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There are many physiological complications which are associated with the birth of premature infants due to their early interruption of intrauterine life. One of these complications is that of hyperbilirubinemia. Premature infants are placed under flourescent lights, with their eyes occluded by patches, as a means of reducing the high serum bilirubin content in the blood stream. This medical procedure, although necessary, also prevents normal visual stimulation from the environment. Studies of animals have shown that deprivation of visual stimulation in the early days of development can have long lasting effects on the visual perceptual abilities of animals. Therefore, a systematic program of visual stimulation for infants with occluded vision was developed in an effort to increase their visual orientation abilities.

Ten premature infants with hyperbilirubinemia, whose gestational ages were clinically assessed to be between 28 weeks to 38 weeks, were randomly assigned to Experimental and Control groups. Both groups of infants received the visual stimulation program during the time they were under the flourescent lights; however, only infants in the Experimental group had their eye patches removed during this time. The visual stimulation was performed each day for 20 minutes and consisted of moving back and forth at a distance a mobile, a penlight and colored paddles. Following discontinuation of the flourescent lights, the Brazelton Neonatal Behavioral Assessment Scale was administered to each infant. Three days later the infants were tested again on the same scale in an attempt to determine stability of these test scores. It was hypothesized that infants in the Experimental group would perform better on the first test of the Brazelton

Scale following discontinuation of the flourescent light therapy and accompanying eye patches, and that the Control group scores might actually increase more dramatically as these subjects experienced visual stimulation for essentially the first time between Test I and Test II.

The results indicated that the visual orientation abilities as measured by the Interactive Dimension of the Brazelton Neonatal Behavioral Assessment Scale were enhanced by a systematic program of visual stimulation, and that these gains were also stable over time. Significant differences were found in favor of the Experimental infants at both times of testing. Both the Experimental and Control group scores for the Interactive dimension increased from Test I to Test II but there was not a significant difference in amount of improvement between groups.

The State Control dimension of the Brazelton scale was also analyzed, since measuring the Interactive dimension requires the ability to maintain an alert state. The results indicated that the Control group scores were higher at the first time of testing than those of the Experimental group but this difference was not significant. At the second time of testing both groups' scores had increased and by then the Experimental group scores were greater than those of the Control group; again, this did not represent a significant difference.

On both the Motoric and Physiologic dimensions of the Brazelton Scale the Experimental group scores were higher than those of the Control group; similar to the results for the Interactive and State Control dimensions, both of these scores showed an increase from Test I to Test II.

Implications for future visual stimulation efforts by nurses and parents working with prematures were discussed; suggestions were also made for possible alternatives to the use of eye patches with infants undergoing phototherapy.

VISUAL STIMULATION FOR PREMATURE INFANTS WITH HYPERBILIRUBINEMIA

by

Michelle C. Evans

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TABLE OF CONTENTS

555649

APPENDIX Page

LIST OF TABLES

LIST OF FIGURES

Page

FIGURE

CHAPTER I

REVIEW OF LITERATURE

Introduction

The newborn infant becomes aware of his/her environment through the visual, auditory, tactile, gustatory and proprioceptive senses. Knowledge derived from early experience is therefore dependent on the perceiving abilities of the senses and on the quality and quantity of impinging environmental stimuli.

Piaget (1947) and Hebb (1949) have provided theoretical bases in support of the argument that all infants need and can benefit from early stimulation. Piaget described development during the "sensory motor stage" as the emergence of "a hierarchal organization of symbolic representation and information processing strategies derived to a considerable degree from past experiences" (Piaget 1947, p. 109). Hebb theorized that intelligence was a developmental process which combined neurophysiological and environmental components occurring early in the life of the organism. Two of Hebb's major theoretical contributions have been influential in the experimental work on early enrichment and deprivation: (1) an arousal theory which pointed to sustained stimulation as crucial for normal function and alerting and (2) a developmental concept which emphasized the crucial importance of early experience. As explained by Forgus (1954) the latter theory held "that the organization of adult behavior is largely determined by the quality of infant experience and learning" (page 331). Thus, several major theorists have drawn attention to the crucial importance of early experience.

The nature of the intrauterine environment is such that there are many provisions for stimulation. However, the infant who is born early is deprived of its full share of stimulating opportunities during intrauterine development. When an infant is born fragile and immature and often in need of additional warmth and oxygen he/she is placed in the sterile and rigidly controlled environment of the incubator-isolette. The environment of the incubator-isolette precludes tactile, kinesthetic, auditory and visual stimulation normally surrounding the full term, more robust infant. Parents, often unsure and frightened with the tiny infant, may take their cues for home care from the model they observe in the hospital where hospital personnel are cautious and often reluctant to provide more than minimal stimulation of the premature infant. Consequently, it is assumed that the premature infant may suffer more from deprivation of stimulation, not only during the prenatal but also during the postnatal developmental period, than does the full term infant.

The vulnerability and need for stimulation of any newborn infant are now widely recognized characteristics; awareness of these needs has resulted in the initiation of many early stimulation programs, although it is only recently that such efforts have also been extended to prematures.

Stimulation of Full Term Infants

Although stimulation per se may apply to a variety of sensory modalities, investigators have focused primarily on the full term infants' visual capabilities, as well as on the effects of early visual stimulation.

Knowledge of the newborn infants' visual capabilities has been increased greatly in the past decade. The essential indicators are visual scanning, visual fixation (chcice of target, length, frequency), the

concomitants of alerting or attending (cardiac and respiratory deceleration, pupillary dilation, motor quieting), the reverse of these, habituation or boredom and operant procedures. It is through these indicators that one is able to determine what the infant can and wants to perceive visually, what the infant is tired of, and what preferences the infant may have regarding designs or schema within the visual field.

It appears that the visual space of the infant is not drastically unlike that of the adult. Haynes, White and Held (1965) used retinoscopy to demonstrate that the newborn can focus only at relatively fixed distance of approximately nineteen centimeters (about $7\frac{1}{2}$ inches), but that by four months of age the infant performs more like that of an adult in terms of focal length. Gorman, Cogan and Gellis (1957) also tried to determine visual acuity using the neonates' opticokinetic responses to a moving drum lined with stripes, and found that 93 of 100 infants responded preferentially to stripes at an angle that would indicate a 20/150 vision. Dayton et. al., (1964) found the same results using the technique described above.

Tronich and Clanton (1971) examined the pattern of head and eye movements in three week old infants and found that when infants were in an upright position both the head and eyes became aimed at the target. When the infant moved its line of sight from one target to another, the eyes typically moved first with a rapid saccadic shift, followed by a slower head movement. These complex patterns appeared to be quite organized in the newborn and it was suggested that the infant has a cortically controlled visual system at birth that co-ordinates head and eyes for the extraction of information from the environment.

The infant's ability to diminish responses to repeated visual stimuli was studied by Brazelton (1962) with a series of 20 bright light stimuli presented at one minute intervals. The infant demonstrated diminished motor responses, and by the tenth stimulus had decreased cardiac and respiratory responses as well. The latency to evoked responses was measured by EEG (electroencephalography) tracings and were found to increase with repeated stimuli. This capacity on the part of the neonate to suppress his responses to visual stimuli has been interpreted as a kind of neurologic habituation and has been found to be present in neonates with intact central nervous systems (Ellingson, 1960).

Fantz (1965) was one of the first to point out neonatal preference for certain kinds of complex visual stimuli. Fantz used recorded fixations indicated by target reflections on the cornea of the eye. He found that infants preferred sharply contrasting colors, larger squares and medium lit objects. Goren (1975) showed that, immediately after delivery, a human neonate would not only fix on a drawing that resembled a human face but would also follow it for 180° arcs, with eyes and head turning to follow. A "scrambled face" pattern did not demand the same kind of attention or following by the infant. This had led some to believe that there is an innate attraction to the human face evident even in newborn infants. Hershenson (1964), and Stechler and Laty (1966), have demonstrated that neonates prefer moving and somewhat complex visual patterns to stationany ones. If an object is moved slowly, parallel to the natural, lateral movements of the eyes, it is more likely to capture the interest of the neonate. Furthermore, the duration and degree of an infant's attention may be correlated with both a middle range of complexity and the similarity

of the target to the ovoid shape and structures of the human face. Salapatek and Kessen (1966) found that the most concentrated visual fixation occurs in the neonate's response to the contrasting edges of an object. For example, the most compelling features of the human facial configuration seem to be the eyes or sides of the head, in terms of the neonate's visual fixation.

There is also reason to believe that the world of the young infant (and perhaps of the newborn as well) is three-dimensional. Studies using the "visual cliff" (Gibson and Walk, 1960) show avoidance (and therefore imply perception) of the apparent drop as soon as the young of the species studied can make the required motor response, that of moving or ambulation. Because of the slow locomotor development of the human infant, avoidance of the visual cliff is difficult to demonstrate behaviorally before the age of six months; however evidence from other species suggests that the preceptual capabilities might be present well before this time (Gibson, 1970; Routtenberg, 1964; Rosenblum, 1963; Meyer, 1963). Campos, et al. (1970) investigated depth perception in 32 pre-crawling 2 month old infants. The visual-cliff apparatus was used and heart rate was measured at each side of the cliff. The infants manifested a small cardiac response on the shallow side but a highly significant deceleration on the deep side, thereby demonstrating depth perception as early as 2 months of age in a human infant.

Several investigators have provided early stimulation techniques and have recorded its effect on the visual responses of infants. Brody (1951) reported that infants receiving moderate amounts of maternal handling seemed to be more interested in their visual surroundings than those who received minimal amounts of such stimulation. She also noted infants who

received the moderate handling were consistently more visually attentive than those receiving minimal handling. White and Castle (1964) also reported that infants showed significantly more visual interest in their environments when they were given small amounts of extra handling during the first five weeks of life. The extra handling began the sixth day of life and continued for the next 30 days. They concluded that early post-natal handling played a significant role in determining the amount of visual exploratory behavior seen in human infants. They further postulated that visual attention was a pre-requisite for the utilization of and the development of the intellect. Korner and Grobstein (1964) observed that when babies cried and were picked up, they not only stopped crying but they frequently became visually alert and scanned the environment. They investigated how frequent soothing of the infant elicited visual alertness. Twelve two and three day old infants were picked up while crying and put alternately to the right and left shoulder and propped to a sitting position. Results reflected significant differences between positions in alerting and scanning. White (1969) demonstrated that even the usual handling of infants in institutions could produce enhancement of visual attention and in visually monitored reaching. Development of visual attention and reaching was significantly enhanced by as little as 20 minutes a day of extra handling by a nurse during the first month of life for institutionalized infants. Greenberg, Uzgirus and Hunt (1968) demonstrated that infants who had increased experience with looking (at least 30 minutes a day) responded with a blink response to a dropped target several weeks sooner than did infants without such experience.

It appears that visual perception is available in humans from birth

and that it plays an important role in the infants' interaction with the environment. Vision appears to be a well developed sensory modality at birth, ready to function without prior experience. However, it is the interaction with the environment which enhances and refines the basic genetic endowments present in the neonate. Without frequent and varied visual stimulation from the environment the continued development of these innate capacities may be seriously impaired.

Visual Deprivation

Of necessity, many of the studies on visual deprivation have used neonatal animals rather than human subjects. There were differential effects on vision of animals when they were reared in total darkness as opposed to being reared in patterned light (Riesen, 1975). The length of deprivation as well as the time it occurred in the life of the animal also appeared significant to later development of visual abilities.

