Neonatal State Profiles: Reliability and Short-Term Prediction of Neurobehavioral Status

John Colombo, Madelyn Moss, and Frances Degen Horowitz

University of Kansas

Colombo, John; Moss, Madelyn; and Horowitz, Frances Degen. *Neonatal State Profiles: Reliability and Short-Term Prediction of Neurobehavioral Status.* Child Development, 1989, **60**, 1102–1110. Observations were made on 40 newborns prior to hospital discharge in which states were scored every 10 sec in two 35–70-min periods separated by 6–48 hours. Newborns' states, particularly sleep states and crying, were fairly reliable across observation sessions. Cluster analyses identified 3 separable state profiles that subsequently differentiated infants on the Neonatal Behavioral Assessment Scale with Kansas Supplements (NBAS-K) at 2 weeks of age. Additionally, state observations and NBAS-K exams showed significant agreement on individual differences in neurologically based measures, such as startles, tremulousness, and lability of state.

Behavioral state during infancy has long been regarded as an obstacle to inquiry about psychological processes occurring early in life (Korner, 1972). A few investigators, however, have stressed the importance of early state organization as a variable in its own right that can have considerable influence in the determination of later developmental status (Korner, 1972; Prechtl, 1974; Thoman, 1975; Wolff, 1966).

There are at least two ways in which early state behavior or state organization can work to determine subsequent development (Colombo & Horowitz, 1987). First, as a fundamental behavioral reflection of the infant's internal status, state may serve to indicate the degree of integrity of the CNS. For example, behavioral states appear to be better defined in full-term infants than in preterm infants with estimated gestational ages (EGA) under 36 weeks (Aylward, 1981). Further, the instability of state profiles assessed under conditions in which the neonate is undisturbed has been shown to predict subsequent morbidity and mortality in both low-risk (Thoman, Denenberg, Sievel, Zeidner, & Becker, 1981) and high-risk (Tynan, 1986) populations. Second, as a behavioral trait to be dealt with by caretakers in everyday life, state may also serve to modulate early stimulation patterns (Colombo & Horowitz, 1987; Korner, 1972). As an example of this second mechanism, infants whose state organization involved more extended or more frequent periods of waking activity or alertness would obviously have more opportunity to engage in social interaction with their caretakers.

While a link has been made between profiles of undisturbed states during the neonatal period and subsequent medical problems and developmental delays (Thoman et al., 1981; Tynan, 1986), the relation between early state organization and more subtle measures of neurobehavioral or cognitive status is less well documented. Some weak relations have been reported between elicited state measures from the Neonatal Behavioral Assessment Scale (NBAS) and subsequent performance on the Bayley Scale (Caldera, Schwartz, & Horowitz, 1985; Sostek & Anders, 1977; Vaughn, Taraldson, Crichton, & Egeland, 1980). Furthermore, Moss, Colombo, Mitchell, and Horowitz (1988) have recently reported two studies in which newborns scoring high on the NBAS with Kansas Supplements (NBAS-K) Range of State clus-

J. C. and M. M. share primary authorship on this paper. This work was partially supported by grant HD018295 and a grant from the University of Kansas Mental Retardation Research Center. The authors are grateful to the staff of Lawrence Memorial Hospital nursery (especially Ruth Mitchell and Sylvia Black) for their assistance and consistent good nature. We also thank Diana Anderson-Goetz, Jeff Coldren, Marion O'Brien, and Jay D. Atwater for assistance during various phases of this research. Finally, we are grateful for the cooperation and generosity of the parents of infants who participated in this study. Address correspondence and reprint requests to either J. C. or M. M., Department of Human Development, University of Kansas, Lawrence, KS 66045.

[*Child Development*, 1989, **60**, 1102–1110. 0009-3920/89/6005-0003$01.00]

ter were shown to also perform better on a visual discrimination task at 3 months of age. While these findings are encouraging, the magnitude of the correlations tends to be modest, perhaps as a function of the perfunctory nature of the state observations made during that examination, or perhaps due to the elicited nature of states assessed on the NBAS. Although more extended undisturbed state observations such as those used by Thoman and her associates (Thoman, 1975; Thoman et al., 1981; Thoman, Korner, & Kraemer, 1976; Thoman & Tynan, 1979; Tynan, 1986) would seem to provide a more comprehensive representation of infant state patterns, no studies have employed such extended observations in conjunction with measures of subsequent behavioral status.

