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Special Care Nursery Intervention with Preterm Infant-Parent Dyads

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SPECIAL CARE NURSERY INTERVENTION WITH PRETERM INFANT-PARENT DYADS

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This work is dedicated to my parents, Mary and Patrick.

VITA

The author, Kathleen M. Malee, was born on July 15, 1950, in Chicago, Illinois.

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Ms. Malee co-authored a paper entitled "Serial Developmental Follow-up of Infants with Intraventricular Hemorrhage" which was presented at a poster session at the April, 1987 conference of the Society for Research in Child Development.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

LIST OF TABLES

CONTENTS OF APPENDICES

INTRODUCTION

Advances in perinatology have greatly increased the rate of survival and enhanced the chances of improved long term outcome among very immature, low birthweight infants (Hunt, Tooley, & Harvin, 1982; Kitchen, Ryan, McDougall, Billson, Keir, & Naylor, 1980; Knoblock, Malone, Ellison, Stevens, & Zdeb, 1982). As a result, attention has been directed towards understanding the salient behaviors and characteristics of these preterm infants within the specialized environment of the Special Care Nursery (SCN). Concomitantly, acknowledgement has been given to the effect of a preterm birth upon the infant's family system and upon the process of family development.

A transactional view of development (Sameroff & Chandler, 1975) suggests that the preterm infant, his parents, and the SCN environment affect and, in turn, are affected by one another in the process of development. The vulnerabilities of both infants and parents are accentuated by the environmental input of the SCN. The potential sequela of interaction of this triad is delayed or aberrant development for preterm infants.

Longitudinal studies have identified both transient and long-term consequences of prematurity, including motor dysfunction, interactional disturbances, perceptual-motor problems, and language delay (Caputo & Mandell, 1970; Drillien, Thomson, & Burgoyne, 1980; Parmelee & Schultz, 1970; Weiner, 1968). While recent studies suggest that outcome is improving for preterm infants, the outlook for the smallest and youngest infants remains worrisome; the lower the birthweight and the shorter the gestational period, the greater the likelihood for some type of developmental delay during childhood (Fitzhardinge, Pape, Arstikaitis, Boyle, Ashby, Rowley, Netley, & Swyer, 1976).

Numerous types of intervention programs both during and after hospitalization have been designed to ameliorate the delays often associated with preterm birth (Burns & Hatcher, 1984). While multiple positive affects typically accrue as a result of intervention (Meisels, Jones, & Stiefel, 1983), the precise mechanism for change remains inadequately articulated; the most appropriate recipient, type, and intensity of stimulation have yet to be defined.

Clarification of the relationship between intervention and early development necessitates appreciation of the transactional nature of the relationship of infant, parent, and SCN environment. It further requires an appropriate conceptualization of early preterm infant development; i.e., the synactive nature of preterm infant behavioral functioning (Als, 1982) must be recognized.

The goal of this study was to design and implement an intervention program which meets the needs of both infant and parent within the SCN mileau. The intervention program was based upon an understanding of the developmental agenda of preterm infants and an appreciation for the impact of premature birth upon parental adaptation.

Specifically, the intervention program was based upon the assumption that appropriately timed, controlled, and patterned physical stimulation (i.e., physical therapy) would facilitate the behavioral organization of the infant, allowing him/her to gradually respond to increasingly complex stimuli. The intervention was based upon the additional assumption that sharing information with parents regarding the infant's development would promote appropriate adaptation of parental expectations, attitudes, and behaviors towards the preterm infant.

In order to investigate the effects of early intervention upon both the behavioral competence of infants and the behavior and perceptions of their parents, the experiences of both were varied during the infants' hospitalization and the effects were measured both during and after hospitalization. To determine the consequences of SCN intervention:

1. neurobehavioral physical therapy was provided to ten preterm infants on a daily basis during a four week time period;

2. education and training was provided to the parent(s) of those infants receiving neurobehavioral physical therapy;

3. the characteristics and behaviors of a group of treated and untreated infants were examined at significant points in their early development; and

4. the behavior and perceptions of parents of both groups of infants were measured concurrently with infant assessments.

The results of this study have potential clinical and theoretical implications. The findings elaborate upon the current understanding of preterm infants by delineating factors relevant to their emerging behavioral organization. At the same time, the findings suggest the degree to which parental perceptions of preterm infants are a function of time and experience with those infants in the SCN and at home. Finally, the results of the study suggest a viable model for successful intervention with preterm infant-parent dyads.

REVIEW OF THE LITERATURE

The Special Care Nursery Environment

Premature birth places a potentially competent and adaptive infant in an external environment which cannot approximate the more optimal intrauterine experience of rhythmic and cyclic stimulation from maternal heart beat patterns, sleep/activity patterns, and neurohormonal cycles. The Special Care Nursery (SCN) is designed so that medical expertise and advanced technology can assume control of the infant's primary physiological functions. As such, the nursery environment is typically characterized by high intensity and low frequency noise, high illumination levels, and various aversive stimuli.

The sound level in the average neonatal intensive care nursery, for example, ranges from 70-80 decibels, with high upper levels. The overall noise environment is comparable to the sound of light auto traffic and at times reaches the level of large machinery (Gottfried, Wallace-Lande, Sherman-Brown, King, Coen, & Hodgman, 1981; Pederson & Gross, 1974). Human speech sounds within the isolette tend to be muffled and indistinct. In fact, the sounds penetrating most loudly and clearly are those from non-human mechanical or metallic devices including high frequency sounds from doors, squeaking hinges, garbage cans, and machines (Newman, 1981). Effects of noise upon immature preterm infants include disruption of sleep, tachycardia, peripheral vasoconstriction, decreased transcutaneous pO2, and increased intracranial pressure (Peabody & Lewis, 1985).

Infants in special care nurseries are continuously exposed to cool-white fluorescent lighting. The mean illumination level provided by the typical special care nursery's flourescent lighting ranges from 35 to 190 footcandles, with a median value of 90 footcandles (Glass, Avery, Subramanian, Keys, Sostek, & Friendly, 1985); it is comparable to the lighting found in a large supermarket and likely interferes with the development of diurnal and circadian rhythms (Als, 1986) . Both noise and illumination conditions are continuously present with little variation throughout the day.

Appropriate tactile, vestibular, kinesthetic, and auditory experience is, on the other hand, infrequently and irregularly available. Continuous observations of preterm infants in the Special Care Nursery reveal that contacts predominantly involve medical and /or nursing care and are often stressful, resulting in adverse physiological responses, such as apnea, decreased oxygen tension and transcutaneous pO2, and tachycardia (Gorski, 1985; Long, Alister, Phillip & Lucy, 1980; Murdoch & Darlow, 1984).

Simple social contacts, such as holding, rocking, and talking to infants occur sporadically (Gottfried, 1985; Murdoch & Darlow, 1984). Environmental stimuli of any kind lacks rhythmicity and is rarely integrated or coordinated with the infant's own behavioral patterns (Gottfried, 1985; Holmes, Nagy-Reich, & Pasternak, 1984; Lawson, Daum, & Turkewitz, 1977; Masi, 1979; Newman, 1981).

The Preterm Infant

As a result of preterm birth and its medical and environmental sequelae, preterm infants are unique types of organisms; their physiological, motor, state and attentional systems are different and seemingly less mature than those of their fullterm peers. For example, moderately preterm infants (31-36 weeks gestational age) lack mature hypothalamic thermoregulatory capacity which is challenged by a large body surface area relative to body mass. Thus, heat is lost to the environment unless it is counteracted by measures in the nursery such as temperature-controlled incubators, particularly important for infants less than 33 weeks gestational age. Infants of 34-36 weeks gestational age can generally tolerate exposure to the ambient air, although temperatures are monitored carefully (Usher, 1981).

Further evidence of relative physiologic immaturity is exemplified by the respiratory and gastrointestinal systems of premature infants. The respiratory system of the preterm infant is immature, and as such has two primary consequences/sequelae (Stahlman, 1981). The quality and quantity of pulmonary surfactant, necessary to decrease the work of respiration, are inadequate and result in varying degrees of respiratory distress syndrome. In general, otherwise healthy, moderately premature infants have mild disease and require a modicum of ventilatory support and oxygen therapy for the first few days of life. A second possible sequelae of respiratory immaturity is apnea (temporary cessation of breathing), ascribed to the lack of full development of the central regulatory mechanism of the respiratory system.

The gastrointestinal system of premature infants lacks full functional capacity and necessitates nursery intervention to assure the appropriate caloric intake for continued development (Usher, 1981). For example, the calories for infants of 31-33 week gestational age are typically delivered by nasogastric feeding tubes. As coordinated sucking and swallowing are lacking in infants 34-36 weeks gestational age, they are routinely gavage fed. Ability for independent nipple feeding is generally demonstrated by the 36th or 37th week of gestation.

Many differences in neuromotor functioning are noted between preterm infants and fullterm infants. The neuromotor functioning of preterm infants differs significantly from that of fullterm infants, in part because preterm birth eliminates the availability of total cutaneous somatesthetic input from the amniotic fluid (Als, 1986). Preterm infants therefore lack the characteristic flexed posture of the newborn (40 week) infant (Aylward, 1981; Saint-Anne Dargassies, 1977). A typical 32 week old infant is predominantly in an extended posture, gradually developing flexor tone in a caudal-cepalic, distal to proximal fashion (Almli, 1986). Preterm postural control is similarly immature. A 32 week old infant shows complete head lag on a pull to sit manuever (Volpe, 1977) and generally demonstrates weak, unsustained efforts to extend the neck when placed in a prone position (Sarnat, 1984). Preterm postural control gradually increases over time. A 36 week old infant typically begins to attempt to hold his head in anti-gravity positions; a forty week old infant shows consistent, sustained efforts.

Diffuse body movements, i.e., uncoordinated movement involving all four limbs, occur in preterm infants from 32 to 40 weeks with varying frequencies. For example, a 32 week gestational age infant is predominantly hypotonic and mildly active; he can bring his hand to his face, move his trunk, and rotate his head actively. A 35 week old infant's increasing muscle tone facilitates more sustained activity such as lower extremity straightening and upper extremity stretching (Saint-Anne Dargassies, 1977). A forty week old infant tends to be active and tonic.

When the motor activity of preterm infants at forty weeks adjusted age is compared to that of fullterm infants, it is both qualitatively and quantitatively different (Aylward, 1981; Kurtzberg, Vaughan, Daum, Grellong, Albin, & Rotkin, 1979; Parmelee, 1975). When the infant born prematurely reaches term or forty weeks, their motor actions are generally found to be random, jerky and tremulous, with a tendency to recycle and self-perpetuate (Als, Lester, & Brazelton, 1978). This diffuseness of behavior is consequently less likely to affect the quality and quantity of stimulation it elicits.

The state organization of preterm infants is similarly less mature than that of fullterm infants (Aylward, 1982; Dreyfus-Brisac, 1970; Friedman, Jacobs, & Werthman, 1982; Parmalee, Waldemar, Wenner, Schultz, & Stern, 1967) and develops over time between 32 and 40 weeks. The first differentiation between quiet and active sleep occurs after 30 weeks conceptional age. Active sleep becomes more fully developed as the infant approaches 35 weeks and decreases with maturation. Quiet sleep and quiet alertness become more stable after 37 weeks. Preterm infants at 40 weeks adjusted age have shorter sleep-wake cycles than their fullterm counterparts (Gorski, 1985), and additionally show less mature patterns of sleep on EEG (Dreyfus-Brisac, 1970; Beckwith, & Parmalee, 1986; Prechtl, Fargel, Weinman, & Bakker, 1979). Preterm infants are more easily upset than fullterm infants (Sell, Luick, Poisson, & Hill, 1980) and exhibit poor modulation of aroused states (Kurtzburg et al., 1979). Moreover, transitions from one state to another are completed with less ease than is typically apparent in fullterm infants, in part because preterm infants' sleep-wake patterns are so often disrupted by activities in the SCN (Gabriel, Grote, & Jonas, 1981).

While preterm infants as young as 26 weeks are responsive to sound (Parmelee, 1981), the type and quality of their responses vary considerably as a function of both age and environmental stimuli (Oehler, 1979). Reactions to sounds have been identified in infants prior to 32 weeks (Monad, 1971; Wedenberg, 1965) but are more consistently demonstrated at 36 weeks conceptional age (Parmelée, 1981). Auditory responsivness tends to improve with time, with more rapid changes occurring after 40 weeks conceptional age (Oehler, 1979).

The preterm infant's visual system is immature but responsive to environment stimuli at early ages. Infants at 30 weeks conceptional age, for example, can visually fixate upon facial configurations and various inanimate patterns such as a checkerboard or other black and white figures (Hack, Mostow, & Miranda, 1976; Hack, Muszynski, & Miranda, 1981); their ability to fixate increases steadily from 31 to 36 weeks. Discriminative visual function is present by 31-32 weeks conceptional age and becomes more readily apparent by 33 to 35 weeks (Dubowitz, Dubowitz, & Morante, 1980; Fantz & Miranda, 1977). The ability to follow a stimulus visually through an arc of 30-60 degrees develops gradually from 30 weeks onward. Early tracking behavior is typically characterized by jerky, inconsistent eye movements in arcs of less than 60 degrees. Visual following in the vertical plane is usually demonstrated after 40 weeks conceptional age. In general, preterm infants visual orientation improves more rapidly after they reach 40 weeks conceptional age, with less jerky eye movements and more consistent following in all planes demonstrated. Attention to patterns with more elements, angles, and contours is typically apparent as well (Oehler, 1979).

Qualitative differences in visual and auditory responsivness are demonstrated by full term and preterm infants. When compared with full term counterparts, preterm infants have less mature alertness (Als & Brazelton, 1981) and less adequate visual and auditory processing abilities, especially with respect to complex stimuli (Dubowitz et al, 1980; Friedman, Jacobs, & Werthman, 1982; Kurtzburg et al, 1979). In addition, intersensory integration, the simultaneous coordination of visual and auditory input, develops more slowly among preterm infants than in fullterm infants (Lawson, Daum, & Turkewitz, 1977; Rose, Gottfried, & Bridger, 1978; Rose, 1981).

The Parents

The effects of preterm birth are not exclusive to the infants themselves. Premature delivery is a time of emotional crisis for parents (Bidder, Crowe, & Gray, 1979; Caplan, 1960) and interrupts the process of physical and mental preparation that parents typically undergo during the late antenatal period of pregnancy (Gorski, 1985). This interruption results in a continuum of parental reactions which includes guilt, grief, denial, anxiety, and ambivalence (Kaplan & Mason, 1960; Nance & Timmons, 1982; Seashore, Leifer, Barnett, & Leiderman, 1973).

Parents who experience the physical and psychological crisis of preterm birth are forced to assume the parental role prematurely and subsequently face several major tasks while their infant is hospitalized (Desmond, Wilson, Alt, & Fischer, 1980). First, they must deal with shattered assumptions about personal control and the predictability of events (Affleck, Tenner, & Gershman, 1985). Secondly, parents must accept the loss of the healthy, full- term infant they anticipated (Solnit & Stark, 1961). They must accept temporary separation from their vulnerable preterm infant while acknowledging the possibility of loss of that infant. Parents must cope with these feelings in a hospital environment which tends to diminish their sense of competence (Jeffcoate, Humphrey, & Lloyd, 1979). Finally, parents must gradually renew their relationship with their infant and adapt to the specific characteristics of that infant's interactive style and development status.

Negotiation of these tasks is frequently difficult for parents of preterm infants. For example, mothers of preterm infants reportedly cry more, experience more feelings of helplessness, worry more about future pregnancies and their ability to cope, and request more support from SCN staff at discharge time than do parents of fullterm infants (Trause & Kramer, 1983). Parents' acknowledgement of their infant's current status and verbal expression of the seriousness of their infant's medical condition while in the SCN are often discrepant with reality (Minde, Whitelaw, Brown, Fitzhardinge, 1983). This misperception of illness subsequently impacts upon parents' behaviors with their infants during hospitalization.

The nature of the mother's psychological background and personal history typically influences the intensity with which she interacts with her infant and the degree to which she is sensitively responsive to that infant (Marton, Minde, & Ogilvie, 1981). Mothers of preterm infants, regardless of their psychological background, initially interact less with their infants than mothers of fullterm infants. This tendency towards reduced interaction persists even after medical recovery is complete (Minde et al., 1983).

Outcome Studies

Given the early differences in the characteristics of preterm infants and parents, a transactional model (Sameroff & Chandler, 1975) of effects may be expected. The preterm infant, his parents, and the Special Care Nursery environment affect, and in turn, are affected by one another in the process of development. The described vulnerabilities of the infant and the parents are exaggerated by the less than optimal environmental input of the SCN. A potential sequela of transactions within this triad is the risk of delayed development for the preterm infant.

Various longitudinal studies of preterm infants have identified both transient and long-term consequences of prematurity (Caputo & Mandell, 1970; Drillien, 1972; Drillien, Thomson, & Burgoyne, 1980; Hunt, 1981; Parmalee & Schultze, 1970; Weiner, 1962). Developmental difficulties among preterm infants manifest themselves in motor, cognitive, and social/emotional functioning.

Abnormal motor functioning is a common transient finding during the first year of life (Davies, & Tizard, 1975; Masi, 1979; Stave, & Ruvalo, 1980). The most common abnormal finding during this time period is increased lower extremity extensor tone in conjunction with decreased central tone. While it appears that most early tone dysfunctions dissipate over time (Davies & Tizard, 1975; Ungerer & Sigman,1983), a small percentage of pre-school age children continue to have perceptual and gross motor difficulties secondary to extremity and central tone abnormalities (Drillien, Thoman, & Burgoyne, 1980; Weiner, Rider, Opel, & Harper, 1968). Gross motor difficulties include gait abnormalities and poor coördination of running and jumping. Perceptual motor weaknesses are reflected in difficulties with reproduction of figures and designs as well as discrimination of part-whole and figure-ground relationships (Klein, Hack, Gallagher, & Fanaroff, 1985).

Preterm infants demonstrate a greater incidence of impaired cognitive functioning compared with their fullterm counterparts. For example, developmental lags in visual information processing are demonstrated by preterm infants during their first year of life. Preterm infants are less able than conceptionally age-matched fullterm infants to process visual relational information (Caron, & Caron, 1981), to encode information in visual preference and discrimination tasks (Rose, 1981; Sigman, Parmalee, 1974), and to detect invariant shape information across tactual and visual modalities (Rose, Gottfried, & Bridger, 1978). Cognitive differences between preterm infants and fullterm infants at times persist during the second year of life. For example, thirteen month old preterm infants are less able than fullterm counterparts to demonstrate their understanding of an object's permanence or to comprehend means-ends relationships in some contexts. Less adequate receptive and expressive language skills among preterm infants are also demonstrated during the second year of life (Ungerer & Sigman, 1983).

