The Relationship between State and Prandial Condition in High-Risk and Healthy Infants

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THE RELATIONSHIP BETWEEN STATE AND PRANDIAL CONDITION IN HIGH-RISK AND HEALTHY INFANTS

by

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VITA

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INTRODUCTION AND LITERATURE REVIEW

When attempting developmental research it is important for the researcher to isolate variables that can be readily used in assessing individual differences from the neonatal period onward. Differences which can be described early in life can help the researcher to understand current behavior and to predict future behavior. One variable which has become increasingly useful for this purpose is infant state, or the percentage of time an infant spends in various sleeping and awake states and the patterning of these states.

Behavioral state characteristics have been shown to be consistent indicators of individual differences in infants (Korner, 1970, 1972, 1974; Korner & Grobstein, 1967; and Thoman, 1975). For instance, in the population of full-term healthy infants, differences are found in the capacity for alert inactivity, in the frequency and duration of crying, in the alterability of state by stimulation, and in the clarity with which state is expressed (Korner, 1972). Aside from the differences found in full-term healthy infants, state is also found to differ as a function of maturity and illness. Infants at risk due to prematurity or illness have state patterns that are unlike those of the full-term healthy infant.

Preterm infants differ markedly from full-term infants in their state characteristics. In preterm infants of less than 32 weeks conceptional age it is difficult to discriminate between sleeping and awake states. After 32 weeks, state begins to become more organized (Berg & Berg, 1979). Preterm infants in general do not obtain the level of organization in sleep that full-term infants display, with preterms showing lack of sleep cycling and shortened sleep periods (Dreyfus-Brisac, 1970). Research has also indicated that preterm infants cry less and spend more time sleeping than full-term infants (Holmes, Nagy, Slaymaker, McNeil, Gardner & Pasternak, 1980; Parmelee, 1975).

Infants who are at risk for reasons other than prematurity have also been shown to differ from normal newborns in their state characteristics. Prechtl, Theorell and Blair (1973), for example, studied behavioral state cycles in a group of 14 high-risk infants with symptoms of cerebral functional disturbances such as convulsions, apathy and muscular hypertonia and hypotonia. Among these infants, those five who were being treated with anticonvulsant drugs spent more time in both quiet sleep and active sleep than a normal group. The non-drugged high-risk infants spent less time in active sleep than normals, but there was no difference in the amount of time spent in quiet sleep.

The state differences noted above are interesting in that they are indicative of the current status of the infants observed. However, state may also be useful as a predictor of later functioning. In a research project designed to study the sleeping and waking behaviors over the first five weeks of life of 41 infants, chosen from a population of normal full-term infants, Thoman (1975) observed aberrant state patterns in one infant who later died of Sudden Infant Death Syndrome (SIDS) at three months of age. This particular infant showed an increasing rate of state change over the first five weeks along with a larger percentage of an aberrant form of quiet sleep in which there were spells of apnea and erratic respiration. The unusual state characteristics of this infant and the infant's subsequent death suggest the utility of state in identifying infants who are at risk despite their normal appearance along other behavioral dimensions.

Another study (Harper, Leake, Hoffman, Walter, Hoppenbrouwers, Hodgman & Sterman, 1981) looked at the succession of sleeping and waking states in 20 infants who were subsequent siblings of SIDS victims and in 20 normal infants. Subsequent siblings of SIDS victims have a three to fourfold higher risk for SIDS than than the general population. State was observed in these infants during the first week of life and at one, two, three, four, and six months of age during all night monitoring sessions. State was classified as quiet sleep, active sleep or awake in one-minute intervals. At two and three months of age siblings of SIDS victims had a decreased tendency to enter short waking periods when compared to normal infants. During the newborn period these infants had longer intervals between active sleep periods at particular times during the night. These findings suggest that state may be potentially useful for differentiating infants who may be at risk for SIDS before the critical age of two or three months.

Thus far, two important uses of state as a variable have been discussed. State is useful in assessing individual differences in healthy as well as high-risk newborns, and state might also be useful in predicting outcome. Another important aspect of state is that state patterns of infants may be altered by the introduction of various types of environmental stimuli. Brackbill, for example (1971, 1973), found that continuous sensory stimulation reduces the infant's level of arousal. Auditory, visual, proprioceptive-tactual and temperature (increase) stimuli were all noted to have this effect. The infants subjected to continuous stimulation slept more and cried less than the infants receiving ordinary stimulation. In another study (Dreyfus-Brisac, 1970) it was discovered that providing premature infants with rocking and the sound of a heartbeat increased the amount of time these infants spent in a quiet sleep state. Since state is thought to be a reflection of the maturity and integrity of the central nervous system (Parmelee, Wenner, Akiyama, Schultz & Stern, 1967; Prechtl, Theorell & Blair, 1973; and Thoman, 1975), and the amount of quiet sleep normally increases with age in preterm infants, this finding may have important implications for facilitating the maturation of such infants.

Another factor which is known to influence state is the prandial condition of the infant, or hunger, which is operationally defined as time since feeding (Ashton, 1973; Dreyfus-Brisac, 1974; Feldman & Brody, 1978; Harper, Hoppenbrouwers, Bannett, Hodgman, Sterman & McGinty, 1976, Hendry & Kessen, 1964; Irwin, 1930, 1932; Korner, 1970, 1972; Korner, Chuck & Dontchos, 1968; Marquis, 1941; Salzarulo, Fagioli, Salomon, Ricour, Raimbolt, Ambrosi, Cicchi, Duhamel & Rigoard, 1980; and Wolff, 1965, 1966). Except for the research of Dreyfus-Brisac (1974) and Salzarulo, et al. (1980), studies relating state to prandial condition to date have looked at these variables in the full-term healthy infant.