The present study was designed to address three issues concerning our present knowledge about neonatal state organization. First, the study sought to provide additional information on the validity of individual differences in neonatal state profiles by assessing the test-retest reliability of infant state characteristics. Using intraclass correlations for a measure of test-retest consistency, Thoman et al. (1976) report significant reliability for deep sleep and amount of crying across two undisturbed 1-hour observations, and for some aspects of "irregular" or "active" sleep for that portion of their sample that provided ample sleep data. However, the time intervals between observations reported by Thoman et al. (1976) were only 3 to 4 hours. It is possible that such brief test-retest intervals could work to either inflate or reduce the estimate of reliability. Additionally, the use of intraclass correlations as a measure of test-retest reliability is extremely conservative. In any case, we thought it would be advantageous to provide additional data on the reliability of these individual differences across a longer test-retest period.

Second, we sought to determine whether particular infants could be classified on the basis of their state behavior. If individual states showed reasonable test-retest reliability, is it possible that some *combinations* (i.e., "profiles") of states might be useful for classification.

Finally, in this study, we tried to determine whether these state parameters or profiles were related to concurrent or future measures of neurobehavioral status. This was done by examining the relation of those profiles to infants' performance on the Neonatal Behavioral Assessment Scale with Kansas Supplements (NBAS-K) at three points during the first 2 weeks of life.

Method

Subjects

State profiles were collected on 40 newborns before hospital discharge. On 37 of these infants, two such observations were collected. These infants comprised a small subsample of a large longitudinal study;[1] health and demographic data on this heterogeneous subsample are presented in Table 1. As Table 1 indicates, the sample included both term (EGA $>$ 36 weeks; N = 34) and preterm (EGA $<$ 37 weeks; N = 6) infants. However, we adjusted for prematurity on all assessments administered to these infants. During the newborn period, state observations and two NBAS-Ks were done at least at 36 weeks conceptional age (CA), and subsequent NBAS-Ks on which we report here were conducted at 42 weeks CA.

Procedure

State observations.—In each of two sessions, an observer scored the newborn's predominant state during 10-sec epochs while the infant lay in a bassinet. As mentioned above, we adjusted for the heterogeneity in our sample with regard to gestational age (range 28–42 weeks; see Table 1) by conducting these two observations when infants' mean CA was 39.3 and 39.5 weeks, respectively (range 36–40 weeks). We conducted observations when infants were 37 weeks CA or above, except for three observations that were done at 36 weeks CA because the infant was to be discharged from the hospital.

Observations were scheduled midway between scheduled 3–4-hour feedings (on average, they occurred 80.7 min following the last feed), but some variability occurred with this procedure (the SD for time since feeding was 61.5 min) due to feeding on demand, or a failure to nurse well at the scheduled feed.

[1] Infants were enrolled in the Kansas Infant Development Project, a large ($N > 300$) longitudinal study of the interactions between infants' initial risk status, perceptual-cognitive abilities, and environment in the prediction of intellectual and developmental status (e.g., Horowitz, 1987). Because these infants comprise a subsample of a larger study, only NBAS-K data relevant to neonatal state observations are presented here. The 40 infants included in the study were those who were born at Lawrence Memorial Hospital and enrolled in the longitudinal project during the time period between January and July 1987.

TABLE 1

DEMOGRAPHIC AND HEALTH CHARACTERISTICS OF THE NEWBORN SAMPLE

Variable	Mean	SD	Range
Gestational age (weeks)	38.4	3.1	28–42
1-min Apgar score	7.5	1.3	3–9
5-min Apgar score	8.7	.6	7–10
Birth weight (grams)	3,131.5	849.3	1,200–4,450
Birth length (cm)	49.5	3.8	36–55
Head circumference (cm)	34.2	2.4	26–38
Number of siblings	.8	1.2	0–5
Maternal age (years)	26.8	5.3	17–38
Maternal education (years) ...	13.8	2.7	10–20
Paternal age (years)	27.8	4.9	19–37
Paternal education	14.2	2.6	10–20

NOTE.—Sample consisted of 21 female and 19 male infants. Thirty were Caucasian, eight black, and two Native American. Thirty-one were nursing, and nine were on formula.