The differences between fullterm and preterm infants attenuate over time to the extent that most preterm infants are functioning within the normal range of intelligence by the time they reach pre-school age (Ungerer & Sigman, 1983). Ninety-one percent are able to participate in regular grade school educational programs (Eilers, Desai, Wilson, & Cunningham, 1986). Preterm infants, however, tend to remain more heterogeneous as a group than do fullterm infants. There is some continuity between the impairments in information processing in infancy and the perceptual motor deficits identified in later school years (Caputo, Goldstein, & Taub, 1979). Problems with attention, concentration, impulse control, and abstract reasoning also persist and occur with greater frequency in the preterm population (Drillien, Thoman, & Burgoyne, 1980; Hunt, Tooley, & Harvin, 1982; Weiner, Rider, Opel, & Harper, 1968).

The quality of attachment and interaction between parent and infant is frequently affected by a preterm birth experience (Field, 1977), as are parental attitudes and expectations regarding the infant and his role in the family (Holmes, Nagy-Reich, & Pasternack, 1984). Reduced or exagerrated expectations of preterm infants are common. For example, mothers of preterm infants demonstrated a positive bias towards their own preterm infants by evaluating their behaviors significantly more positively than did an objective examiner (Murray, 1986). In contrast, mothers of both fullterm and preterm infants demonstrated a more negative bias towards preterm infants in general by giving negative ratings to infants labelled premature (Stern & Hildebrandt, 1984). Mothers of preterm infants perceive the sleeping, eating, size, and strength of their infants as different than that of healthy fullterm infants during the first six months of life (Holmes, Nagy, Danko, & Slaymaker, 1983). They perceive their infants as more fragile, less likable, and more difficult to care for at home than do mothers of fullterm infants (Springer, Farren, & Vorian, 1982; Stern & Hildebrandt, 1984).

Parental perceptions of preterm babies often affect interactive behaviors. Some parents seemingly overcompensate for their infants' perceived weaknesses with intensive interactive behavior (Beckwith & Cohen, 1978; Field, Dempsey, Hallock, & Schuman, 1978), while others demonstrate a reduction in responsiveness to the infant after preterm birth and/or serious illness (Barrera, et al., 1986; Minde, Whitelaw, Braun, & Fitzhardinge, 1983); i.e., they tend to smile, touch, and laugh less with their infants than do parents of fullterm infants (Barnard, Bee, & Hammond, 1984; Crnic, 1983; Field, 1982; Goldberg, 1978; Ragozin, Crnic, Greenberg, Robinson, & Basham, 1982; Ungerer & Sigman, 1983). Optimal intensity and level of stimulation with preterm infants are often difficult for many parents to gauge as low levels of stimulation fail to elicit responses and high levels frequently result in irritability (Field & Greenberg, 1982; Goldberg, Brachfeld, & DiVitto, 1980).

Interactional differences between preterm-mother dyads and fullterm-mother dyads typically persist during the first year (Crnic, Ragozin, Greenberg, Robinson, & Bashan, 1983) and occasionally through the second year of the child's life (Barnard, Bee, & Hammond, 1984). The impact of premature birth upon parental behavior and perceptions of their child tend to diminish over time, however, such that during the pre-school years parental perceptions are more dependent upon the particular child's developmental outcome than upon the preterm birth experience. Parents of three through five year old very low birthweight children with obvious handicaps, for example, more frequently note developmental abnormalities and difficulties associated with their child's play than do parents of fullterm infants (Boyle, Giffen, & Fitzhardinge, 1977). The majority of parents, however, do not acknowledge that the birth, growth and development of a very low birthweight infant has a significant, persistent effect upon the family. Indeed, by the time most preterm infants reach pre-school age, the only dimension upon which significant differences between them and fullterm infants is found is that of strong versus weak (Bidder, Crowe, & Gray, 1974).

More recent developmental follow-up studies suggest improved outcome for the preterm infant, in part due to medical advances (Hack, Caron, Rivers, & Fanaroft, 1983; Knoblock, Malone, Ellison, Stevens, & Zdeb, 1982; Pape, Buncic, Ashby, & Fitzhardinge, 1978; Saigal, Rosenbaum, Stoskopf, & Sinclair, 1984; Teberg, Hodgman, Wu, & Spears, 1977). The outlook for the smallest and youngest of infants, however, remains worrisome. The lower the birthweight and the shorter the gestational period, the greater the likelihood for some type of developmental delay during childhood (Cohen & Parmelee, 1983; Hertiz, 1981; Hunt, 1981; Sell, 1982).

Intervention

Based upon the assumption that environmental input impacts upon development by promoting species appropriate ontogenetic integration patterns (Als, 1986), numerous types of intervention programs have been implemented to support development and prevent or ameliorate delays often associated with preterm birth. Many of these interventions have been specifically designed to meet the presumed needs of the infant. For example, some intervention programs have been based upon the rationale that preterm infants benefit from the same type of stimulation which fullterm infants normally receive. These multimodal stimulation programs (Leib, Benfield, & Guidubaldi, 1980; Powell, 1974; Rice, 1977; Rose, Schmidt, Riese, & Bridger, 1980; Scarr-Salapatek & Williams,1972) provide a combination of auditory, visual, and tactile stimulation to preterm infants over some period of their hospitalization.

Other intervention programs have been designed to help preterm infants compensate for the experiences they miss by virtue of their prematurity; they attempt to provide the rhythmic, patterned stimulation which predominates *in utero*. For example, swing hammocks (Neal, 1968) and oscillating waterbeds (Korner, Kramer, Haffner, & Cosper, 1975; Pelletier, Short, & Nelson, 1985) have been used to provide vestibular input similar to that experienced *in utero*. Auditory stimulation, such as intrauterine sounds (Burns, Deddish, Burns, & Hatcher, 1983), the sound of a heartbeat (Barnard, 1972) or of a mother's voice (Kramer & Pierpont, 1976) has been added to these vestibular programs in order to more closely approximate the stimuli provided in the typical intrauterine environment. In a further modification of the vestibular model, discontinuous, rather than constant vestibular stimulation has been provided in an effort to contingently respond to the current state of the infant (Barnard & Bee, 1983).

Tactile-kinesthetic stimulation is another form of intervention frequently provided to reduce stress and facilitate preterm infant development (Als, Lawhon, Brown, Gibes, Duffy, McAnulty, & Blickman, 1986; Field, 1986; Field, & Goldson, 1984; Freeman, 1969; Hasselmeyer, 1964; Rausch, 1981; Rosenfield, 1980; Solkoff, Weintraub, Yaffee, & Blase, 1969; Solkoff & Matusak, 1975). Holding, stroking, passive movement of the limbs, rocking, and provision of a pacifier for sucking have been incorporated into caretaking protocols for various periods of time during an infant's hospitalization.

Some neonatal intervention programs have been designed to address the particular needs of the parent. Parent support groups, for example, have been designed and utilized to allow verbalization of concerns with other parents and professionals during the infant's hospitalization. These groups attempt to reduce parental anxiety by fostering both parental self-esteem and family adaptation (Minde, Shosenberg, Martin, Thompson, Ripley, Burns, 1980).

Despite the considerable variability in methodology, most nursery intervention programs have produced some benefits for the stimulated infants, regardless of the type (unimodal or multimodal) of stimulation (Field, 1986; Holmes, Nagy-Reich, & Pasternak, 1984; Meisals, Jones, & Stiefel, 1983). Improvements as a result of infant or parent treatment are reflected in the infant's physiological status, such as need for ventilation (Als et al., 1986), weight gain (Field, 1986; Hasselmeyer, 1964; Powell, 1974; Rice, 1977), and frequency of apnea (Korner, Schneider, & Forrest, 1983), and in measures of state organization (Barnard, 1981), developmental status (Burns, Deddish, Burns, & Hatcher, 1983; Kramer & Pierpont, 1976; Rice, 1977; Solkoff & Matuzcak, 1975), parental visitation patterns (Minde et al., 1980), and mother-infant interaction (Field, Dempsey, Hallock, & Schuman, 1978)

Post-hospitalization intervention programs have also been implemented for preterm infants and parents after discharge from the hospital. Home intervention, directed towards optimizing parent-infant interaction, has been utilized as one treatment strategy. Parents have been taught to become sensitive to their infant's cues and receptive to modifying not only their behavioral styles but that of the home environment as well, so as to better meet the infant's needs (Barrera, Rosenbaum, & Cunningham, 1986).

Developmental education has been provided to parents of preterm infants to increase both infant skill attainment and parental participation in home treatment (Moxley-Haegert & Serbin, 1985). Physical therapy, coupled with parental education, was provided to preterm infants weekly for the first three months at home and twice monthly for the remainder of the infants first year (Piper, Kunos, Willis, Mazer, Ramsay, & Silver, 1986).

The effects of post-discharge intervention for preterm infants are varied and inconsistently demonstrated. Physical therapy and parent education, for example, had no positive impact upon the neuromotor functioning of the preterm infants during the first year of life (Piper et al., 1986). Developmental education, on the other hand, reportedly improved infant-parent interactions during the first year of life. Focus upon recognition of normal developmental progression enabled parents to discriminate small developmental gains by their children and tended to facilitate intrinsic parental motivation to work with their children (Barrerra, Rosenbaum, & Cunningham, 1986; Moxley-Haegert & Serbin, 1985).

The various results of interventions with preterm infants and parents during and after hospitalization suggest that the precise mechanism for positive change in infant and/or parent behavior remains inadequately articulated. Few intervention programs have been designed to concurrently meet the needs of both the preterm infants and parents. In addition, few programs have been based upon an appropriate conceptualization of preterm infant development or an adequate analysis of preterm infants' competencies.

Rationale for the Study

Clarification of the relationship between intervention and early development requires that the quality of life in the typical intensive care nursery be recognized and, more importantly, that the effect of the SCN environment upon the infant-parent dyad be appreciated. Acknowledgement of the transactional relationship between the infant, parent, and the environment is in itself insufficient to design and establish the optimal intervention program. A realistic conceptualization of early preterm infant development is also essential to complete a framework upon which neonatal intervention can be logically based.

The conceptual model upon which this study is based is Als' synactive theory of development (Als, Lester, Tronick, & Brazelton, 1982). Als' conceptualization of the preterm infant recognizes the transactional nature of the relationship between the infant and his environment and further describes how the infant potentially negotiates the process of development over time. Als purports that "...the organism, from the unicellular stage on, negotiates within itself increasingly differentiated subsystem agenda while simultaneously eliciting from the environment that feedback he is programmed to seek actively for his own development" (Als & Duffy, 1983).

Als identifies the autonomic system, the motor system, the state organizational system, the attention and interaction system, and a self-regulatory balancing system as interactive and mutually supportive of one another. The autonomic system includes heart rate, respiration, temperature control, and digestive functioning. These processes, which normally develop in utero in conjunction with adequate maternal blood flow and placental functioning, must be stabilized in the SCN before the infant's continued development is assured. As autonomic functions stabilize, the motor system becomes increasingly more active. With elaboration of movement repertoires, the infant's states of consciousness evolve and differentiate. Finally, in conjunction with better organized state capabilities, alertness becomes more modulated and social interaction becomes possible within the context of balance and self-regulation.

Through the differentiation and elaboration of the various systems and the simultaneous integration of each with the others, the infant gradually becomes more organized and adaptive. The drive for stabilization and integration is inherent to the infant; he consistently "...seeks to realize genetically programmed agenda which are species-specific" (Als & Duffy, 1983). Environmental input can either facilitate or hinder this ongoing developmental process.

This infant-parent intervention is based upon the hypothesis that appropriately timed, controlled, and patterned physical stimulation, i.e., physical therapy, will optimize the behavioral organization of the infant and allow him/her to respond to increasingly complex stimuli. It is further hypothesized that sharing information regarding the infant's development and capabilities will promote appropriate adaptation of parental attitudes, expectations, and behaviors. Together, these factors potentially produce an environment conducive to the total development of the preterm infant.

Physical therapy is a frequently utilized intervention for infants and toddlers who are demonstrating atypical motor development. The physical therapist uses specifically designed maneuvers and handling to facilitate the development of balance mechanisms, such as head righting, and equilibrium reactions (Bobath, 1967, 1980). Motor functioning is typically improved as a result of this type of treatment (Paine, 1962; Scherzer, Mike, & Ilson, 1976; Wright & Nicholson, 1973).

Physical therapy techniques as adapted into Als' synactive theory (1982) are used to facilitate subsystem differentiation and integration. Specifically, physical therapy attempts to both improve body postures and reduce abnormal extremity muscle tone. This theoretically allows the infant to use his or her energy more efficiently, thus taxing the physiological system less. In addition, improvement of underlying balance mechanisms (head and neck righting) improves motor capabilities; the infant learns to control his head and body more efficiently and becomes better able to cope with environmental input and demand.

Improved physiological and motoric functioning facilitates improved state organization. Physical handling, which is appropriate to the current state of the infant and contingently variable in speed, actions, and kinesthetic pressure, allows the infant to achieve a modulated state of alertness. As purported by Als, achievement of a quiet alert state implies social, emotional, and cognitive availability and is therefore a key developmental task of the young infant. Physical therapy effectively expands the preterm infant's strategies to attain and maintain balanced quiet alertness and thus sets the stage for continued developmental progress, central to any interventional program design.

Dyadic interaction is a potent influence upon behavior and development (Sameroff & Chandler, 1975) and is strongly influenced by the mutual perception of each partner of the other. In preterm infant-parent dyads, the perception of the parent is particularly important. Recognition of this fact necessitates that parent education be the other core component of the intervention program. Parent education accesses others to the infant-parent dyad and offers the potential for perceptions to be shaped by the opinions of those outside the dyad. Parent education is therefore a means by which individual parental responses to situations with preterm infants can be modified within a socially supportive context.

Parent education facilitates greater awareness of infant's current developmental capabilities and allows parents to better observe and interpret their infant's behavioral cues and respond appropriately to such. Knowledge of their infant's current developmental status and contact with their infants give parents additional confidence in handling and caring for their infants and results in more realistic observations of their development as well (Zeskind & Iacino, 1984). By learning physical therapy techniques and by understanding the developmental agenda of their infants, parents potentially expand their ability to respond sensitively and contingently to their infant's behaviors.

METHODS

Subjects

The study was conducted at the Special Care Nursery (SCN) and Developmental Evaluation Clinic (DEC) of Prentice Women's Hospital and Maternity Center, Northwestern Memorial Hospital in Chicago. The SCN is a forty bed, Level III nursery with a 90% inborn population. The study sample consisted of two groups of ten subjects each: an intervention group and a control group. Infant selection was based upon established criteria for study inclusion: 1) medically stable at time of selection; 2) mechanical ventilation for less than seven days; 3) absence of congenital anomalies; 4) absence of intraventricular hemorrhage greater than Grade I by ultrasound (Papile, 1978); 5) absence of maternal history of drug or alcohol abuse. Parents of those infants who met selection criteria were contacted by one of the investigators following approval by the SCN attending neonatologist. At this time, parents were advised of the purpose, content and time schedule of the study. They were further advised that all collected information would remain confidential and that the infant's primary physician would be notified should any worrisome condition become apparent during the duration of the study. After written parental permission was obtained, the infant and family were randomly assigned to either the control or the intervention group.

Thirty infants and families were identified as meeting the study criteria over the course of a fifteen month study period. Seven infants were not recruited for reasons such as family language barrier, out of state residence, and/or parental refusal/inability to participate in the study. Three infants were recruited but later excluded from the study secondary to onset of medical complications which precluded study participation (oxygen requirement, feeding intolerance, etc.). Twenty infants born between September 1, 1985 and December 31, 1986 successfully participated in all portions of the study.

Study Design

The infant-parent intervention study was designed to sample patterns of behavior over a period of time in order to observe the interaction of continuity and change. All infants were studied longitudinally from 32±1 weeks through 40±1 weeks conceptional age. The neurobehavioral functioning of both the intervention and control infants was assessed at 32±1 weeks conceptional age using the Assessment of Preterm Infant Behavior (APIB) (Als, 1982). The intervention infants participated in the treatment phase of the study from 32±1 through 36±1 weeks during which time the control infants received the standard SCN medical and nursing care and educational services. All infants were again assessed with the APIB at 36±1 weeks, prior to their SCN discharge. The post-discharge evaluation of each infant in the intervention and control groups was completed at 40±1 weeks conceptional age.

Parents of infants in the intervention and control groups were studied longitudinally as well. All parents completed the Parent Perception Scale at 32±1 weeks. Control group parents and intervention group parents received routine medical, nursing, and educational information when they visited their infants in the SCN. In addition, intervention group parents participated in the individualized educational sessions with the infant's therapist at 32, 34 and 36 weeks.

Parents of infants in both the intervention and control groups completed the Parent Perception Scale at 36±1 weeks, prior to their infant's discharge, and again at 40±1 weeks, upon return to the hospital with their infants for the 40±1 week post-discharge assessment.

Treatment

Physical Therapy

Physical therapy was provided to intervention group infants between the ages of 32±1 and 36±1 weeks conceptional age. For those infants in isolettes, physical therapy sessions took place through the portholes or through the open side door of the isolette. Infants in open cribs were brought to a quiet, semi-darkened room and received therapy on an exercise mat. Therapy sessions occurred twice daily, thirty to forty minutes prior to the infant's feeding. The duration of therapy was dependent upon the infant's state and current gestational age. Fifteen to twenty minute sessions were most typical for 32 through 34 week infants; 35 through 36 week infants were typically treated for twenty-five to thirty minute periods.

Each therapy session began with an observation of the infant's state and spontaneous behaviors. Physical therapy primarily consisted of controlled movements on or off the available surface. In the sidelying position, the infant was placed on either side with extremities flexed and with head, neck, and back in normal alignment. Gentle rolling movements from side to side were provided. In the supported sitting on the surface position, the infant was supported with one hand anterior and one posterior to the trunk; neck was held neutral or semi-flexed. The anterior hand lightly supported the chin, and the legs were positioned in an abducted, externally rotated position on the surface. The arms were positioned in a neutral position, extended toward the body. In the supported sitting off the surface position, the infant was supported with one hand anterior to the trunk and one hand supporting the buttocks and pelvis. This bottom hand placement was used to hold the patient in space, with the legs free to dangle in a semi-supported, relaxed manner. When in either of the two described positions, lateral-lateral and posterior-anterior weight shifting movements occurred. The posterior or the bottom hand stabilized the pelvis while the anterior hand moved the trunk and head in the above noted directions. During the suppported sitting off the surface maneuver, the additional movement of total body vertical was used. The hand placement and body alignment were the same, but the patient was gently moved vertically through space.

The current state of the infant determined the direction and intensity of the therapy provided on each occasion. For example, an infant who was in a quiet sleep state at the beginning of the therapy session would be awakened slowly with gentle rolling movements from an initial sidelying position. With gradual transition to a drowsy state, the speed and/or intensity of the movement would increase at a level commensurate with the state change. Transition to a more upright position would occur when the infant demonstrated a state change to quiet alertness or in order to facilitate such a change. Gentle movement within upright positions, on and off surfaces, would be provided to both elicit and maintain the state of quiet wakefulness. Since achievement of a quiet alert state was considered a developmental advantage within the theoretical framework of this study, efforts were made to prolong the state during the therapy session without unduly taxing either the physiological, motoric, or regulatory systems of the infant. Low-keyed social interaction between infant and therapist occurred before the conclusion of the therapy session only if the infant appeared available for such interaction.