Prolonged exposure to dark in primates has been found to result, eventually, in atrophic changes in the retina and optic nerve, with loss of retinal ganglion cells and other local morphochemical changes (Chow, Riesen, and Newell 1957; Rasch, Swift, Riesen and Chow 1961; Riesen 1950; Winsburg and Riesen, 1966). Not only were there physiological changes but also behavioral changes which resulted from long term dark-rearing. Depriving animals of visual stimulation from birth severely retards the development of visual abilities, and such animals appeared blind in tests of obstacle avoidance and on other response indicators upon their first exposure to a normally patterned visual environment (Riesen and Aarons, 1959; Held and Hein, 1963; Gany and Fitch, 1968; Hein and Diamond,1971).

Riesen (1947) has described the extreme visual incompetence of two

young chimpanzees when they were first removed from their dark room after being reared there for 16 months. Some basic visual capacities were present in these dark-reared animals immediately upon exposure to light, but in general, their visual-motor abilities were markedly impaired. There was no evidence of visual recognition, visual startle response or sustained visual fixation of either stationary or moving objects. Fantz (1956) also used visual fixation as an index of visual discrimination by comparing the duration of fixation to different targets exposed to monkeys reared in darkness for six weeks. The animals displayed abnormal preferences, showing little or no preference for patterned or solid objects, but rather an increasing tendency to respond to stimuli differentially on the basis of color, size, or brightness. Riesen, Kurke, and Mellinger (1953) compared form discrimination learning from birth in dark reared and normally reared kittens. Beginning at 14 weeks of age they were brought into the light for 30 minutes daily and given diffused light stimulation until the age of 17 to 20 weeks. Discrimination learning was then assessed. Dark reared animals were markedly impaired in their ability to discriminate between horizontal and vertical striations and between a triangle and a circle.

The studies cited above illustrate that the normal development of visual abilities does not proceed when neonatal animals are reared in total darkness. The fact that animals reared only with diffused light stimulation exhibit similar kinds of visual retardation supports the notion that light itself is not a sufficient condition for visual development (Wilson and Riesen, 1966; Zimmerman, 1961; Berger and Meier, 1968; Hubel and Wiesel, 1963). Further evidence of this was provided by Riesen (1950,1958),

who investigated the visual abilities of chimpanzees raised to age seven months in darkness with 1½ hours of daily exposure to diffused light. After examining the chimpanzees upon their removal to daylight, Riesen found that extensive training was required in order for the animals to learn form discrimination.

There appears to be sufficient evidence to conclude that stimulation by visual patterns is essential if animals are to develop the normal complement of visually dependent abilities, such as, visual acuity, discrimination, and perception (Chow and Stewart, 1972; Gany and Fitch, 1968; Rizzolatti and Tradardi, 1971; Wiesel and Hubal 1963,1965). The development of visual acuity in diffused light-reared macaques were examined in a study by Riesen, Ramsey, and Wilson (1964). The results demonstrated a systematic improvement in visual acuity with patterned light stimulation. Beginning on the first day of patterned light exposure, visual acuity was tested daily. Acuity was poor initially, but improved promptly with experience in patterned light at a rate comparable to the development of acuity in normally reared monkeys.

There appear to be other factors related to the development of visual abilities which deal with maturation as well as the experimental factors of length of deprivation and time of onset of deprivation. Wilson and Riesen (1966) studied 12 rhesus monkeys raised for sixty days under deprivation of patterned visual experience. After such deprivation, the animals were like newborn monkeys in many respects; however, their learning or their visual acuity, ocular pursuit of movement and binocular convergence developed significantly more rapidly than they did in normal newborn monkeys. Further studies have shown that shorter periods of deprivation

have less severe effects than long periods of deprivation (Riesen, 1947; Riesen, 1950). Fantz (1965) used Rhesus monkeys reared in darkness to varying ages up to 16 weeks old. Each infant with less than eight weeks of deprivation showed a significant preference for each of the four patterned targets, while longer deprived infant monkeys did not do so and in some cases, favored the unpatterned target. The three longest deprived monkeys generally showed stronger preferences and always in the same direction; red over yellow, black over white and large over small. The two less-deprived groups showed a reliable increase in preference for solid targets with increasing experience, while the longest deprived group never did show this preference.

Rearing in darkness, or deprivation of light, or patterned light appear to have a pronounced, long lasting effect on attention, perception and accompanying responses depending on the length of deprivation, and if it occurs early in the life of neonatal animals. At this point in our developmental knowledge there seems to be little reason to assume that these conclusions do not apply to the human neonate as well.

Infant Assessment Scales

There are several assessment procedures given at birth or within a few days after birth which, when viewed together, can help point to the high-risk status of the premature infant as differentiated from the full-term infant.

The Apgar score could be considered a very basic initial behavioral assessment of the newborn infant. The Apgar score is given at three separate intervals immediately after birth (see Appendix C and methods section). Infants with low Apgars (0 - 5) at five minutes after birth

have been found to show fourfold increase in neurologic abnormalities at one year of age compared to infants with Apgar scores of 7 - 10 at five minutes (Drage, 1968). Correlating the Apgar score with later measures does show that it has some ability to differentiate between optimal and slightly less than optimal infants. Lewis (1967) compared visual attentiveness at 3, 9 and 13 months of age between infants with one minute Apgar scores of 7 - 9 and 10. He found that infants with an Apgar of 10 had an increased capacity to respond to complex visual tasks when compared to other infants with lower scores. It was suggested that the Apgar score may reflect adaptive behavior that could predict future functioning but that more sensitive tests are needed to measure this outcome.

The Brazelton Neonatal Assessment Scale (Brazelton, 1973) has been the most commonly used neonatal behavior exam given to an infant within three days after his birth. The 26 behavioral items assess the neonates' capacities to: (1) organize their states of consciousness, (2) habituate reactions to disturbing events, (3) control motor tone and activity while attending to the events, (4) perform integrated motor acts. These behavioral items have appeared to demand control and central nervous system organization which are dependent on either the cortex or higher brain centers (Brazelton, Parker and Zuckerman, 1976). These behavioral items are scored on a nine point scale and the 20 reflexes are assessed on a three point scale. Scores on the test have been factor analyzed by Brazelton into four A-Priori clusters. These four clusters are: (1) Interactive Processes--responses to auditory and visual stimuli and to cuddling, (2) Motoric Processes--maintaining normal muscle tone and control of body movement, (3) State Organization--as demonstrated by such items as irritability and number of state changes,

which reflect the ability to control level of arousal, (4) Physiologic Organization--autonomic responses to the examination. Each cluster is then scored on a three point scale as normal, worrisone or deficit.

Published reports indicate reliabilities of independent testers trained at the same time as ranging from 0.85 to 1.00 (Freedman and Freedman,1969; Brazelton and Collier, 1969). In addition, testers can be trained to a 0.90 criterion of reliability and the level of reliability remains at 0.90 or higher for a prolonged period. The most extensive test-retest stability was reported by Horowitz (1971). Sixty infants, 30 males and 30 females, were tested on the third and fourth day of life and again at one month of age. The mean test-retest reliability for males was 0.585 using agreement within a one-point criterion and 0.796 using agreement within a two-point criterion. For females the mean test-retest reliability was 0.654 using agreement within a one-point criterion and 0.850 using agreement within a two-point criterion.

In order to assess the effectiveness of the Brazelton Scale, Brazelton and Torick (1975) compared it to a standard neurologic examination to determine it's predictive value and found similarities in both exams in terms of detecting abnormal infants. However, there were striking differences in the discriminative capabilities of the two exams in mislabeling normal infants, or in their "false-alarm" rates. The neurologic exam had a false-alarm rate of 80% whereas the Brazelton exam had a false-alarm rate of only 24%. Thus, the Brazelton exam achieved a rate of 80% for detecting abnormal neonates without including as many normal infants in a suspect or abnormal category.

Premature Infants

The premature infant is different in many respects from the full-term infant. Many infants whose birth weights are 2,500 grams or less suffer

significantly more handicaps in physical, neurological and mental development and general functioning than full-term infants (Harper, 1959; Lubchenco, 1963; Beargie, James and Green, 1970; Rubin, Rosenblatt and Balow, 1973). Further, the disabilities may extend to psychological and social functioning (Drillien, 1958, 1961, 1970; Alm, 1963).

There are several clinical problems associated with premature infants, based on their immaturity. They include; jaundice after four days, respiratory distress, intracranial hemorrhage, diminished ability to handle solute load, decreased ability to maintain body temperature, decreased ability to absorb fats, apnea and susceptibility to retrolental-fibroplasia. Small-for-gestational-age babies, on the other hand, have an increased frequency of hypoglycemia and a relative increase in oxygen consumption, requiring greater caloric intake on a per-killogram basis. Chromosomal abnormalities and fetal infection are more likely to be associated with in-utero growth retardation as seen in small-for-gestational-age babies. Drillien (1972) has shown that small-for-gestational-age babies did less well on developmental testing when compared to premature appropriate-for-gestational-age babies of the same age. (See Appendix A and B, and methods section for Dubowitz scoring of gestational age and intrauterine weight chart.)

As stated previously, the majority of premature infants have many medical problems due to their lack of physiological organization and maturity. One of the main problems has been that of hyperbilirubinemia. Hyperbiliruinemia has been a regular occurrence in all neonates. This

condition has been the result of the substance bilirubin in the blood stream of the infant at a level exceeding 1 mg./100 ml. Bilirubin is formed from the breakdown of erythrocytes or red blood cells. The liver and spleen of the newborn and particularly the premature infant have not matured enough to catalyze all the bilirubin, so that the overflow is retained in the blood plasma. Jaundice occurred when the bilirubin in the serum exceeded 4-6 mg./100 ml. and the bilirubin became visible in the pigment of the skin giving the baby a "yellow" appearance. In premature infants, jaundice was first evident after 48 hours and disappeared by the ninth or tenth day. If the serum bilirubin level reached 15 mg./100 ml. in the premature, the danger of brain damage by the bilirubin was increased. Because the bilirubin is fat soluble it had a high affinity for extra-vascular tissue, particularly for fatty tissue and for brain tissue. It has been found that 10-20% of low birth-weight infants develop hyper-bilirubinemia (Obes-Polleri, 1967; Lucey, 1967; Guinta and Rath, 1969). Evidence has also been provided from a study by Boggs (1967) indicating that small premature infants have an increased incidence of retarded motor development measured at nine months of age if their serum bilirubin levels have been above 15 mg.%.

Hyperbilirubinemia has been treated medically by a number of methods, the most common of which has been phototherapy. Phototherapy has used a device called a light cradle which contained eight, two foot long, 40 watt light blue fluorescent tubes. The emitted radiation of 200 to 400 footcandles of the spectrum of wave lengths between 300 my and 60 my has been found to be the most effective in reducing serum bilirubin in many premature infants (Sisson, 1970). Blue light of this wave length has

been the most effective source for rapidly lowering serum bilirubin levels. The tubes are arranged inside a semicylindrical stainless steel shield which directed the light onto the infant lying below the shield. The length of time that an infant remained under the lights was a medical decision usually based on the serum bilirubin concentrations periodically taken from blood samples (see Appendix E for determination of light levels and exchange levels). During the treatment of phototherapy the infant was naked except for gauze eye patches which were taped to the head. There were several reasons for the use of these patches to cover the infant's eyes while being exposed to the lights. Research by Wurtman (1970) has shown that retinal damage has occurred in rats when exposed to intense light. The most recent research which has been done, again on rats, indicated that light had a profound effect on biologic rhythms. It has become increasingly apparent that light generates the cyclic activity of pineal enzyme (hydroxyindale-0-mthyl transferase) which makes the hormone melatorin. This hormone synchronized daily rhythms in body temperatures, food comsumption, physical activity and adrenocartical secretion. In animals, light has a profound influence on gonad weight and ovulation. Minor shifts in the spectrum of light has been found to make a significant difference in the effects on weight and ovulation in young animals (Wurtman, 1970). These effects have been found to be mediated through special photo-receptor cells in the retina of the eye; therefore, it has been deemed medically necessary that infants under bilirubin lights have their eyes covered by patches.