The length of the state observations also varied, ranging from 35 to 70 min in length, with a mean of 54.0 (SD = 8.9; the mode was 60 min). Shorter observation sessions were precipitated by mothers' calling for their infants for feeding or for visiting hours. The sessions were separated by test-retest intervals ranging from 6 to 48 hours, with a mean of 16.4 hours (SD = 11.5). In 75% of the cases, the two observations were made by different observers. The two observers who collected data for this study were trained to a reliability criterion of 95% agreement on the seven states used during the study prior to actual data collection.[2]

The states were adapted from those used on the NBAS (Brazelton, 1973) with the exception that State 1 (deep sleep) was divided into two separate deep sleep states (after Thoman et al., 1976), labeled A and B, which were distinguished primarily by the rate and regularity of respiration. The actual definitions of each of the seven states were as follows:

Deep Sleep A (A).—No movement except mouthing or startles; deep, regular, and slow (40/min) abdominal respirations.

Deep Sleep B (B).—No movement except mouthing or startles; respirations are more irregular and faster (48/min) than Deep Sleep A but still deep and abdominal.

Active Sleep (AS).—Facial and bodily movement during sleep; respirations are costal, shallow, irregular, and fast (60/min). Rapid eye movements may be present or absent.

Drowsiness (D).—Eyes may be open but appear dazed, with slow facial and bodily movement. Respiration is shallow and fast.

Alert Inactivity (AI).—Eyes open and bright, infant quiet and inactive.

Waking Activity (WA).—Generalized motor activity, facial grimacing or grunting, with brief vocalization or cry outburst (one per 10 sec).

Crying (C).—Intense motor activity, continuous crying.

Startles and tremors (see Brazelton, 1973) were also noted during the observation sessions, and these were converted into perminute rates to allow comparison among infants with different observation lengths. Finally, a measure of state "lability" was derived by counting the number of state changes that occurred during the observation and converting this frequency into a perminute rate to again adjust for different observation lengths.

NBAS-K.—The NBAS with Kansas Supplements (Brazelton, 1973; see also, Horowitz, Sullivan, & Linn, 1978) was administered to newborns at two separate points within the first 4 days of life, and again at 42 weeks CA. Examinations were administered by testers trained and certified on the NBAS-K to a 90% criterion of reliability.

[2] The observers from this study were experienced NBAS examiners very familiar with the state classifications used in this study, with perhaps the exception of the division of deep sleep into Deep Sleep A and Deep Sleep B. The distinction between these was facilitated and kept reliable by counting respirations in 10-sec epochs during sleep periods.

TABLE 2

DESCRIPTIVE AND TEST-RETEST STATISTICS FOR STATE OBSERVATION VARIABLES (N = 37)

	MEAN % TIME IN EACH STATE		PEARSON	INTRACLASS	FULL-TERMS ONLY (N = 32): PEARSON
	Obs 1	Obs 2	r	CORRELATION	r
Deep Sleep A	13.92	12.51	.47**	.20	.37*
Deep Sleep B	20.21	18.45	.55**	.28	.62***
Active Sleep	39.08	35.80	.44*	.17	.44*
Drowsiness	5.20	6.24	.40*	.14	.24
Alert Inactive	10.44	8.55	.22	−.02	.04
Waking Activity	4.31	5.66	.06	.03	.07
Crying	6.84	5.31	.76***	.56	.74***
	MEAN FREQUENCY PER MIN				
	Obs 1	Obs 2			
State Changes	1.23	1.25	.49*	.21	.54**
Startles	.07	.05	.98***	.96	.98***
Tremors	.23	.21	.81***	.65	.85***

* $p < .05$.
** $p < .01$.
*** $p < .001$.