Several aspects of state have been studied in relation to prandial condition in newborns. One of the earliest investigations (Irwin, 1932) looked at the distribution of motility of 73 full-term infants ranging in age from one to 16 days, between two nursing periods. Although motility is not generally described as an infant state it is one of the behaviors included in several state categories such as active and/or REM sleep, awake activity and crying. In other words it is a state dependent behavior, and as such it is of interest here. Motility of these infants was measured using a stabilimeter. The mean number of oscillations per minute for thirteen 15-minute periods between consecutive feedings was recorded. Irwin found that motility increased from 17 oscillations per minute during the first 15-minute interval after nursing to 45 oscillations per minute in the 15-minute interval prior to the next feeding period. This research suggests that as the time since feeding increases, state patterns also change since motor behaviors are observed more often in some states than in others.

Specific motor behaviors which have been studied in relation to prandial condition include mouthing, hand-mouth contacting, hand-face contacting, and kicking (Hendry & Kessen, 1964; Korner, Chuck & Dontchos, 1968; and Wolff, 1965, 1966). Hendry and Kessen found that mouthing and hand-mouth contacting increased with hunger, while Korner, Chuck and Dontchos reported that only mouthing was related to hunger. In a more recent study (Feldman & Brody, 1978) it was pointed out that the inconsistencies in the above findings may be accounted for by variations in the pre- versus post-prandial distributions of states across studies. These researchers believed that specific motor patterns may exhibit state dependent patterns across waking and crying states as do spontaneous behaviors (startles, reflex smiles, rhythmical mouthing, erections, myoclonic twitches of the face, hands and feet and sobbing inspirations) for states of sleep and drowsiness. They proceeded to observe 354 newborn infants for one half hour before feeding and one half hour after feeding, recording state and specific motor behaviors. A ten second time sampling procedure was used in which state and behavior were observed for ten seconds and then recorded in the following ten second interval. They discovered that prandial condition differences in specific motor behaviors could be accounted for by concomitant changes in state. Mouthing was the only motor behavior that seemed to exhibit prandial condition differences independent of state.

Unfortunately, Feldman and Brody did not investigate the significance of state differences in the preprandial and postprandial conditions. However, they did report the probabilities of states for these conditions. These probabilities (reported in Table 1) suggest differences in quiet sleep, REM sleep and crying as a function of prandial condition. The percentage of quiet and REM sleep is greater after feeding while the percentage of crying is greater just prior to feeding.

Fortunately, a few researchers have systematically studied the effects of feeding on state in the full-term neonate (Harper, Hoppenbrouwers, Bannet, Hodgman, Sterman & McGinty, 1976; Korner, 1970, 1972; and Wolff, 1965, 1966). Korner, who studied newborn behavior in the half hours immediately following and preceding a feeding and at midpoint between feedings (1972), reported that "...sleeping, particularly regular sleep, significantly decreased with hunger;

TABLE 1

State Probabilities for Pre- and Postprandial Conditions

State	State Probabilities* Preprandial	Postprandial
Quiet Sleep	.239	.313
REM Sleep	.249	.360
Drowsy	.062	.062
Awake Inactive	.047	.040
Awake Active	.109	.092
Cry	.294	.133

*Data from Feldman & Brody (1978)

whereas crying frequency and the number of shifts of state increased." Harper, et al., (1976) who used EEG recordings to study the effects of feeding on state and heart rate in infants from one week to six months of age, found that quiet sleep and REM sleep increase immediately after feeding. These data are in agreement with Korner's as well as with Feldman and Brody's (1978) findings that infants spend a greater percentage of time sleeping after being fed than before being fed.

Another state which may vary with prandial condition is the state of alertness (Korner, 1970, 1972; Wolff, 1965, 1966), although there may be no effect of prandial condition on the state of alertness during the first few postnatal days. In Wolff's (1965) observations of 12 infants over the first four days after birth no significant differences were found in durations of alert activity across prandial conditions. Korner's (1970) investigation of visual alertness in 32 two to three day old infants replicated Wolff's finding. However, when Wolff (1966) studied the development of attention in ten infants over the first week of life he found that 86.4% of their alert time took place during the first hour after feeding. In this study he noted that absence of hunger is a necessary condition for alertness in infants. Since this study focused on infants beyond two or three days of age it may be that absence of hunger is a necessary condition for alertness only after the first two or three days of life.

The above studies indicate that the patterns of behavioral state characteristics vary as a function of prandial condition in the full-term healthy neonate. Infants tend to cry more just prior to feeding and sleep more following feeding. The relationship between feeding and alertness is more complex. In infants of four or more days of age alertness increases after feeding, while in younger infants alertness is not related to prandial condition.

To date most of the research investigating the relationship between state and prandial condition has involved full-term healthy infants. Since the pattern of state for high-risk infants is different from that of full-terms, one might expect a difference in how state relates to prandial condition in these infants. Little research has been done to study this relationship. The one available study noted that "feeding does not seem to influence sleep in prematures" (Dreyfus-Brisac, 1974). Preterm infants, unlike full-terms, are not awakened by hunger. In other high-risk groups of infants the relationship between state and prandial condition has not been assessed.

The purpose of the present study was to assess the relationship between state and prandial condition in several groups of high-risk and healthy infants. It was noted earlier that high-risk infants exhibit state patterns which are unlike those of the healthy full-term infant. Given these data and the data relating state to prandial condition in healthy full-term and in preterm infants, it is likely that the state patterns of high-risk infants will relate to prandial condition in ways that are different from those of the healthy full-term. These differences would be important both for indicating the present status of the infants involved and for their implications for predicting later functioning.

The present study was designed to tease apart the effects of prematurity, illness and hospitalization on the relationship between state and prandial condition. Preterm infants are immature, are more subject to infection and other illnesses than full-terms and experience the hospital environment for longer than the healthy full-term. Some full-term infants are born with infections or other illnesses which keep them in hospital nurseries for longer than normal. There are also times when full-term healthy infants spend a longer than usual time in hospital nurseries due to maternal illness. All these groups of infants might be expected to have state patterns that relate to prandial condition in ways that are unlike the healthy full-term infant, who goes home with his or her parents a few days after birth. These differences were addressed in the present study.