In the event that an infant did not make a transition from a sleep or drowsy state to an alert state throughout the duration of the treatment, appropriate positioning and movement were provided to facilitate maintenance of or return to a quiet sleep state. In the event that an infant was highly aroused at the beginning of or during a treatment session, repositioning and movement were utilized to facilitate return to a quiet wakeful or a quiet sleep state. In all situations, each infant was re-positioned in prone or sidelying positions at the conclusion of the treatment and was ovserved until return to a quiet sleep or quiet wakeful state was assured.

Parent Education

Education of parents of infants in the intervention group occurred at 3 points in time during the hospital stay, at 32±1, 34±1, and 36±1 weeks conceptional age. Each parent session included: 1) observation and discussion regarding infant's current state and quantity and quality of infant's spontaneous movements; 2) demonstration of appropriate positioning of infant for maintenance of quiet sleep or quiet wakefulness; 3) modeling of appropriate holding and movement of the infant to facilitate elicitation and/or maintenance of quiet alert state; 4) discussion of impact of normal posture and movement upon the infant's state and attention.

1. Observation and discussion regarding infant's state and quality and quantity of movement

The therapist would identify the state of alertness demonstrated by the infant and would characterize the infant's movements as smooth, jerky, wide-arced, diffuse, stretching type or tremulous. He would point out infant's exhibition of salutes, finger splay, bracing, hand to mouth, airplane, etc., as defined on the APIB.

2. Demonstration of appropriate positioning for maintenance of quiet sleep or wakeful state

The therapist would show the parent how to place the infant in prone or sidelying positions, with extremities flexed and head aligned appropriately with body. Blanket rolls would be utilized as necessary to stabilize the infant in the correct position. The therapist would describe the benefits of correct repositioning of the infant in terms of its effects upon the infant's state and activity level.

3. Demonstration of appropriate movement of the infant to facilitate quiet alertness

The therapist would show the parent how to place the infant in sidelying position for rolling movement or in upright position for weight-shifting movements (as previously described in Treatment section). The therapist would demonstrate the movement and would describe the movement's impact upon the infant's state. The parent would practice the activities with the infant in the therapist's presence at parent's own discretion.

4. Discussion of impact of normal posture and movement upon infant's state, attention, and development

The therapist and parent would discuss the impact of normal body alignment and controlled movement upon the infant's state of consciousness. The potential implications of repeated experience with normal position and movement upon the infant's behavior and development were identified. The parent was encouraged to utilize these techniques at her own discretion when visiting the infant in the SCN. The importance of time spent by the infant in quiet wakefulness or quiet sleep was emphasized.

The specific nature of information discussed and activities demonstrated at each teaching session was individualized to meet the particular needs of both the infant and parent. Special emphasis was consistently placed upon teaching each parent to identify the infant's current state and quality of movement and techniques to utilize for elicitation and/or maintenance of quiet sleep or alertness. Calming techniques were particularly emphasized at the 36 week teaching session since this time typically coincided with the availability of ligher levels of state functioning (active wakefulness and/or irritable crying) in many preterm infants.

Measures

The effectivness of the SCN infant-parent intervention program was assessed in terms of: 1) medical/physical outcome during and after the infant's hospitalization; 2) developmental outcome at 36±1 and 40±1 weeks conceptional age; 3) parental perception at 36±1 and 40±1weeks; and 4) frequency of parental visitation during the infant's hospitalization.

1. Medical/Physical Status of Infants

Relevant medical information pertaining to each infant was collected and recorded throughout the infant's hospitalization through examination of physician/nursing notes in the medical chart. This included information related to birth status and growth parameters as well as respiratory and central nervous systems functioning. Information regarding the infant's current physical condition was recorded at each assessment; onset of full nipple feeding and number of days of hospitalization were also noted.

Each infant's weight, length, and head circumference were recorded at the 40±1 week assessment. Measurements were conducted in a standardized manner by one of the investigators; the same scale in the Developmental Evaluation Clinic was utilized to weigh each infant. All medical charts were re-reviewed at the conclusion of the study to insure accuracy of recorded information.

2. Infant Neurobehavioral Functioning

All infants were studied longitudinally from 32±1 weeks through 40±1 weeks conceptional age. The neurobehavioral functioning of each infant was assessed at 32±1weeks, 36±1 weeks, and 40±1 weeks using the Assessment of Preterm Infant Behavior (APIB) (Als, Lester, Tronick, & Brazelton, 1982). The APIB is a substantial refinement and extension of the Brazelton Neonatal Behavioral Assessment Scale (NBAS) (Brazelton, 1973) and is appropriate for preterm and other high risk infants. In the APIB, the maneuvers of the NBAS are used as graded sequences of increasingly intrusive environmental input, moving from distal stimulation presented during sleep to mild tactile stimulation, to medium tactile and vestibular stimulation and then to social stimulation. The APIB yields six major summary scores of behavioral functioning that quantify the infant's reactivity and thresholds of disorganization and stress in response to various environmental input. Specific areas measured include autonomic functioning, motoric functioning, state organization, attentional functioning, self-regulation capacity, and degree of environmental facilitation necessary to help the infant maintain or regain synchronization of internal subsystem stabilization. The APIB also provides detailed information on each individual task presented and allows for the documentation of specific regulation that reflects the infant's current thresholds of balance and stress.

The validity of the APIB has been recently documented in the identification of stable, reproducible patterns of behavior in preterm and fullterm infants two weeks after expected due date (Als, 1985) and in the identification of orderly electrophysiological correlates to behavioral patterns implicating differential vulnerability of the right hemisphere and the frontal lobe (Duffy, 1985). In addition, predictive validity to nine months and to five years has identified the low threshold, easily disorganized infant as at greater risk for later organizational difficulties (Als, 1985). APIB data has also been found to be robust in that assignment of infants to groups by cluster analysis resulted in 86% correspondence between group category and assigned cluster.

Administration and scoring of the APIB was conducted in this study by the author, who was deemed reliable according to established criteria and blinded to the group membership of the subject. The assessment was scheduled at an appropriate time in the sleep-wake cycle of the infant. For the 32±1 week assessments, evaluations were scheduled to occur after the infant had maintained a sleep state for at least 60 minutes and at least 45 minutes prior to the next nursing check. 36±1 week assessments occurred 60-90 minutes prior to the infant's next feeding. Outpatient, 40±1 week assessments were coordinated with the infant's current state cycle as well. Parents were contacted by telephone one to two days prior to the evaluation. The examination was then scheduled so that the infant would arrive at the DEC 90-120 minutes prior to his next expected feeding time. Parents were requested to make every effort to arrive at the DEC with the infant in a quiet sleep state. Scoring of the APIB was completed within three hours after the conclusion of the assessment.

3. Parent Perception Scale

An adapted version of the Parent Perception Scale (PPS) (Holmes, Nagy, Danko, & Slaymaker, 1983) was utilized to assess parents' perceptions and understanding of their preterm infant's characteristics. This scale was based upon the Neonatal Perception Inventory (NPI) (Broussard & Hartner, 1970), a projective measure designed to allow parents to rate the behavioral and affective characteristics of their child and the "average" child.

The NPI and PPS score is derived by determining the discrepancy between the mother's rating of her own infant and the average infant. If a mother rates her baby as better than average, her perception is considered positive and the infant is considered to be at low risk for subsequent psychosocial disorder. Given any other maternal rating, the perception is considered negative and the infant is thought to be at higher risk for developmental delay. A significant association (p .007) was demonstrated between the NPI risk rating at one month and psychiatric rating at age 15 (Broussard, 1981).

Items of the PPS were presented along a seven point semantic differential scale (Osgood, Suci, & Tannebaum, 1957) in dimensions reflecting the infant's behavior and affective characteristics and maternal orientation. They include: calmness, quality of sleep, size, consolability, eating ability, movement, state control, strength, activity, alertness, tactile sensitivity, predictability, and parent worriment. The PPS was administered to all parents at 32±1, 36±1, and 40±1 weeks conceptional age. It was explained to all parents prior to their completion of the scale and an example was reviewed. Parents were instructed to circle the number that reflected their understanding of their infant's current behaviors as well as their conception of the "average" infant's typical behavior at the same time period. The PPS was completed concurrently by the same examiner who evaluated to infant with the APIB.

4. Parent Visitation Behaviors

Frequency of parent visitation was recorded throughout the infant's hospitalization. Nursing notes in the medical chart were reviewed daily to determine whether the parent visited the infant in the preceeding twenty-four hour time period. When possible, this information was corroborated through interview with the infant's primary nurse.

Data Reduction

The individual system scores, behavioral items, and reflexes of the APIB were reduced to the 30 clusters derived by Als (1984). In the clustering procedure, modifications of individual scores on behavioral items were made so that higher scores on a nine point scale represented more optimal performance. System scores (physiological, motor, state, attention, regulation and examiner facilitation), on the other hand, were derived such that lower scores were more optimal. Of the 30 clusters, 17 of those judged most pertinent to the hypotheses of the study were selected for analyses and interpetation (see Table 1 for clusters names and descriptions).

The individual dimension scores of the PPS were also recoded and reduced to summary scores for analyses. All dimensions were first recoded so that all higher scores represented a more optimal perception. A summary score for both mother's "my baby" and mother's "average baby" was then derived. A difference score was also computed by subtracting the "my baby" summary score from the "average baby" summary score. This score indicates the degree and manner in which the mother perceives her baby to deviate from the average baby of the same age.

Similar procedures were completed for the observer perception scales. A summary score (observer's "my baby" score) was derived from the observer's rating of each infant on all dimensions of the PPS. A difference score (observer's difference score) was computed by subtracting mother's "my baby" scores from observer's "my baby" scores. This score indicates the degree and manner in which the mother perceives her infant differently from the rating of the observer. Table 2 presents a summary of dimensions included in the PPS.

TABLE 1

DEFINITION OF APIB CLUSTERS

Physiological System	stability and modulation of infant's cardiorespiratory system, color, and visceral reactions
Motor System	motor reactivity as demonstrated by tone, movement, posture,and activity
State System	state organization, as demonstrated by the range of states from sleeping through alertness to crying, the pattern of state transitions, and robustness of state maintenance
Attentional System	quality, responsivity and duration of alert states
Regulatory System	ability to maintain levels of behavioral organization in autonomic, motoric, and state systems with increasing exam manipulation
Examiner facilitation	input provided by the examiner to elicit behavioral responses
Orientation	ability of infant to orient to animate and inanimate visual and auditory input
Autonomic	degree of tremulousness, startles, skin color lability and threshold to color change during examination
Motor Maturity	degree of flaccidity versus hypertonicity and degree of smoothness of limb movements

TABLE 1 (continued)

Alertness	quality of alertness during interaction and degree of examiner facilitation necessary to sustain alertness
Range of State	regulation of state functioning as reflected by flexibility of state and level of irritability
Stability of State	stability and lability of state functioning as reflected by level of arousal and consolability
Autonomic signals	indicators of physiological stress
Motor signals	indicators of motoric distress
Motor self regulation	indicators of self-regulation behaviors
State signals	indicators of state stress
Attention signals	indicators of attentional stress

TABLE 2

DIMENSIONS OF PARENT PERCEPTION SCALE

Calmness: calm/excitable

Quality of Sleep: sleeps lightly/sleeps well

Size: small for age/big for age

Consolability: is easily consoled/is difficult to console

Eating Ability: eats well/eats poorly

Movement: usually moving/rarely moving

State Control: quiet, does not cry/cries a lot

Strength: weak and fragile/healthy and strong

Activity: passive/active

Alertness: usually sleepy/usually awake, alert

Tactile Sensitivity: likes to be touched/doesn't like to be touched

Predictability: predictable/unpredictable

Parent Worriment: causes me a lot of worry/causes me little worry

Statistical Analyses

All statistical analyses were performed using the statistical package for the social sciences (SPSS-X, 1983). Students' t-test were computed to determine the comparablity of the physical and medical characteristics of the two groups. Chi-square analyses were also performed to determine the significance of differences in demographic variables between the two groups. Split plot multivariate analyses of variance with repeated measures were performed to measure the effects of the intervention program on both the infants' behavior and parental perceptions. Scheffe's tests were calculated to determine the source of interactive effects obtained in the multivariate procedures (Kirk, 1982). Multiple discriminant analysis was utilized to derive the linear combination of independent variables that best discriminate between the intervention and control groups.

RESULTS

Comparability of Intervention and Control Groups

The recruitment procedures and random assignment of infants to groups resulted in adequate comparibility of the intervention group to the control group. Student's t-tests, two-tailed, performed for gestational age, birthweight, length at birth, head circumference at birth, Apgar scores at one and five minutes, maternal age, and number of siblings were not significant (See Table 3). The gestational ages of subjects in the intervention and control groups are provided in Table 4. Similarly, there were no significant differences in maternal social class, marital status, educational level, or infants' sex or race (See Table 5). Inspection of specific medical variables upon entry into the study revealed no significant differences between delivery type, incidence or severity of respiratory distress syndrome or intraventricular hemorrhage in the two groups (See Table 6). The intervention and control groups were therefore comparable in initial severity of illness and demographic background.

TABLE 3
COMPARISON OF INTERVENTION AND CONTROL GROUPS ON
NEWBORN/MATERNAL CHARACTERISTICS

VARIABLES	INTERVENTION[a]	CONTROL	t-VALUE	p VALUE
Gestational Age (wks)	30.5 (1.1)	30.5 (.7)	0.0	1.0
Birthweight (gms)	1412.0 (257)	1393.0 (85.6)	.22	.83
Length (cm)	40.2 (1.5)	40.8 (.9)	- .98	.34
Head Circumference (cm)	28.2 (1.3)	27.7 (1.0)	1.01	.33
One Minute Apgar	5.3 (2.1)	5.2 (2.7)	.09	.93
Five Minute Apgar	7.7 (1.1)	7.8 (1.4)	- .18	.86
Maternal Age	27.8 (6.8)	24.6 (7.1)	1.03	.32
Number of Siblings	.90 (1.2)	.50 (.85)	.85	.40

a=$\overline{X}$, SD

TABLE 4

GESTATIONAL AGES OF INFANTS
IN INTERVENTION AND CONTROL GROUPS

Intervention		Control	
Subject	Age (weeks)	Subject	Age (weeks)
1	29	1	31
2	31	2	29
3	32	3	30
4	30	4	30
5	31	5	31
6	31	6	31
7	30	7	30
8	32	8	31
9	30	9	31
10	31	10	31
	$\overline{X}$=30.5 SD=1.1		$\overline{X}$=30.5 SD=0.7

TABLE 5

COMPARISON OF INTERVENTION AND CONTROL GROUPS
ON DEMOGRAPHIC VARIABLES

VARIABLES		INTERVENTION	CONTROL
Sex_b	Male	5	4
	Female	5	6
$Race_c$	Caucasian	2	2
	Black	4	6
	Hispanic	4	2
SES_c	Lower	5	5
	Middle	3	4
	Upper	2	1
Maternal $Education_c$	High School	4	5
	College	2	3
	College grad	4	2
Marital $Status_c$	Married	5	5
	Divorced	1	1
	Single	4	4

Note: No significant differences between groups.

b Fischer's Exact Test
c Chi Square

TABLE 6

COMPARISON OF INTERVENTION AND CONTROL GROUPS ON MEDICAL CHARACTERISTICS/COMPLICATIONS

VARIABLES		INTERVENTION	CONTROL
Delivery type[b]	Vaginal	4	4
	C-section	6	6
Respiratory Distress Syndrome[c]	Absent	4	4
	Mild	5	6
	Moderate	1	0
Intra-ventricular Hemorrhage[b]	Absent	9	9
	Grade 1	1	1
Apnea[b]	Absent	6	4
	Present	4	6

Note: No significant differences between groups

b Fischer's Exact Test
c Chi Square

Special Care Nursery Outcome

Inspection of medical outcome variables revealed no significant differences between the intervention and control groups. Weight, length, and head circumference at discharge were comparable (p>.05) for both groups. Number of days in the hospital and number of days until full nipple feeding did not reach significant levels, although group differences were in the direction favoring the intervention group, i.e., somewhat earlier discharge and nipple feeding for the intervention group (See Table 7). Similarly, the number of infants requiring theophylline for the control of apnea at the time of discharge from the SCN was lower for the intervention group than for the control group; this difference was not statistically significant, however (See Table 6).

Rate of parental visitation of infants in the SCN did not differ significantly between the intervention ($\underline{M}$=22.4) and control ($\underline{M}$=14.4) groups, $\underline{t}(18)=1.81$, $p<.10$. Group differences, however, again favored the intervention infants, with intervention infants being visited an average of eight times more frequently than the control infants during an approximately thirty-eight day hospitalization.

Growth parameters at the forty week assessment were comparable (p>.05) for the two groups (See Table 8). There were no significant differences in weight, length, or head circumference for the intervention and control groups at the forty week assessment.

TABLE 7

DISCHARGE GROWTH PARAMETERS

VARIABLE VALUE	INTERVENTION[a]	CONTROL	t VALUE	p
Discharge weight (gm)	2021.0 (116.7)	2114.2 (110.4)	- 1.83	.08
Discharge length (cm)	44.7 (1.7)	45.1 (1.6)	- .61	.55
Discharge head circ. (cm)	31.8 (.8)	31.6 (.9)	.31	.76
Days to nipple feeding	33.5 (9.5)	35.8 (5.4)	.66	.52
Days visit	22.4 (13.2)	14.4 (5.1)	1.81[b]	.10
Length hosp(d)	37.8 (11.1)	38.8 (5.5)	- .25[b]	.80

a = $\overline{X}$, SD

b = 2 tailed probability from the separate variance procedure (df for hosp = 13.21, visit = 11.75). All other t values are from the pooled variance procedure with df = 18.

TABLE 8

FORTY WEEK GROWTH PARAMETERS

VARIABLE	INTERVENTION[a]	CONTROL	t-VALUE	p VALUE
40 week weight (kg)	3.2 (.45)	3.3 (.27)	-.30	.77
40 week length (cm)	47.9 (1.1)	48.1 (1.8)	-4.0	.70
40 week head circumference (cm)	35.1 (.88)	35.0 (1.1)	.18	.86

a = $\overline{X}$, SD

Developmental Outcome

Split-plot factorial analyses of variance were utilized to determine the main effects of the intervention as well as the effects of time and group by time interactive effects. Random assignment of infants and parents to intervention and control groups resulted in samples which were normally distributed and homogeneous, therefore assuring that the assumptions for analyses of variance were met. Significant main effect differences between the intervention and control groups were found in five of the seperately analyzed APIB cluster scores. The intervention infants' autonomic functioning, $F(1,18)=5.24$, $p \leq .05$, as reflected in the degree of tremulousness, threshold to startles and color change, and skin color lability was more optimal than that of the control infants. Intervention infants' motor maturity, $F(1,18)=11.98$, $p \leq .01$, as demonstrated by their posture and muscle tone, was more adequate than that of control infants while their tendency to demonstrate signs of motoric distress, $F(1,18)=6.14$, $p \leq .01$, was reduced. Intervention infants' state stability, $F(1,18)=9.71$, $p \leq .01$, that is their ability to self-quiet and self-console when motorically aroused, was similarly more intact than that of control infants. Finally, the intervention infants' ability to orient visually and auditorally to inanimate and animate stimuli, $F(1,18)=18.33$, $p\leq.01$, was more fully developed than that of control infants at the conclusion of the study. (Means and standard deviations of the APIB cluster scores are presented in Tables 9, 10, 11).