Results

Normative Data and Test-Retest Reliability

Table 2 presents the mean percentage of time infants spent in each of the states; preliminary analyses indicated that there were no significant differences between the first and second observations. Table 2 also shows the test-retest reliabilities across the two state observations for each of the seven classifications used; residuals analyses performed on the bivariate distributions indicated that there were no outliers for any of these relations. We have also presented intraclass coefficients in Table 2 to facilitate a direct comparison between these data and those reported in Thoman et al. (1976).

Although there are some small discrepancies in the magnitude of the observed correlations between our data and Thoman et al.'s (1976), our test-retest results closely parallel theirs. From the entire sample of 37 infants, the most reliable states were Deep Sleep A and B (r's of about +.50) and Crying (r = +.75). Zero-order test-retest coefficients for Active Sleep and Drowsiness were also significant, although at somewhat lower magnitudes. The last column of Table 2 shows test-retest correlations for only the 32 full-term infants in the sample, in which the reliability of Drowsiness drops below statistical significance. This reduction of the reliability in drowsiness when preterms are extracted from the sample fits well with Aylward's (1981) report that preterm infants are more likely to show behavioral states that are difficult to classify as either waking or sleeping.

Additionally, measures of tremor rate (r = +.81), startle rate (r = +.98), and state lability (r = +.49) were extremely reliable across the two observations. These results were also unaffected by computing the reliabilities for only full-terms (see Table 2).

State Profile Group Analyses

We next sought to classify individual newborns into groups[3] based on their state profiles. Infants' percent times in each state were averaged across both observations and were entered into a within-subjects average linkage method cluster analysis along with a profile stability measure (see Thoman et al., 1981).[4] This analysis identified three separable groups of infants (see Fig. 1).

[3] Although "cluster" is the more common statistical term to describe such subdivisions of the sample, we use the term "group" here to minimize confusion during subsequent sections in which the word "cluster" is used with reference to the reduction of NBAS-K data (e.g., Lester, 1983).

[4] Thoman et al. (1981) describe the calculation of a stability index for each infant by entering each infant's percent time in each state at each of the two observations into individual observation (in this case, two levels) × state (for the present study, seven levels) ANOVAs. This analysis will yield valid mean squares (MS) for the state main effect and the observation × state interaction. The

The largest of these three groups (N = 24) shows a substantial predominance of sleep states and high stability across observations and can be characterized as the "Sleep" group. Interestingly, all preterm infants were included in this classification. A second group (N = 8) exhibits a stable mixture of various states, with approximately equivalent percentages spent in Active Sleep, Alert Inactivity, and Crying, and may be characterized by an overall predominance of waking states as the "Alert-Crying" group. The last group (State Group 3: N = 5) shows an overall predominance of Active Sleep when profiles are averaged across observations, but may be most accurately characterized by the instability of state profiles across the two neonatal observations as the "Unstable" group.

Relation of State Clusters to NBAS-K Performance

A last set of analyses examined whether infants in these state groups exhibited differences in neurobehavioral status as reflected by the NBAS-K exams administered during the first 4 days of life, and again when the infants were 2 weeks of age.

Data from these exams were reduced into item clusters of "best" orientation, motor maturity, range of state, regulation of state, and autonomic stability as specified by Lester (1983).[5] Additionally, clusters derived from the Kansas modifications to the NBAS (see Horowitz & Linn, 1982; Horowitz et al., 1978) were also calculated. These included an average of modal orientation scores, and an "interactive" cluster composed of the Kansas Supplement items (General Irritability, Examiner Persistence, Quality of Infant Responsiveness, and Reinforcement Value of the Infant) was also calculated. These seven clusters were entered into separate MANCOVAs run for each of the three NBAS-K exams[6] with a between-subject factor of State Group (3). For each analysis, two variables were entered as covariates: estimated gestational age (to control for possible differences between preterm and fullterm infants), and the mean length of the two neonatal state observations (since correlations between mean observation length and states AS, AI, and C approached statistical significance).