METHOD

Subjects. Subjects for this study consisted of four groups of newborn infants (who were part of a larger longitudinal study) varying in length of gestation, health, and length of stay in the hospital. There were 17 preterm infants (PT), 14 full-term sick infants who spent time in the intensive care nursery (FT/ICN), 11 full-term healthy infants who spent more than the usual three days in the normal newborn nursery due to maternal illness (FT/M), and 12 full-term healthy infants who formed the control group (FT/C). Preterm infants ranged from 29 to 36 weeks gestational age at birth while full-term infants ranged from 38 to 42 weeks gestational age at birth. A more detailed summary of subject characteristics for each group including mean gestational age at birth, the sex distribution of each group, mean number of days spent in the hospital, mean birth weights, and mean Parmelee Postnatal Complications Scores is presented in Table 2. One- and five-minute Apgar scores were seven or above for all subjects and all infants had birthweights that were average for gestational age. All subjects were born to intact families of middle to upper socioeconomic status. Maternal ages ranges from 20 to 35.

Procedure. Continuous state observations were routinely attempted on each infant in three, three-hour blocks of time per week for the duration of time spent in the hos-

TABLE 2

Subject Characteristics

Group	N	Mean Length of Gestation (Weeks)	Mean Length of Hospitalization (Days)	Mean Parmelee Postnatal Complications	Mean Birthweights (Grams)
PT	17 8 Female 9 Male	33.6 (2.3)*	24 (20.2)	84 (21.3)	2189 (657.2)
FT/ICN	14 7 Female 7 Male	40.5 (1.5)	12 (6.6)	81 (14.0)	3346 (654.5)
FT/M	11 2 Female 9 Male	40.3 (1.0)	7 (2.0)	150 (22.7)	3697 (447.2)
FT/C	12 6 Female 6 Male	40.3 (0.7)	3 (1.2)	155 (16.2)	3364 (279.6)

* Standard deviations are reported in parentheses.

pital. Nine hours of continuous observation time was not obtained in all cases, however, due to interruptions for caretaking or parental visits. A trained observer (observer reliability = 90%) continuously recorded the infant's predominant state in ten second intervals using the following state categories (Holmes, et al., 1980):

Quiet sleep. The infant's eyes are closed and still. There is little or no motor activity (i.e., no more than a startle, or a slight movement of one limb).

Active sleep without REM. The infant's eyes are closed and still, but motor activity is present.

REM sleep. The infant's eyes are closed (although they may open briefly), and rapid eye movements occur during the ten second epoch. Motor activity may or may not be present.

Drowsy REM. The infant's eyes are partially open for a major part of the epoch; however, rapid eye movements are also present. Motor activity may or may not be present.

Drowsy. The infant's eyes may be partially open or fully open but dazed in appearance. Motor activity may or may not be present.

Alert inactivity. The infant's eyes are wide open, focused, bright, and shining (Wolff, 1966). Motor activity is usually absent, but may be present if it is involved with the infant's looking behavior (e.g., infant slowly moves hand across field of view while following with eyes).

<u>Alert activity</u>. The infant's eyes are wide open and motor activity is present.

<u>Fussing</u>. The infant's eyes may be open or closed, and motor activity is usually present. Mild, agitated vocalization (with up to one cry burst) is present.

<u>Crying</u>. The infant's eyes may be open or closed, and intense motor activity is presents Two or more cry bursts occur during the epoch.

All observations took place in the respective nurseries housing the infants. The times at which observations took place varied so that all times of the day and night were represented in the observations.

For the present study all recorded state observations for each of the infants were utilized. Since the observer always noted the time, type and amount of feeding on the state records it was possible to extract fifteen minute periods of state observations immediately before each infant was fed, immediately after feeding and half-way between feedings. Table 3 provides a summary of 15 minute observations obtained for the various groups of infants. Since, on the average, the preterm and full-term sick infants spent more time in the hospital before going home, more observa-

TABLE 3

Mean Number of 15 Minute Observations For Each Group

Group	Before Feeding	After Feeding	Between Feedings
PT	4.1	4.1	4.6
FT/ICN	1.9	2.2	2.2
FT/M	1.5	1.5	2.1
FT/C	1.6	2.1	2.0

tions were obtained for them. Records for each infant were examined so that one or more pre-feed, post-feed and inter-feed 15 minute intervals were obtained. These 15 minute intervals were then studied to extract information about state in relation to prandial condition.

Each 15 minute record of state consisted of 90 ten second intervals. The number of ten second intervals spent in each of the nine states was computed for each observation. Since a different number of records was available for each infant, (due to the different amounts of time spent in the hospital and to interruptions in observations) the number of intervals spent in each state was averaged across observations for each prandial condition. This provided a state profile representing the entire hospitilization period for each infant. For purposes of statistical analysis four state categories were used. Quiet sleep, active sleep without REM, and REM sleep were all included in the category Sleep. Drowsy REM and drowsy were included in the category Drowsy. Alert inactivity and alert activity were included in the category Alert. Finally fussing and crying were subsumed under the heading Crying.

Statistical analyses. It was hypothesized that there would be group differences in the number of intervals spent in each of the four general state categories for each prandial condition. It was also hypothesized that state would vary across prandial conditions; i.e. that the amount of time spent in each state would differ depending on when the infant was last fed. Therefore, two factor analyses of variance (four groups by three prandial conditions) with repeated measures on one factor (prandial condition) were planned using percent of observation time spent in each of the four general state categories as the dependent measure.

After collecting the data it became doubtful that the assumption of homogeneity of variance across prandial conditions could be met. Hartley F_{max} tests were performed for each state category to determine if the assumption of homogeneity of variance across prandial conditions should be rejected. In each case the critical F value for the .05 level test was exceeded. Therefore, the hypothesis of homogeneity of variance across prandial conditions was rejected.

