

## *A Critique of the Neonatal Neurologic and Adaptive Capacity Score (NACS)*

AMIEL-TISON AND COLLEAGUES<sup>1,2</sup> claim to have developed "a test of neonatal neurobehavioral performance that is quick, easy to perform and score, with high interobserver reliability," with the goal of utilizing it to "differentiate between the infant who has drug-induced depression and one whose depression results from asphyxia, birth trauma, or neurologic disease." Central to the evaluation of this claim is the validity of the examination itself, or to put it another way, the implied definition of the neonate embedded in the examination along with an evaluation of the research designed to test the adequacy of the examination. I will focus this review on the question, "What is a neonate?", but I must first comment on the adequacy of the research.

Evaluation of an examination's validity relies on demonstrating relationships between it and other variables of concern, *e.g.*, a relationship between the Neurologic and Adaptive Capacity Score (NACS) and obstetric medication. Such an evaluation typically involves choosing appropriate variables and appropriate analyses. In this study relationships are demonstrated between the NACS and the Early Neonatal Neurobehavioral Scale (ENNS), and infants' scores and time, which were "significantly lower at 2 hours than at 24 hours." The NACS-ENNS relationship is not surprising, as the authors note, since NACS borrows from the ENNS, while the relationship of performance to age is an indicator that the examination can detect the expected improvement in performance with age. These two relationships provide the only evidence that the examination has some validity, and they are not especially strong ones.

I must also point out that the analysis of the data by these researchers is not sufficient to their purposes. Their statistical approach is to take the percentage of infants who score above 35 in each of their drug/control groups. I presume they do this because their data do not have certain parametric qualities and they wish to be conservative. However, they have gone too far. They could have used several techniques, among them certain multivariate techniques, that would have assessed the relative contributions of certain quantitative variables—birthweight, Ponderal Index, oxygenation, acid-base status—to the actual score, 0-40, available on each infant from NACS.<sup>3</sup> Such techniques are much more powerful methods for detecting effects, if only for more fully exploiting the

quantitative information available in the data, and might have better demonstrated the validity, read sensitivity, of the examination. Without such a demonstration, the result indicating a lack of drug effects could be accurate or could just as easily be the result of the lack of sensitivity of the data analysis. And even had a more powerful analysis been done, there is still a third possibility—the insensitivity or inappropriateness of the examination itself. This is my central critique.

This examination fails to adequately conceptualize the capabilities of the neonate and the process of early development, and so it is unlikely to detect the effects of drugs or other variables in neonatal performance. These inadequacies are especially apparent as concerns the infant's state of consciousness, the quality of the infant's alertness and orienting, and the effect of the infant's performance on the caregiving environment and its own development.<sup>4</sup>

As regards the lack of specification of state, almost every behavior, including the reflexes elicited during the NACS, is modified by the states of sleep or states of alertness of the infant at the time of elicitation. Prechtl<sup>5</sup> and others<sup>6</sup> have extensively documented these effects, but it might not be quite as well-known that it wasn't until states were carefully specified in developmental experiments that the newborn's capabilities for specific visual and auditory orienting responses were discovered.<sup>4</sup> To disregard state and make statements such as the examination can "always be completed even if the infant is lethargic, irritable, or almost inconsolable," causes one to react with disbelief. Relatedly, the authors should not equate "no arousability, or extremely poor arousability" with sleep state S<sub>1</sub> or awake state A<sub>1</sub>. Sleep states S<sub>1</sub> and S<sub>2</sub> and awake state A<sub>1</sub> are normal states of physiologic and neurologic organization. They certainly are not abnormal as such, and indeed the quality of their organization and their change over time may be one of the more sensitive indices of neurologic function.<sup>7,8</sup>

The quality of the infant's orienting is not appreciated by the examination. The newborn is capable of detecting and tracking visual objects with coordinated head and eye movement, and visually discriminating one object or even one face from another.<sup>9-11</sup> The newborn can turn its head toward the appropriate location of sounds, search for them with its eyes, and discriminate between sounds, including voices<sup>12,13</sup>; the newborn can smell and taste differences in objects and possibly even feel the difference

between objects<sup>14-16</sup>; the newborn can imitate facial and hand gestures.<sup>17</sup> Certainly one would not expect a "quick and easy-to-perform" screening test to assess all of these capabilities, but given these capabilities, what would one want to conclude from an examination that did not assess them at all.

There is another side to these capabilities as well—their effect on the caregiving environment.<sup>18,19</sup> It is well-documented that the quality of the infant's performance in these areas of functioning has a strong effect on the responsiveness of the caregiver. Newborns who are quiet or sleepy, for example, have mothers who try to alert them through vigorous play, while active and irritable infants have mothers who try to avoid active interactions,<sup>20</sup> and the stimuli, either auditory or visual, presented by mothers to their infants are related to the infants' differential auditory and visual responsiveness.<sup>21</sup> Moreover, it is also documented that these behaviors are related to the infants' birthweight, Ponderal Index, nutritional status, gestational age, and other factors, as well as to maternal obstetric medication, nutritional status, prenatal history, and other factors.<sup>4</sup> Again, if one does not assess the infant along these dimensions, it will not be possible to assess the effects on the environment's response to an infant.