In many hospital settings bilirubin babies have been exposed to these lights on a 24 hour bases for as long as a week at a time. Often their

respiration and cardiac functions have been monitored via elaborate machinery which have been attached superficially to the infant. This has usually required that the infant be immobilized in static positions for long periods of time without the benefit of quality sensory stimulation, particularly visual stimulation.

Stimulation with Premature Infants

The vulnerability of the premature infant to deficit areas of development has been used by authors as a basic premise for the institution of early stimulation programs with premature infants (see table 1, page 24). These studies were based on the belief that the environment of the incubator-isolette precludes tactile, kinesthetic, auditory and visual stimulation normally surrounding the full-term infant. It was assumed, therefore, that the premature infant suffers significant deprivation of stimulation during his early developmental period as most premature infants are placed in isolettes for necessary medical reasons.

In general, the purpose of all intervention studied was to show evidence of the effects of environmental manipulations on the behavior and subsequent development of premature infants. There were three basic dimensions along which these studies varied considerably: 1) the use of unimodel or multimodel stimulation, 2) the sensory modalities stimulated and, 3) the intensity, frequency and length of stimulation.

Several different sensory systems were the target for stimulation. The majority delt with tactile stimulation usually through handling such as picking up and holding or by stroking the body of the infant (Powell, 1974; Scarr-Salapack and Williams, 1973; Salkoff, Weintraub and Blase, 1969; White and Labarba, 1976; Siqueland, 1970). Several studies have

attempted to simulate the sensory experiences of the womb through vestibular or rocking stimulation in an effort to make up for possible sensory deficits in this area (Scarr-Salapatek and Williams, 1973; Wright, 1971; Powell, 1974; White and Labarba, 1976). Neal (1971) designed a hammock apparatus which allowed a fetal posture and provided rotations and rhythmical activity thought to be comparable to that of uterine life. Kramer and Pierpont (1976) used the same idea but their apparatus was a rocking waterbed and they also used a heart beat (seven beats per minute) as it might be heard by the fetus in the uterus of a pregnant woman. One problem with vestibular duplication of the womb has been that there is no mechanical device which can reliably give the varied stimulation produced in the womb of the mother. Auditory stimulation or sound stimulation to the auditory system of the newborn was also a means of intervention (Scarr-Salapatek and Williams, 1973; Wright, 1971; Segall, 1972; Kramer and Pierpont, 1976). Katz (1971) provided premature infants from the fifth day of life until they were 36 gestational weeks old with a taped recording of their mothers' voice. Most of the studies in Table 1 used the voice of a person, particularly that of the mother when providing auditory stimulation. Most of the studies which provided auditory and tactile stimulation employed types of stimulation belived to be characteristic of the experience of the full-term neonate in order to accelerate the development of the premature (Powell, 1971; Scarr-Salapatek and Williams, 1973; White and Labarba, 1976; Siqueland, 1970).

Providing prematures with the same stimulation given for full-term infants was questionable however, since it has not yet been established what is appropriate for full-term infants (Starr, 1971). Visual input

was generally treated indirectly in many of the stimulation programs. Visual input was largely dependent on voluntary opening of the infant's eyes during other manipulations ie., while rocking, during feeding. Wright (1971) provided striped sheets while Scarr-Salapatek and Williams (1973) placed nursery "birds" in the form of mobiles over the cribs. Siqueland (1970) was the only author who later tested the effects of his handling program on the visual exploration abilities of the infants.

The second dimension along which intervention studies have differed pertained to a particular type or of several types of stimulation used together. Studies were differentiated into those using a unimodal approach (Neal, 1968; Salkoff et al., 1969; Siqueland, 1970; Katz, 1971), or a multimodal approach (Wright, 1971; Scarr-Salapatek and Williams, 1973; Powell, 1974; Kramer and Pierpont, 1976; White and Labarba, 1976). When an author utilized a unimodal method of stimulation, it was one sensory system of the infant which received the stimulation such as gentle rubbing of the body of the infant for tactile input or a program of systematic rocking for vestibular input. Multimodal stimulation was utilized to stimulate several sensory systems at one time such as strcking while talking to the infant. A limitation of the use of multimodal stimulation was that there may be effects atypical of the seperate application of unimodal stimulation. For example, the effects of automated crib rocking (Katz, 1971) may be very different from the effects of rocking while handling (Scarr-Salapatek and Williams, 1973). It has been found that due to the neurological integration of sensory systems, providing one sensory system with stimulation ultimately affects other sensory systems as well (Ayres, 1973). Therefore, other limitations of the multimodal

treatment of stimulation have been the inability to ascertain; 1) individual results of a particular type of stimulation and 2) which individual stimulation was the most affective on the subsequent outcome measures. An example was provided by Siqueland (1970) who provided a handling or tactile stimulation program and measured visual exploration as the outcome. He found that tactile stimulation increased visual exploratory abilities of premature infants.

The third dimension along which intervention studies have differed has been the intensity, frequency and the length of the stimulation program. There was much variety in auditory stimulation given to premature infants. Wright (1971) used a "stimulator crib" activated by a timer for ten hours daily. The crib provided music and talk from a radio station for 15 minutes every hour and a half. This auditory stimulation was performed for 21 days in the home of the infant. Katz (1971) provided premature infants from the fifth day of life to the 36th gestational week with a taped recording of their mother's voice. A timing device was set to activate the recorder for five minutes, six times a day at two hour intervals.A speaker was placed in baby's isolette eight inches from the ear at 70 decibels. Segall (1972) also used a tape recording of the mother's voice. This stimulation was presented every day for 30 minutes until the infant was 36 gestational weeks old. Kramer and Pierpont (1976) also provided auditory stimulation in the form of a woman's voice as well as the heartbeat. The program was begun on the second to seventh day of life lasting for the duration of time that the infant was in the isolette. One hour prior to each feeding the infant was exposed to the tape of a simulated heartbeat of 72 beats per minute and a female voice of 74 to

84 db. General auditory stimulation programs were presented by Powell (1974), Scarr-Salapatek and Williams (1973) and provided by mothers and nurses who talked to the infants while feeding or visiting them. There was no standard method employed in these studies for the auditory input. All of these dimensions of stimulation reflected a lack of concensus as to the ecology of the premature infant.

The studies can also be compared on their sample characteristics, the sample requirements and their size. With respect to sample characteristics, the infants in most of these studies were Negro or Caucasian and tended to be in the lower socioeconomic class. Accross all studies there were approximately equal numbers of boys and girls.

Scarr-Salapatek and Williams (1973) required that the infants be premature but the prematurity was associated with pre- and peri-natal complications. Katz (1971), Neal (1968), Segall (1972), and Kramer and Pierpont (1976) required premature infants but only if they were free of physiological or neurological disturbances at birth. Since stimulation may have differential effects with different populations, it is necessary to ascertain the medical status of the prematures as well as their pre-natal and peri-natal histories.

Sample size in all the studies shown in Table 1 were generally small. Therefore the generalizability and validity of the results may be justifiably questioned.

There were generally two types of assessments given in the studies in Table 1: physical and behavioral measures. These assessments were given while the infants were still in the hospital and some were given several months later. Physical measures included such items as; weight gain, head circumference, length, frequency of voiding and stooling and temperature.

Salkoff et al., (1969), White and Labarba (1976) and Scarr-Salapatek and Williams (1973) all found that there was a greater weight gain and increase in formula comsumption in the experimental groups as opposed to the control groups. Katz (1971) and Wright (1971) found in their studies that there were no significant differences in these variables between the experimental and control groups. These measures were generally taken before the infants left the hospital. Behavioral measures were performances on standardized developmental batteries such as; the Brazelton Neonatal Behavioral Assessment Scale, the Modified Graham Behavior Text for Neonates, the Cattell Infant Intelligence Scales and the Bayley Scale of Infant Development. Katz (1971), Neal (1968), Scarr-Salapatek and Williams (1973) found that the overall status of experimental infants, as measured by the Brazelton and Rosenblith neurobehavioral scales before leaving the hospital, was better than that of control infants. The experimental groups tended to excell on specific items involving motor development, muscle tonus and responsiveness to auditory stimuli. Salkoff et al., (1969) tested physical development of prematures six to nine months later. Siqueland (1970) tested the development of learning and exploration four months later. Powell (1974) looked at developmental scores at four to six months corrected age. Salapatek and Williams (1973) checked intelligence at one year of age. All of the above stated longitudinal studies found that the experimental groups of infants appeared to score higher than controls. A review by Cornell and Gottfried (1976) suggested that the most pervasive trend found in the studies of stimulation on the behavior of premature infants was in the area of motoric ability. The performance of stimulated or experimental infants tended to exceed

that of control infants on measures of sensorimotor and motor skills as well as muscle tonus in all assessments.

A review of these studies in interventions with premature infants has helped to point out considerations or priorities for further work in this area. One important consideration has been the awareness of the capabilities of the premature as they differ or as they resemble those of the newborn. Fantz (1971) has compared visual abilities of the premature to those of the full-term infant and has found them to be more primitive, more simplistic and less discriminating than those of the full-term infant at the time of birth. Brazelton (1975) summarized the differences between these groups of newborns as differences in levels of excitation and inhibition. All the evidence has tended to point to a more primitive neurological system in which one of the most important processes taking place in the first few months of life is that of neurological integration (Brazelton, 1962; Benjamin, 1961; Brazelton, Koslowski and Main, 1974).

Statement of the Problem

It was clear from the review of stimulation studies with prematures that there were few if any studies which directly focused on enhancement of the visual abilities of the premature infant. Both the Scarr-Salapatek and Williams (1972) study and the Wright (1971) study used visual stimulation only indirectly with other modes of stimulation. Siqueland (1970) tested for visual exploratory behavior but his stimulation program did not consist of visual stimulation.

Fantz (1970) has been one of the only authors to look at visual parameters for premature infants as they differ or as they resemble those of

the newborn. Other than this work most of the information concerning vision in premature infants has come from medical observation and description of the eye of the premature rather than looking at actual capabilities. Therefore, the purpose of this study was to further investigate the visual abilities of premature infants with restricted visual input. This involved the systematic use of visual stimulation on a group of these infants in order to determine possible effects on their visual abilities.

It was hypothesized that a systematic intervention program providing visual stimulation to premature infants under bilirubin lights would have the following effects:

1) Visual orientation abilities of the experimental group were expected to be greater than those of the control group at the first time of testing with the Brazelton Neonatal Assessment Scale following intervention.

2) Visual orientation abilities of both groups were expected to have improved by the second time of testing, due to comparable visual input following removal from the bilirubin lights.

3) Despite the predicted improvement for both groups between Test I and Test II, it was hypothesized that the mean level of visual orientation for the control group would still fail to match that of the experimental group by Test II.

4) It was further expected that the degree of increase in visual orientation abilities from Test I to Test II would be greater for the control group than for the experimental group, as the interval of time between tests represents the first significant exposure to visual stimulation for the control group infants.

