightly shut and mouth open wide during a long deep inhalation.

sneeze: a brief, forceful, noisy exhalation through the nose with mouth open or closed.

hiccough: rapid intake of breath, associated with rapid contraction of diaphragm.

grunting: short, low-pitched, non-distressed sounds, associated with exhalation against a partially closed glottis.

occ whimper: 1-3 episodes of short, high-pitched, sounds.

fuss cry: frequent short, high-pitched, and staccato distressed sounds and/or short, louder, lower-pitched sounds (moderately loud cry).

mod loud cry: short to moderately long in length and rythmical.

loud cry: moderately long to long in length and rythmical.

hard cry: almost continuous, very loud crying with a grating quality.

Head, Limb and Other Movement:

head: side to side and/or back and forth of head.

slight hand: some flexion or extension of one hand while arms are still.

hand mouth: hand touches any part of the mouth.

hand pass: movement of hand over face without contacting the mouth with any part of the hand; hand may or may not touch the face.

arm movement: movement of one or both arms.

kicking: leg movement.

squirming: general body movement.

startle: rapid outward flexing of arms, openning of hands, and leg extension, followed by a slow return to the relaxed position.

body tension: arms and hands held in a tightly flexed position, or rigid extension with head retraction.

jerky movement: sudden, abrupt limb or body movement.

APPENDIX D

RESEARCH CONSENT FORM

RESEARCH CONSENT

PROJECT TITLE: *Patterns of Newborn Wakefulness*

INVESTIGATOR: Joanna R. Greenhalgh, R.N., MEd.
M.N. Candidate, University of Alberta.
Staff Nurse, University Hospitals.
Telephone: 432-8233

ADVISOR: Dr. J. Morse, R.N., PhD
Professor, University of Alberta
& Clinical Nurse Researcher, University Hospitals
Telephone: 432-6250

Little is know about the typical patterns of wakefulness in the newborn infant. This knowledge is needed for further research, such as comforting, colic etc.. The objectives of this study are to describe typical patterns of wakefulness in newborn infants and to identify related factors.

Your baby will be studied for one night only (between 11 PM and 7 AM) on the second day in the night nursery. Your baby will be videotaped every time he/she wakes up. The camera will be turned off again after he/she has fallen asleep or when he/she needs feeding. Your baby will not be left to cry for longer than normal any time during this study. No other aspect of her/his care will be affected by this study and your baby will be brought to you for feeding as per your usual routine. The nursery nurse will return your infant to the nursery when the feeding is over.

There will be no apparent risk to your baby by participating in this study. All information will be coded so that the information cannot be identified with your baby. Your baby's last name will not appear in any document or reports. Although your baby may not directly benefit from involvement in this project, information gained through her/his involvement may contribute to a greater understanding of newborn wakefulness and assist in planning further research.

I/WE UNDERSTAND THAT I/we are free to withdraw consent and terminate my/our baby's participation at any time without compromise to either our or our baby's care.

I/WE HEREBY AUTHORIZE Joanna Greenhalgh to videotape my/our baby

____ (Baby's Name).

I/WE HEREBY WAIVE all rights that we or our baby have to any claims for payment in connection with any presentation of these recordings. This release is made with the understanding that these recordings will be kept and not destroyed so that they may be used and reused for research, scientific and other institutional purposes including publication. Ethical review will be sought as per protocol, should they be reused for research purposes.

I/WE HAVE BEEN GIVEN THE OPPORTUNITY TO ASK WHATEVER QUESTIONS I/WE DESIRE AND ALL SUCH QUESTIONS HAVE BEEN ANSWERED TO MY/OUR SATISFACTION.

DATE_______________________________ SIGNATURE__________________________

INVESTIGATOR____________________ SIGNATURE__________________________

APPENDIX E

EDUCATIONAL CONSENT

EDUCATIONAL CONSENT

PROJECT TITLE: *Patterns of Newborn Wakefulness*

INVESTIGATOR: Joanna R. Greenhalgh, R.N., MEd.
M.N. Candidate, University of Alberta,
Staff Nurse, University Hospitals.
Telephone: 432-8233

ADVISOR: Dr. J. Morse, R.N., PhD., PhD.
Professor, University of Alberta,
Clinical Nurse Researcher, University Hospitals.
Telephone: 432-6250

CONSENT

I/WE HEREBY CONSENT to allow my/our infant's first or given name, and do not allow my/our surname, to be associated with any of these recordings. I/we understand that protection of my/our baby's identity may not be possible when using the films for teaching professionals in health care or related fields. I/we understand that I/we are free to withdraw consent and terminate my/our baby's participation at any time without compromise to either our or our baby's care.