MANCOVAS on the first two NBAS-K exams did not reveal significant differences as a function of the newborns' State Group (multivariate F's < 1.0). However, a significant effect for State Group emerged for the 2-week NBAS-K: multivariate $F(14,30) = 2.71$, $p < .02$; Wilks's lambda = 0.19. Univariate analyses indicated that this effect was attributable to differences among the three groups on Modal Orientation, $F(2,22) = 3.67$, $p < .05$, and Regulation of State, $F(2,22) = 3.63$, $p < .05$, clusters. This apparent "lagged" effect was not due to the stability of state-related behavior in a small group of infants retained within each of the samples; the same analyses performed on only those infants included in the last analysis yielded the identical pattern of results on the first two NBAS-Ks.

Those infants from the Sleep group showed significantly higher Regulation of State scores than those infants from either the Awake-Crying group, $t(27) = 2.18$, $p < .05$, or from the Unstable group, $t(10) = 2.84$, $p <$

---

division of MS state by MS observation × state will yield an F ratio that is large when state profiles are similar across observations, and small when profiles are dissimilar. Such an F ratio is appropriate for data from studies such as Thoman et al. (1981), where state is assessed over lengthy periods (7.5 hours), since a predominance of sleep will likely be observed. However, under the substantially shorter observation periods (35–70 min) of this study, such predominance was not always evident. A profile lacking a predominant state will not yield a high state MS within the observation × state ANOVA and thus depress the F ratio measure, despite the fact that a state profile with no predominant state is exhibited by the infant across both observations. We found that the observation × state MS from the ANOVA provided a good ranking of the relative stability of the profiles across the two observations under such conditions, with high stability reflected by a low MS, and low stability reflected by a high MS.

[5] In nearly half of the sample, NBAS decrement items were missing. This is common for a 42-week exam, as these items must be administered when the infant is in a sleep state, and are omitted if the infant is brought to the exam awake, or awakens during the first decrement item. In such cases, the habituation cluster cannot be calculated.

[6] Because not all infants had complete NBAS-K exams at each of the three occasions, separate MANOVAs were run on the data available for each exam. This practice sacrificed the power of the within-subject analysis but did allow analysis of all available data. Sample sizes for the three MANOVAs varied: respective N's for the three examinations were 34, 29, and 26. Missing data for the 42-week NBAS-K were attributable to withdrawal from the study (N = 2), examination not performed within 1 week of the 42-week CA point (N = 2; these were both preterms under 34 weeks EGA, and while their exclusion does not completely exclude preterm infants from the sample, it does bring the EGA range for this final analysis to 34–42 weeks), or excessive fussiness during the exam (N = 7). Subject loss was appropriately proportional across the three state groups.

