THE NEONATAL BEHAVIORAL ASSESSMENT SCALE (NBAS) – BACKGROUND AND CONCEPTUAL BASIS

History
The dominant view for much of the earlier part of the twentieth century was that infants were generally passive recipients of sensory stimulation, responding to environmental input with innate reflexes, as Berry Brazelton points out in the Preface. There was scant evidence that learning could be demonstrated in the first few weeks or even months of life. Newborn assessment tools reflected these assumptions, so that the earlier neonatal scales, which emerged from the field of neurology, focused on the assessment of the so-called ‘primitive reflexes’ and ‘postural reactions’ (e.g. Andre-Thomas and Dargassies 1960, Peiper 1963, Prechtl and Beintema 1968). These scales were designed specifically to assess brain functioning by examining newborn reflexes. In clinical settings, the assessment of neonates was confined to Apgar scores and pediatric examinations of physical competence.

However, a number of advances, especially in the fields of psychology and psychiatry, contributed to a major shift in thinking about newborn behavior and development. Back in the early 1960s, it was still assumed that the newborn could not see at birth or could see shadows at best. And then, Robert Fantz demonstrated that the newborn infant could not only see but also had clear-cut visual preferences (Fantz 1961). In terms of auditory capacities, the prevailing assumption among both researchers and clinicians was that newborns’ fluid-filled ears impaired their hearing for the first few days. However, in 1963 a report appeared in the journal *Science* showing that newborns could orient towards a sound as early as 8 hours of age (Wertheimer 1961). The notion that the baby could indeed see, hear, and respond differentially to positive and negative stimuli stimulated a new body of scientific research on newborn behavior and development.

Influences
While innovative thinkers such as John Bowlby, Erik Erikson, Donald Winnicott and Selma Fraiberg, from the emerging field of infant mental health, studied the mother’s role in the development of early parent–infant relations, a new generation of researchers, among them Jerome Bruner, Peter Wolff, Jerome Kagan, Robert Emde and Arnold Sameroff, stimulated by the work of Jean Piaget, began to study learning in infancy in an effort to determine how early and under what conditions infants could learn. In the 1960s and 1970s, a new body of research on newborn capabilities began to emerge, which provided a rich empirical database for subsequent conceptualizations of newborn and infant development. Researchers
such as Lewis Lipsitt, Louis Sander, T.G.R. Bower and Rachel Keen developed innovative research methods to demonstrate that newborns could, indeed, learn from the very beginning. This new body of data, which provided evidence to show that the newborn infant was competent and complex, contributed significantly to the development of the NBAS.

However, it was Berry Brazelton’s own clinical experience with parents and his work at the Children’s Hospital in Boston which led to a breakthrough in our understanding of newborn and infant development. It was his contention that newborn infants were unique, with their own individual styles of responding, and it was this discovery which prompted him to begin the quest for a scale that, on the one hand, could do justice to the newborn’s capabilities and, on the other, could describe the full range of individual differences in newborn behavior.

He first provided evidence for differences in crying patterns in his own research (Brazelton 1962a, 1962b), and later he presented his ideas on individual differences to a wider audience in his groundbreaking book, *Infants and Mothers: Differences in Development*. Then, at the Center for Cognitive Studies at Harvard, he worked with Jerome Bruner, Tom Bower, Martin Richards, Colwyn Trevarthen and Edward Tronick on new microanalytic observational techniques in an effort to develop a more detailed and complex understanding of individual differences in infant behavior and early infant–parent transactions. This body of research confirmed his hypothesis that newborns were equipped with powerful innate reciprocal communicative abilities and moreover that this could be reliably coded. He could see that they were also capable of the kind of ‘organized’ behavioral responses Peter Wolff had demonstrated earlier in his seminal work on ‘newborn behavioral states’ (Wolff 1959). Indeed, the idea of ‘state’ was to become a critical matrix on which to assess all reactions, sensory as well as motor, in the newborn. Working with Mary Louise Scholl from the Department of Neurology at Massachusetts General Hospital, Berry Brazelton also began to integrate developmental and neurological principles into his clinical understanding of newborn behavior and development. These ideas and discoveries provided a conceptual foundation for the development of the Neonatal Behavioral Assessment Scale.