RELEASE

I/WE HEREBY WAIVE all rights that I may have to any claims for payment in connection with any presentation of these recordings. This release is made with the understanding that these recordings will be kept and not destroyed so that they may be used and reused for educational purposes, including publication.

DATE ______________________ SIGNATURE______________________

INVESTIGATOR______________ SIGNATURE______________________

APPENDIX F

DURATION AND FREQUENCIES OF STAGES FOR EACH INFANT

INFANT 1

I. Duration and Number of Rest Periods of Stages of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	2256	1	112	1	2
		2	159	0	1
		3	3	0	1
		4	148	4	4
		5	14	0	1
		TOTAL	**447**	**35.7%**	**64.3 %**
(ii)	0145	1	70	0	1
		2	595	5	3
		3	23	1	1
		4	200	5	3
		TOTAL	**898**	**57.9 %**	**42.1 %**
(iii)	0435	1	181	1	2
		2	80	0	1
		3	13	0	1
		5	68	1	2
		TOTAL	**342**	25.0 %	75.0 %

INFANT 01 (continued)

II. The Relative Frequencies of Stages in Each of the Three Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODES		
	1st Episode n=14 [1]	2nd Episode n=19[1]	3rd Episode n=8[1]
SELF CONSOLING			
Hand Mouth	n=11 78.5 %	n=17 89.5 %	n=6 75 %
Sucking	n=2 14.3 %	n=8 42.1 %	n=1 16.7 %
ALERT	n=1 7.1 %	n=0 0.0 %	n=0 0.0 %
JERKY MOVEMENTS	n=3 21.4 %	n=6 31.6 %	n=4 66.7 %

[1] Total number of stages within waking episode.

INFANT 02

I. Duration and Number of Rest Periods of Stages of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0100	1	17	0	1
		2	142	0	1
		3	694	6	7
		4	166	6	3
		TOTAL	**1019**	**50.0 %**	**50.0 %**
(ii)	0306	1	10	0	1
		2	128	0	1
		3	23	0	1
		4	175	3	3
		5	34	0	1
		TOTAL	**336**	**30.0 %**	**70.0 %**
(iii)	0530	1	55	1	1
		2	155	1	2
		5	21	0	1
		TOTAL	**228**	**33.3 %**	**66.7 %**

INFANT 02 (continued)

II. The Relative Frequencies of Stages in Each Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODE		
	1st Episode n=24[1]	2nd Episode n=10[1]	3rd Episode n=6[1]
SELF CONSOLING			
Hand Mouth	n=17 70.8 %	n=5 50.0 %	n=3 50.0 %
Sucking	n=6 25.0 %	n=4 40.0 %	n=0 0.0 %
Alert	n=7 29.2 %	n=3 12.5 %	n=0 0.0 %
JERKY MOVEMENTS	n=4 16.7 %	n=2 20.0 %	n=1 16.7 %

[1] Total number of stages within waking episode.

INFANT 03

I. Duration and Number of Rest Periods of Stages of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0129	1	6	0	1
		2	20	0	1
		3	387	4	5
		TOTAL	**413**	**36.4 %**	**63.6 %**
(ii)	0306	1	11	0	1
		2	42	0	1
		3	123	0	1
		4	6	0	1
		TOTAL	**182**	**0.0 %**	**100.0 %**
(iii)	0616	2	70	2	2
		3	30	0	1
		TOTAL	**100**	**40.0 %**	**60.0 %**

INFANT 03 (continued)

II. The Relative Frequencies of Stages in Each Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODE		
	1st Episode n=11[1]	2nd Episode n=4[1]	3rd Episode n=5[1]
SELF CONSOLING			
Hand Mouth	n=9 81.8 %	n=4 100.0 %	n=3 60.0 %
Sucking	n=3 27.3 %	n=3 75.0 %	n=0 0.0 %
ALERT	n=1 9.1 %	n=0 0.0 %	n=0 0.0 %
JERKY MOVEMENTS	n=1 9.1 %	n=1 25.0 %	n=1 20.0 %

[1] Total number of stages within waking episode.