Further analyses of the results indicate that significant group by time interaction effects occurred in the cluster scores of physiology, $F(2,36)=4.85$, $p\leq.01$, motor maturity, $F(2,36)=7.44$, $p\leq.01$, motor reactivity, $F(2,36)=3.15$, $p\leq.05$, signals of motor distress, $F(2,36)=5.61$, $p\leq.01$, stability of state, $F(2,36)=5.36$, $p\leq.01$, range of state, $F(2.36)=4.70$, $p\leq.01$, attention, $F(2,36)=4.35$, $p\leq.05$, and orientation, $F(2,36)=3.19$, $p\leq.05$. Post hoc analyses of group differences using the Scheffe test indicated significantly more optimal scores for the intervention group at 36 and/or 40 weeks (See Figures 1-8 in Appendix A and Tables 9, 10, 11).

No significant main effects, or group by time effects were found in the remainder of analyzed cluster scores. These include: state system, regulation, examiner facilitation, alertness, signals of attentional distress, signals of autonomic distress, signals of motor self-regulation and state signals. Significant effects of time, however, were obtained in most APIB cluster scores: autonomic, $F(2,36)=4.19$, $p\leq.05$, signals of autonomic distress, $F(2,36)=6.90$, $p\leq.01$, motor reactivity, $F(2,36)=4.75$,

TABLE 9

APIB CLUSTER SCORES

CLUSTER		32 Weeks[a]	36 Weeks	40 Weeks
Physiology	Intervention	3.81 (.4)	3.41 (.5)*	3.67 (1.0)
	Control	3.47 (.6)	4.13 (.4)*	4.12 (.8)
Motor Reactivity	Intervention	3.83 (.4)	3.54 (.7)*	3.91 (1.1)*
	Control	3.81 (.6)	4.23 (.7)*	4.83 (.9)*
State	Intervention	4.92 (.6)	3.60 (.5)	3.81 (1.4)
	Control	4.76 (1.0)	4.16 (1.0)	5.00 (1.2)
Attention	Intervention	7.41 (.9)	5.20 (1.1)*	5.38 (.8)
	Control	6.94 (1.3)	6.31 (1.1)*	6.31 (1.1)
Regulation	Intervention	3.65 (.6)	3.35 (.8)	4.17 (1.5)
	Control	3.53 (.7)	4.29 (.8)	5.26 (1.5)
Examiner Facilation	Intervention	3.47 (.5)	3.19 (.6)	4.13 (1.4)
	Control	3.39 (.7)	4.10 (.8)	5.23 (1.5)

Note: Lower scores are more optimal

a = $\bar{X}$, SD

* $p < .05$ on Post Hoc Scheffe

TABLE 10

APIB CLUSTER SCORES

CLUSTER		32 Weeks[a]	36 Weeks	40 Weeks
Autonomic	Intervention	6.09 (1.3)	6.77 (1.0)	7.31 (1.1)
	Control	5.74 (1.2)	5.56 (1.2)	6.45 (1.2)
Motor Maturity	Intervention	3.48 (.9)	5.32 (1.0)*	5.43 (1.1)*
	Control	3.62 (.6)	3.92 (.8)*	3.60 (1.1)*
Stability of State	Intervention	5.06 (1.2)	6.49 (1.0)	6.15 (1.1)*
	Control	5.41 (1.0)	5.65 (1.2)	4.07 (1.3)*
Range of State	Intervention	5.00 (.6)	6.74 (1.1)*	6.36 (1.3)*
	Control	5.32 (1.3)	5.44 (1.0)*	5.04 (1.5)*
Orientation	Intervention	3.62 (.6)	5.32 (.7)*	5.00 (.6)*
	Control	3.36 (.7)	3.97 (.9)*	4.00 (.8)*
Alertness	Intervention	3.30 (.8)	4.82 (.4)	5.25 (.8)
	Control	3.12 (1.2)	4.51 (.7)	4.61 (1.2)

Note: Higher scores are more optimal

a = $\bar{X}$, SD

* $p < .05$ on Post Hoc Scheffe

TABLE 11

APIB CLUSTER SCORES

CLUSTER		32 weeks[a]	36 weeks	40 weeks
Signals of Autonomic Distress	Intervention	0.23 (.2)	0.46 (.2)	0.59 (.3)
	Control	0.36 (.3)	0.52 (.3)	0.54 (.3)
Signals of Motor Distress	Intervention	1.07 (.4)	1.24 (.5)	1.10 (.4)*
	Control	1.05 (.5)	1.56 (.4)	1.88 (.6)*
Signals of Motor Self-Regulation	Intervention	1.05 (.4)	1.40 (.3)	1.21 (.4)
	Control	1.12 (.6)	1.20 (.6)	1.43 (.5)
Signals of State Stress	Intervention	.57 (.2)	.71 (.3)	.41 (.4)
	Control	.63 (.2)	.82 (.4)	.52 (.4)
Signals of Attention Stress	Intervention	.20 (.2)	.64 (.3)	.67 (.5)
	Control	.30 (.3)	.51 (.2)	.80 (.3)

Note: Lower scores are more optimal

a = $\overline{X}$, SD

* $p < .05$ on Post Hoc Scheffe

$p \leq .05$, motor maturity, $F(2,36)=9.65$, $p \leq .01$, signals of motor distress, $F(2,36)=7.16$, $p \leq .01$, state, $F(2,36)=5.74$, $p \leq .01$, range of state, $F(2,36)=4.63$, $p \leq .05$, stablity of state, $F(2,36)=3.95$, $p \leq .05$, attention, $F(2,36)=14.70$, $p \leq .01$, alertness, $F(2,36)=22.60$, $p \leq .01$, orientation, $F(2,36)=16.32$, $p \leq .01$, regulation, $F(2,36)=7.75$, $p \leq .01$, and examiner facilitation, $F(2,36)=12.05$, $p \leq .01$.

Multiple discriminant analysis yielded a linear discriminant function which indicated a statistically significant difference between the intervention and control groups. Those variables that most effectively discriminated between the intervention and control groups included: motor reactivity at 40 weeks, motor maturity at 40 weeks, examiner facilitation at 40 weeks, regulation at 40 weeks, stablity of state at 40 weeks, and orientation at 36 weeks (See Table 12). The derived discriminant function had a X^2 of 45.74 with an associated p value of .000. The intervention group had significantly more optimal scores on the variables entered in the stepwise discriminant procedure.

Despite significant differences in the behavioral functioning of intervention and control group infants (as measured by the APIB), parental perceptions of their infants and average infants and the difference between the two were not significantly influenced by the intervention program. No significant main

TABLE 12

VARIABLES ENTERED IN DISCRIMINANT ANALYSIS

Physiology 36 weeks, 40 weeks

Motor Reactivity 36 weeks, 40 weeks

State 36 weeks, 40 weeks

Attention 36 weeks, 40 weeks

Regulation 36 weeks, 40 weeks

Examiner Facilitation 36 weeks, 40 weeks

Motor Maturity 36 weeks, 40 weeks

Signals of Motor Distress 36 weeks, 40 weeks

State Stability 36 weeks, 40 weeks

Range of State 36 weeks, 40 weeks

Orientation 36 weeks, 40 weeks

effects, effect of time, or group by time interaction effects were obtained (See Table 13). Parents in both the intervention group and control group typically perceived their own infants more positively than "average" infants.

Differences between the two groups were, on the other hand, perceived by the assessor of infant neurobehavioral functioning when this observer completed the PPS at the conclusion of each neurobehavioral assessment. Analyses of the observer's perception scores revealed significant group, $F(1,18)=4.45$, $p \leq .05$, time, $F(2,36)=6.49$, $p \leq .01$, and group by time, $F(2,36)=7.80$, $p \leq .01$, effects of the intervention. The observer's perceptions of infants in both groups were typically lower than parents' perceptions. While the observer perceived the two groups of infants quite similarly at 32 weeks, the scores of the intervention group increased relative to the control group scores between 32 and 40 weeks such that the intervention group received significantly higher ratings ($p \leq .05$) than the control group at the 40 week assessment period (See Table 13).

TABLE 13

PERCEPTION SCORES

Perception Score		32 Weeks[a]	36 Weeks	40 Weeks
Mother's "My Baby" Score	Intervention	60.9 (6.9)	62.0 (12.4)	61.6 (11.2)
	Control	62.2 (7.5)	63.0 (7.6)	60.3 (7.7)
Mother's "Average Baby" Score	Intervention	57.5 (7.5)	61.0 (8.2)	58.7 (7.7)
	Control	59.7 (8.9)	61.5 (9.9)	64.5 (9.1)
Mother's Difference Score	Intervention	-3.4 (4.3)	-1.0 (11.6)	-2.9 (7.4)
	Contol	-2.5 (12.0)	-1.5 (7.6)	4.2 (12.9)
Observer's "My Baby" Score	Intervention	48.8 (2.8)	56.7 (6.7)	58.8 (10.5)*
	Control	49.4 (4.5)	53.2 (6.0)	46.7 (7.7)*
Observer's Difference Score	Intervention	-12.1 (5.7)	-5.3 (12.2)	-2.8 (8.5)
	Control	-12.8 (8.0)	-9.8 (6.4)	-13.6 (7.9)

a = $\bar{X}$, SD
*$p \leq .05$ on Post Hoc Scheffe

DISCUSSION

Early infant development is characterized by a coordination of change and stability in physiological, motoric, state, attentional, and regulatory systems over time. Stability of positive functioning and positive change over time are advantageous; development of underlying subsystem stability facilitates the emergence of higher level behavioral and cognitive functioning.

The results of this study indicate that the SCN infant-parent intervention program positively affected the integration of behavioral subsystems for infants in the intervention group. The intervention group's autonomic and motoric functioning, their state stability, and their visual/auditory orientation were generally more optimal than those of the control group when they reached fullterm age. In addition, the intervention had specific differential effects upon the infants at particular times in their development between 32 and 40 weeks.

For example, the intervention group infants' physiological functioning, as reflected in their respiration pattern, color, and visceral reactions, stabilized between 32 and 36 weeks to such an extent that it differed significantly with the physiological status of the control group at the 36 week time period (Figure 1). Similarly, the motoric reactivity of the intervention group was relatively stable across time whereas the control group tended to deteriorate, resulting in significantly differential functioning at both 36 and 40 weeks (Figure 2). The intervention group demonstrated greater motor maturity (Figure 3) at both time periods and fewer signals of motor distress (Figure 4) at 40 weeks as well.

The trend of increasing disorganization among control group infants relative to intervention group infants is also evident in their state functioning. Stability of state diminished for control group infants between 36 and 40 weeks to the extent that they distinguished themselves significantly from the intervention group infants at 40 weeks (Figure 5). Further, intervention group infants exhibited a more mature range of state functioning at both 36 and 40 weeks (Figure 6).

It would appear that the SCN intervention facilitated the internal subsystem organization which allowed the intervention group infants to more successfully manage environmental input and thus show greater behavioral competence relative to control infants. The attentiveness of the intervention group improved between 32 and 36 weeks such that their alertness was more robust at 36 weeks than that of control infants (Figure 7). The intervention infants similarly demonstrated better orientation to visual and auditory input at 36 and 40 weeks (Figure 8) than did the control group infants. Their social availability suggests that intervention group infants have greater potential for reciprocal interaction with their parents at home than do the control group infants.

While the intervention affected some positive impact upon the behavioral organization of the intervention group, it simultaneously had no negative impact upon the growth and development of the intervention infants relative to control infants. The intervention group did not differ from the control group in growth parameters after the four week intervention period in the SCN or after their first four weeks at home. The intervention groups' efficiency of physiological functioning was also reflected in the comparable rates at which they accomplished full nipple feeding and interim to discharge from the hospital.

These positive findings of the study, while encouraging, must be considered in concert with the non-significant findings of the study. Parental perceptions and parental rate of visiting their babies did not differ significantly by virtue of their participation in the intervention program. In addition, significant effects of the intervention were not found in various infant behavioral dimensions.

The lack of significant measurable effect of intervention upon parental perception suggests that parents' understanding of their babies during this time period is generally positive, regardless of objective information relayed concerning the infant's developmental functioning. Individual parental history and current psychological functioning appear to have a more powerful influence upon parents' judgments of their babies than do the observations/input of an objective observer. It is of interest, however, that the discrepancy between parents' perception and observer's perception of the same infant appears to diminish (although not significantly) over time for the intervention group while it remained relatively large for the control group (See Table 11). This suggests that intervention group parents may have begun to be more realistic and objective about their infants' behavior. Also of interest is the fact that control group parents viewed their infants less positively than the "average" infant at 40 weeks, suggesting that they may be beginning to perceive that the infants' behaviors are less than what they consider to be typical.

Irrespective of these speculations, the possibility exists that failure to find significant group differences in parental perceptions is an artifact of the assessment device utilized in the study. Since an adapted version of the Parent Perception Scale (Nagy, Holmes, Danko, & Slaymaker, 1983) was created for this study, reliability and validity data are not available. The lack of significant differences between and within groups over time may indicate that this assessment tool is not sensitive to the true perceptions of parents of developing preterm infants.

The fact that parents of intervention infants visited their infants an average of eight more times than did control group parents, within a similar time period, suggests that the intervention may have influenced their behavior in a positive, yet statistically non-significant manner. Intervention parents may have realized that their interactions with their babies have developmental implications and that techniques learned during educational sessions could be used to facilitate their infants' physical comfort and state control.

In future intervention studies, parental attitude and behavior may be better assessed through additional mechanisms, such as parent interview or observation of a parent during infant handling or routine care. These types of assessment mechanisms may more clearly discriminate the differential effects of parent education upon parental adaptation to a preterm infant.

The lack of significant differences between the intervention and control groups on various APIB behavioral dimensions (state, regulation, examiner facilitation, alertness, signals of attentional distress, signals of autonomic distress, signals of motor self-regulation, and state signals) may be related to true lack of differences between the two groups. However, the likelihood of noting intervention effects may also be influenced by the use of cluster scores in analyses of group differences as measured with the APIB. Although cluster score rather than item score analysis effectively reduces the amount of data for statistical investigation, it also tends to diminish one's ability to discern subtle behavioral differences between and within preterm infants. It may reduce the likelihood of understanding the developmental complexity of preterm infants and lessen the chance of noting intervention effects. The fact that the APIB cluster scoring system successfully identified significant change over time for both groups of infants, however, tends to attest to its value as a sensitive index of early infant development.

Various study design factors likely impacted upon experimental results as well. For example, the two modes of treatment, physical therapy and education, were necessarily variable to meet the emerging individual needs of the infant-parent dyad. Physical therapy and education were not operationally defined in a strict manner or standardized in their application or implementation. Rather, specific physical therapy maneuvers matched the current state and body posture of the infant as opposed to utilizing a pre-established routine. Educational sessions were similarly flexible by design so as to match the family system's interactive style. The goodness of fit between the physical therapy/education and the infant parent dyad was considered more critical in this study than was standardization of implementation.

The lack of operationally defined independent variables, while necessary to the study, makes confirmation of replication studies more difficult. Future intervention designs should consider methods to more clearly define the intervention without loss of the flexibility necessary for program success.

Other design factors likely influenced the findings as well and resulted in maintenance and/or attenuation of intervention effects for the intervention group between 36 and 40 weeks, rather than continued improvement. For example, lack of daily physical therapy and intermittent parent education for the intervention group infants between 36 and 40 weeks perhaps interrupted their stability or trend towards increasingly better organized subsystem functioning (as reflected in their physiological and attention cluster scores). Concurrently, the greater availability of varying experiences at home may have dampened intervention infants' emerging abilities to absorb and adapt to environmental input effectively. Coupled with these new environmental factors is the fact that the 36-40 week time period is one of inherent rapid reorganization. Both neurological maturation and the increasing availability of energy tend to produce wider, more variable ranges of infant behavior than is typically observed between 32 and 36 weeks. As a result, positive change by intervention infants may not be as easily demonstrated in all subsystems during that time period; the positive effect of the intervenion may have been reflected in their ability to maintain subsystem organization between 36 and 40 weeks rather than actually improve their subsystem functioning.

An additional factor to consider upon examination of study results is the ability of parents to implement the intervention in the home setting. Intervention group parents may have had variable abilities to recall and utilize the specific suggestions and information gleaned during the parent sessions. At the same time, the control parents were quite likely developing their own successful strategies for caring for their infants at home, thus diminishing the degree of difference between the intervention and control groups.

The effects of the intervention program may be better maintained and potentiated if the model included supplemental post-discharge contact with the parents. Additional contact and support during the 36-40 week time period could help reinforce the handling and developmental suggestions demonstrated and discussed in the SCN.

CONCLUSION

The individualized approach to the preterm infant-parent dyad in the Special Care Nursery improved infants' bio-behavioral organization during the neonatal period. The combination of infant physical therapy and parental education during hospitalization resulted in better differentiation and modulation of infant-parent functioning which persisted, to some extent, even after the formal intervention period ended. The model thus appears viable and worthy of further study.

The results of this study suggest that physical therapy is an effective mechanism to promote positive developmental change in preterm infants. Stimulation which was contingent to the infant's current level of developmental organization facilitated further elaboration of modulated responsivity. As a result of improved integration of physiological, motoric, and state functioning, intervention infants became better able to engage in reciprocally reinforcing social interactions with others.

The findings of the study also suggest that parents of preterm infants perceive their infants in a generally positive manner, irrespective of specific information they learn regarding the infant's current level of developmental organization/ disorganization. The effects of learning specific handling techniques demonstrated themselves only indirectly and in the infants' behaviors rather than in measurable parent perception. Positive neurobehavioral functioning during the 36-40 week time period was apparent in the intervention group infants in a number of behavioral dimensions (motor, state, and orientation), suggesting that their home environment was, at least to some extent, conducive to further elaboration and integration of adaptive behaviors. The fact that intervention group parents visited their infants more frequently in the SCN also suggests that parents were positively affected by learning that their behaviors potentially influence their infants' early development.

These results suggest that future SCN intervention programs be designed to provide the therapeutic handling which appears to facilitate preterm infant development. The SCN intervention program should also attempt to capitalize upon the positive perceptions parents typically have of their own infants. SCN intervention should direct parental energies toward sensitive and flexible handling of infants at home as well as towards a beginning understanding of the complex nature of infant behavior during a volatile neonatal period for both infant and parent.