**THE CAMBRIDGE SCALES**
The Graham Scale (Graham et al 1956) and the Graham-Rosenblith Scale (Rosenblith 1961) were the first scales to attempt to outline behavioral differences among neonates. Shortly thereafter, the first iteration of the NBAS appeared – The Cambridge Neonatal Scales – developed by Berry Brazelton and Daniel Freedman (Brazelton and Freedman 1971). Using this scale, Freedman and his colleague were able to identify behavioral differences between Caucasian and Chinese neonates (Freedman and Freedman 1969). Intrigued by these findings, Brazelton and John Robey then went to southern Mexico to study the Zinacanteco Indians, in the highlands of Chiapas (Brazelton et al 1969). Here, their ideas on neonatal differences were confirmed. They discovered that, compared to their Caucasian counterparts, these infants, even after delivery, ‘lay quietly on the blanket looking around the room with alert faces for an entire hour’ (Brazelton et al 1969: 279).

Confident that the scale could capture individual differences in newborn behavior, the next challenge was to refine the scoring system in a way that could describe, identify, and
ultimately code these differences with a high degree of inter-rater reliability (Brazelton 1973, 2009). With the help of Daniel Freedman, Frances Degan Horowitz, Barbara Koslowski, Henry Riciuti, John Robey, Arnold Sameroff and Edward Tronick, Berry Brazelton developed a new scoring system, which was incorporated into the first edition of the Scale, which was published in 1973 by Spastics International Medical Publications in London. In the preface to that volume, Ronald Mac Keith and Martin Bax were perceptive when they wrote that they were ‘happy to predict that people will be using and working with the NBAS for many years to come’. The second edition, which appeared in 1983, added the ‘supplementary items’, which were adapted from the NBAS-K (Kansas version) (Horowitz et al 1978) and the then newly developed Assessment of Premature Infant Behavior (Als et al 1982a), and provided additional scoring criteria for use of the Scale with at-risk infants. The usefulness of these items has been supported by studies of high-risk infants (e.g. Dreher et al 1994, Eyler et al 1998, Sagiv et al 2008). Thirteen years later, the third edition appeared, in which J. Kevin Nugent joined Berry Brazelton as co-author and added a new set of guidelines on the clinical uses of the NBAS. This current edition expands the scope of the previous editions by highlighting the wide range of research and clinical contexts in which the NBAS can be used.

Conceptual basis
In developing the Scale, we were impressed from the beginning by the newborn infants’ ability to interact with the environment and by their capacity to deal selectively with environmental stimuli. The NBAS assumes that the newborn is a social organism, predisposed to interact with her caregiver from the beginning and able to elicit the kind of caregiving necessary for her species-specific survival and adaptation. The Scale was conceptualized, therefore, not as a series of discrete stimulus–response presentations simply to assess the baby in isolation, but rather as an interactive assessment, in which the examiner plays a major role in facilitating the performance and organizational skills of the infant. We therefore wanted a scale that could yield a comprehensive profile of neonatal functioning by describing the full range of neonatal behavior including competencies and strengths as well as identifying areas of difficulty or deviation. The NBAS does not merely provide a catalogue of newborn competencies, but over the course of the first four weeks of life it allows us to see how the baby’s discrete behaviors are integrated into coherent patterns of behavior. It enables us to identify what role the caregiver can play in facilitating the infant’s adaptation and development. Above all, the goal of the NBAS was to identify and describe individual differences in neonatal behavioral adaptation.

THE COMPETENT NEWBORN
The NBAS is based on the assumption that the newborn infant is both competent and complexly organized. Over the past 25 years, an ever-expanding body of research has yielded an extensive taxonomy of newborn and infant behavior, showing that, for example, the newborn can visually track (Slater et al 1985, Dannemiller and Freedland 1991, Laplante et al 1996), can hear and locate sounds (Muir and Field 1979) and seems to prefer to look at faces (Walton et al 1998, Farroni et al 2004). This body of research also demonstrates
that the newborn infant is a social organism; infants are predisposed to interact with their
caregivers from the beginning and able to elicit the kind of caregiving necessary for their
successful adaptation (Trevarthen 2001). The newborn is drawn to the mother’s voice
(deCasper and Spence 1991, Spence and Freeman 1996), can imitate facial expressions
(Field et al 1982, Meltzoff and Moore 1983, Nagy 2006), and can clearly discriminate her
mother’s face from that of a stranger (Nazzi et al 1998). After three decades of intensive
research on newborn behavior and development, newborn human infants have emerged
as competent, as complexly organized and as playing an active role in shaping their own
development.