Table 1: Stimulation Studies with Premature Infants

Reference	Stimulation	Infant Requirements	Number of Infants	Outcome Assessments	Results
Powell (1971)	Stroking, handling, mother frequently visiting	Black infants with birth weights 1,000-2,000 grams	Experimental design E treatment n=13 E handled n=11 Control n=12	Brazelton Cambridge Newborn Scales; Bayley Scales; of Infant Development; Maternal Behavior Ratings; Kueth Measuring Emotional Distance	Extra dialy stimulation and maternal involvement improved developmental scores at 4-6 month corrected age. No correlation found between mothers who touched infants in hospital and later maternal behavior. High correlation between responsivity at newborn and when 4-6 months.
Williams, Scarr-Salapatek (1972)	Hospital: Visual stimulation, nursery "birds" and mobiles. Nurses picked up and held, talked to infants, rocked in chair. Home: Weekly visits to home by social worker. Developmental toys and stimulation provided.	All infants born for one year weighing between 1300 and 1780 grams. Mothers; black, young, unmarried	Experimental design E | n=15 C | n=15	Brazelton Behavioral Assessment 1 week and 4 weeks. Cattell Infant Intelligence Scale at one year.	C group showed more motor maturity at one week and less startle. General health and neurological behavior and organization better at one week. At four weeks the E group was superior, more weight gain.

Table 1: Stimulation Studies with Premature Infants

Reference	Stimulation	Infant Requirements	Number of Infants	Outcome Assessments	Results
Wright (1971)	Kinesthetic, (rocking) Auditory (music) Tactile, kinestetic and visual (striped sheets, picked up and walked)	Weight less than 2500 grams and 36 week gestational age or lower, not require temperature control, oxygen	Experimental design E = 5 C = 5	Weight gain Glucocorticoid chemistries "Siqueland-Lipsett's" conditioning task.	Marked differences between control and experimentals on glucocorticoid, neurological development (rooting reflex). No significant in weight gain or overall neurological status.
Salkoff Weintraub Blase (1969)	Tactile (rubbing body)	Premature infants between 1190 gms. and 1590 gms. at birth. Physician examination as a "normal" infant	Experimental design E n = 5 C n = 5	Activity Weight Temperature Startle resp. Crying Frequency of urination and defecation Physical development from 6-9 mo. by examination Bayley scale of Infant Development.	Handled infants regained birth weight faster and were more active than control. All experimental were physically healthier than control. Gross and fine motor development greater in experimental group. Homes more stimulating in experimental group.

Table 1: Stimulation Studies with Premature Infants

Reference	Stimulation	Infant Requirements	Number of Infants	Outcome Assessments	Results
White Labarba (1976)	Tactile (rubbing body) Kinesthetic (passive range of motion to limbs)	Premature infant Less than 36 wk. gestational age with birth weight 1588-2041 grams. No gross organic defects	Experimental design E n = 6 C n = 6	Heart rate Weight gain Temperature Respiration Number of feedings Amount of formulation Frequency of voiding and stooling	Experimental infants gained weight at a greater rate than Control. Also more formula taken in in Experimental group. Frequency of feeding greater in Experimental group. All other data showed no difference.
Siqueland (1973)	Handling (non-specific)	Twin premature infants	Experimental design E n = 10 C n = 10	Visual reinforcement task looking at visual exploration. At four months tested for development of learning and exploration.	Non-handled twin failed to show evidence of visual reinforcement, control of their sucking behavior. Experimental group performed better at four months than control on testing of learning and exploration.

Table 1: Stimulation Studies with Premature Infants

Reference	Stimulation	Infant Requirements	Number of Infants	Outcome Assessments	Results
Segall (1972)	Auditory (Mother's voice)	Premature with low birth weight between 28-32 weeks gestation. No major neurological or physiological defect at birth.	Experimental design E n = 30 C n = 30	Cardiac response.	The experimental group was apparanely more easily aroused and more capable of attending to auditory stimulation than Controls.
Neal (1971)	Vestibular (hammock in isolette)	Premature infants between 28-32 weeks gestational age with no definable major problems.	Experimental design E n = 31 C n = 31	Rosenblith behavioral test for Neonates.	Excitation of vestibular apparatus by body motion may have bearing on development of premature infant in both motor and visual responses.

Table 1: Stimulation Studies with Premature Infants

Reference	Stimulation	Infant Requirements	Number of Infants	Outcome Assessments	Results
Kramer and Pierpont (1976)	Vestibular Auditory (Mechanical motor rocking waterbed) (Woman's taped voice and heartbeat)	Premature infants less than 34 weeks gestational age Excluded if weight, length or head circumference not appropriate for gestational age or if clinical course became too complex or if not on oral feedings by one week of age.	Experimental design E n = 11 C n = 9	Weekly assessments over 8 month period. Growth movements 1) weight 2) head circumference 3) biparietal diameter of head 4) neurological status 5) behavioral Brazelton Behavioral Assessment	Neurological and behavioral assessments showed no difference. Weight and head circumference and biparietal diameter of head showed significant differences.
Katz (1971)	Auditory (Mother's voice)	Premature infants between 28-32 weeks gestational age. Admit no infant with severe neurological or physiologic disturbances evident within first four days after birth.	Experimental design E n = 31 C n = 31	Rosenblith Behavioral Test for Neonates	Maturational development, auditory and visual response were statistically significant at .01 level. Significant muscle tension responses between two groups but experimental were not less irritable than control

CHAPTER II

METHOD

The study included prematurely born infants admitted to the Neonatal Intensive Care Nursery, the Intermediate Care Nursery and the Newborn Nursery of the North Carolina Memorial Hospital in Chapel Hill, North Carolina. The babies met the following criteria as determined in consultation with hospital personnel:

1. Were between the gestational ages of 28 weeks to 37 weeks at the time when fluorescent lighting was required.
2. Received phototherapy for at least two days in succession.
3. Did not have a diagnosis of Respiratory Distress Syndrome or known major neurological deficit at birth.
4. Were not included in the research project of the Department of Nursing which was undertaken at the same time as this study and which involved visual stimulation of prematures.

Hospital Setting

The North Carolina Memorial Hospital is a 643 bed, state operated, general hospital. It is also the primary teaching hospital of the School of Medicine, University of North Carolina at Chapel Hill, North Carolina. The hospital, and in particular the Neonatal Intensive and Intermediate Care Nurseries, serve as a referral and diagnostic center for infants born throughout the state who need specialized, intensive care due to their high risk births and related medical course. The North Carolina Memorial Hospital cannot be compared to the typical, local community hospital seen most often within the state of North Carolina because of its University Medical School function. The patient population admitted

to the North Carolina hospital tends to be exceptional in its relative high risk medical status.

The research proposal for the study was first presented to the hospital's Committee on the Protection of the Rights of Human Subjects for approval. The Committee was comprised of doctors and "non-medical" personnel from the North Carolina Memorial Hospital. A pre-committee of three doctors was required to review the proposal and submit a recommendation of approval, revision or rejection. The study received the approval of the pre-committee. The proposal was then submitted to the full committee and received its formal approval also. The forms which were sent for approval included: a brief summary of the project (see Appendix F), the volunteers' statement, i.e., mothers' (see Appendix G), and the information letter to the mothers (see Appendix H).

Both the control and the experimental group of infants received the same basic nursing care given in the daily routine of the nurseries. Members of the nursing staff were requested to report in their notes any specific or outstanding observations relating to the infants' feeding patterns. Otherwise they were not involved in the study. In this way, the nursing staff was encouraged to emphasize feeding patterns as they cared for the infants, rather than giving any extra visual input other than that which was part of their normal nursing routine.

Subjects

Most of the infants were born during the months of April to June, 1977 at the North Carolina Memorial Hospital. There was one exception and this infant was born in a neighboring county but was flown via helicopter to the hospital within 24 hours of its birth. All babies

had a primary diagnosis of prematurity but all but one had other related problems of prematurity in addition to hyperbilirubinemia.

The infants were assigned to experimental and control groups based on a pre-determined randomization. This was determined by flipping a coin to indicate whether the first subject would be placed in the control or experimental group. From this first placement the infants were alternately designated into each group as they were admitted and met the stated criteria. Since a small group of subjects was to be used in the study, this method of randomization appeared to be the most efficient in acquiring an equal number of infants in each group. There were five infants in the experimental group and five infants in the control group. No attempt was made to control for either race or sex in assigning infants to groups. Therefore the experimental group was comprised of three White and two Black infants, and of these three were males and two females. Similarly, the control group consisted of three White, one Black and one infant of mixed Black and White heritage, of which four were males and one was female.

When an infant was admitted to the nursery and met the entry requirements for the study, the mother was contacted by a visit in the hospital or by telephone if she had been discharged from the hospital. A phone call was also necessary if the mother was located elsewhere in the state. A verbal explanation of the project was given by the investigator and the mother's written signature was obtained on the consent form. The information letter was left with the mother. If a phone contact was made, a witness was necessary to verify the mothers' approval and the mother's signature was signed by the investigator and by the witness. The mothers were not informed as to the group in which their child had been placed.

None of the mothers refused permission to allow their infant to participate in the study. Several wanted to consult with their husbands first and many gave permission once they understoon that the stimulation was not detrimental to their baby. None of the mothers changed their original decision. One mother gave provisional consent with the qualification that she could watch the final assessment as it was given to her infant.

Following the last assessment, mothers were given a booklet on infant stimulation and verbal suggestions on effective ways to enhance their interactions with their babies by way of stimulation. This was done by the investigator.

Assessment Procedures

Apgar: The Apgar Score (see Appendix C) is perhaps the most utilized of all neonatal assessments. It is a measure of an infant's ability to adapt to the postnatal environment. The score summarizes the newborn's cardiorespiratory functioning, neuromuscular tone and response to painful stimulation at one, five and fifteen minutes after the baby is born. This assessment is significant in that it focused the physician's attention on the newborn's responsiveness. It is also a gross quantitative measurement indicative of possible need for resuscitative efforts on the part of the obstetric team. The limitation of the Apgar score is that it measures only the immediate postnatal neurophysiological adjustment, and has been shown to have limited long term predictability (Drage, 1968). All infants were examined and given Apgar ratings at the time of birth by delivering Obstetricians. Scores were then taken from the infants' medical chart.

EGA: Assessment of gestational age provided a method of assessing impaired fetal growth and provided the appropriate context in which one can

interpret an infants' behavioral and centrol nervous system capacities. Specifically, it differentiated premature babies who were "appropriate for gestational", (AGA) from similar weight full-term "small for gestational age" (SGA) babies.

Dubowitz (1970) has developed a cumulative scoring system that assesses the newborns' gestational age with a 95% confidence limit within a two week period. The assessment consisted of two parts. The first half assessed the neurological behaviors; measures of tone were evaluated by such items as ankle dorsiflexion, arm and leg reciol, heel to ear scarf sign, head lag, popliteal angle. The other half of the exam consisted of 11 external characteristics and they were; edema, skin texture, skin color, skin opacity, lanugo, plantar creases, nipple formation, breast size, ear form, ear firmness and genitals.

Following the assessment of gestational age, intrauterine growth charts developed by Lubchenco (1973) were used to assess intrauterine growth retardation. Forty weeks has been considered full term gestational age for a normal infant (Korones, 1970).

The neurological criteria and scoring system of the Lubowitz method is shown in Appendix B. The intrauterine weight chart is presented in Appendix C.

Each child was assigned an estimated gestational age as well as a weight-age classification by the infant's pediatrician. This information was then taken from the infant's chart. There were two SGA babies, both of whom were in the control group. There were a total of eight AGA babies. The mean EGA of the experimental infants was 34.4 weeks and ranged from 30 weeks to 37 weeks. The mean EGA of the control infants was 32.6 weeks and ranged from 30 weeks to 37 weeks.