Although this intervention program focused upon facilitating the development of the relatively healthy preterm infant and his parent, it may also be appropriate for use with the very immature, low birthweight preterm infant who typically has significant and sometimes chronic medical complications. The individualized approach, with focus upon promotion of subsystem development and integration, requires that intervention/stimulation be contingent upon the infant's current level of organization/disorganization. As such, it allows for provision of protective support when the infant's energies need to be preserved for effective physiological functioning; promotion of development through activity occurs only when the infant's energy becomes available.

This model is also appropriate for use with parents of very immature, low birthweight infants. Since these infants are typically fragile, vulnerable to overstimulation, and behaviorally disorganized, it is often difficult for parents to interact with them in a mutually rewarding manner. Parent education which focuses upon teaching parents ways to sensitively handle the infant is a mechanism by which parents may become effective agents for positive change in their infants.

While this study focused upon the early development of the preterm infant-parent dyad, the intervention model is adaptable to long-term intervention strategies. The motor activities utilized to facilitate neonatal subsystem organization may be easily modified to effect environmental exploration and organization as the preterm infant develops. Similarly, the parent education component of the model can be adapted to the individual needs of the developing child-parent system in its own milieu. Appropriate parental observations and positive expectations can be supported and reinforced as the infant and parent interact within their family system.

Continued study of the preterm infant-parent dyad, especially in its emergence beyond the neonatal period, is warranted. The APIB appears to be an effective tool for understanding the interaction of continuity and change during the preterm infant's early months of life. Further use should more fully delineate positive preterm infant development and those factors which potentiate it. Concomitantly, parental adaptation to preterm infant development requires further investigation so that those factors which promote goodness of fit between infant and parent can be identified and understood. As infant and parent motivation towards competence is enhanced, so too is the likelihood that positive development will ensue.

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APPENDIX A

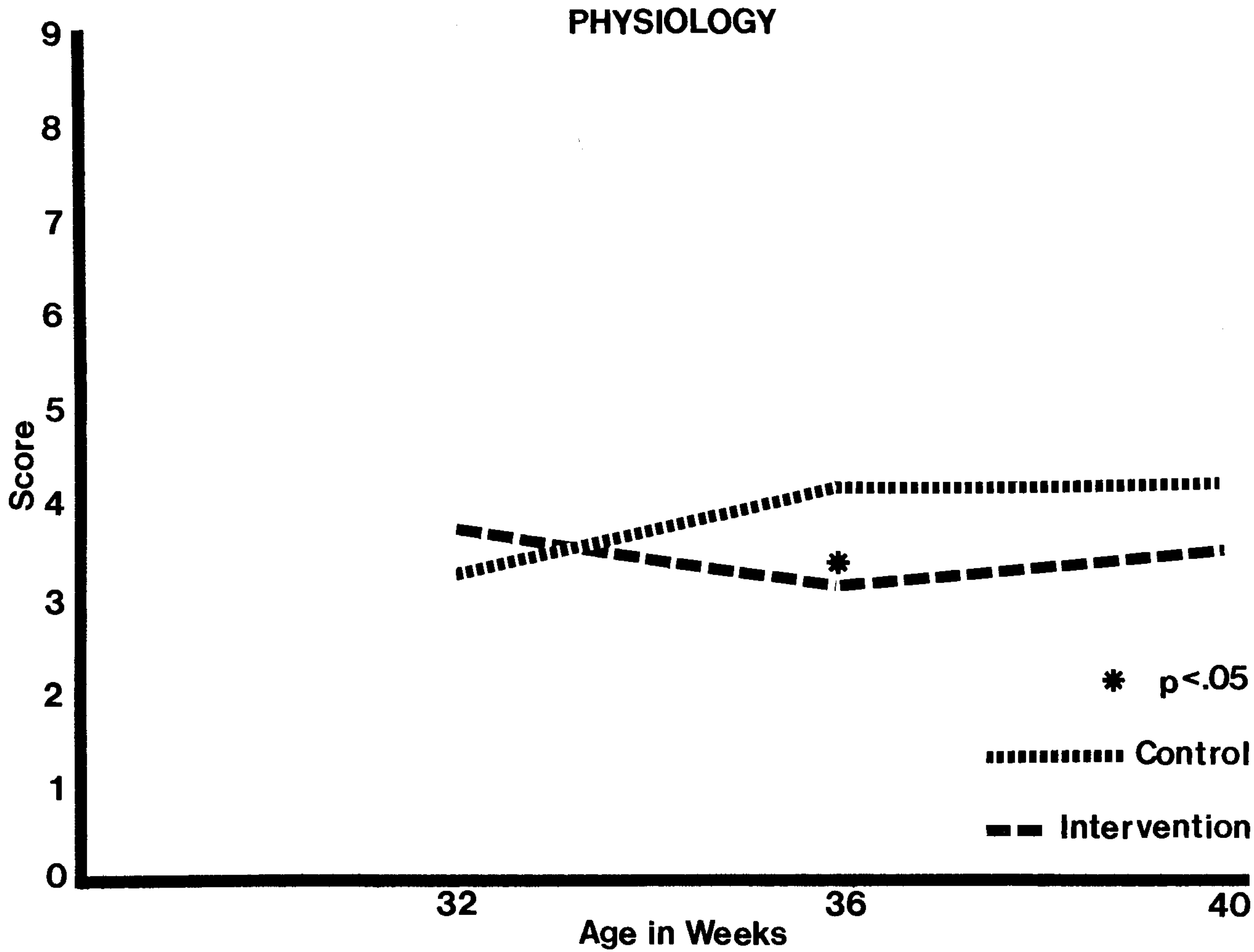

PHYSIOLOGY
Score
9
8
7
6
5
4
3
2
1
0
32
36
40
Age in Weeks
* p<.05
Control
Intervention

Figure 1

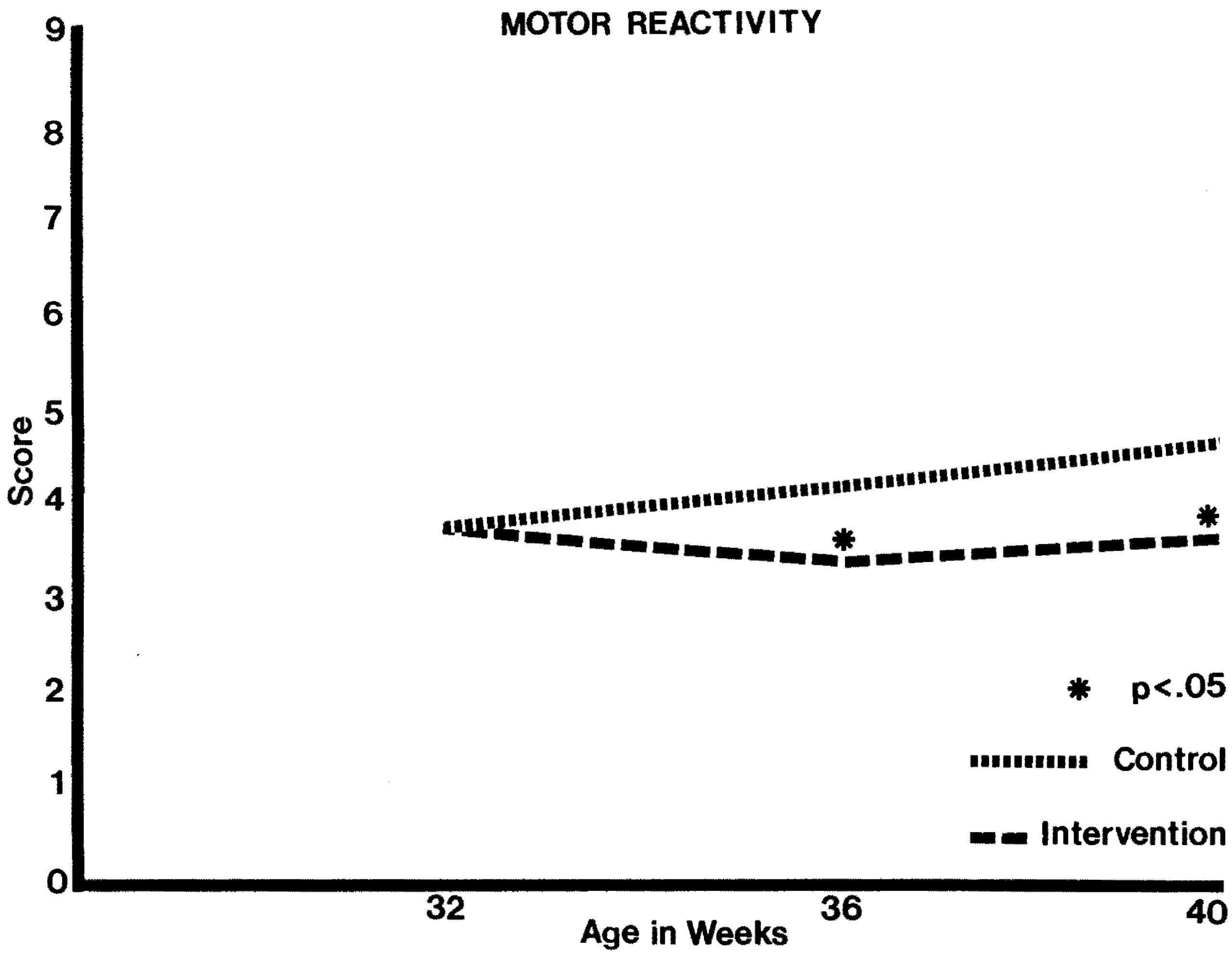

MOTOR REACTIVITY
Score
9
8
7
6
5
4
3
2
1
0
32
36
40
Age in Weeks
* p<.05
Control
Intervention

Figure 2

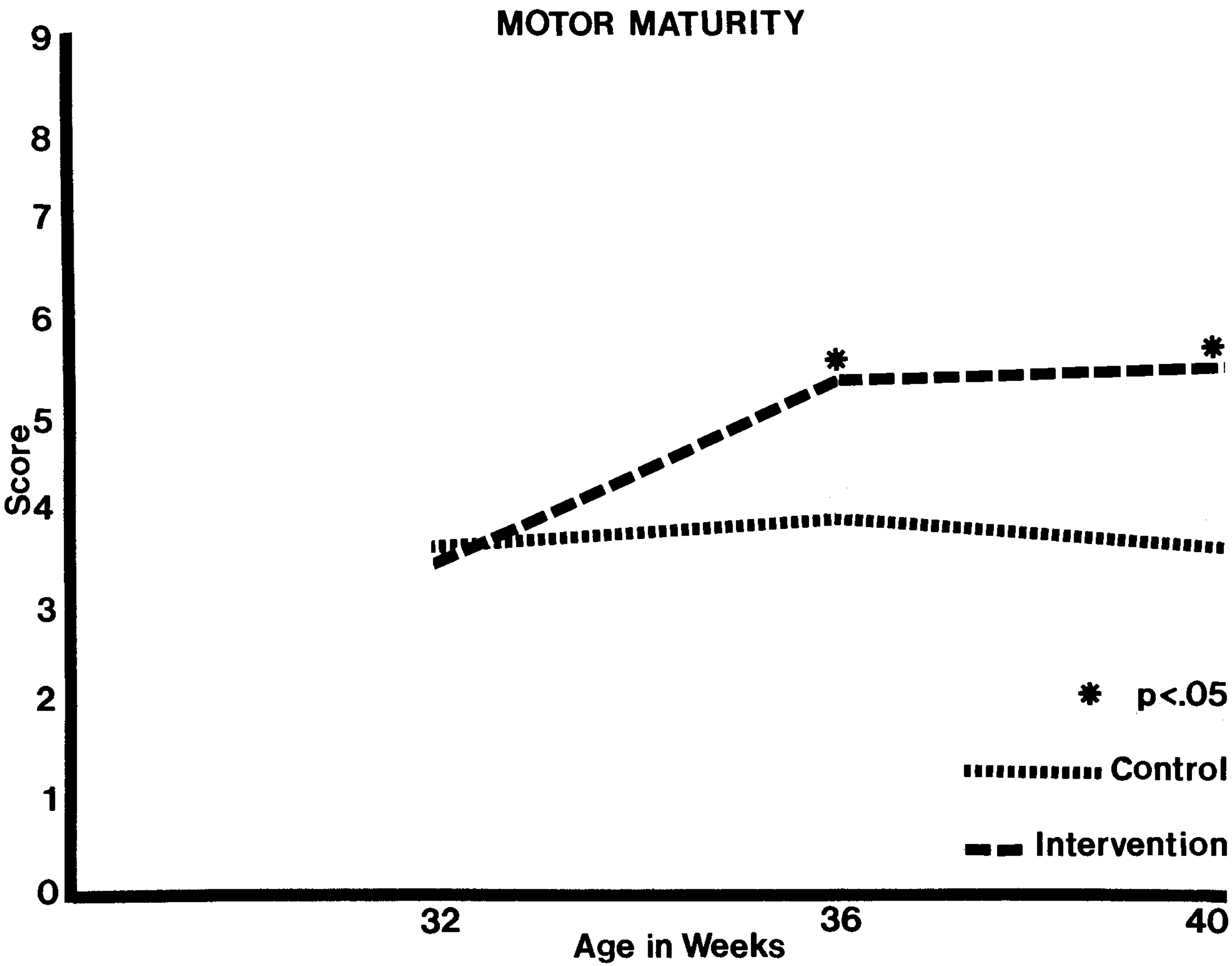

MOTOR MATURITY
9
8
7
6
5
4
3
2
1
0
Score
32
36
40
Age in Weeks
* p<.05
Control
Intervention

Figure 3

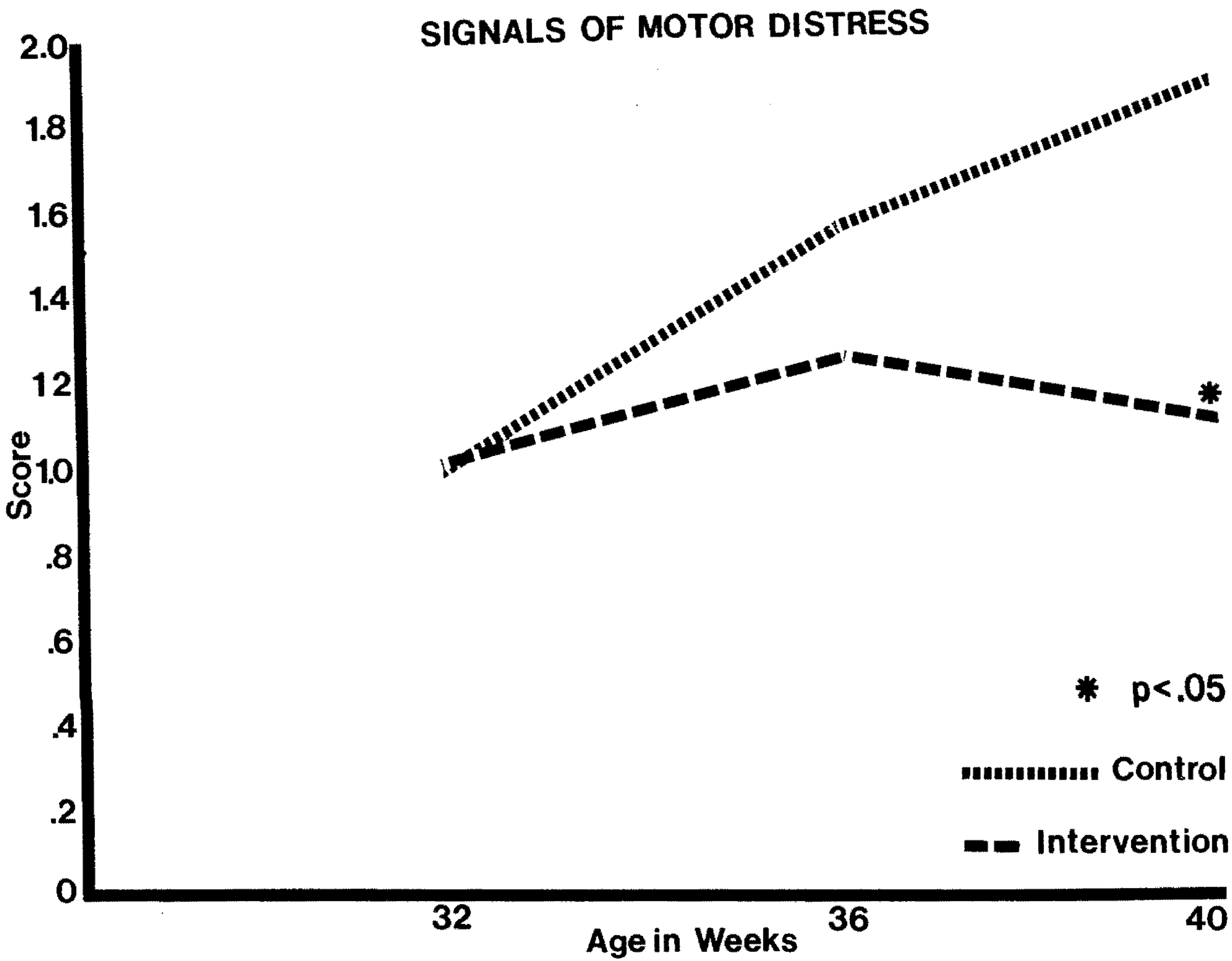

SIGNALS OF MOTOR DISTRESS
Score
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0
32
36
40
Age in Weeks
✱ p<.05
Control
Intervention