Research with the NBAS also reveals that the neonate’s behavior can no longer be
assumed to be biologically determined. Infant behavior at birth is phenotypic, not genotypic,
so that intrauterine nutrition and infection (Lester and Brazelton 1982, Oyemade et al 1994)
and drugs (Fried and Makin 1986, Chasnoff and Griffith 1989, Coles et al 1992, Beeghly
few possible influences, are affecting the fetus throughout pregnancy, interacting with
genetic endowment to shape newborn behavior. There is rapidly accumulating evidence that
the newborn infant is powerfully shaped before delivery, and routine perinatal events, such
as maternal medication and anesthesia, and episodes of hypoxia, further influence his or her
reactions (Sepkoski et al 1992). Research shows that extraterine stimulation which involves
the pregnant mother may also be shaping the neonate’s learning in utero and may be
influencing prenatal brain development (Dobbing 1990, Als et al 2003). This has led to the
recognition that the infant has well-established behavioral endowments at birth and that the
infant’s development is influenced by both biological and environmental influences from
the beginning.

THE DEVELOPMENTAL AGENDA OF THE NEWBORN PERIOD

The scope of the Scale extends from birth to the end of the second month of life and is
designed to describe the infant’s adaptation and development, specifically the capacity for
self-regulation over that period of time. From this developmental systems perspective, the
NBAS enables us to study behavioral changes systematically over time by describing the
process of hierarchical integration of the different domains or systems of behavior over the
first two months. Newborn infants are seen to face a series of hierarchically organized
developmental challenges as they attempt to adapt to their new extrauterine world, both the
inanimate and animate world (Brazelton 1982). This includes their capacity to first regulate
their physiological or autonomic system, then their state behavior, their motor behavior
and finally their affective interactive behavior, which develops in a stage-like epigenetic
progression over the first two months of life (Als et al 1982a, 1982b). The NBAS items cover
these four domains of neurobehavioral functioning:

1. **Autonomic/physiological regulation**: the infant’s homeostatic adjustments of the central
   nervous system as reflected in color change, tremors and startles.

2. **Motor organization**: the quality of movement and tone, activity level and the level of
   integrated motor movements.
State organization and regulation: infant arousal and state lability, and the infants’ ability to regulate their state in the face of increasing levels of stimulation.

Attention/social interaction: the ability to attend to visual and auditory stimuli and the quality of overall alertness.

The first – and basic – task for newborn infants is to organize their autonomic or physiologic behavior. This involves dealing with stress related to homeostatic adjustments of the central nervous system. It involves the task of stabilizing their breathing, of reducing the number of startles and tremors and being able to maintain temperature control. When this homeostatic adjustment has been achieved, newborn infants can move on to the second task – that of regulating or controlling their motor behavior. This means gaining control over and inhibiting random motor movements, developing better muscle tone, and reducing excessive motor activity. Although these challenges may not develop in an absolute sequence and they may be contemporaneous, there is an assumption of a hierarchical progression, such that each precedes the next.

The third challenge of this period is state regulation. This is the ability to modulate his/her states of consciousness. This includes the ability to develop robust and predictable sleep and wake states and what could be called sleep protection, or the ability to screen out negative stimuli while asleep. State control means that the infant is able to deal with stress, either through self-regulation strategies such as hand to mouth maneuvers, or through being able to communicate with the caregiver through crying and being consoled with the caregiver’s help.

The final task for newborn infants is the regulation of their affective interactive or social behavior. This involves the capacity to maintain prolonged alert periods, the ability to attend to visual and auditory stimuli within their range, and the ability to seek out and engage in social interaction with the caregiver. The NBAS can reveal where along this hierarchical continuum the individual baby falls and in which domain she needs support and what kind of support she may need.

The Scale can therefore be used to describe the current status of the individual infant’s autonomic, motor, state and social-attentional systems as they interact with each other and become integrated during the neonatal period (Als et al 1982a, Nugent and Brazelton 2000). Serial observations with the NBAS can reveal how the systems are being integrated over time and how they are being affected by environmental factors. This integrative task proceeds in a hierarchical fashion, with autonomic regulation preceding motor organization, followed by the task of state regulation and finally social interactive tasks. Moreover, the model of development on which the NBAS is based assumes that developmental outcome is a function of the interaction of organismic and environmental factors, so that most researchers who have used the NBAS to examine the relationship between newborn behavior and later outcome have combined the NBAS scores with measures of the infant’s environment (e.g. Nugent 1991, Van den Boom 1991, Stjernqvist and Svenningsen 1995, Ohgi et al 2003).
Content and uses
The NBAS can be described as a neurobehavioral assessment scale, designed to describe newborn infants’ responses to their new extrauterine environment and to document the contribution of the newborn infant to the development of the emerging parent–child relationship (Brazelton 1973, 1984, Brazelton and Nugent 1995). The NBAS assesses the newborn’s behavioral repertoire with 28 behavioral items, each scored on a nine-point scale. It also includes an assessment of the infant’s neurological status on 20 items, each scored on a four-point scale. The reflex items are used to identify gross neurological abnormalities through deviant scores or patterns of scores, but they are not designed to provide a neurological diagnosis. In the two previous editions of the NBAS (Brazelton 1984, Brazelton and Nugent 1995), a set of supplementary items was added in an attempt to better capture the range and quality of the behavior of fragile high-risk infants. The usefulness of these items has been confirmed by studies of high-risk infants (e.g. Dreher et al 1994, Eyler et al 1998, Sagiv et al 2008).