Brazelton: The Brazelton Neonatal Assessment Scale (Brazelton, 1973) was not a neurological examination in itself, but served to complement a comprehensive neonatal neurological exam. The scale was developed to test and document the infants' organized responses to various environmental events and their use of state behavior (see Appendix D).

The Brazelton Assessment was given to all infants by two members of the University of North Carolina School of Nursing Faculty who were both trained and received their certification during the same period of time. Each individual tester examined one baby for all of its assessments. They were "blind testers" in that they were not aware of any infant's placement in either the experimental or the control group. The first test was originally due to be given within 24 hours before the baby was to be exposed to the fluorescent lighting, however due to the unpredictability in the timing of this occurrence it was necessary to alter this aspect of the study. The first testing was then given within 24 hours after the lighting had been discontinued and the second and last time, three days after the first testing (see Appendix I for sample schedule of testing and intervention.)

Stimulation Procedures

The intervention techniques were performed on both the experimental and control group of babies by the investigator. The difference in the intervention was that the control babies did not have their eye patches removed during this period of potential visual stimulation. This procedure was decided upon in an attempt to control for the possibility of any extraneous, or unintentional effects of the intervention process.

The intervention consisted of a 20 minute period of time each day, Monday through Friday, or for every day that the baby was exposed to the

lights. The investigator was unable to provide stimulation on the weekends due to the distance it was necessary to travel to Chapel Hill, North Carolina. The number of days during which all the babies were exposed to the fluorescent lighting ranged from two days to seven days with a mean of 4.0 days. The number of days that the babies received stimulation ranged from two days to five days with a mean of 3.7 days (see Table 2 for additional explanation). The intervention was intended to be done one hour after the baby had been fed (Wolff, 1965). While this was appropriate for newborns of full term gestation it was necessary to stimulate prematures one half hour before they were fed as this was found to be their more "alert" period. If there was an interruption in the 20 minute time span or if the baby remained in too deep a sleep to be responsive ie., to open its eyes, a final attempt was made that same day.

During the time of intervention the flourescent lights were turned off for both groups of babies and the eye patches removed for only the experimental group. The bottom of the isolette was elevated vertically, about 45°, in order to attempt to bring the baby to an alert state (Korner and Thoman, 1970). The heels of both groups of babies were lightly snapped by the investigator's thumb and finger as another means of changing the state of the infants from that of sleep to alert. It was also necessary to wipe both groups of babies faces with a wet, cold wash cloth in order to facilitate eye opening.

During the visual stimulation period the investigator attempted to give no auditory stimulation through the use of her voice or by talking to the infant.

Apparatus

The intervention was in the form of visually stimulating objects including; a small penlight, a visually appealing mobile and colored paddles (as illustrated in Appendices J and K). The penlight was flashed on and off at the peripheral line of vision once the babies' eyes were open. If they were closed it was flashed on the eyelids. An opthamalogist at the North Carolina Memorial Hospital was consulted to determine the type of light to be used in the procedure. The mobile was based on the work of Fantz (1965) and consisted of four "God's eye" design pendants. The colors of yarn were combinations of red and white, black and white, red and black and one multicolored. They were hung in a free swinging manner from two $\frac{1}{4}$" dowels so that they were able to rotate and move freely. Five colored paddles of red, green, yellow, blue and orange were also used as stimulation objects. They were 6" long with a 3 3/8" diameter made of the colored plastic at one end and a wooden handle at the other.

These stimuli were presented individually seven to ten inches in front of the infants' line of vision (Haynes, White and Held, 1965). The penlight was presented first, then the mobile and then the paddles. In the 20 minute period of time this pattern of presentation was done twice for both groups of babies. The objects were moved in a horizontal, vertical and circular pattern to encourage alerting and following with the eyes and head.

If the infant fell asleep during the 20 minute time period of stimulation, after he/she had awakened to an alert state, the infant was stimulated once more to an alert state. If the infant did not respond by awakening, he/she was left to sleep. If two presentations of the stimuli had been

accomplished before the 20 minute time period and the infant remained in an alert state, he/she was left to view other stimuli present in the environment for the remainder of time left.

CHAPTER III

RESULTS

The data analyses were conducted in three stages. First the characteristics of the sample population and mother-infant variables were analyzed. These variables were: sex, race, type of delivery, weight/age classification, age of mother, gestational age of infant, infant birth weight, Apgar score, and peak bilirubin level. Secondly, the mean scores and standard deviations were computed for each Brazelton Scale Dimension. These Dimensions are: Interactive, Motoric, State Control and Physiologic. These Dimension mean scores were compared for the Experimental and Control group for Test I and Test II. Thirdly, t-tests were computed on the differences in mean scores for the Interactive and State Control dimensions of the Brazelton Scale. This final analysis allowed comparisons of between-group differences as well as within-group changes over time. These two, of the four Brazelton dimensions, Interactive and State Control, were considered to be of particular interest in the present study. As can be seen by the delineation of items in the Brazelton dimensions (Appendix D), the Interactive items are the only ones which specifically include visual orientation responses or stimulation. State control is also relevant to the study however, since the infant must attain a state of alertness in order to score on the scale in the visual orientation items. Although the remaining two Dimensions, Motoric and Physiologic, upheld the same trends over time as noted for Interactive and State Control Dimensions (see Figure 2 and 4),

they were not subjected to further analysis due to their presumed lack of relevance to the visual system.

Characteristics of Sample Population and Mother Infant Variables

Table 2 demonstrates the characteristics of the sample population and the means and standard deviations on the Mother-Infant Variables. As is seen by examining characteristics of the sample used, the numbers of infants representing sub-categories such as race or sex are too few to justify further analysis of their possible contributing influence. Therefore, analysis of variance on the basis of these demographic variables is deemed unfeasible in this study. As evidenced in Table 2, the average age of the Experimental group mothers is approximately one year less than that of the Control mothers; although there was also a slightly greater age variation with the Experimental group. The gestational age of the Experimental group ranged from 30 weeks to 37 weeks. The gestational age of the Control group ranged from 28 weeks to 36 weeks. The average gestational age (GAGE) of the infants for both groups is in close agreement with a difference of less than two weeks. The Experimental group of infants has a larger average weight in grams (2288.9) than the Control group (1628.0) but there is also greater variation in their weight (s.d.=374.86). Apgar scores are somewhat higher in the Experimental group of infants (8.2) than in the control group (6.4) although in this case there is greater variability for the Control group scores indicating less consistency in their Apgar scores as a group. The Peak Bilirubin Level is slightly higher in the Experimental group (13.44) as compared to the Control group (10.64) however, this difference would not be considered medically significant enough in the infants in this study to cause differential

hospital treatment of these two groups. None was considered important enough to differentiate them in terms of medical diagnosis or treatments, or to have a substantial effect on the viability of the study.

Scores for Brazelton Dimensions

The mean scores and standard deviations are given in Table 3 for the experimental and control group of infants on each Dimension of the Brazelton Scale. Repeated measures for these Dimensions are also shown. The mean scores on Test I are greater for the Experimental group than for the Control group on all except one Dimension, State Control. Similarly, there is slightly more variation from the mean scores for the Experimental group than for the Control group on all but one Dimension at the first time of testing. On Test II the Experimental group mean scores are greater on all Dimensions than for the control group at that time. The variation in these scores for the Control group is generally greater than that of the Experimental group at the second time of testing.

The greatest difference in mean scores between the two groups is found on the Interactive Dimension. The mean score for the Motoric Dimension on Test I for the Experimental group ($\bar{x}$ = 27.60) is also greater than that of the Control group ($\bar{x}$ = 17.20). Scores on the Physiologic Dimension show the least difference between the Experimental group ($\bar{x}$ = 10.60) and the Control group ($\bar{x}$ = 10.40) at Test II than on any other Dimension at either time of measurement.

TABLE 2

CHARACTERISTICS OF SAMPLE POPULATION

Number of Subjects in Each Category

	Sex		Race		Delivery		Wt./Age	
	M	F	B	W	Vag.	C/sect.	SGA	AGA
Total Population	7	3	4	6	7	3	1	9
Experimental	3	2	2	3	4	1	0	5
Control	4	1	2	3	3	2	1	4

Mean Scores on Mother-Infant Variables

	Mother		Infant			
	Age		GAGE (weeks)		Wt. (grams)	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Total Population	23.1	4.65	33.5	2.92	1923.4	613.61
Experimental	22.6	5.27	34.4	2.88	2218.8	698.92
Control	23.6	4.51	32.6	2.97	1628.0	374.86

	Infant			
	Apgar		Peak Bilirubin Level	
	$\bar{x}$	sd	$\bar{x}$	sd
Total Population	7.3	1.83	12.04	2.96
Experimental	8.2	0.84	13.44	3.45
Control	6.4	2.19	10.64	1.70

Trends Over Time

Figures 2 through 5 compare the mean score trends over time for each group on each Dimension. Generally, as would be expected, both groups showed improvement over time. The Experimental group showed the greatest change over time in the State Control Dimension as compared to State Control in the Control group. The Control group showed the greatest change over time in the Interactive Dimension as compared to the Interactive Dimension in the Experimental group. As can be seen in Figure 4, the Control group starts at a higher level of State Control on Test I, but by Test II the Experimental group mean score exceeds that of the Control group.

Between-Group Analysis

Interactive Dimension: An analysis of the data compared the difference in the Control group and Experimental group mean scores at Test I for the Interactive Dimension. A one-tailed t-test was applied to determine the significance of difference between the Experimental group score ($\bar{x}$ = 31.20) and the Control group score ($\bar{x}$ = 10.00). The results indicate a significant t-value of -2.18, ($p < .031$). The group mean scores were then analyzed for Test II in which there is also a difference in the expected direction; that is, the Experimental group score ($\bar{x}$ = 37.6) is greater that that of the Control group score ($\bar{x}$ = 22.2) at the second time of testing. A one-tailed t-test again reveals a significant difference obtained between the two treatment groups ($t = -2.31$, $p < .025$).

The amount of change in group means over time was also compared (see Table 3). While the Control group Interactive scores increase by 12.2 points from Test I to Test II, the Experimental group Interactive

only increases 6.4 points but still maintains higher scores at both times of measurement. To test the difference in group change scores, a one-tailed t-test was again used, but no significant difference was obtained ($t = .67$, $p < .26$).

State Control Dimension: Comparing group means on Test I of the State Control Dimension, there are differences in the opposite direction from the previously reported finding in the Interactive Dimension. The Control group scores ($\bar{x} = 28.0$) are slightly higher than the Experimental group scores ($\bar{x} = 25.6$). However, a t-test again reveals this difference is not great enough to assume that it is not due to chance alone ($t = .51$, n.s.).

The difference between mean scores of the Experimental and Control groups, on the State Control Dimension at the second time of measurement, was also tested statistically. In contrast to the first test of State Control, group means at a later date show a reversed trend; that is, the Experimental group scores are now higher ($\bar{x} = 36.0$) that the Control ($\bar{x} = 31.4$), similar to the findings on the Interactive Dimension seen at both times of testing. However, this trend does not represent a significant difference when analyzed further ($t = -.57$, n.s.).

The change in scores for each group over time was also examined. The Experimental group increases by 10.4 points from Test I to Test II, and has surpassed the Control group scores by the second time of measurement. The Control group mean score changes by only 3.4 points. A t-test performed on the group change scores for State Control indicates a t-value of -.74 which is not a significant difference between the Experimental and Control groups' degree of improvement on this measure.

Within-Group Analysis

Experimental Group: A paired t-test was used to examine the degree of improvement over time for the Experimental subjects on the same two Dimensions. The mean score for the Experimental group on the Interactive measure shows an improvement of 6.4 points by the second testing. However, when statistically analyzed by a paired t-test, this does not prove to be a significant change ($t = -1.47$, $p < .11$).