Figure 4

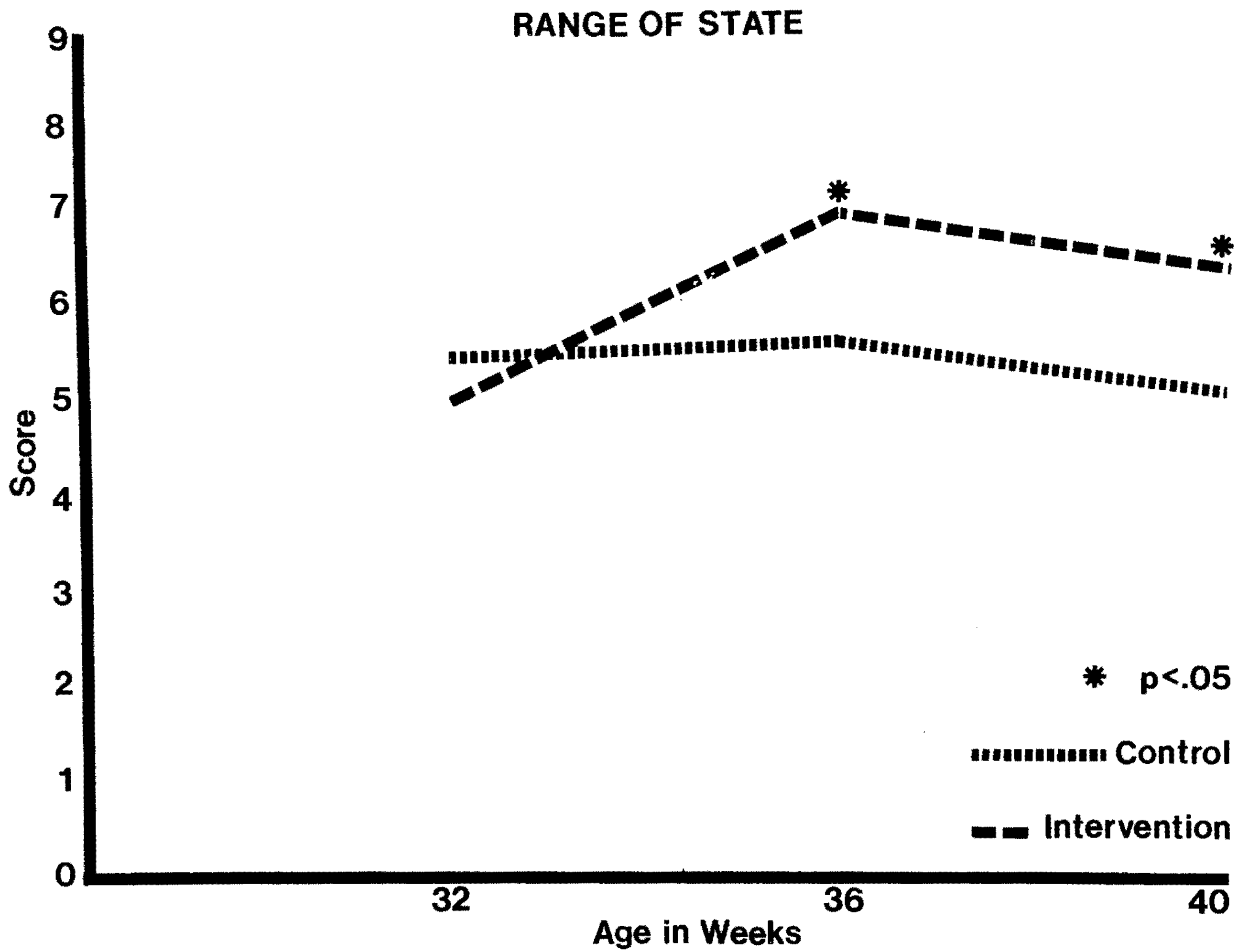

RANGE OF STATE
9
8
7
6
5
4
3
2
1
0
Score
32
36
40
Age in Weeks
✱ p<.05
Control
Intervention

Figure 5

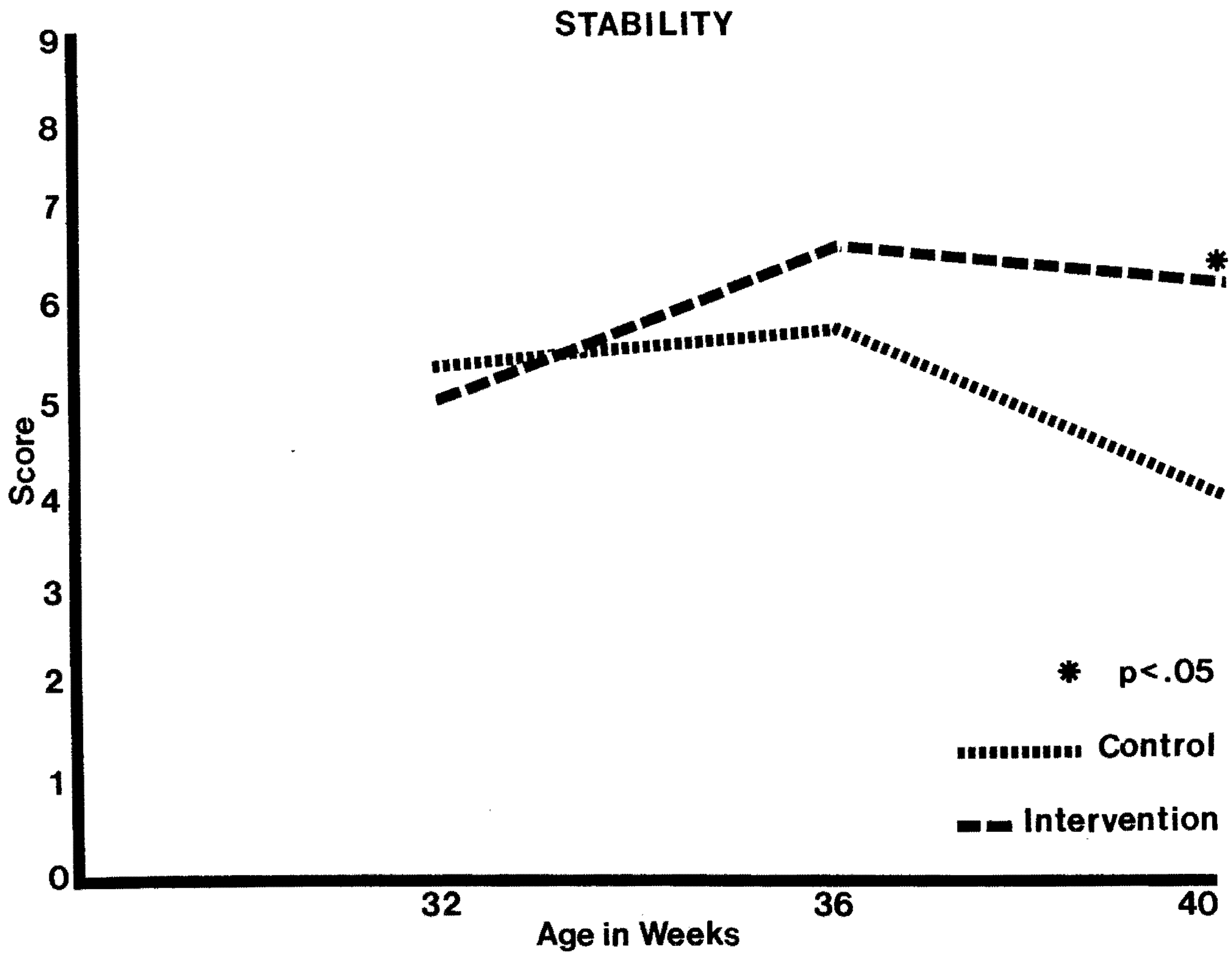

STABILITY
Score
9
8
7
6
5
4
3
2
1
0
32
36
40
Age in Weeks
* p<.05
Control
Intervention

Figure 6

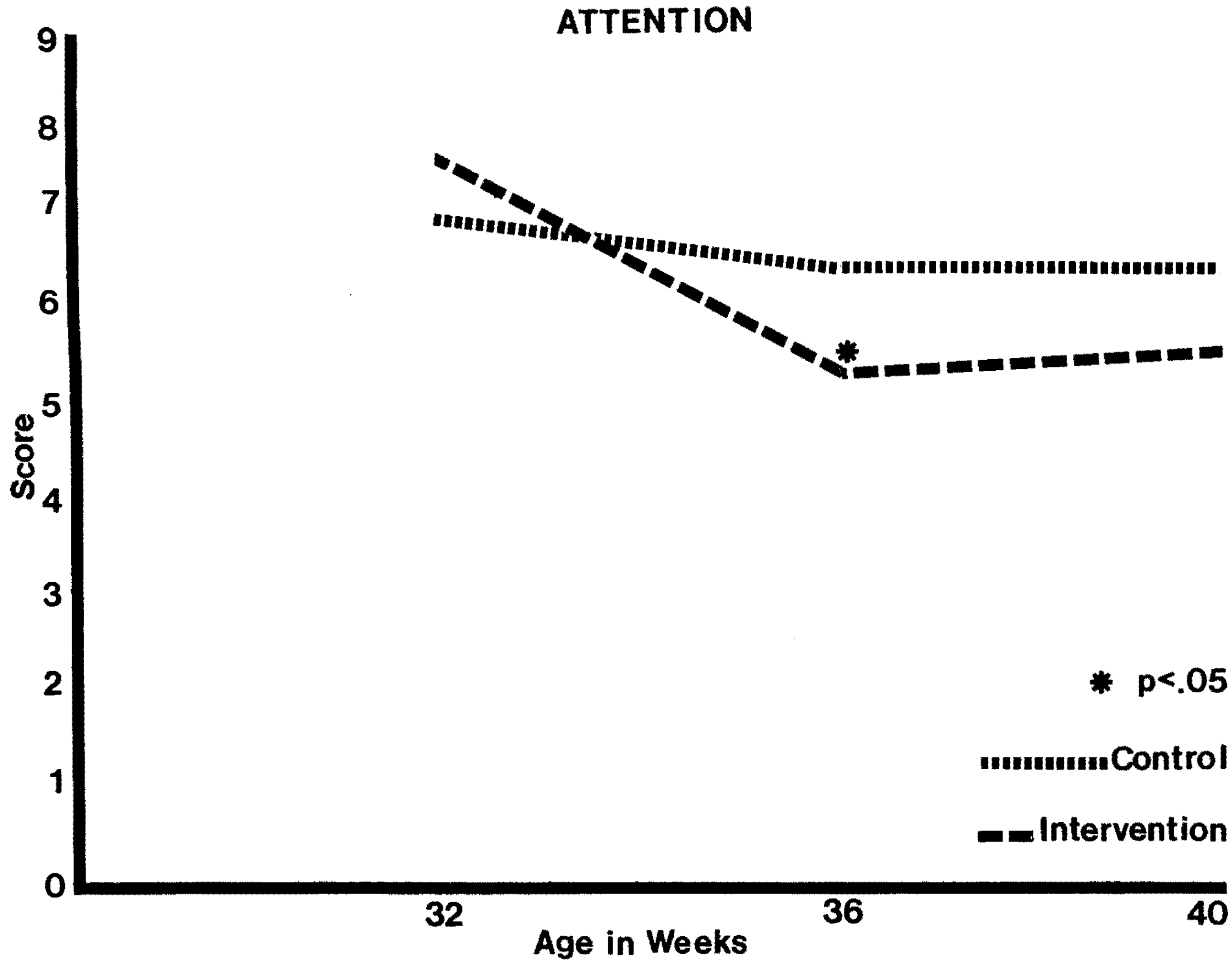
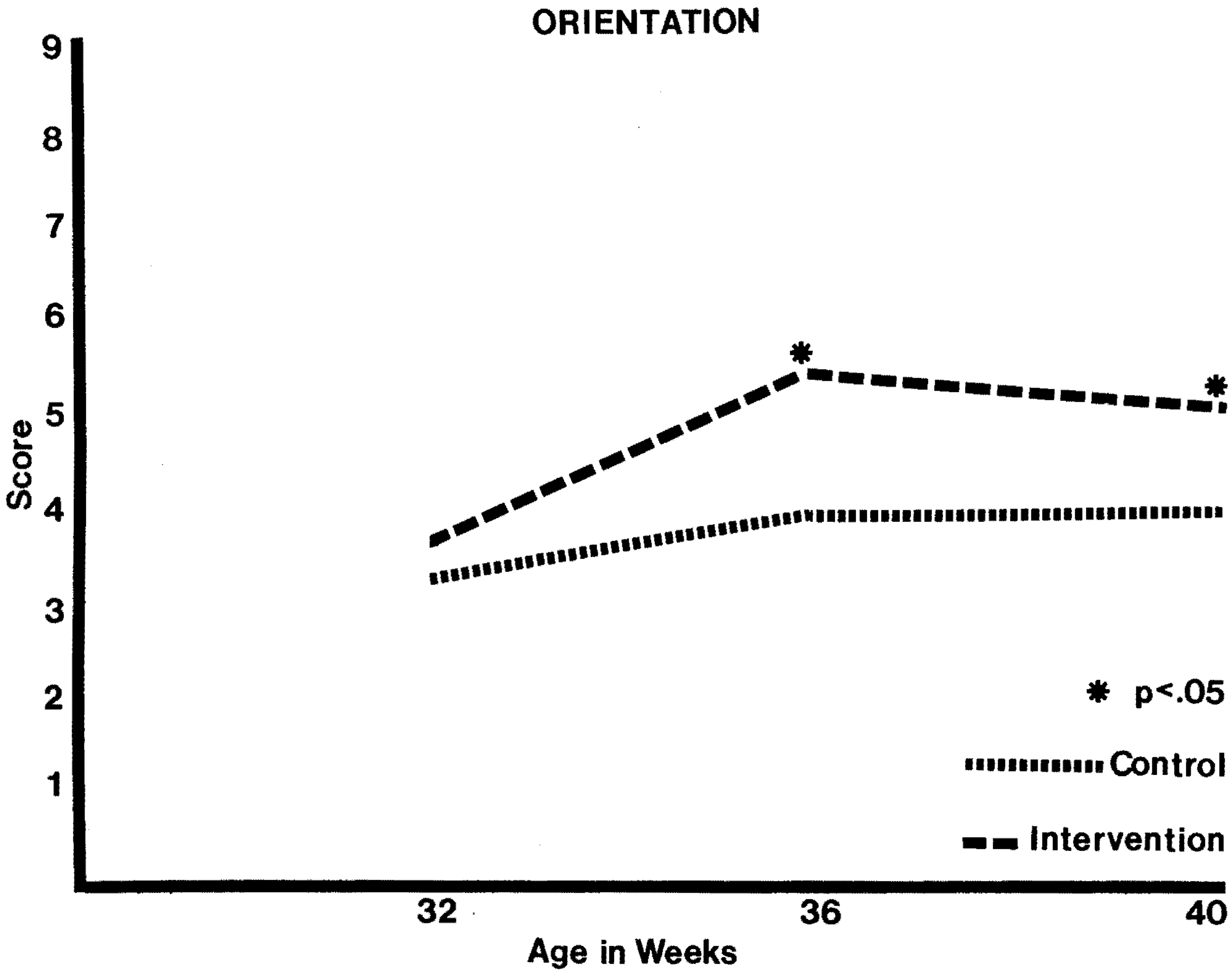

ATTENTION
Score
9
8
7
6
5
4
3
2
1
0
32
36
40
Age in Weeks
* p<.05
Control
Intervention

Figure 7


ORIENTATION
Score
9
8
7
6
5
4
3
2
1
32
36
40
Age in Weeks
* p<.05
Control
Intervention
Figure 8

APPENDIX B

H. Als, Ph.D.
B.M. Lester, Ph.D., E. Tronick, Ph.D., T.B. Brazelton, M.D.

ASSESSMENT OF PRETERM INFANT BEHAVIOR (APIB)

INFANT'S NAME | MED. REC. NO. | DATE OF BIRTH | AGE (Post-conception)

TIME – LAST FEEDING | TYPE OF FEEDING | CURRENT INTERVAL BETWEEN FEEDS

INITIAL CIRCUMSTANCES OF INFANT

POSITION: ☐ SUPINE ☐ PRONE ☐ SIDE
HEAD: ☐ RIGHT ☐ LEFT ☐ MIDLINE
COVERING: ☐ DIAPER ☐ SHIRT ☐ CLOTHES ☐ BLANKET(S)

INFANT'S INITIAL STATE | INFANT'S PREDOMINANT STATE

WEIGHT ______ LBS ____ OZS ____ GMS | HEIGHT ______ INCHES ________ CM | HEAD CIRCUMFERENCE ________ INCHES ________ CM | PONDERAL INDEX

DATE OF EXAM | TIME OF EXAM | PLACE OF EXAM | PERSONS PRESENT ☐ MOTHER ☐ FATHER ☐ SIBLING(S) ☐ OTHER ____________

INTERFERING VARIABLES | EXAMINER | VIDEO | DURATION OF EXAM

SCORE SHEET I – SYSTEMS

LEGEND: B = Baseline R = Reaction P = Post-package Status

	ORDER OF PKG.	PHYSIOLOGY			MOTOR			STATE			ATTN/INTERACT			REGULATORY			EXAM FACIL
		B	R	P	B	R	P	B	R	P	B	R	P	B	R	P	
PACKAGE I SLEEP/DISTAL																	
PACKAGE II UNCOVER/SUPINE																	
PACKAGE III LOW TACTILE																	
PACKAGE IV MEDIUM TACTILE/VESTIBULAR																	
PACKAGE V HIGH TACTILE/VESTIBULAR																	
PACKAGE VI ATTENTION/INTERACTION																	

COMMENTS:

SCORE SHEET II – PACKAGES AND MANEUVERS

								ORDER
I: SLEEP/DISTAL LIGHT	Decrement	BNBAS	Ease of Elicitation	Timing	Recycling	Dis-organization	Discharge	
RATTLE	Decrement	BNBAS	Ease of Elicitation	Timing	Recycling	Dis-organization	Discharge	
BELL	Decrement	BNBAS	Ease of Elicitation	Timing	Recycling	Dis-organization	Discharge	
II: SLEEP PRONE/SUPINE UNCOVER	Capacity to deal with	→						
PRONE TO SUPINE	Capacity to deal with	→						
III: LOW TACTILE FREE FEET/HANDS	Capacity to deal with	→						
HEEL TOUCH	BNBAS	Ease of Elicitation	Timing	Recycling	Dis-organization	Discharge	→	
PLANTAR GRASP	BNBAS/R	BNBAS/L	→					
FOOT SOLE STROKE (Babinski)	BNBAS/R	BNBAS/L	→					
CLONUS	BNBAS/R	BNBAS/L	→					
PALMAR GRASP	BNBAS/R	BNBAS/L	→					
PALMAR MENTAL GRASP	APIB	→						
PASSIVE MOVEMENT ARMS	Resistance R	Resistance L	Recoil R	Recoil L	BNBAS/R	BNBAS/L	→	
PASSIVE MOVEMENT LEGS	Resistance R	Resistance L	Recoil R	Recoil L	BNBAS/R	BNBAS/L	→	
ARM/LEG DIFFERENTIATION	APIB	→						
GLABELLA	BNBAS	→						
ROOTING	BNBAS/R	BNBAS/L	→					
SUCKING	BNBAS	→						

SCORE SHEET II – PACKAGES AND MANEUVERS (Continued)

								ORDER
IV: MEDIUM TACTILE/ VESTIBULAR UNDRESS	Capacity to Deal With	→						
PULL TO SIT	BNBAS	Hyper-extension	Hyper-flexion	→				
STANDING	Umbrella	BNBAS	→					
WALKING	Umbrella	BNBAS	→					
PLACING	Umbrella R	Umbrella L	BNBAS/R	BNBAS/L	→			
INCURVATION	BNBAS/R	BNBAS/L	→					
CRAWL	APIB	BNBAS	→					
CUDDLING	Vertical	Fetal Tuck	Horizontal	Fetal Tuck	BNBAS	→		
TONIC NECK REFLEX	BNBAS/R	BNBAS/L	→					
DEFENSIVE REACTION	BNBAS	→						
V: HIGH TACTILE/ VESTIBULAR ROTATION	Head R	Head L	Eyes R	Eyes L	BNBAS/R	BNBAS/L	Nystagmus	
MORO	Arms Extension	Arms Adduction	Legs	BNBAS	→			
VI: ATTENTION/ INTERACTION ANIMATE VISUAL & AUDITORY (Face&Voice)	Elicitation Maintenance	Orientation (B)	Orientation (A)	Effort	Cost	Quality	→	
ANIMATE VISUAL (Face)	Elicitation Maintenance	Orientation (B)	Orientation (A)	Effort	Cost	Quality	→	
ANIMATE AUDITORY (Voice)	Elicitation Maintenance	Orientation (B)	Orientation (A)	Effort	Cost	Quality	→	
INANIMATE VISUAL & AUDITORY (Rattle)	Elicitation Maintenance	Orientation (B)	Orientation (A)	Effort	Cost	Quality	→	
INANIMATE VISUAL (Ball or Rattle)	Elicitation Maintenance	Orientation (B)	Orientation (A)	Effort	Cost	Quality	→	
INANIMATE AUDITORY (Rattle)	Elicitation Maintenance	Orientation (B)	Orientation (A)	Effort	Cost	Quality	→	