One way between groups analyses of variance were then performed to assess group differences in the percentage of observation time spent in a given state. Separate analyses were performed for each of the three prandial conditions. Planned comparisons were then performed to determine whether state differences were due to maturity, illness, or length of hospitalization. For example after assessing group differences in the percentage of time spent in an alert state after feeding the following comparisons were made. In order to determine if differences were due to maturity the preterm group (PT) was compared to the full-term groups (FT/ICN, FT/M and FT/C). To look at differences due to illness the two sick groups (PT and FT/ICN) were compared to the two healthy groups (FT/M and FT/C). Finally, to see if differences were due to length of hospitalization the full-term control group (FT/C) was compared to the three hospitalized groups (PT, FT/ICN and FT/M).

RESULTS

Results of this study are presented in Figures 1 through 5. The mean percentage of total observation time spent in each state is presented as a function of prandial condition for each of the four groups in Figures 1 through 4. The mean number of state changes taking place during a 15 minute observation period is presented as a function of prandial condition for each of the four groups in Figure 5.

One way analyses of variance (groups) revealed significant group differences for percentage of observation time spent crying before feeding ($\underline{F}(3,48)=2.704$, $p<.05$) and halfway between feedings ($\underline{F}(3,47)=2.532$, $p<.05$). These differences are illustrated in Figure 1. Note that for the before feeding condition the three full-term groups spend more time crying than the preterm group. Planned comparisons revealed that this difference is significant ($\underline{F}(1,48)=5.375$, $p<.05$). These results suggest that the before feeding differences in crying may be accounted for by length of gestation. Preterm infants, who are physiologically immature at birth cry less in response to hunger than their full-term counterparts. For the between feedings condition a different pattern emerges, with the two high-risk groups crying less than the two healthy groups This difference was found to be significant using planned comparisons ($\underline{F}(1,47)=5.859$, $p<.05$). ANOVA tables for

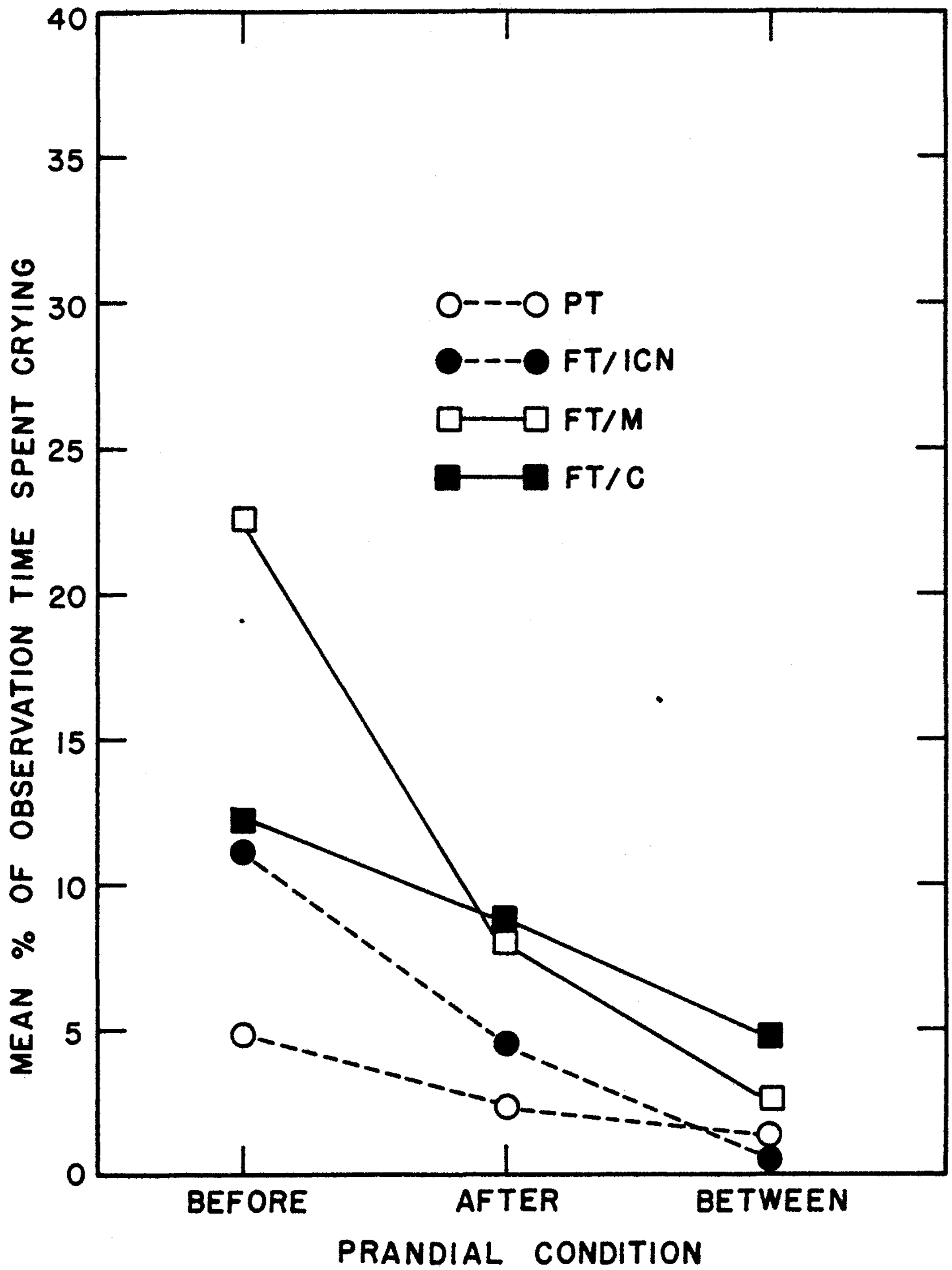

Figure 1. Mean percentage of observation time spent crying as a function of group and prandial condition.