The mean score for the Experimental group on the Control measure shows an increase in 10.4 points, resulting in a t-value of 1.75 which approaches significance ($p < .08$).

Control Group: The paired t-test comparison was also used to examine the amount of change over time within the Control group on the two Dimensions. The difference in the Control group scores on the Interactive Dimension (as reported earlier) represents an improvement of 12.2 points. This change does approach significance, with a t-value of -1.65 ($p < .09$).

However, the difference in the Control group performance on the State Control measure at two times of testing is not great enough to be significant ($t = -.46$) with an improvement of only 3.4 points.

TABLE 3

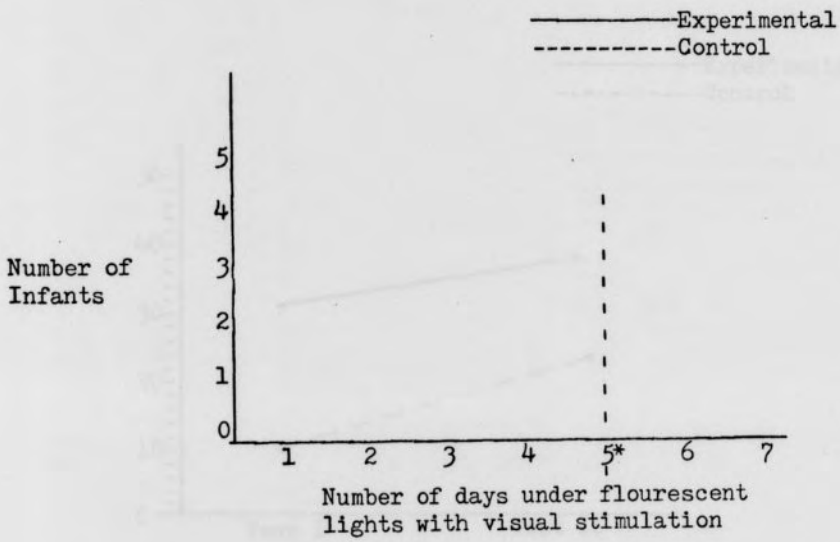
MEAN SCORES AND STANDARD DEVIATIONS FOR BRAZELTON NEONATAL ASSESSMENT SCALE

	Experimental Group			
	Test I		Test II	
Brazelton Dimensions	mean	sd	mean	sd
I Interactive	31.20	19.02	37.60	9.71
II Motoric	27.60	9.89	29.00	9.07
III State Control	25.60	6.77	36.00	8.57
IV Physiologic	9.80	3.37	10.60	3.26

	Control Group			
	Test I		Test II	
Brazelton Dimensions	mean	sd	mean	sd
I Interactive	10.00	10.56	22.20	11.30
II Motoric	17.20	8.32	24.60	7.20
III State Control	28.00	8.16	31.40	15.73
IV Physiologic	7.60	2.05	10.40	4.88

FIGURE 1

LENGTH OF TIME DURING WHICH INFANTS IN EACH GROUP WERE EXPOSED TO FLOURESCENT LIGHTS WITH AND WITHOUT VISUAL STIMULATION



*Visual stimulation discontinued after maximum of five days

FIGURE 2

MEAN SCORES FOR BRAZELTON INTERACTIVE DIMENSION
FOR EXPERIMENTAL AND CONTROL GROUPS
BETWEEN TEST I AND TEST II

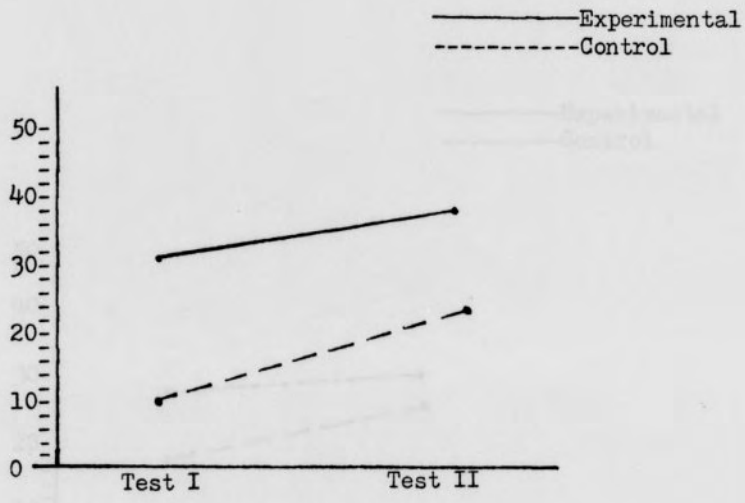


FIGURE 3

MEAN SCORES FOR BRAZELTON MOTORIC DIMENSION
FOR EXPERIMENTAL AND CONTROL GROUPS
BETWEEN TEST I AND TEST II

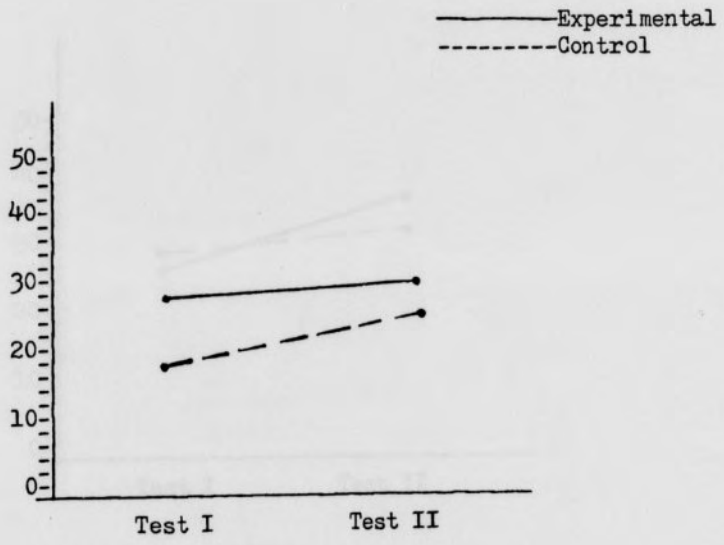


FIGURE 4

MEAN SCORES FOR BRAZELTON STATE CONTROL DIMENSION
FOR EXPERIMENTAL AND CONTROL GROUPS
FOR TEST I AND TEST II

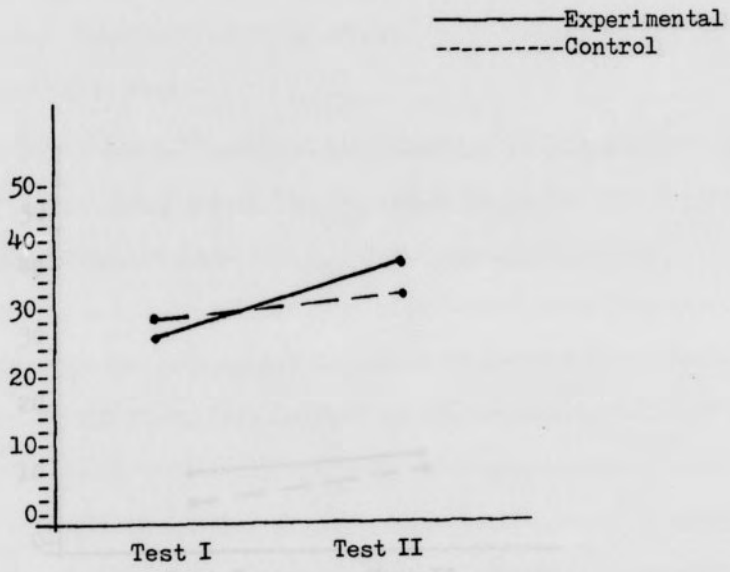
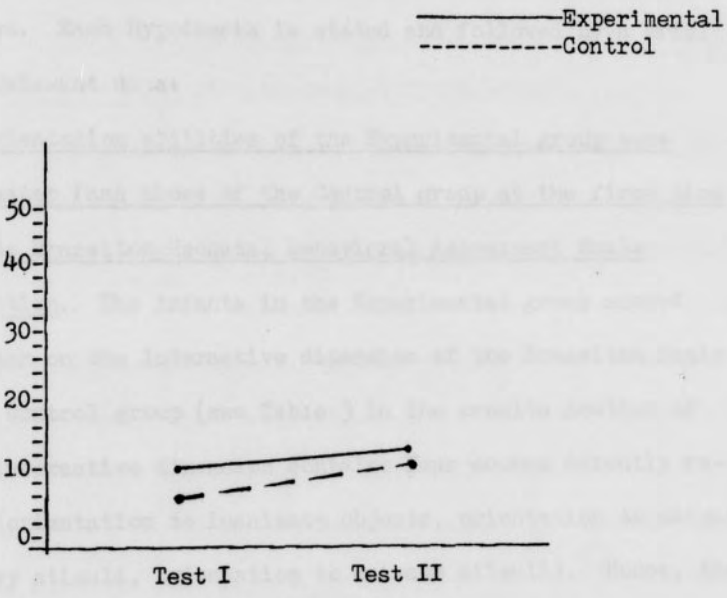


FIGURE 5

MEAN SCORES FOR BRAZELTON PHYSIOLOGIC DIMENSION
FOR EXPERIMENTAL AND CONTROL GROUPS
FOR TEST I AND TEST II



CHAPTER IV

SUMMARY AND DISCUSSION

A primary objective of this study was to determine the effect of systematic visual stimulation of premature infants who lacked environmental visual stimuli due to eye patches worn while they were under fluorescent lights.

Discussion of the results can be best accomplished by reviewing the original hypotheses. Each hypothesis is stated and followed by a brief statement of the relevant data:

1. Visual orientation abilities of the Experimental group were expected to be greater than those of the Control group at the first time of testing with the Brazelton Neonatal Behavioral Assessment Scale following intervention. The infants in the Experimental group scored significantly higher on the Interactive dimension of the Brazelton Scale than those of the Control group (see Table 3 in the results section of the paper). The Interactive dimension contains four scores directly relating to vision (orientation to inanimate objects, orientation to animate visual and auditory stimuli, orientation to animate stimuli). Hence, the hypothesis stated above was confirmed. This result was congruent with the findings of Brody (1951), White and Castle (1964), Korner and Grobstein (1964), White (1969), and Greenberg, Uzgiris and Hunt (1968), who also found increased visual capacities due to stimulation.

2. Visual orientation abilities of both groups were expected to have improved by the second time of testing. From Table 3 it can be seen that the above hypothesis was confirmed. The mean scores of the Experimental group and the Control group of infants both increased significantly from

Test I to Test II on the Interactive dimension of the Brazelton Scale. This could be due to comparable visual input following removal from the bilirubin lights. These results were similar to those of Riesen, Ramsey and Wilson (1964) who demonstrated improvement in visual abilities of visually deprived rhesus monkeys once they were exposed to normal patterned light.

3. Despite the predicted improvement for both groups of infants between Test I and Test II, it was hypothesized that the mean level of visual orientation for the Control group would still fail to match that of the Experimental group by Test II. See Figure 2 for comfirmation of the above stated hypothesis. Both the Experimental and Control group scores increased between Test I and Test II but the Control group mean scores did not match those of the Experimental group at the second measurement. It was felt that the deprivation of stimulation may have had short term detrimental effects on the Control infants; that is, while normal environmental stimulation may have resulted in improved visual capabilities, it did not entirely reverse the effects of deprivation during what may be a "critical period", ie., the first few weeks of life. The critical period during which stimulation is most effective is thought to be immediately following birth (Levine, 1960; Wolf, 1959; Cosler, 1965; Barnard, 1972; Neal, 1968; Salkoff, et. al., 1969). Fantz (1967) has also referred to the short-term as well as long-term detrimental effects of deprivation on visual preferences and visual perceptual abilities in rhesus monkeys.