SCORE SHEET III – BEHAVIORAL SUMMARY SCALES

PHYSIOLOGICAL PARAMETERS

TREMULOUSNESS	BNBAS			
STARTLES	BNBAS			
SKIN COLOR	Lability of Good Color	Lability of Comp. Color	Threshold	Jaundice
SMILES	APIB	BNBAS		

MOTOR PARAMETERS

TONUS	BNBAS	Balance		
MOTOR MATURITY	BNBAS	Threshold	Postural Control	Symmetry
ACTIVITY	Spontaneous Activity	Elicited Activity	BNBAS	
HAND-TO-MOUTH FACILITY	BNBAS			

STATE PARAMETERS

ALERTNESS	Degree (B)	Degree (A)	Quality	Am't. Manipulation
STATE REGULATION	Lability	Range and Flexibility	BNBAS	

SELF REGULATION PARAMETERS

WITHDRAWAL OR AVOIDANCE BEHAVIOR — CATALOG OF REGULATION MANEUVERS

Spit-ups	Gags	Hiccoughs	Bowel Mvt
Grimace	Arching	Finger Splay	Airplane
Salute	Sitting on Air		
Sneezing	Yawning	Sighing	Coughing
Averting	Frowning		

APPROACH OR GROPING BEHAVIOR — CATALOG OF REGULATION MANEUVERS

Tongue Extension	Hand on Face	Sounds	
Hand Clasp	Foot Clasp	Fingerfold	Tuck
Body Movement	Hand to Mouth	Grasping	Leg/Foot Bracing
Mouthing	Suck Search	Sucking	Hand Hold
Ooh Face	Locking	Cooing	

QUIETING	Self-quiet 6↓	Self-quiet Motor ↓	Consolability 6↓	Consolability Motor ↓
PEAK OF EXCITEMENT	BNBAS			
RAPIDITY OF BUILD-UP	Rapidity ↑6	Rapidity ↑ Motor		
IRRITABILITY	Irritability (B)	Irritability (A)		
ROBUSTNESS	Robustness			
CONTROL OVER INPUT	Control Over Input			
FACILITATION STIMULATION	Facilitation Stimulation			

SUMMARY

ATTRACTIVENESS

SYSTEM ORGANIZATION GRAPH (APIB)
(From SCORE SHEET I)

H. Als, Ph.D.
B.M. Lester, Ph.D., E. Tronick, Ph.D., T.B. Brazelton, M.D.

INFANT'S NAME ______________ MED. REC. NO. ______________ DATE OF EXAM ______________ AGE (Post-conception) ______________

PHYSIOLOGICAL SYSTEM

	Sleep/Distal			Uncov./ Supine			Low Tactile			Med. Tact./Vest.			High Tact./Vest.			Attn./ Interact.		
9																		
8																		
7																		
6																		
5																		
4																		
3																		
2																		
1																		
	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P
	* I (		)	II (		)	III (		)	IV (		)	V (		)	VI (		)

MOTOR SYSTEM

	Sleep/Distal			Uncov./ Supine			Low Tactile			Med. Tact./Vest.			High Tact./Vest.			Attn./ Interact.		
9																		
8																		
7																		
6																		
5																		
4																		
3																		
2																		
1																		
	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P
		I			II			III			IV			V			VI	

STATE SYSTEM

	Sleep/Distal			Uncov./ Supine			Low Tactile			Med. Tact./Vest.			High Tact./Vest.			Attn./ Interact.		
9																		
8																		
7																		
6																		
5																		
4																		
3																		
2																		
1																		
	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P
		I			II			III			IV			V			VI	

REGULATORY SYSTEM

	Sleep/Distal			Uncov./ Supine			Low Tactile			Med. Tact./Vest.			High Tact./Vest.			Attn./ Interact.		
9																		
8																		
7																		
6																		
5																		
4																		
3																		
2																		
1																		
	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P	B	R	P
		I			II			III			IV			V			VI	

ATTENTION/INTERACTION

		Attn./ Interact.		
9				
8				
7				
6				
5				
4				
3				
2				
1				
		B	R	P
			VI	

EXAMINATION FACILITATION

	Sleep/Distal	Uncov./ Supine	Low Tactile	Med. Tact./Vest.	High Tact./Vest.	Attn./ Interact.
9						
8						
7						
6						
5						
4						
3						
2						
1						
	I	II	III	IV	V	VI

* Fill in order of administration

SUPPLEMENTAL LIST OF ASYMMETRIES

Check, rate degree and describe asymmetries noted; rate degree of asymmetry on a 0 – 3 continuum.

0 = no asymmetry noted (the item was not checked)
1 = subtly & mildly present and/or very transient
2 = moderately pronounced and/or intermittent
3 = pronounced, strong

Asymmetries	Check	Degree	Side	Description
1. Arm	_____	_____	_____	_____
2. Hand	_____	_____	_____	_____
3. Fingers	_____	_____	_____	_____
4. Leg	_____	_____	_____	_____
5. Foot/Toes	_____	_____	_____	_____
6. Trunkal Posture	_____	_____	_____	_____
7. Head Positioning	_____	_____	_____	_____
8. Face	_____	_____	_____	_____
9. Eyes	_____	_____	_____	_____

Comments:

APPENDIX C

A.P.I.B. Features: Summary Variables

Thirty-two* a priori summary variables, or features, are derived from 285 scores contained on the score sheets of the APIB. The Construction of Features section contains a listing of the summary variables giving their computer abbreviations, a brief narrative, conceptual explanation, and finally their specific constructions and computations. To derive these scores, several steps are followed:

1. Scores are considered by score sheet, numbered sequentially by sheet (see sheet appended) and converted to uniform direction where necessary.

Score Sheet I: Systems Sheet

Direction of scales is uniform; all scores go from 1, meaning very well organized, to 9, meaning very poorly organized.

Score Sheet II: Packages and Maneuvers

Direction of scales is not uniform. For some scales, 1 represents optimal performance and 9, poorly organized performance, while for others the reverse is true. Therefore, a number of scales are inverted, in order to achieve uniformity of direction, with 1 representing very poor performance and 9 representing excellent performance for all scales. The following scales, listed by item name and number, are inverted (I):

13, 14, 15 Recycling (Light, Rattle, Bell); 16, 17, 18 Disorganization (Light, Rattle, Bell); 19, 20, 21 Discharge (Light, Rattle, Bell); 28, 29, 30 Recycling, Disorganization, Discharge (Heel touch); 59, 60 Hyperextension, Hyperflexion (Pull to Sit); 74, 76 Fetal Tuck (Vertical and Horizontal Cuddling); 116-121 Cost of Orientation Items (Animate Visual and Auditory, Animate Visual, Animate Auditory; Inanimate Visual and Auditory, Inanimate Visual and Inanimate Auditory).

The inversion is as follows:

1 becomes 9; 2 becomes 8; 3 becomes 7; 4 becomes 6; 5 stays 5; 6 becomes 4; 7 becomes 3; 8 becomes 2; 9 becomes 1.

Furthermore, one item, Crawl, is skewedly U-shaped in terms of quality of performance. It therefore is folded (U) as follows:

71 U Crawl: A=1 1=1; 9=2; 2=3; 3=4; 4=5; 2=6; 7=7; 5=8; 6=9.

* Two additional scores have been developed since the publication of the APIB manual, namely Eye Movements (EYEMST) and Asymmetry of Orientation Performance (ASSYMP).

Score Sheet III: Summary Scales and Catalogue of Regulation Behaviors

Direction of scales is not uniform. For some scales, 1 represents optimal performance and 9, poorly organized performance, while for others the reverse is true; yet other scales are U shaped with the mid-range representing optimal performance and both ends disorganized performance. Some scales are skewed in one direction in terms of quality of performance. In order to achieve uniformity of direction for all scales, with 1 representing very poor performance and 9 representing excellent performance, certain scales are inverted while others are folded.

The following scales, listed by item name and box number, are inverted (I), using the same inversion rule as for Score Sheet II above:

1 Tremulousness; 3 & 4 Lability of Good and Compromised Color; 5 Threshold of Color Change; 6 Jaundice; 12 Threshold of Motoric Imbalance; 22 Amount of Manipulation Necessary During Attention/ Interaction; 23, 25 Lability of States (APIB, BNBAS); 33, 34 Irritability (BNBAS, APIB).

The following scales, listed by item name and box number, are folded (U), using the conversion rules outlined:

2 Startles; 9 Tonus; 15, 16, 17 Activity (Spontaneous and Elicited, and BNBAS); 30 Peak of Excitement; 31 Rapidity of Buildup to State 6; 32 Rapidity of Buildup to Motor Arousal:

U Startles: 1 = 1; 2 = 9; 3 = 8; 4 = 7; 5 = 6; 6 = 5; 7 = 4; 8 = 3; 9 = 2.

U Tonus (N = 1): 1 = 1; 9 = 2; 8 = 3; 2 = 4; 3 = 5; 7 = 6; 4 = 7; 5 = 8; 6 = 9.

U Activity (N = 1): 1 = 1; 9 = 2; 8 = 3; 7 = 4; 6 = 5; 2 = 6; 5 = 7; 4 = 8; 3 = 9.

U Peak of Excitement: 1 = 1; 9 = 2; 2 = 3; 8 = 4; 3 = 5; 7 = 6; 4 = 7; 5 = 8; 6 = 9.

U Rapidity of Buildup to State 6: 9 = 1; 1 = 2 unless Range & Flexibility of States is 9 and/or the first or both predominant states are 4B. In that case 1 = 9; 8 = 3; 7 = 4; 6 = 5; 5 = 6; 4 = 7; 3 = 8; 2 = 9.

U Rapidity of Buildup (Motor): 9 = 1; 1 = 2; 8 = 3; 7 = 4; 6 = 5; 5 = 6; 4 = 7; 3 = 8; 2 = 9.

Other Items: If Cuddliness vertical or horizontal (73, 75) is N, assign a score of 1.

C: Catalogue

The catalogue of regulation behaviors contains scales rated from 0 - 3. They go in the direction of none or little of a behavior to a lot of a behavior. They are treated with this in mind.

2. A total of 30 summary variables or features are derived from the APIB. They are mutually exclusive in terms of construction. All scores are utilized except for 18. These 18 are Brazelton scale scores (BNBAS), which are subsumed under the new expanded APIB scores. They are as follows:

Sheet II: Response Decrement to Light (4), to Rattle (5), to Bell (6), subsumed under APIB Response Decrement scores (1), (2), (3).

Passive Movement Arms (44, 45) and Legs (50, 51), subsumed under APIB Passive Movement scores--Arms (40 - 43), Legs (46 - 49), Extension and Recoil separately.

Crawl (72) subsumed under Crawl (71).

Cuddling (77) subsumed under (73 - 76) APIB Cuddling

Tonic Deviation of Head and Eyes (85, 86) subsumed under APIB Tonic Deviation of Head (81, 82) and Eyes (83, 84) separately.

Moro (91) subsumed under APIB Moro; Arms: Extension (88), Recoil (89), Legs (90).

Sheet III: Lability of Skin Color (3) subsumed under APIB Lability of Compromised Skin Color (4). If marked N, give 9 for excellent color.

Smiles: Number of Smiles (8) subsumed under APIB Smile scale (7).

Activity (17) subsumed under APIB scales Spontaneous Activity (15) and Elicited Activity (16).

Lability of States (25) subsumed under APIB Lability of States (23).

Irritability (33) subsumed under APIB Irritability (34).

Catalogue: Body Movements (24) subsumed and better specified under Tuck and Specific Arm and Leg Movements.

3. Construction of Features

APIB: 30 Features
per examination

(1 = good; 9 = bad;
if A give 9)

Sheet I

PHYSM1

The infant's autonomic reactivity or modulation and threshold to disorganization as assessed by observation of his respiration pattern (respiration pauses, tachypneic bursts, irregular respiration), color (paleness, webbing and cyanosis and their fluctuation), and visceral reactions (gagging, spitting up, hiccoughing, bowel movement strains), in the course of the sequence of maneuvers of the APIB.

Mean of 1 - 18

MOTOM1

The infant's motoric reactivity or modulation and his threshold to motoric disorganization as assessed by observation of tone fluctuations, movement, and postural patterns in the course of the sequence of maneuvers of the APIB.

Mean of 19 - 36

STATM1

The infant's state organization pattern in the course of the sequence of maneuvers of the APIB, focusing on the range of states from sleep through alertness to crying, the pattern of state transitions, and the diffuseness versus robustness of state maintenance.

Mean of 37 - 54

ATTNM1

The infant's attentional availability in the course of the orienting and social interaction maneuvers of the APIB as measured in terms of the attentional clarity, robustness, and degree of animation with which interaction with animate and inanimate stimuli is accomplished.

Mean of 55 - 57

REGUM1

The infant's ease or difficulty in keeping himself in a well balanced, self-regulated synchrony of autonomic, motoric, and state organizational functioning, the efforts he makes to return to such balance, and the success with which he returns to balance in the course of the maneuvers of the APIB.

Mean of 58 - 75

EXFAM1

The degree of facilitation necessary from the examiner to reorganize and stabilize the infant autonomically, motorically, and statewise in the course of the maneuvers of the APIB, and the ease with which the infant can utilize the examiner's facilitation.

Mean of 76 - 81

Sheet II

HABIMI

The infant's ability to inhibit response to repetitive visual and auditory stimuli presented in sleep state. Size, timing, ease of elicitation, and aspects of the pattern of individual and overall response are measured, as well as the degree of discharge at the end of the stimulus sequence (habituation).

Mean of (1-3)$\bar{x}$; (7-9)$\bar{x}$; (10-12)$\bar{x}$; (13_I-15_I)$\bar{x}$; (16_I-18_I)$\bar{x}$; (19_I-21_I)$\bar{x}$

If total HABI (all 3 stimuli)→A, give 2;
If only 1 item→A, give 1 per box.

If in the course of the 10 trials of an HABI stimulus the baby moves from sleep(N) to 4B, give 9;
If he moves to any other state (3A, 3B, 4A, 5A/B, 6A/B) aside from staying asleep, give 1.

If R, disregard each R and take $\bar{x}$ of the remaining scores.

If 1 or 2 Cs, disregard and take $\bar{x}$ of remaining numbers.
If all HABI→C (all Cs), check on initial state:

If initial state is 4B→9
4A→7
3A or 5A→3
6A→4
3B or 5B→6
6B→6

CAPAMI

The infant's capacity to maintain autonomic, motoric, and state stability when uncovered, placed into supine position, having his hands and feet freed and being undressed.

Mean of 22, 23, 24, 57
If A give 1;
If C give the same score as habituation

TACHAB

The infant's ability to inhibit response to repetitive tactile stimulation to his heel (tactile habituation).

Mean of 25, 26, 27, 28_I, 29_I, 30_I

If A give 1 as the $\bar{x}$;
If C give 9 as the $\bar{x}$;
If X and HABIMI→A give 1;
If X and HABIMI→C give 9.

REFLEX

The proportion of abnormal reflexes to the number of reflexes assessed.

Number of abnormal reflexes, i.e., 0, 1, or 3 (except clonus: only 3; TNR: only 3; Nystagmus: only 3; Palmar Mental: only 0 or 3), over number of reflexes tested, expressed as percent. The higher the number, the worse the performance.

If A count abnormal;
If X give 2;
If R give 0;
If TNR, Standing, Walking, and/or Moro has asymmetrical score count as abnormal;
If Standing and/or Walking are scored as umbrellas, count abnormal.

PULSIT

The infant's ability to maintain head control when being pulled to sit; the degree of hyperflexion and/or hyperextension is also considered.

Consider 58, 59_I, 60_I; use 58 as base;
If before inverting 59 or 60 "1" ignore 59 & 60;
If not "1", use lower inverted score (= worse);
If absolute score is 2-4, subtract 1 from 58;
If 5-9, 58 should be marked N and counted as 1;
Form mean of resulting 2 scores.

CUDCRA

The infant's ability to utilize the examiner's body and adjust to it in a horizontal and vertical position with cuddling, and his ability to utilize the surface of the bed and adjust to it in a self-limited, modulated, crawling action.

Involves 73, 74_I, 75, 76_I (77 is subsumed under 73, 75) and 71_U (72 is subsumed under 71).

Cuddliness: Mean of 73 & 75 (if N give 1) and mean of 74 & 76:
If absolute score 1, use only 73 & 75;
If absolute score 2, subtract 1 from 73 or 75;
If absolute score 3-4, subtract 2 from 73 or 75;
If absolute score 5-9, 73 or 75 should be N=1.

Crawl: 71_U

Cudcra: mean of cud. & 71_U

MOTACT

The infant's ability to perform specific motoric acts requiring arm, trunk, and head coordination, such as swiping a cloth off his face in defensive reaction and bringing his hand to his mouth to suck on it.

Mean of II, 80; III, 18

ORIEM1

The infant's ability to orient visually and auditorily to various inanimate and animate stimuli.

Mean of (92-97) $\bar{x}$; 98-103) $\bar{x}$; (104-109) $\bar{x}$; (110-115) $\bar{x}$; (116_I-121_I) $\bar{x}$; (122-127) $\bar{x}$.

If Cs, ignore and take mean of remaining scores;
If A→1
If Right and Left scores differ, use best score

Sheet III

AUTONO

The combination of degree of tremulousness, startles, skin color ability and the threshold to color chage as individually assessed in the course of the examination (autonomic parameters).

Mean of 1_1; 2_U; 4_I (if N→9); 5_I

JAUND1

The degree of jaundice observed.

6_I

MOTCAM

The combination of the degree of flaccidity versus hypertonicity observed (tonus) and the degree of smoothness and openness of limb movements (motor maturity).

Mean of 9_U (if N→1); 10; 11; 12_I; 13

ACTIVI

The combination of spontaneous and elicited activity level.

Mean of 15_U, 16_U

If 15_U→A disregard

ALERTM

The quality and degree of alertness during the orientation sequence together with the degree of manipulation necessary to help the infant achieve and sustain an alert state.

Mean of 19 or 20, 21, 22_I

If both 19 and 20 are scored, use best score

STATMM

State regulation consisting of a combination of range and flexibility of state, irritability, robustness in handling the examination, control over input, and improvement with facilitation.

Mean of 24, 34_I, 35, 36, 37

STATE6

A combination of abilities to do with robust crying (state 6): the ability to achieve a robust crying state, the ability to calm himself from a robust crying state and the ability to be consoled when in a robust crying state.