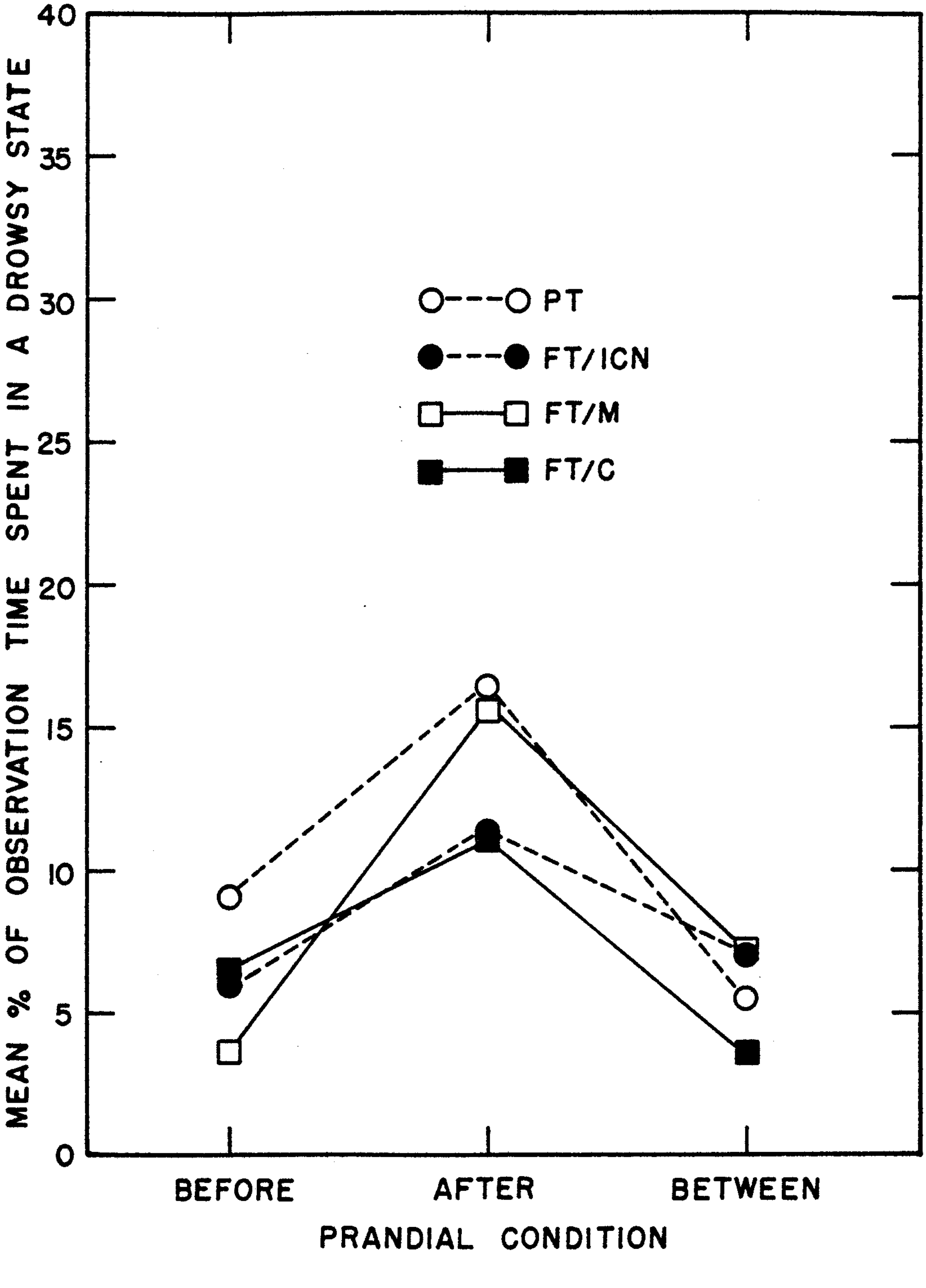

Figure 2. Mean percentage of observation time spent in a drowsy state as a function of group and prandial condition.