INFANT 04

I. Duration and Number of Rest Periods Stages of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0348	2	26	1	2
		3	177	3	4
		4	174	8	3
		TOTAL	**377**	**57.1 %**	**42.9 %**
(ii)	0451	2	37	0	1
		3	13	0	1
		4	78	3	1
		TOTAL	**128**	**50.0 %**	**50.0 %**
(iii)	0548	2	37	0	~1
		3	1971	11	8
		4	63	1	2
		TOTAL	**2100**	**52.2 %**	**47.8 %**

INFANT 04 (continued)

II. The Relative Frequencies of Stages in Each Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODE		
	1st Episode n=21[1]	2nd Episode n=6[1]	3rd Episode n=23[1]
SELF CONSOLING			
Hand Mouth	n=8 38.1 %	[illegible] 50.0 %	n=14 60.9 %
Sucking	n=1 4.8 %	n=0 0.0 %	n=6 26.1 %
ALERT	n=2 9.5 %	n=2 33.3 %	n=5 21.7 %
JERKY MOVEMENTS	n=4 19.0 %	n=4 66.7 %	n=7 30.4 %

[1] Total number of stages within waking episode.

INFANT 05

I. Duration and Number of Rest Periods of Stages of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	2254	1	10	0	1
		2	104	0	1
		3	196	1	2
		4	198	7	3
		TOTAL	**508**	**53.3 %**	**46.7 %**
(ii)	0252	2	97	0	1
		3	473	6	7
		4	14	1	1
		TOTAL	**362**	**46.7 %**	**53.3 %**
(iii)	0559	2	100	1	2
		3	262	1	1
		4	152	4	4
		TOTAL	**514**	**46.2 %**	**53.8 %**

INFANT 05 (continued)

II. The Relative Frequencies of Stages in Each Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODE		
	1st Episode n=15[1]	2nd Episode n=16[1]	3rd Episode n=10[1]
SELF CONSOLING			
Hand Mouth	n=12 80.0 %	n=6 37.5 %	n=7 70.0 %
Sucking	n=7 46.7 %	n=0 0.0 %	n=2 20.0 %
ALERT	n=0 0.0 %	n=0 0.0 %	n=1 10.0 %
JERKY MOVEMENTS	n=14 93.3 %	n=13 81.3 %	n=6 60.0 %

[1] Total number of stages within waking episode.

INFANT 06

I. Duration and Number of Rest Periods Among Stages of Waking for Each Waking. Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0046	1	5	0	1
		2	737	14	8
		TOTAL	**742**	**60.9 %**	**39.1 %**
(ii)	0536	2	945	6	5
		3	34	0	1
		4	76	3	1
		TOTAL	**1055**	**56.3 %**	**43.8 %**

INFANT 06 (continued)

II. The Relative Frequencies of Stages in Each Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODE	
	1st Episode[1] n=23[2]	2nd Episode n=17[2]
SELF CONSOLING		
Hand Mouth	n=8 34.8 %	n=0 0.0 %
Sucking	n=6 26.1 %	n=5 29.4 %
ALERT	n=0 0.0 %	n=4 23.5 %
JERKY MOVEMENT	n=4 17.4 %	n=4 23.5 %

[1] This waking episode ended in sleep.
[2] Total number of stages within waking episode.

INFANT 07

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	EPISODE Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0253	1	2	0	1
		2	367	0	1
		3	215	1	2
		4	338	11	8
		5	67	4	1
		TOTAL	**997**	**55.2 %**	**44.8 %**

INFANT 07 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL E[illegible]	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	20	69.0
Sucking	3	10.3
ALERT	3	10.3
JERKY MOVEMENT	28	96.6

INFANT 08

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0141	1	31	0	1
		2	53	0	1
		3	186	3	2
		4	118	5	6
		5	882	48	3
		TOTAL	**1270**	**81.2 %**	**18.8 %**

INFANT 08 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	1	1.4
Sucking	7	10.1
ALERT	11	15.9
JERKY MOVEMENT	30	43.5

INFANT 09

I. Duration (seconds) and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION	# REST PERIODS	# ACTIVE PERIODS
(i)	0058[1]	1	10	0	1
		2	10	0	1
		3	41	1	1
		4	1894	51	10
		TOTAL	**1955**	80.0 %	20.0 %

[1] This waking episode ended in sleep.

INFANT 09 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred[1]

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	14	21.9
Sucking	9	14.1
ALERT	5	7.8
JERKY MOVEMENT	28	43.8

[1] This waking episode ended in sleep.