Mean of 26 (if N disregard); 28 (if N disregard); 31_U

STABIL

A stability measure made up of a combination of state stability parameters such as lability of states, ability to quiet when motorically aroused, ability to be consoled when motorically aroused, rapidity of build up to motoric arousal, peak of motoric arousal, and degree of discharge smiles versus stimulus contingent smiles in alertness.

Mean of 7 (if N disregard), 23_I,
27 (if N disregard), 29 (if N disregard), 30_U, 32_U

ATTRAC — Overall organizational differentiation and modulation paired with social responsiveness and engagement (attractiveness).

38

SYMMET — Degree of motoric and processing symmetry during spontaneous and elicited performance.

14

Specific Body Language Signals of the Autonomic, Motor, State, and Attentional System

(thought to reflect stress or regulatory control)
(3 = a consistent pattern; 0 = not observed)

SIAUTO — Autonomic signal combination of stress behaviors including spitups, gags, hiccoughs, bowel movement strains, tongue extension, sounds and mouthing.

Mean of 1, 2, 3, 4, 17, 19, 28

SIMOT1 — Motor system signal combination of stress behaviors including grimacing, arching, finger splaying, airplaning, salutes, sitting on air.

Mean of 5, 6, 7, 8, 9, 10

SIMOT2 — Motor system signal combination of self-regulatory behaviors including grimacing, hand on face, hand clasp, foot clasp, fingerfold, tuck, hand-to-mouth behavior, grasping, leg and foot bracing, suck-search, sucking and hand holding.

Mean of 16, 18, 20, 21, 22, 23, 25, 26, 27, 29, 30, 31

SISTAT — State related signal combination including sneezing, yawning, sighing, and coughing.

Mean of 11, 12, 13, 14

SIATTN — Attention related signals combination including averting, ooh face, locking, and cooing.

Mean of 15, 32, 33, 34

PREDOS — A combination of the two most predominant states in the course of the assessment, scaled on a 6-point scale.

Use only first 2 predominant states;
Use Code Sheet 1-6 (6=good)

1 = Combinations of 1, 2, 3
2 = Combinations of 1, 2, or 3 and 5, 6
3 = Combinations of 5, 6 and 5, 6
4 = Combinations of 2, 3, 5 and 4
5 = Combinations of 4 and 2, 3 &/or 5, 6
6 = Combinations of 4 and 4

APIB Summary Variables,

Conversion Chart for APIB to Equalize Direction of Scales

I

1 = 9
2 = 8
3 = 7
4 = 6
5 = 5
6 = 4
7 = 3
8 = 2
9 = 1

U Crawl

A = 1
0 = 1
1 = 1
9 = 2
2 = 3
3 = 4
4 = 5
8 = 6
7 = 7
5 = 8
6 = 9

U Startle:

1 = 1
2 = 9
3 = 8
4 = 7
5 = 6
6 = 5
7 = 4
8 = 3
9 = 2

U Tonus (N = 1)

1 = 1
9 = 2
8 = 3
2 = 4
3 = 5
7 = 6
4 = 7
5 = 8
6 = 9

U Activity N = 1)

1 = 1
9 = 2
8 = 3
7 = 4
6 = 5
2 = 6
5 = 7
4 = 8
3 = 9

U Peak of Excitement

1 = 1
9 = 2
2 = 3
8 = 4
3 = 5
7 = 6
4 = 7
5 = 8
6 = 9

U Rapidity of Buildup to 6↑

9 = 1
1 = 2

if Range & Flexibility of States is <u>not</u> a 9 and/or first predominant state is <u>not</u> a 4B. If one of these conditions pertains, then:

1 = 9
8 = 3
7 = 4
6 = 5
5 = 6
4 = 7
3 = 8
2 = 9

U Rapidity of Buildup (Motor Arousal)

9 = 1
1 = 2
8 = 3
7 = 4
6 = 5
5 = 6
4 = 7
3 = 8
2 = 9

ASSESSMENT OF PRETERM INFANT BEHAVIOR (APIB)

H. Als, Ph.D.
B.M. Lester, Ph.D., E. Tronick, Ph.D., T.B. Brazelton, M.D.

INFANT'S NAME	MED. REC. NO.	DATE OF BIRTH	AGE (Post-conception)

TIME — LAST FEEDING	TYPE OF FEEDING	CURRENT INTERVAL BETWEEN FEEDS

INITIAL CIRCUMSTANCES OF INFANT

POSITION: ☐ SUPINE ☐ PRONE ☐ SIDE
HEAD: ☐ RIGHT ☐ LEFT ☐ MIDLINE
COVERING: ☐ DIAPER ☐ SHIRT ☐ CLOTHES ☐ BLANKET(S)

INFANT'S INITIAL STATE	INFANT'S PREDOMINANT STATE
✓	✓✓ [PREDOS]

WEIGHT	HEIGHT	HEAD CIRCUMFERENCE	PONDERAL INDEX
____ LBS ____ OZS ____ GMS	____ INCHES ____ CM	____ INCHES ____ CM	

DATE OF EXAM	TIME OF EXAM	PLACE OF EXAM	PERSONS PRESENT
			☐ MOTHER ☐ FATHER ☐ SIBLING(S) ☐ OTHER ______

INTERFERING VARIABLES	EXAMINER	VIDEO	DURATION OF EXAM

SCORE SHEET I — SYSTEMS   I

LEGEND: B = Baseline R = Reaction P = Post-package Status

	ORDER OF PKG.	PHYSIOLOGY			MOTOR			STATE			ATTN/INTERACT			REGULATORY			EXAM FACIL
		B	R	P	B	R	P	B	R	P	B	R	P	B	R	P	
PACKAGE I SLEEP/DISTAL		1	2	3	19	20	21	37	38	39				58	59	60	76
PACKAGE II UNCOVER/SUPINE		4	5	6	22	23	24	40	41	42				61	62	63	77
PACKAGE III LOW TACTILE		7	8	9	25	26	27	43	44	45				64	65	66	78
PACKAGE IV MEDIUM TACTILE/VESTIBULAR		10	11	12	28	29	30	46	47	48				67	68	69	79
PACKAGE V HIGH TACTILE/VESTIBULAR		13	14	15	31	32	33	49	50	51				70	71	72	80
PACKAGE VI ATTENTION/INTERACTION		16	17	18	34	35	36	52	53	54	55	56	57	73	74	75	81

COMMENTS:

1 = good
9 = bad

X' is not considered because subsumed ; II 1 = bad ; 9 = good I = Invert

SCORE SHEET II — PACKAGES AND MANEUVERS

								ORDER
I: SLEEP/DISTAL LIGHT	Decrement 1	~~BNBAS 4~~	Ease of Elicitation 7	Timing 10	Recycling 13 I	Dis-organization 16 I	Discharge 19 I	
RATTLE	Decrement 2	~~BNBAS 5~~	Ease of Elicitation 8	Timing 11	Recycling 14 I	Dis-organization 17 I	Discharge 20 I	
BELL	Decrement 3	~~BNBAS 6~~	Ease of Elicitation 9	Timing 12	Recycling 15 I	Dis-organization 18 I	Discharge 21 I	
II: SLEEP PRONE/SUPINE UNCOVER	Capacity to deal with 22	→						
PRONE TO SUPINE	Capacity to deal with 23	→						
III: LOW TACTILE FREE FEET/HANDS	Capacity to deal with 24	→						
HEEL TOUCH	BNBAS 25	Ease of Elicitation 26	Timing 27	Recycling 28 I	Dis-organization 29 I	Discharge 30 I	→	
PLANTAR GRASP	BNBAS/R 31	BNBAS/L 32	→					
FOOT SOLE STROKE (Babinski)	BNBAS/R 33	BNBAS/L 34	→					
CLONUS	BNBAS/R 35	BNBAS/L 36	→					
PALMAR GRASP	BNBAS/R 37	BNBAS/L 38	→					
PALMAR MENTAL GRASP	APIB 39	→						
PASSIVE MOVEMENT ARMS	Resistance R 40	Resistance L 41	Recoil R 42	Recoil L 43	~~BNBAS/R 44~~	~~BNBAS/L 45~~	→	
PASSIVE MOVEMENT LEGS	Resistance R 46	Resistance L 47	Recoil R 48	Recoil L 49	~~BNBAS/R 50~~	~~BNBAS/L 51~~	→	
ARM/LEG DIFFERENTIATION	APIB 52	→						
GLABELLA	BNBAS 53	→						
ROOTING	BNBAS/R 54	BNBAS/L 55	→					
SUCKING	BNBAS 56	→						

SCORE SHEET II – PACKAGES AND MANEUVERS (Continued)

								ORDER
IV: MEDIUM TACTILE/ VESTIBULAR UNDRESS	Capacity to Deal With 57	→						
PULL TO SIT	BNBAS 58	Hyper-extension 59 I	Hyper-flexion 60 I	→				
STANDING	Umbrella 61	BNBAS 62	→					
WALKING	Umbrella 63	BNBAS 64	→					
PLACING	Umbrella R 65	Umbrella L 66	BNBAS/R 67	BNBAS/L 68	→			
INCURVATION	BNBAS/R 69	BNBAS/L 70	→					
CRAWL	APIB 71 U	~~BNBAS 72~~	→					
CUDDLING	Vertical 73	Fetal Tuck 74 I	Horizontal 75	Fetal Tuck 76 I	~~BNBAS 77~~	→		
TONIC NECK REFLEX	BNBAS/R 78	BNBAS/L 79	→					
DEFENSIVE REACTION	BNBAS 80	→						
V: HIGH TACTILE/ VESTIBULAR ROTATION	Head R 81	Head L 82	Eyes R 83	Eyes L 84	~~BNBAS/R 85~~	~~BNBAS/L 86~~	Nystagmus 87	
MORO	Arms Extension 88	Arms Adduction 89	Legs 90	~~BNBAS 91~~	→			
VI: ATTENTION/ INTERACTION ANIMATE VISUAL & AUDITORY (Face&Voice)	Elicitation Maintenance 92	Orientation (B) 98	Orientation (A) 104	Effort 110	Cost 116 I	Quality 122	→	
ANIMATE VISUAL (Face)	Elicitation Maintenance 93	Orientation (B) 99	Orientation (A) 105	Effort 111	Cost 117 I	Quality 123	→	
ANIMATE AUDITORY (Voice)	Elicitation Maintenance 94	Orientation (B) 100	Orientation (A) 106	Effort 112	Cost 118 I	Quality 124	→	
INANIMATE VISUAL & AUDITORY (Rattle)	Elicitation Maintenance 95	Orientation (B) 101	Orientation (A) 107	Effort 113	Cost 119 I	Quality 125	→	
INANIMATE VISUAL (Ball or Rattle)	Elicitation Maintenance 96	Orientation (B) 102	Orientation (A) 108	Effort 114	Cost 120 I	Quality 126	→	
INANIMATE AUDITORY (Rattle)	Elicitation Maintenance 97	Orientation (B) 103	Orientation (A) 109	Effort 115	Cost 121 I	Quality 127	→	

1= bad ; 9= good I = invert III u = fold over X is not considered because subsumed

SCORE SHEET III — BEHAVIORAL SUMMARY SCALES

PHYSIOLOGICAL PARAMETERS				
TREMULOUSNESS	BNBAS 1 I			
STARTLES	BNBAS 2 u			
SKIN COLOR	~~Lability of Good Color 3 I~~	Lability of Comp. Color 4 I	Threshold 5 I	Jaundice 6 I
SMILES	APIB 7	~~BNBAS 8~~		

MOTOR PARAMETERS				
TONUS	BNBAS 9 u	Balance 10		
MOTOR MATURITY	BNBAS 11	Threshold 12 I	Postural Control 13	Symmetry 14
ACTIVITY	Spontaneous Activity 15 u	Elicited Activity 16 u	~~BNBAS 17 u~~	
HAND-TO-MOUTH FACILITY	BNBAS 18			

STATE PARAMETERS								
ALERTNESS	Degree (B) 19	Degree (A) 20	Quality 21	Am't. Manipulation 22 I	STATE REGULATION	Lability 23 I	Range and Flexibility 24	~~BNBAS 25 I~~

SELF REGULATION PARAMETERS

C

Catalogue 0 = low 3 = high

WITHDRAWAL OR AVOIDANCE BEHAVIOR — CATALOG OF REGULATION MANEUVERS			
Spit-ups 1	Gags 2	Hiccoughs 3	Bowel Mvt 4
Grimace 5	Arching 6	Finger Splay 7	Airplane 8
Salute 9	Sitting on Air 10		
Sneezing 11	Yawning 12	Sighing 13	Coughing 14
Averting 15	Frowning 16		

APPROACH OR GROPING BEHAVIOR — CATALOG OF REGULATION MANEUVERS			
Tongue Extension 17	Hand on Face 18	Sounds 19	
Hand Clasp 20	Foot Clasp 21	Fingerfold 22	Tuck 23
~~Body Movement 24~~	Hand to Mouth 25	Grasping 26	Leg/Foot Bracing 27
Mouthing 28	Suck Search 29	Sucking 30	Hand Hold 31
Ooh Face 32	Locking 33	Cooing 34	

QUIETING	Self-quiet S+ 26	Self-quiet Motor + 27	Consolability S+ 28	Consolability Motor + 29
PEAK OF EXCITEMENT	BNBAS 30 u			
RAPIDITY OF BUILD-UP	Rapidity + S 31 u	Rapidity + Motor 32 u		
IRRITABILITY	~~Irritability (B) 33 u~~	Irritability (A) 34 I		
ROBUSTNESS	Robustness 35			
CONTROL OVER INPUT	Control Over Input 36			
FACILITATION STIMULATION	Facilitation Stimulation 37			

— III cont. —

SUMMARY

ATTRACTIVENESS

38

APPENDIX D

PARENT PERCEPTION SCALE

On the left side of this page, circle the point between two words on each line which you think best describes Your Baby now. Then on the right side of the page, circle the point which gives your impression of the Average Baby of the same age.

MY BABY			AVERAGE BABY		
calm	1 2 3 4 5 6 7	excitable	calm	1 2 3 4 5 6 7	excitable
sleeps lightly	1 2 3 4 5 6 7	sleeps well	sleeps lightly	1 2 3 4 5 6 7	sleeps well
small for age	1 2 3 4 5 6 7	big for age	small for age	1 2 3 4 5 6 7	big for age
is easily consoled	1 2 3 4 5 6 7	is difficult to console	is easily consoled	1 2 3 4 5 6 7	is difficult to console
eats well	1 2 3 4 5 6 7	eats poorly	eats well	1 2 3 4 5 6 7	eats poorly
usually moving	1 2 3 4 5 6 7	rarely moving	usually moving	1 2 3 4 5 6 7	rarely moving
quiet/does not cry	1 2 3 4 5 6 7	cries a lot	quiet/does not cry	1 2 3 4 5 6 7	cries a lot
weak and fragile	1 2 3 4 5 6 7	healthy and strong	weak and fragile	1 2 3 4 5 6 7	healthy and strong
passive	1 2 3 4 5 6 7	active	passive	1 2 3 4 5 6 7	active
usually sleepy	1 2 3 4 5 6 7	usually awake/alert	usually sleepy	1 2 3 4 5 6 7	usually awake/alert
likes to be touched	1 2 3 4 5 6 7	doesn't like to be touched	likes to be touched	1 2 3 4 5 6 7	doesn't like to be touched
predictable	1 2 3 4 5 6 7	unpredictable	predictable	1 2 3 4 5 6 7	unpredictable
causes me a lot of worry	1 2 3 4 5 6 7	causes me little worry	causes me a lot of worry	1 2 3 4 5 6 7	causes me little worry

APPENDIX E

CONSENT FORM

Northwestern Memorial Hospital/Prentice Pavilion

"Nursery Intervention with Preterm Infants and Parents"

1. Explanation of Study: Advances in medicine have allowed us to learn more and better ways to help preterm and sick infants survive. We would like to enroll your infant and you in a study to determine the effects of special physical handling and education in the Special Care Nursery(SCN). If you choose to participate, your infant will be assigned to one of two groups by chance. One group of infants will receive daily physical therapy for four weeks (between the ages of 32 and 36 weeks). Physical therapy will consist of a variety of gentle movements and position changes to provide the infant with normal sensorimotor experiences. Parents of these infants will receive individualized education and training on three occasions during the same four week period and once thereafter. Infants in the other group will receive all normal nursing care provided in the SCN. Their parents will receive routine educational information and suggestions given to patients discharged from the SCN. The development of all infants in the project will be assessed at 32, 36, and 40 weeks of age. Your perceptions of your infant's behaviors will be measured at those times as well.

2. Individual Providing Explanation: The goal and procedures of the investigation described above have been explained to me by____________________________.

3. Benefits: The described study has the following potential benefits: (1) It will provide specific information on the early development of preterm infants; (2) It will identify factors which positively influence the development of preterm infants; and (3) It will provide information on how parents perceive the development of their infants. The combined information will help identify the best approach to the care of preterm infants and their parents.

4. Risks and Discomforts: The procedures used in this study entail minimal risks to the infants and parents. Normal SCN regulations regarding the care and handling of infants will be followed at all times. Physical therapy will be provided by a licensed physical therapist experienced in pediatric therapy. Assessment of the infants will be performed by an individual specially trained in the evaluation of preterm infants.

5. Withdrawal from Study: I understand that I am free to withdraw from participation in this study at any time. This decision will not jeopardize any subsequent care of my infant.

6. Availability to Answer Questions: I understand that any questions regarding the described treatment, training, and assessment will be answered in accordance with prevailing medical and psychological knowledge and judgment by Drs. Deddish or Burns either in person or at phone number 908-7396.

7. Consent: I understand that research activities will be supervised by Drs. Burns and Deddish and whomever he/she designates. I have read the explanation of therapy and activities included in this project or have had it read to me. With this knowledge of the project, the possible risks, and the benefits, I hereby authorize the participation of ________________________________.

8. Confidentiality: I consent to the publication of any data which may result from this investigation for the purpose of advancing medical and psychological knowledge. I understand that my infant's name or my name will not be used in connection with such publications.

9. Compensation Disclaimer: I understand that, in the event of injury or illness resulting from the research procedures, medical treatment for injuries or illness is available through the McGaw Medical Center of Northwestern University. Payment for this treatment will be my own responsibility.

I understand that the Office of Risk Management of Northwestern University, at telephone number 491-5610, can provide further information about my rights as a research subject and is where I should report any research-related injury. Further information regarding this study may be obtained from the project directors, Dr. William J. Burns, at telephone number 908-7396, or Dr. Ruth Deddish,908-7514.

I understand that my participation is voluntary and I certify that I have read and understand the above and consent freely to enter my infant in the study.

Signed________________________________ Witness________________________

Relationship__________________________

Investigator__________________________

Date__________________________

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APPROVAL SHEET

The dissertation submitted by Kathleen Malee has been read and approved by the following committee:

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The final copies have been examined by the co-directors of the dissertation and the signatures which appears below verify the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosphy.

11/30/87
Date

Carol Harding
Jack A. Kavanagh
Co-Directors Signatures