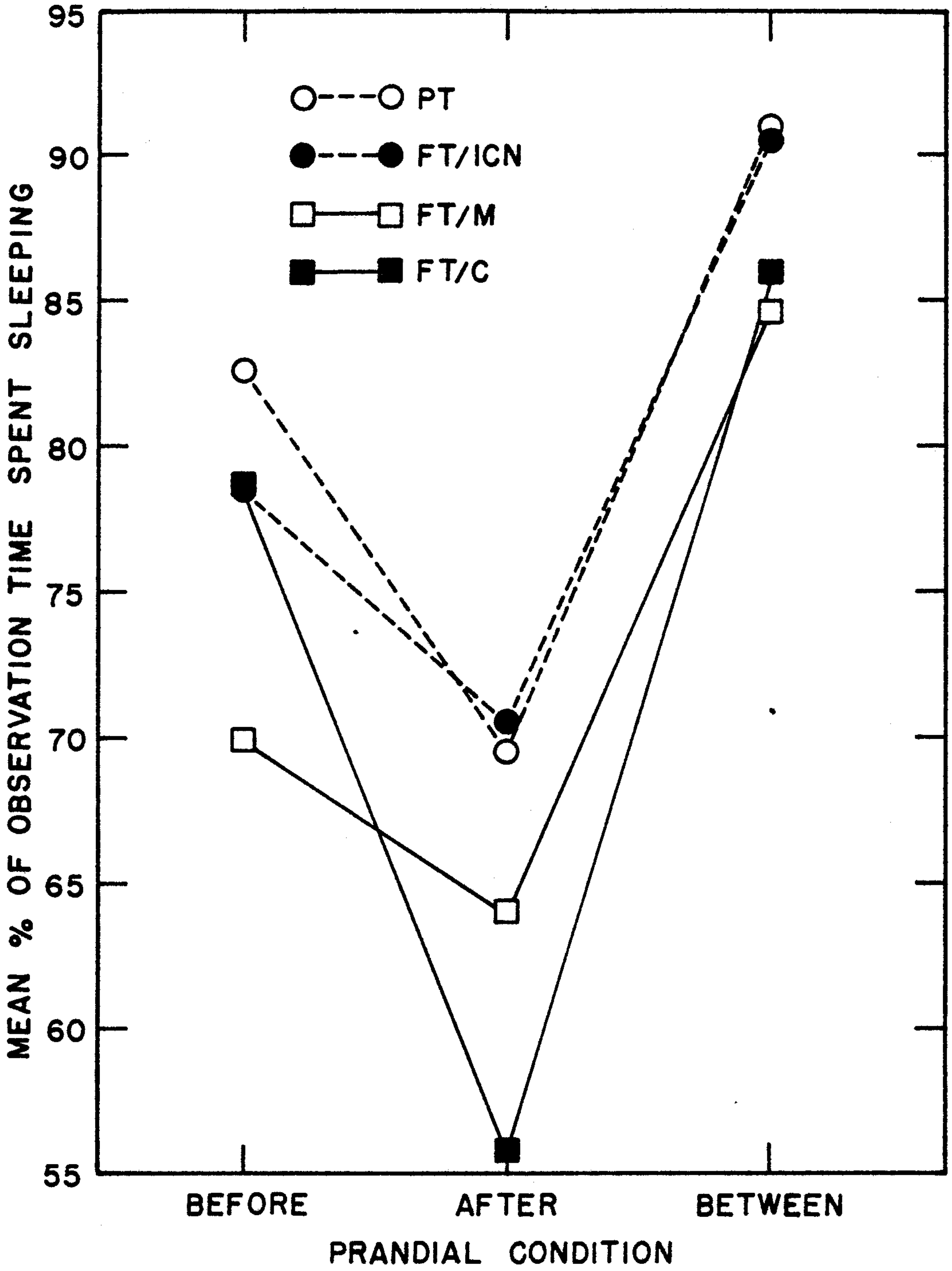

Figure 3. Mean percentage of observation time spent sleeping as a function of group and prandial condition

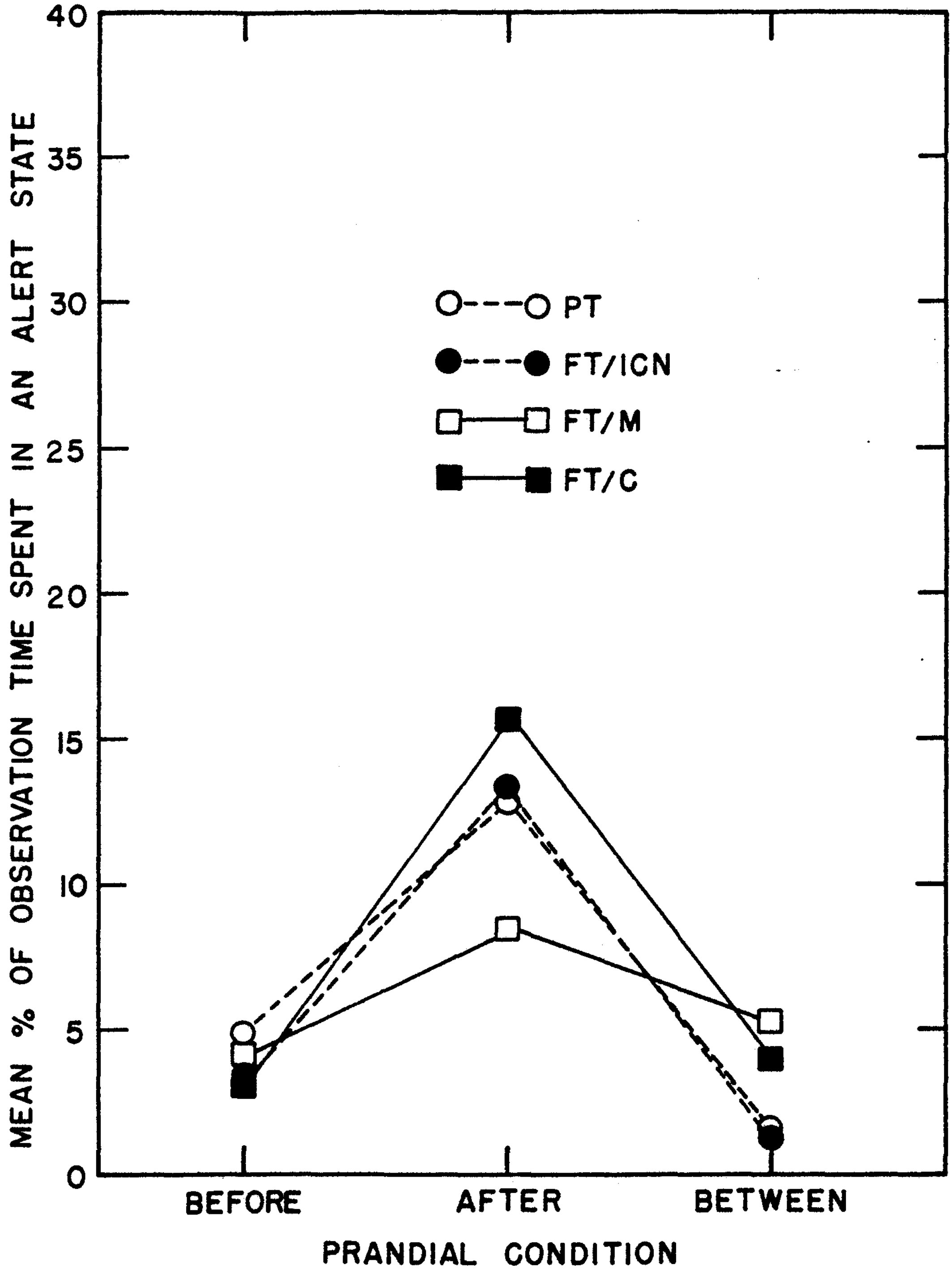

Figure 4. Mean percentage of observation time spent in an alert state as a function of group and prandial condition.