4. It was expected that the degree of increase in visual orientation abilities from Test I to Test II would be greater for the Control group than for the Experimental group. Siqueland (1969) felt that the human infant actively seeks out stimulation, attends selectively and, given an

opportunity to control his stimulus environment, he demonstrates a vigorous appetite for stimulus change. Fantz and Nervis (1967), in connection with obtaining infant's cooperation, found that a period of unrelieved monotony or sensory restriction led to increased preferences for complexity of stimulation. Since the interval of time between Test I and Test II represented the first significant exposure to visual stimulation for the Control group it was felt that their scores would increase significantly more than the Experimental group during this time. However, this hypothesis was not confirmed. The change in scores over time on the Interactive dimension approached significance ($p < .09$) for the Control group but was not significant for the Experimental group ($p < .108$). Evident in Figure 1, the slope is greater for the Control group than for the Experimental group. While not significant, these scores indicate a trend in the predicted direction.

In summary, the confirmation of the hypotheses indicated that the premature infants who received visual stimulation during the time in which they were exposed to flourescent lighting performed significantly better on the Interactive dimension both at Test I and at Test II than did the Control group. Although statistical tests were not used to analyze differences due to the weight of the infant, the mean scores from the two groups show a wider range than the other infant variables (see Table 2); this might suggest that the infants' birth weights may have differentially influenced the visual capacities of the two groups.

Since the Interactive dimension of the Brazelton Scale required the infant to be alert, the degree of infant State Control as measured by the Brazelton Scale was also analyzed. Prechtl, Theorell and Blair (1973) felt that certain disorders of metabolism would have a marked effect on

the brain-stem mechanisms which were involved in the organization of State Cycles. They looked at several groups of abnormal babies, including those with the disorder of Bilirubinemia. They found that the jaundiced infants, i.e., from 10 mg. per-cent to 22 mg. per-cent, seemed to be very sleepy and spent prolonged periods in State 2 or a light sleep. Theyrow et. al. (1976) investigated the effects of phototherapy on neonatal behavior of full-term infants. There were no other perinatal complications other than hyperbilirubinemia in the sample infants. Three groups of ten babies comprised the sample. The treatment group received phototherapy. The second group received no phototherapy and the third group were non-icteric babies or non-jaundiced. Examinations using the Brazelton Scale were performed on all babies at 3, 6, and 10 days of age to determine the effects of the phototherapy. In looking at the individual dimensions of the Brazelton, the authors found no difference in the Motoric Processes or Physiologic Organization at any time. The Treatment group, with lights, had significantly poorer Interactive processes and State organization than either of the control groups at 10 days of age. They describe these babies in the treatment group as "sleepy, fussy, and hard to get to a good, alert state. When alert they did not orient as well as the control group to social stimuli. They had many brief episodes of irritable crying and were harder to comfort when upset than Controls."

Korner (1972) also wrote of State as a variable, obstacle and mediator of stimulation in infant research. If the State of the infant cannot be controlled then one will be apt to find false negative or false positive results. Korner mentioned the alterability of states through stimulation as being a very important variable which must be taken into account when studying infants. That is, some infants are extremely difficult to rouse

as opposed to those who are easily agitated; the amount of time an infant is able to maintain the State of alert inactivity is directly related to the number of opportunities that infant has to view the environment. Therefore, as Korner demonstrates, the State of the infant acts as a mediator of stimulation. State must therefore be of major importance when conducting a research program using young infants. The State of the infant may either optimize and facilitate the stimulation, or it may render the stimulation totally ineffective.

The State Control dimension of the Brazelton Scale implies reactivity and a way of organizing responses to incoming stimuli. From the above discussion of related studies, it was considered necessary to further analyze the State Control dimension. Both the Control group's and the Experimental group's mean scores for the State Control dimension increased from the first time of testing to the second time of testing. However, the extent of the change over time did not prove to be statistically significant when compared between the Experimental and Control group. This is in contrast to the Telyrow study (1976) where their infant scores on this dimension decreased with time. In the present study, the Control group had a higher mean score at the first time of testing than that of the Experimental group although the difference was not significant (Table 4). It was expected that the Control group's mean score on this dimension might have been lower than the Experimental group's since the mean scores for the Interactive dimension demonstrated significant results in favor of the Experimental group. A possible explanation for this finding could be that the external manipulation of the Experimental group infants' state for treatment was in fact a form of overstimulation. This involuntary state change for the infants for the purpose of visual stimulation could have served to disrupt

their ability to organize their own internal control; inhibitory mechanisms, which serve the purpose of controlling random movements or in facilitating changes of state, might have been affected and thus caused lower scores on this dimension. Segall (1972) and Bromwich (1977) both caution against overstimulating the newborn. They refer to one of the earliest developmental tasks being that of neurological integration. External manipulations in the form of stimulation may interfere with this fundamental process or at least disorganize it.

By the second time of testing, the Experimental group mean scores were higher than those of the Control group on the State Control dimension, although, again, the difference was not significant (Table 3). There was also greater variability within the Control group mean scores than those of the Experimental group. This may indicate the long-term effectiveness of providing external stimulation although the stimulation was unrelated to the State Control dimension. The overstimulation theory is not fully substantiated in that early stimulation effects may override the initial disorganization seen at the first testing. The potential long-term effectiveness of providing early stimulation was also seen in other stimulation studies (Salkoff, 1969; Powell, 1971; and Scarr-Salapatek and Williams, 1972).

The mean scores for the Motoric and Physiological Response dimensions of the Brazelton Scale (Table 3) demonstrated that the Experimental group exceeded that of the Control group both at Test I and at Test II. Both group mean scores increased over time from Test I to Test II. Even though these dimensions were not the direct concern of the stimulation program the trend of increased mean scores or greater developmental gains over time by the Experimental group may relate to the generalized influence

of stimulation on other dimensions of behavior.

In addition to the actual testing and intervention, several observations were made during the course of the stimulation program relating to the behavior of the infants. It appeared that head turning to follow and orient to a stimulus when presented to the right was more easily accommodated than head turns to the left. Infants, regardless of treatment group,appeared to assume a right tonic neck position while lying supine more often than to the left. Liederman and Kinsbourne (1977) found that a sample of 83 alert newborn girls, when presented positive and negative stimuli, executed more right than leftward head turns. This rightward bias was significantly correlated with parental hand preference. In the present study there were no sex differences noted in this regard; that is, rightward head turns appeared with similar frequency among both boys and girls.

It was also noted that the premature infants seemed to never reach a State 6 (intense crying) but appeared to reach only a State 5 (possible fussing with a high degree of motor activity). A change of State required by Brazelton in his Scale must be recorded for 10 seconds before it is a legitimate state change. However, these criteria were based on full-term infants and not prematures. The premature infant was observed to make state changes much more quickly, within a 5 second range, so that lower scores, or no score at all, were often recorded in the testing. This is an indication of the need for more descriptive data relating to premature behavior in comparison to that of the full-term newborn. The development of a more precise scale for prematures is obviously needed. The premature group of bilirubin infants also appeared generally unresponsive, less irritable to stimuli and very sleepy with short periods of alertness

compared to premature infants without bilirubinemia. The premature infants in this study appeared to be more responsive to the investigator's face than to any of the other stimuli presented, such as the mobile and pen-light. These observations were not tested further, as they had not been anticipated in the original design of the study.

There are several cautions to interpreting or drawing conclusions based on the results of this study. The sample size for the study was very small (n = 10). Results from this small number would be very difficult to generalize to the larger population of premature infants. However, this appears to be typical of many studies dealing with premature infants as well as full term neonates (see Table 1). In the case of prematures, these tiny infants have not been readily available subjects for researchers of infant development due to their high-risk status, precautionary restraints in the nursery and vulnerability to infectious diseases.

It is evident in Table 2 (see Results Section) of the sample characteristics that there were few initial differences between the two groups of infants. The weight differences, mentioned previously, may have influenced the results as the mean weight score for the Experimental group was higher ($\bar{x}$ = 2218.80) compared to that of the Control group ($\bar{x}$ = 1628.00). Although the gestational ages of the infants were fairly similar (Experimental mean GAGE 34.4; Control mean GAGE 32.6), it has been found by Field and Shuman (1977) that this index is one of the best single predictors of follow up assessments on the Bayley mental score at four months and at eight months. Further follow up of the subjects in the present study would have to be carried out in order to determine whether similar predictability could be demonstrated. It seems reasonable to assume that weight differences would have influenced the results in the area of the

Motoric and Physiologic dimensions to a greater degree than results on the Interactive dimension.

It was also felt that the lack of a pre-test to determine the base-line capabilities of the two groups of infants might have led to less validity in the conclusions of this study. Many problems were encountered in attempting to pre-test the infants before they were placed under the bilirubin lights. Priorities had to be given to medical procedures and schedules which tend to override the needs of research with these infants. More often than not the time element (from time of delivery, to consent of the mother, to the time of day or night that the infant was placed under lights) proved to be the greatest barrier to the actual accomplishment of a pre-test.

A second control group of infants who did not have jaundice and who were not under the lights would have been very useful in order to establish information on the behavioral patterns and capabilities of a sample group of less icteric prematures. The scores from the Experimental and Control group of study infants could have been viewed as relating or contrasting to those of this second Control group for more meaningful data.

Another possible weakness of the study was the inability to control for various extraneous stimulation given to the infants by the nursing staff and parents in their visits to the nursery. Although the nurses in this study were not told into which group an infant was placed, they could not help but notice which infant was receiving the visual stimulation without the patches. This could inadvertently have influenced the nursing care given to one group or the other. Ideally all of the infants could be removed to another private room away from the nursing staff for testing and/or stimulation. However, their medical status usually demands constant nursing supervision.

The infants may also have received various extraneous stimulation during the parental visits. Depending on the medical status of each infant, the parents may be allowed to hold, feed or otherwise stimulate their infants in the nursery or they may only be able to view their infant through the isolette. Frequency of parental visits was recorded from nursing notes but details of what transpired during those visits were not recorded. This unknown variable was applicable for both groups.

It is recommended that in possible replications of this study follow up assessments be made later in the infants' development in order to ascertain the stability of the Experimental group's superior performance on the Interactive Dimension over that of the Control group. It would be interesting to note whether or not this early achievement continues in the Experimental group or whether this advantage tends to disappear with time so that both groups eventually appear the same. Another aspect needing further investigation is the possible effect of the Experimental group's gains on the mother-infant interaction. The Interactive dimension encompasses many socializing as well as integrative-affective behaviors, which could certainly enhance the reciprocal relationship between mother and infant. This relationship could be compared between the Experimental and Control group. Since this issue was beyond the scope of this study, no quantitative measures were obtained on the quality of the mother-infant interaction.

It would be interesting to study the effect on the Interactive dimension of multiple types of stimulation such as tactile, vestibular as opposed to just visual stimulation. As stated previously, Ayres (1973) found that stimulation of one sensory system ultimately affects all systems. Perhaps tactile stimulation affects visual perceptual abilities

as much as visual stimulation alone. Multiple or individual sensory stimulation effects could be tested out through further research.