The NBAS is appropriate for use without adaptation for term infants, and can be applied until the end of the second month of life. With the addition of the supplementary items it

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can also be used for apparently healthy preterm (who have reached 37 weeks gestational age) or late preterm infants, and for them, depending on the degree of immaturity, its application is still possible at 2 months corrected age. It will be obvious that the NBAS should not be attempted for infants requiring neonatal intensive care with multichannel monitoring, oxygen therapy and intravenous or gavage feedings. A baby who is either immature or recovering from illness may become over-stressed by the examination.

Because it is sensitive to even subtle environmental effects, the NBAS has demonstrated that newborn behavior and development can be affected by many variables, including intrauterine growth restriction, low birthweight, and preterm birth (e.g. Costas et al 1989, Eyler et al 1998); environmental polychlorinated biphenyls (PCBs) (e.g. Lonky et al 1996, Sagiv et al 2008); different modes of delivery and obstetric medication (e.g. Lester et al 1982, Sepkoski et al 1992); gestational and pregestational diabetes (e.g. Botet et al 1996); infant massage (e.g. Field 2009); neonatal hyperbilirubinemia (e.g. deCaceres et al 1991) and maternal ingestion of toxins – cocaine, tobacco, alcohol and caffeine (e.g. Mayes et al 1993, Datta-Bhutada et al 1998, Morrow et al 2001, Lewis et al 2007, Mansi et al 2007).

**DATA REDUCTION AND ANALYSIS**

Since the NBAS contains 28 behavioral items and 20 reflex items, the search for the most effective data reduction and data analysis procedures challenged researchers from the beginning. Item-by-item comparisons across the individual NBAS items have given way to approaches based on factor analysis (e.g. Jacobson et al 1984, Lester 1984, Sostek 1985, Azuma et al 1991), but it is Lester’s seven-cluster system which has become the most widely used system among researchers (e.g. Mayes et al 1993, Sagiv et al 2008). Chapter 4 describes research uses and the different data reduction procedures used with the NBAS in more detail.

**USES IN DIFFERENT CULTURAL SETTINGS**

From the time it was first published, the NBAS has been used to examine neonatal differences and their natural variations in different cultural settings. These studies have been reviewed by Lester and Brazelton (1982) and Super and Harkness (1982), while Nugent, Lester and Brazelton (1989, 1991) later presented a series of NBAS studies from 24 different cultures in Europe, Asia, North and South America and Africa. While this body of cross-cultural research constitutes a fraction of the canon of cultural and cross-cultural studies, the NBAS studies have made a unique contribution to the field by showing that while the basic organizational processes in infancy may be universal, the range and form of these adaptations are shaped by the demands of each individual culture. Moreover, these studies expand our understanding of the range of variability in newborn behavioral patterns and the diversity of child-rearing practices and belief systems (Nugent et al 2009).

**CLINICAL USES**

While the NBAS has been used in many research studies as an outcome measure and continues to be used as a means of assessing the effects of a wide range of pre- and perinatal influences on newborn behavior, we began to realize in the 1980s that the NBAS was a powerful teaching tool and could be used as a form of intervention (Nugent 1985). A series
of studies, summarized by Nugent and Brazelton (Nugent and Brazelton 1989, Brazelton and Nugent 1995, Nugent and Brazelton 2000), showed that demonstrating the newborn infant’s behavioral capacities to parents can serve as a mechanism for helping parents learn about their new infant, thereby strengthening the relationship between parent and child and supporting the family adjustment. A number of follow-up studies have consistently reported positive effects of exposure to the NBAS on variables such as maternal confidence and self-esteem, parent–infant interaction and developmental outcome (e.g. Myers 1982, Rauh et al 1988, Parker et al 1992, Achenbach et al 1993, Beeghly et al 1995, Gomes-Pedro et al 1995, Kaarelsen et al 2006).