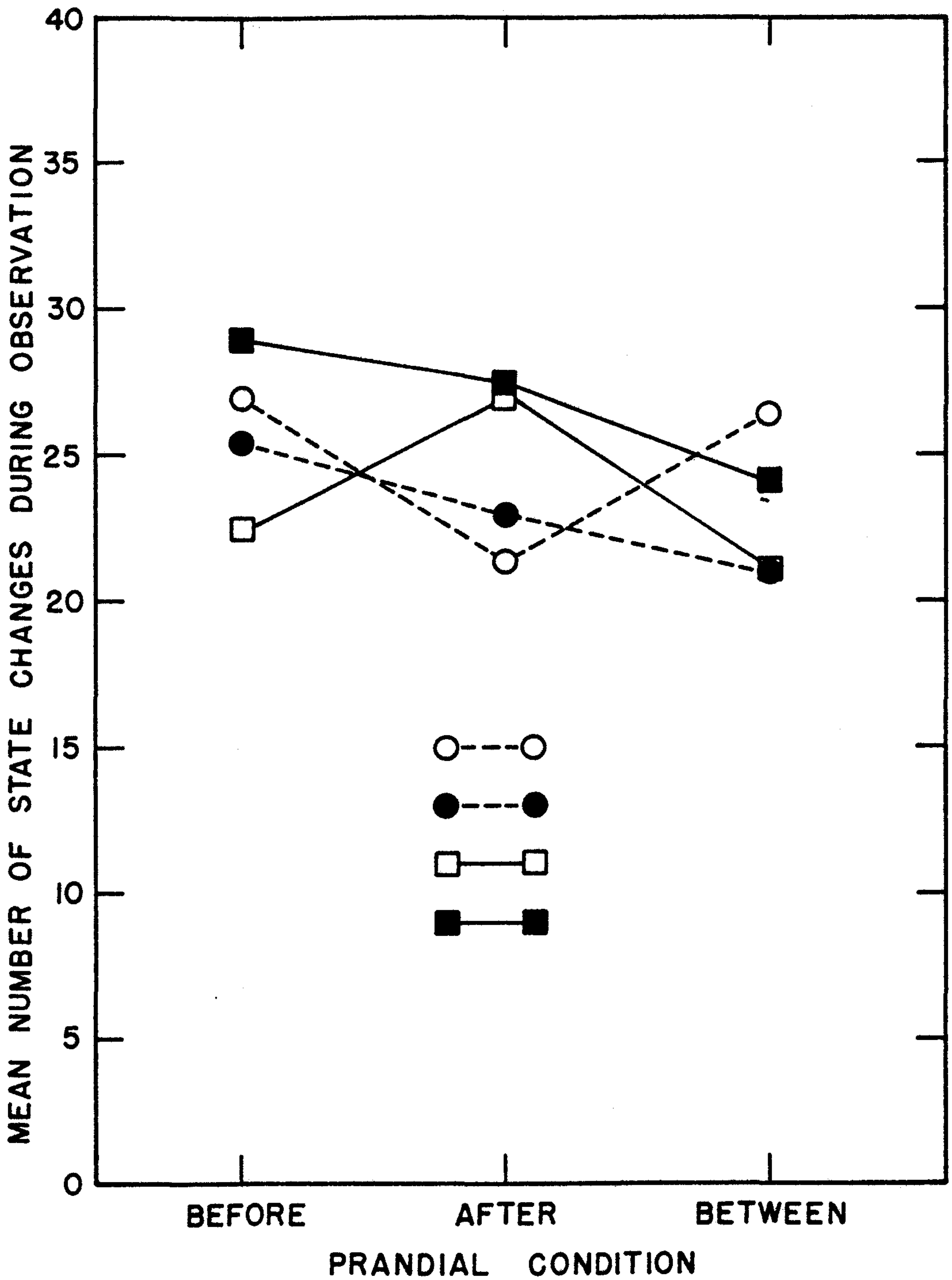

Figure 5. Mean number of state changes during observation as a function of group and prandial condition.

the above results are provided in Table 4.

Although prandial condition differences were not assessed statistically for reasons discussed earlier the data suggest that full-term infants spend the most time crying just before they are fed. Crying decreases after feeding and half-way between feedings it decreases even more. Preterm infants, in contrast, exhibit very small differences in amount of time spent crying across prandial conditions, although the trend to cry less after feeding than before feeding appears to be the same as that for the full-term infants.

Group differences for states other than crying (sleeping, drowsy and alert states) were not significant for any of the prandial conditions. If one looks across prandial conditions, however, it is noted that there is a trend for all groups to vary for each of these states. For the drowsy state (Figure 2), there is an increase immediately after feeding with little difference before feeding or between feedings. For the sleeping state (Figure 3), infants spend the least time sleeping after being fed, more time sleeping before being fed, and the most time sleeping between feedings. The alert state (Figure 4) is observed the greatest percentage of time after feeding and is less prevalent before and between feedings.

Figure 5 indicates the mean number of state changes taking place in each group for each prandial condition. No significant group differences were found. If one ignores the

TABLE 4

ANOVA Tables For Crying State

Before Feed ANOVA's

Source	SS	df	MS	F
Between Groups	1530.091	3	510.030	*2.704
PT vs. FT	1014.178	1	1014.178	*5.375
Within Groups	9057.558	48	188.699	

Between Feed ANOVA's

Source	SS	df	MS	F
Between Groups	104.104	3	34.701	*2.532
High-risk vs. Healthy	80.284	1	80.284	*5.859
Within Groups	644.016	47		

*$p < .05$

full-term/sick mother group (FT/M) there seems to be a slight trend for number of state changes to increase before feeding.