By discussing these points I realize that we are no closer to having a useful clinical instrument, although the dimensions of a valid research instrument may be clarified and even already worked out by Brazelton.<sup>22</sup> However, I do not think the NACS comes close to being such an instrument, yet by its very publication it might become thought of as one. That would be a mistake. From my perspective, it is unlikely that it can be sensitive to the kinds of effects it hopes to detect. Clinically, by systemizing observations and putting them in an overall framework, it may be useful. Certainly to the extent that it is a distillation of Amiel-Tison's experience it must be useful. But as a research tool aimed at detecting the effects of drugs or other variables it is not sufficient. For such an instrument speed of administration is hardly the primary concern (should it be clinically?), but rather its ability to find or not to find effects of the variables of concern on the functioning neonate. Only when we are confident that our research instrument does that can we make recommendations with confidence about what is safe and what is not safe for use with neonates.

EDWARD TRONICK, PH.D.  
*Associate Professor of Developmental Psychology  
University of Massachusetts, Amherst*

and  
*Director, Developmental Pediatrics Program  
Baystate Medical Center  
Springfield, Massachusetts*

### References

1. Amiel-Tison C, Barrier G, Schnider SM, et al: A new neurologic and adaptive capacity scoring system for evaluating obstetric medications in full-term newborns. *ANESTHESIOLOGY* 56:340-350, 1982
2. Stefani SJ, Hughes SC, Schnider SM, et al: Neonatal neurobehavioral effects of inhalation analgesia for vaginal delivery. *ANESTHESIOLOGY* 56:351-355, 1982
3. Hanushek E, Jackson JE: *Statistical Methods for Social Scientists*. New York, Academic Press, 1977
4. Tronick E, Als H, Brazelton TB: Early development of neonatal behavior, *Human Growth*, vol. 3. Edited by Faulkner F, Tanner JM. New York, Plenum, 1979, pp 305-328
5. Precht H, Beintema D: *The Neurological Examination of the Full-term Newborn Infant*. London, Little Club Clinics in Developmental Medicine No. 12, William Heinemann Medical Books, 1964
6. Kleitman N: *Sleep and Wakefulness*, 2nd ed. Chicago, Chicago University Press, 1963
7. Parmelee AH, Michaelis R: *Neurological examination of the newborn, Exceptional Infant*, vol. 2. Edited by Hellmuth J. New York, Bruner/Mazel, 1971, pp 3-23
8. Anders TF, Weinstein P: Sleep and its disorders in infants and children: A review. *Pediatrics* 50:312-324, 1972
9. Brazelton TB, Scholl ML, Robey J: Visual behavior in the neonate. *Pediatrics* 37:284-290, 1966
10. Ball W, Tronick E: Infant response to impending collision: Optical and real. *Science* 171:818-820, 1971
11. Fantz R: The origin of form perception. *Sci Am* 204:66-72, 1961
12. Kearsley RB: The newborn's response to auditory stimulation: A demonstration of orienting and defensive behavior. *Child Dev* 44:582-590, 1973
13. Brazelton TB: *Neonatal Behavioral Assessment Scale Clinics in Developmental Medicine*, No. 50. London, Spastics International Medical Publications, William Heinemann Medical Books, Ltd., 1973b
14. Jensen K: Differential reactions to taste and temperature stimuli. *Genet Psychol Monogr* 12:361-479, 1932
15. MacFarlane JA: Olfaction in the development of social preferences in the human neonate. Edited by Porter, R, O'Connor M. Elsevier, New York, Ciba Foundation Symposium 33, 1975, pp 103-113
16. Engen T, Lipsitt LP, Kaye H: Olfactory responses and adaptation in the human neonate. *J Comp Physiol* 56:73-77, 1963
17. Meltzoff AM, Moore MK: Imitation of facial and manual gestures by human neonates. *Science* 198:75-78, 1977
18. Bell RQ: Stimulus control of parent or caretaker behavior by offspring. *Dev Psychol* 4:63-72, 1971
19. Brazelton TB: Assessment of the infant at risk. *Clin Obstet Gynaecol* 16:361-375, 1973
20. Als H, Lewis M: The contribution of the infant to the interaction with his mother. Denver, Society for Research in Child Development, 1975
21. Osofsky J, Danzger B: Relationships between neonatal characteristics and mother-infant characteristics. *Dev Psychol* 10:124-130, 1974
22. Brazelton TB: *The Neonatal Behavioral Assessment Scale*. London, Spastics International Medical Publications, 1973