Although many of these intervention studies are characterized by small sample sizes, the evidence for short-term positive effects of NBAS-based interventions is consistent for both high-risk and low-risk samples. A meta-analysis of 13 parenting intervention studies based on the NBAS, by Das Eiden and Reifman (1996), concluded that the NBAS interventions had beneficial effects on the quality of later parenting. But, although the longitudinal data show positive effects, the results are not used to argue for direct long-term effects as an exclusive function of NBAS-based interventions. In the case of Rauh et al’s (1988) Vermont follow-up study and the Kaarelsen et al (2006) longitudinal study in Norway, the initial NBAS-based intervention was complemented by other interventions at later points. We can therefore conclude that although there may not be persistent direct effects as a result of NBAS-based interventions, long-term effects may derive from indirect transactional effects.

The NBAS is unique in that it can be used by the clinician to gather objective data about the infant’s behavior on the one hand, but in the context of conducting a clinical session with parents, these data yield a comprehensive profile of behavior that is at the core of the treatment and is used to organize the experience of the family around the new infant. In practice, the value of the NBAS for the clinician is that the Scale provides an assessment of the infant’s current level of functioning across behavioral domains, describing both strengths and weaknesses, but at the same time this profile is used as a blueprint to help parents better understand their infant and thereby support them in developing a positive and productive relationship with their infant.

**Scales Inspired by the NBAS**

The NBAS has also stimulated the development of a number of assessment scales for use with different populations and in different settings – a testament to its theoretical richness and generativity. The NBAS-K (Kansas version) was developed by Horowitz and colleagues ‘to identify individual “outlier” infants whose behavioral organization can be said to be very different from normal’ (Horowitz and Linn 1984: 97). The Assessment of Premature Infant Behavior was derived from the NBAS and has become the most widely used instrument to assess preterm infant behavior (Als et al 1982a). The Neonatal Intensive Care Unit Network Neurobehavioral Assessment Scale (Lester and Tronick 2004) was designed for the neurobehavioral assessment of drug-exposed and other high-risk infants, including preterm infants. A number of clinical approaches based on the NBAS were also developed as a form of parent support or intervention. The Mother’s Assessment of the Behavior of
her Infant (Widmayer and Field 1980) and the Family Administered Neonatal Activities (Cardone and Gilkerson 1990) were adapted from the NBAS, while Keefer (1995; see also Chapter 8.7 in this volume) based the combined Physical and Behavioral Neonatal Examination (PEBE) on the NBAS. The recently developed Newborn Behavioral Observations (NBO) system (Nugent et al 2007) was also inspired by the clinical uses of the NBAS. The NBO is a flexible, interactive relationship-building instrument and is used extensively in clinical settings as a means of sensitizing parents to the capacities and individuality of the newborn infant and fostering the relationship between parent and child and between clinician and parent.

In sum, the newborn period can be considered a major transition stage in the newborn’s adaptation and development. It is a period defined by specific developmental challenges as the newborn attempts to make a successful transition to his or her new extrauterine environment. What the NBAS has revealed is that this process is highly individualized and there is a wide range of variability in how newborn infants adapt to their new environment over these first two months. This period can also be considered a major transition stage in the development of the parent–infant relationship. From an interventionist point of view, it has become clear that this transition period provides clinicians with a remarkable opportunity to play a supportive role in promoting the baby’s self-regulation, on the one hand, and facilitating the mutual affective regulation process between parent and infant, on the other.

**Conclusion**

The NBAS has now established itself as an invaluable neurobehavioral assessment tool in research and clinical settings across the world (Nugent et al 2009, Lester and Sparrow 2010, Nugent 2010). It remains the most comprehensive examination of newborn behavior available. Because it yields a comprehensive description of newborn competencies, on the one hand, and is able to identify individual differences in newborn behavior, on the other, the NBAS can be said to have begun where other scales left off. The NBAS has enriched our understanding of the competencies and complexities of newborn behavior and helped us identify the multiplicity of variables which influence newborn behavior and development. It adds to our understanding of what can be considered normal or typical, and can broaden our appreciation of the range of variability of newborn behavior and the relationship between prenatal influences and newborn behavior, on the one hand, and the relationship between newborn behavior and later development, on the other.

With the growing interest in viewing development through the lens of developmental psychobiology, the history of the NBAS suggests that it can play a key role in the emerging field of cognitive neuroscience. Combining NBAS observations with emerging neuroimaging techniques, such as event-related potentials and functional magnetic resonance imaging, should make possible a more comprehensive exploration of newborn behavioral functioning and a greater understanding of the neural underpinnings of newborn behavioral patterns (Nelson et al 2006, Nugent 2010). Finally, because the model on which the NBAS is based is, by nature, both flexible and adaptable, it can be predicted that the NBAS will continue to enrich the lives of researchers, clinicians and parents in years to come and make a unique contribution to the field.