DISCUSSION

The purpose of this study was to assess prandial condition differences in state in newborn infants as well as to determine whether or not factors of length of gestation, health and hospitalization would impact on prandial condition differences. The fact that the assumption of homogeneity of variance across prandial conditions could not be met made state differences as a function of prandial condition difficult to interpret using standard statistical methods, even though the data presented in Figures 1 through 4 seem to indicate real differences. The fact that the within group variability differed greatly across prandial conditions is an interesting phenomenon in itself. The greatest amount of within group variability always occurs before or after feeding. Within group variability is usually smallest half-way between feedings. Within group mean square error terms for each state category and for each prandial condition are presented in Table 5 in order to better illustrate this phenomenon. One interpretation of this difference in variability is that individual differences between infants are more likely to emerge in the time surrounding feeding. Infants may be more likely to respond differently to hunger or to a full stomach when there is a greater amount of physiological imbalance than when they are neither hungry nor satiated, and

TABLE 5

Within Group Mean Square Error Terms Used For ANOVA's at Each Prandial Condition and Each State Variable

	Prandial Condition		
State	Before Feeding	After Feeding	Between Feedings
Crying	188.699	79.152	13.702
Sleeping	363.875	481.778	175.556
Drowsy	75.616	139.334	60.744
Alert	27.900	132.269	42.945

have usually been sleeping for at least one hour. For example, full-term or preterm, healthy or sick infants are all usually sleeping half-way between feedings. Just before feeding full-term infants are more likely to wake up and start crying than are preterm infants who may be too weak to cry. Also among full-term infants there will be some who cry a great deal when they wake up, others who cry for very brief intervals and some who do not cry at all.

In some respects it is surprising that previous studies in which prandial condition state differences were assessed did not report any differences in variability as a function of prandial condition. However, in these studies it is usually the case that state variables are measured just prior to feeding and immediately after feeding (Irwin, 1930, 1932; Hendry & Kessen, 1964; Feldman & Brody, 1978; Harper et al., 1977; Korner, 1970, 1972; Korner, Chuck & Dontchos, 1968; Wolff, 1965, 1966), times during which even in the present study the variability seems homogeneous. The problem of lack of homogeneity of variance across prandial conditions may only arise when the interval half-way between feedings is observed.

If one disregards the problem of lack of homogeneity of variance across prandial conditions it is possible to make some interesting interpretations of the data illustrated on Figures 1 through 4. Except for the state of sleeping, these data agree with those of other researchers who have studied the effects of feeding on state in the full-term infant (Feldman & Brody, 1978; Harper, et al., 1976; Korner, 1970, 1972; Wolff, 1965, 1966). Before feeding there is an increase in crying for all groups of infants, the smallest increase being exhibited by the preterm infants whose crying function is flatter than the other groups. Crying decreases after feeding and decreases more half-way between feedings.

The alert state increases after feeding, a result which agrees with Wolff's (1966) study in which he found lack of hunger to be a necessary condition of alertness. Korner's (1970) interpretation, that this may only be true after the first three postnatal days does not explain the results of the present study, since the full-term control infants were all observed during the first three days of life and the effect shown in Figure 4 is most robust for these infants. It may be the case that as long as infants are given a period to recover from the birth process, the alert state is more prevalent after the infant has been fed. In the present study all observations took place at least 24 hours after the birth of the infant.

The sleeping data, presented in Figure 3, do not agree with previous findings (Feldman & Brody, 1978; Harper, et al., 1976; Korner, 1972). Previous findings indicate that sleeping should increase after feeding. The present data show that sleeping is least prevalent immediately after feeding when compared to the percentage of time spent sleeping immediately before feeding. It is possible that one's results depend on how long after feeding state is assessed as even the present findings show that sleep is most prevalent half-way between feedings. In the 15 minute interval immediately after feeding it makes sense that infants would not be sleeping since this is the time when the greatest percentage of alert time is observed. Former studies may have observed state for longer periods of time after feeding. This would account for differences found in the present study. Another interpretation of the discrepancy found in the present study is that it may be caused by the fact that infants were on a strict feeding schedule. Often they had to be awakened from sleeping states because it was time for feeding. Feeding was not typically on a demand schedule. If it had been, perhaps we would have seen great decreases in sleep time before feeding.

In assessing group differences in state for each of the four general state categories (crying, alert, drowsy and sleep states) at each prandial condition, only differences in the percentage of observation time spent crying before feeding and between feedings was significant. As indicated in Figure 1, the preterm group of infants spent the least amount of time crying in the fifteen minutes prior to feeding. Planned comparisons indicated that the significant group differences for crying before feeding were related to maturity since the preterm infants differed significantly from the other three groups. The group differences in crying half-way between feedings seem to be related to illness since the two high-risk groups (PT and FT/ICN) were shown to differ significantly from the healthy groups (FT/M and FT/C). The ways in which groups differed before feeding and between feedings indicate that although both prematurity and illness both affect the amount of time infants spend crying, they do so in different ways. Illness may depress crying until the infant experiences an urgent physiological stimulus such as hunger. In most cases, the full-term sick infant has mature lungs and is physically capable of crying given an urgent physiological need. The preterm infant, on the other hand, has immature lungs and is not always capable of crying, especially for long intervals of time.

The fact that preterm infants do not cry as much as full-term infants is consistent with the Dreyfus-Brisac (1974) study which found that the preterm infant is not awakened by hunger. This is an important finding in terms of its implications for the infant's relationship with his/her mother or primary caretaker. Since the preterm infant does not cry or cries very little when hungry, it may be difficult for the mother to know when to respond to the infant's need for nourishment. The mother either has to learn to respond to much more subtle cues than crying in the infant's behavior or has to respond to a external cue such as a clock in order to know when to take care of the physiological needs of her infant. In either case, the care of a preterm infant may be much more frustrating to the mother than the care of a full-term infant who, according to previous studies (Korner, 1974; Moss & Robson, 1968), initiates 80 percent of all interactions with his/her caretaker by crying or fussing.

Researchers have been trying for years to determine what early variables in infants are related to later outcome. The present study has shown that the behavioral states displayed by the newborn infant differ for groups of high-risk and health infants as a function of prandial condition. These differences may have important implications for the infant's development in that they may be found to be related to measures of later functioning in which case they could lead to early intervention to increase the likelihood of optimal development. The infants in this study will continue to be followed until they are at least three years of age. It will be interesting to learn how these infants' early state characteristics impact on later development.

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APPROVAL SHEET

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The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Arts.

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