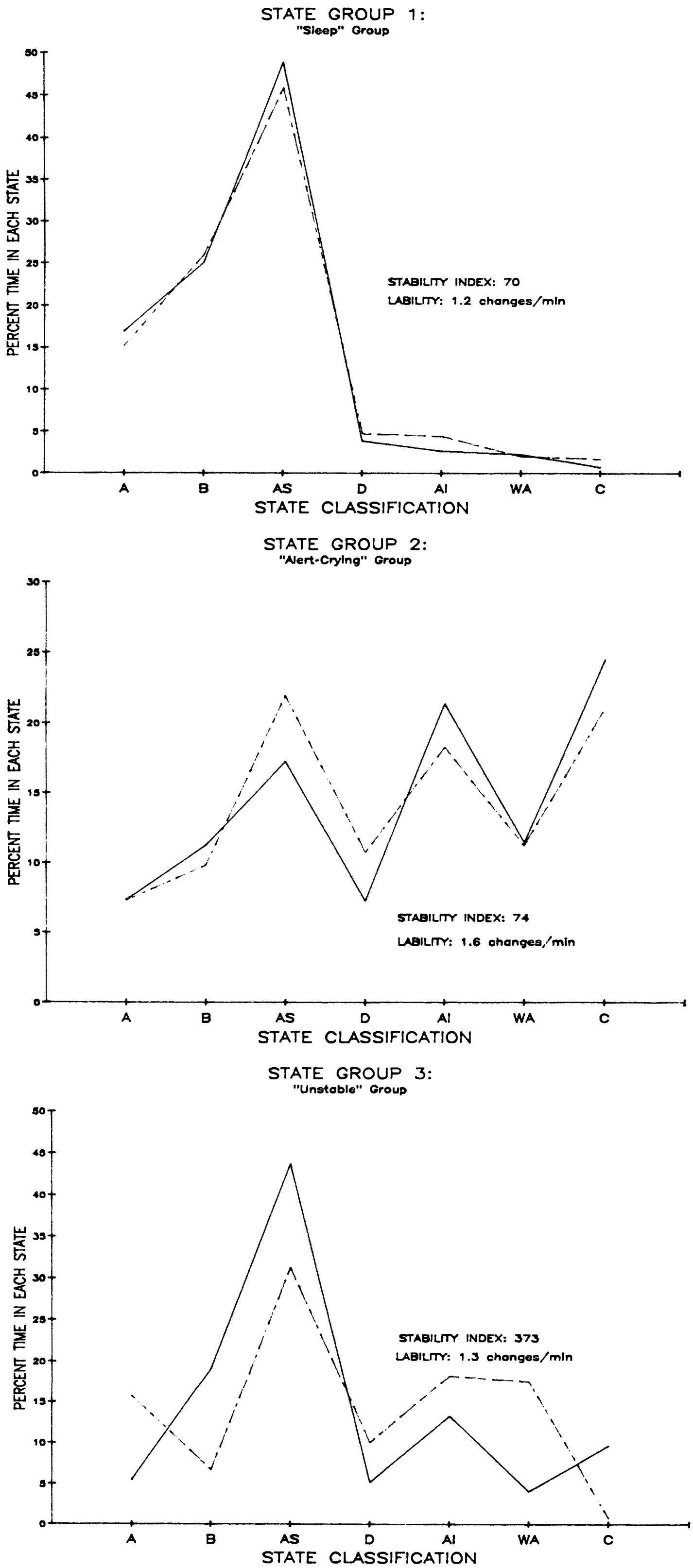

FIG. 1.—Mean state profiles for the three neonatal groups described in the text. Solid lines represent profiles from the first observation, dashed lines represent profiles from the second observation. Sample sizes for the three groups are 24, 8, and 5, respectively.

.025. The respective means for the Regulation of State cluster for the Sleep, Alert-Crying, and Unstable groups were 4.4, 3.3, and 3.3. This result was not attributable to any one of the four individual items that make up this NBAS cluster (Hand-to-Mouth Facility, Self-Quiet, Consolability, and Cuddliness) as individual analyses did not yield any significant differences among the three groups. However, when the two items of Hand-to-Mouth and Cuddliness were entered into a one-way State Group (3) MANOVA, a significant State Group term did emerge, $F(4,56) = 2.53$, $p = .05$, suggesting that these two items together were responsible for the observed difference.

On the Modal Orientation cluster, however, infants from the Alert-Crying group scored higher than those from the Sleep group, $t(20) = 2.61$, $p < .025$. The respective means for the two groups were 6.8 versus 5.2. The mean performance of the small Unstable group on this cluster fell between these two groups ($M = 5.5$) and is statistically indistinguishable from either of them.

Finally, we examined the correspondence between tremors, startles, and state lability observed during the state observations with NBAS-K items assessing similar characteristics: Tremulousness, Startles, and Lability of State (averages for these items were calculated across all three exams). Although correlations between the state observations and any single NBAS-K exam did not attain significance, correlations between state observation variables and NBAS-K items averaged across the three NBAS-Ks yielded statistically significant ($p < .05$) agreement: the startle measures correlated at $r = .45$, the tremor measures correlated at $r = .40$, and state lability correlated at $r = .36$. The first two correlations might perhaps be regarded as unremarkable, as individual rates of startling or tremulousness might be expected to generalize across undisturbed versus examination situations. However, the third correlation is surprising, since it reflects reliable individual differences on state lability across spontaneous (state assessment) versus elicited (NBAS-K) assessments of state.