INFANT 10

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	EPISODE Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0358	1	5	1	1
		2	637	4	3
		3	74	0	1
		4	548	6	4
		5	849	20	2
		TOTAL	**2113**	**73.8 %**	**26.2 %**

INFANT 10 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	0	0.0
Sucking	6	14.3
ALERT	9	21.4
JERKY MOVEMENT	10	23.8

INFANT 11

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0006	1	38	0	1
		4	378	18	14
		TOTAL	**416**	**54.5 %**	**45.5 %**
(ii)	0434	1	30	0	1
		2	186	0	1
		3	97	4	5
		4	49	5	1
		5	237	27	1
		TOTAL	**599**	**80.0 %**	**20.0 %**

INFANT 11 (continued)

II. The Relative Frequencies of Stages in Each Waking Episode During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	WAKING EPISODE	
	1st Episode n=33[1]	2nd Episode n=45[1]
SELF CONSOLING		
H[illegible]	n=14	n=28
	34.8 %	62.2 %
[illegible]	n=0	n=4
	0.0 %	8.9 %
[illegible]ERT	n=2	n=0
	6.1 %	0.0 %
JERKY MOVEMENT	n=33	n=44
	100.0 %	97.8 %

[1] Total number of stages within waking episode.

INFANT 12

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0210	2	1036	14	10
		3	133	3	4
		4	113	8	5
		5	140	7	4
		TOTAL	**1422**	**58.2 %**	**41.8 %**

INFANT 12 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	13	23.6
Sucking	3	5.5
ALERT	8	14.5
JERKY MOVEMENT	20	36.4

INFANT 13

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0120 [1]	1	8	0	1
		3	262	3	4
		4	211	10	4
		5	283	28	12
		2	329	3	4
		1	137	3	1
		TOTAL	**1230**	**65.8 %**	**34.2 %**

1 This waking episode ended in sleep.

INFANT 13 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred[1]

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	12	16.4
Sucking	6	8.2
ALERT	7	9.6
JERKY MOVEMENT	38	52.1

[1] This waking episode ended in sleep.

INFANT 14

I: Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0108	1	54	1	2
		3	282	4	2
		4	39	1	2
		5	116	2	3
		TOTAL	**491**	**47.1 %**	**52.9 %**

INFANT 14 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	4	23.5
Sucking	1	5.9
ALERT	2	11.8
JERKY MOVEMENT	8	47.1

INFANT 15

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	EPISODE Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	2325	1	22	1	1
		2	125	0	1
		5	201	4	2
		TOTAL	**348**	**55.6 %**	**44.4 %**

INFANT 15 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	3	33.3
Sucking	1	11.1
ALERT	0	0.0
JERKY MOVEMENT	6	66.7

INFANT 16

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0244	1	14	0	1
		2	301	2	2
		4	167	1	2
		5	905	40	12
		TOTAL	**1387**	**71.7 %**	**28.3 %**

INFANT 16 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	31	51.7
Sucking	4	6.7
ALERT	1	1.7
JERKY MOVEMENT	39	65.0

INFANT 18

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0127	1	11	0	1
		2	275	2	2
		3	398	9	10
		4	1310	44	17
		TOTAL	**1994**	**64.7 %**	**35.3 %**

INFANT 18 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	28	32.9
Sucking	6	7.1
ALERT	9	10.6
JERKY MOVEMENT	67	78.8

INFANT 20

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0251	1	33	0	1
		2	334	4	4
		3	296	5	6
		4	237	6	5
		5	186	12	5
		TOTAL	**1086**	**56.3 %**	**43.8 %**

INFANT 20 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	21	43.8
Sucking	3	6.3
ALERT	7	14.6
JERKY MOVEMENT	23	47.9

INFANT 21

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	2311	2	468	1	2
		3	6	0	1
		5	194	1	1
		TOTAL	**668**	**33.3 %**	**66.7 %**

INFANT 21 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	2	33.3
Sucking	1	16.7
ALERT	1	16.7
JERKY MOVEMENT	5	83.3

INFANT 22

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	2350	1	10	0	1
		3	74	2	2
		4	284	10	4
		5	318	6	1
		TOTAL	**686**	**69.2 %**	**30.8 %**

INFANT 22 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	18	69.2
Sucking	1	3.8
ALERT	0	0.0
JERKY MOVEMENT	14	53.8

INFANT 23

I. Duration and Number of Rest Periods in Each Stage of Waking for Each Waking Episode

EPISODE #	EPISODE Hour	STAGE	DURATION (seconds)	# REST PERIODS	# ACTIVE PERIODS
(i)	0557	1	52	0	1
		2	150	1	2
		3	369	6	4
		4	838	34	10
		TOTAL	**1409**	**70.7 %**	**29.3 %**

INFANT 23 (continued)

II. The Relative Frequencies of Stages During Which Selected Behavioral Events Occurred

BEHAVIORAL EVENT	FREQUENCIES OF STAGES	
	n	%
SELF CONSOLING		
Hand Mouth	42	72.4
Sucking	33	56.9
ALERT	5	8.6
JERKY MOVEMENT	24	41.4