Discussion

These data indicate that early state profiles are useful characterizations of individual differences in early development and provide further support for the notion that neonatal state holds promise for predictive relationships sought between early infancy and later development (Colombo & Horowitz, 1987; Korner, 1972; Thoman, 1975). In replicating the patterns observed first by Thoman et al. (1976), the present study suggests that individual differences in the distribution of behavioral states culled from observations during the neonatal period are relatively reliable characteristics. Furthermore, newborns could be classified into separable groups on the basis of particular types of state profiles. Two of the groups were discernible from one another on the basis of their distribution of states, with one group showing a stable predominance of sleep and a second exhibiting a stable mixture of both waking and sleep states. A third small group of infants was separable from the other two by the instability of state distributions across the two observations.

Additionally, membership in these three neonatal state groupings predicted differences in neurobehavioral status at 2 weeks of age, as measured by the NBAS-K. The Sleep group scored higher on an NBAS-K Regulation of State cluster than either of the other two state groups, while the Alert-Crying group scored higher than the Sleep group on a cluster of averaged Modal Orientation items. While these findings may simply be taken to reflect some stability of sleep versus alertness characteristics across the first 2 weeks of life, the fact that the state groupings were not associated with concurrent NBAS-K examinations suggests that some other mechanism (or mechanisms) must account for these relations.

One scenario that might plausibly explain the higher 2-week Regulation of State scores in the Sleep group is based on proposals made from studies of spontaneous states (e.g., Prechtl, 1968; Stern, Parmelee, Akiyama, Schultz, & Wenner, 1969) that the attainment of deep sleep states may reflect some aspect of homeostatic control in the infant. During the first few, biologically chaotic, postnatal days, the assessment of such homeostatic control may be better reflected with a relatively longer assessment of spontaneous state activity than in a relatively brief assessment of elicited states (i.e., the NBAS).[7] By the second or third week of life, the infant

[7] Under such conditions, during the first days of life, a measure of adaptive *reactivity* during the NBAS may be more important than would some measure of state control or regulation. This would suggest that, from the earliest days of life, the NBAS *Range* of State cluster might be more relevant to longer range development than would the *Regulation* of State cluster. This, in fact, is the exact finding reported in Moss et al. (1988).

may have recovered from the birth process and may have attained some degree of biological or physiological stability, in which the solidification of state regulation is robust enough to emerge within the framework of the NBAS. In support of this notion, Lancioni, Horowitz, and Sullivan (1983) have found the 2-week examination to be a better predictor of infants' later performance than NBAS-Ks administered during the first few days of life. Thus, for purposes of individual difference studies, the 2-week NBAS-K measure may yield a more useful characterization of the infant.

Incidentally, our finding that the NBAS Cuddliness item was implicated in the differential NBAS-K performance of the Sleep group also nicely parallels Schaffer and Emerson's (1964) report with a much older age group (9–10 months) that infants characterized as being more "cuddly" also slept significantly more than infants who were "noncuddlers."

A more straightforward explanation may account for the lagged relation between the higher Modal Orientation scores observed for the Alert-Crying group. This relation may be mediated by environmental effects during the 2-week interval between the neonatal state observation and the last administration of the NBAS-K. Infants who are awake and crying more during those 2 weeks should also be available for, and elicit more stimulation from, their caretakers over that time. Such increased levels of stimulation could easily be reflected in a higher modal performance on NBAS-K items involving orientation. Such a model of environmental mediation formed the basis for Korner's (1972) call for the study of state variables over a decade ago, and this interactional path has also been specifically hypothesized by Colombo and Horowitz (1987).

The present research is obviously limited by several factors. The sample tested was relatively small and heterogeneous, the parameters surrounding the state observations were not strictly controlled, and, as with all longitudinal work, we encountered some attrition from the sample that began the study. As a result, this work should be regarded as a first step rather than as a definitive study on the interplay between state and early behavioral status. Despite such problems, however, the results are encouraging and support the early contentions of Korner (1972), Prechtl (1974), and Thoman (1975) regarding the importance of state in the developmental equation.

References

Aylward, G. (1981). The developmental course of behavioral states in preterm infants: A decriptive study. *Child Development*, **52**, 564–568.

Brazelton, T. B. (1973). *The Neonatal Behavioral Assessment Scale*. Philadelphia: Lippincott.

Caldera, Y., Schwartz, S., & Horowitz, F. D. (1985, April). *Prediction of later developmental status from repeated neonatal assessments*. Paper presented at the meeting of the Society for Research in Child Development, Toronto, Ontario.

Colombo, J., & Horowitz, F. (1987). Behavioral state as a lead variable in neonatal research. *Merrill-Palmer Quarterly*, **33**, 423–437.

Horowitz, F. D. (1987). *Exploring developmental theories*. Hillsdale, NJ: Erlbaum.

Horowitz, F., & Linn, P. (1982). The Neonatal Behavioral Assessment Scale. In M. Wolraich & D. K. Routh (Eds.), *Advances in developmental pediatrics* (Vol. 3, pp. 233–255). Greenwich, CT: JAI.

Horowitz, F., Sullivan, J., & Linn, P. (1978). Stability and instability in the newborn infant: The quest for elusive threads. In A. J. Sameroff (Ed.), Organization and stability of newborn behavior: A commentary on the Brazelton Neonatal Behavioral Assessment Scale. *Monographs of the Society for Research in Child Development*, **43**(5–6, Serial No. 177).

Korner, A. (1972). State as a variable, as obstacle, and as a mediator of stimulation in infant research. *Merrill-Palmer Quarterly*, **18**, 77–95.

Lancioni, G., Horowitz, F. D., & Sullivan, J. (1983). The NBAS-K. I: A study of its stability and structure over the first month of life. *Infant Behavior and Development*, **3**, 341–359.

Lester, B. (1983). Change and stability in neonatal behavior. In T. Brazelton & B. Lester (Eds.), *New approaches to developmental screening of infants* (pp. 51–75). New York: Elsevier.

Moss, M., Colombo, J., Mitchell, D. W., & Horowitz, F. D. (1988). Neonatal behavioral organization and visual discrimination at 3 months of age. *Child Development*, **59**, 1211–1220.

Prechtl, H. (1968). Polygraphic studies of the full-term newborn: II. Computer analysis of recorded data. In R. MacKeith & M. Bax (Eds.), *Studies in infancy* (pp. 22–40). London: Spastics International Publications.

Prechtl, H. (1974). The behavioral states of the newborn (a review). *Brain Research*, **76**, 185–212.

Schaffer, H., & Emerson, P. (1964). The development of social attachments in infancy. *Monographs of the Society for Research in Child Development*, **29**(3, Serial No. 94).

Sostek, A., & Anders, J. (1977). Relationships among the Brazelton neonatal scale, Bayley infant scales, and early temperament. *Child Development,* **48**, 320–323.

Stern, E., Parmelee, A., Akiyama, Y., Schultz, M., & Wenner, W. (1969). Sleep cycle characteristics in infants. *Pediatrics,* **43**, 65–70.

Thoman, E. (1975). Sleep and wake behaviors in neonates: Consistencies and consequences. *Merrill-Palmer Quarterly,* **21**, 295–314.

Thoman, E., Denenberg, V., Sievel, J., Zeidner, L., & Becker, P. (1981). State organization in neonates: Developmental inconsistency indicates risk for developmental dysfunction. *Neuropediatrics,* **12**, 45–54.

Thoman, E., Korner, A., & Kraemer, H. (1976). Individual consistency in behavioral states in neonates. *Developmental Psychobiology,* **9**, 271–283.

Thoman, E., & Tynan, W. (1979). Sleep states and wakefulness in human infants: Profiles from motility monitoring. *Physiology and Behavior,* **23**, 519–523.

Tynan, W. (1986). Behavioral stability predicts morbidity and mortality in infants from a neonatal intensive care unit. *Infant Behavior and Development,* **9**, 71–79.

Vaughn, B., Taraldson, B., Crichton, L., & Egeland, B. (1980). Relationships between neonatal behavioral organization and infant behavior during the first year of life. *Infant Behavior and Development,* **3**, 47–66.

Wolff, P. (1966). The causes, controls, and organization of behavior in the neonate. *Psychological Issues,* **5** (Whole No. 17).