Implications from this study regarding hospital care of the premature are relevant to both the parents and the nursing staff. It is recommended that parents be permitted to be more actively involved in stimulation and care-taking procedures for their hospitalized infants. The fears of American medical personnel that mothers would introduce infection into the nursery have been proven unfounded (Farnoff, Kennell and Klaus, 1972; Barnett et. al., 1970). In studies where mothers were permitted to care for their premature infants, no increased incidence of infection was found, nor was the work of the ward personnel interrupted. Mothers of premature infants, in the absence of complications, usually feel well enough to go home in one to three days. Their infants tend to remain in the hospital from two to six weeks longer. A program of stimulation whereby the mother or father could care for their infant would alleviate some of the effects of hospital personnel shortages, enhance the mother-infant relationship by providing the opportunities for bonding and the forming of early attachment behaviors, and provide the infant with the stimulation and individual care which is so critical to neonatal growth and development. Recent research by Bakeman and Brown (1977)as well as Minde, Hines, and Bowkydis (1977) has demonstrated the lack of social responsiveness of the premature with respect to initiating interaction with the primary caregiver. This is in contrast to the full-term infant who is shown to be an active initiator in interactions with the primary caregiver. This further substantiates the need for incorporating mothers into stimulation programs with their premature infants. The ability to read behavioral cues and initiate interaction appears paramount to

mother-infant interaction and future psycho-social development of the infant.

The need for stimulation programs which involve nursing personnel in the hospital care of the premature infant is also implicated by this study. In the course of this study it was noted that there were many opportinities available for visual stimulation during the daily nursing care of these infants that were not taken advantage of. One obvious reason the infants were not visually stimulated was due to the eye patches themselves. The guaze pads were held in position over the eyes by tape, which when removed from the infant's skin sometimes caused abrasion and bleeding. The tenderness of the premature's skin prevented the constant removal and replacement of the guaze pads during the course of the day; however, one might assume that with the sophisticated medical knowledge available currently, this seemingly minor problem might be overcome quite easily and ingeniously.

A natural outcome of this study was also the inspiration for its existence. It seems feasible from the above description of the lack of voluntary eye opening and lack of patterned light that the designing of goggles to cover the infant's eyes might provide an alternative to the use of eye patches. A proposal to this effect was presented by the author to a group of engineers from the General Electric Company in Burlington, North Carolina, who felt that it was possible to design a lens that would be protective to the eyes yet allow the infant voluntary eye opening and the opportinity to visually observe incoming stimuli. The goggles could be adapted to fit into a frame that would fit the infant's head and face. It could be removed easily without ill-effects to the infant. They could be made of material that would be easily sterilized and reused with other infants. One of the most important benefits which the goggles would

provide would be that of eye to eye contact with mothers of infants whose medical condition will not allow them to touch or fondle their infants.

Many studies have verified the importance of eye-contact in bonding. Klaus and Kennel (1976) have shown that one of the earliest behaviors of mothers upon the presentation of their newborn infant is to seek out the infant's eyes in order to establish contact. Both Greenman (1963) and Wolff (1963) note the pleasure that new mothers take when their infants begin to "see them." Mothers specifically articulate that eye-to-eye contact released strong positive feelings. These feelings have something to do with "being recognized" in a highly personal and intimate way. Watson (1965), and Andrews (1965), all of whom were early authors exploring the infant's social responses to faces, established an important fact: that one of the earliest and most effective stimuli for eliciting social smiling in the infant is a visual image consisting of the two eyes and forehead in an "en face" position, i.e., the eyes of the infant and those of the observer meet fully in the same vertical plane of rotation. Fixation and smiling appear to be maximal in this position. Later studies have shown that eye-to-eye contact is one important component of maternal-infant behaviors that comprise reciprocal interaction. Robson (1967) demonstrated the importance of eye contact in terms of the quality and intensity of the infant's tie to the mother's face, and in forming his/her earliest, and possible future, human relationships. As one would expect, visual abilities, such as visual fixation, following and attending, can effectively enhance the mother/infant attachment and further the bonding process.

In conclusion, it is believed that one effect of a visual stimulation treatment, i.e., the facilitation of eye-to-eye contact, might also nurture,

enhance and make richer the mother-infant relationship. This phenomenon could have significant effects on the infant's continuing development of psycho-social-cognitive behaviors. It seems reasonable to predict from the finds of this study that a premature infant who achieves greater interactive abilities would be more effective in reinforcing early maternal responsiveness; this in turn might set up the cyclical interaction of stimulus-response patterns designed to enhance nurturing behavior of the caretaker and the developmental behavior of the infant.

An underlying concern of all studies of stimulation with premature infants has been the type of stimulation program provided. As Cornell and Gottfried (1976) have argued, the lack of agreement regarding the ecology of the premature infant is reflected in the fact that some studies attempt to duplicate the experiences of the womb and others the experiences of the full term neonate. In defense of the latter Scarr-Salapatek and Williams (1973) stated:

> If these infants were still in utero, they would not be exposed to visual stimuli but would experience other forms of stimulation. A major consideration, however, in comparing experience in the third-trimester fetuses and extra uterine premature infants is the different functioning of the two organisms. At birth it seems likely that sensory systems change in their organization and functioning just as respiratory and digestive systems alter their modes of operation. Different forms of stimulation may be necessary for extrauterine development than intrauterine maturation regardless of gestational age (p. 95).

Although this study has not resolved the argument it does indicate a demonstrable difference in the performance of premature infants who have been exposed to visual input normally available to full-term infants and that was not available in the premature nursery due to the patching of the eyes.

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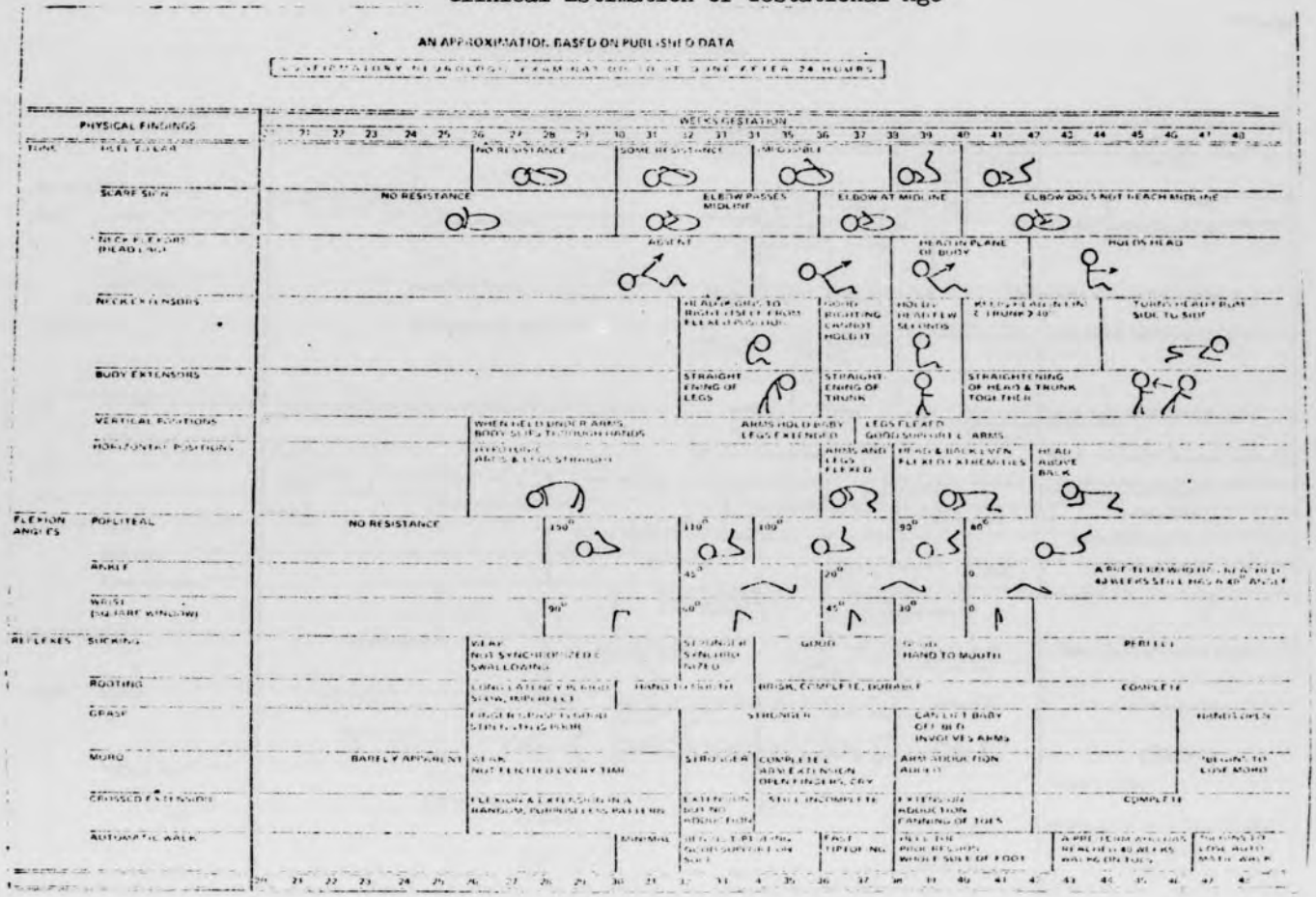
Appendix A

Clinical Estimation of Gestational Age



Clinical Estimation of Gestational Age

An APPROXIMATION BASED ON PUBLISHED DATA

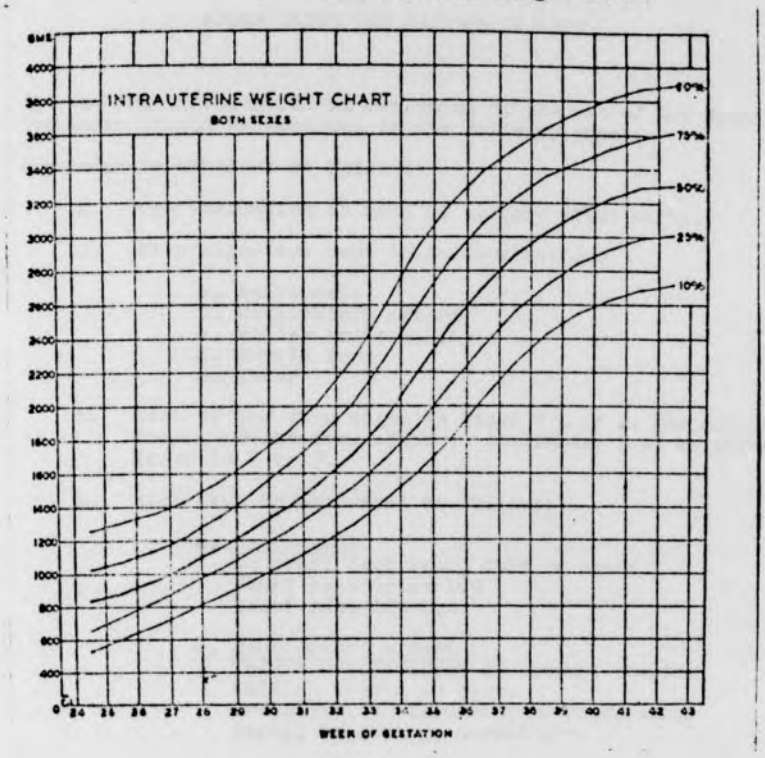
[EXAMINATIONS TEST HOLES]

PHYSICAL FINDINGS	WEEKS GESTATION
SKIN — VERNIX	CAUSEOUS — COVERS BODY, THICK LAYER — ON BACK, SCALP, IN CREASES — SCANT, IN CREASES — NO VERNIX
BREAST TISSUE AND AREOLA	AREOLA FLAT, NIPPLE BARELY VISIBLE, NO PALPABLE BREAST TISSUE — AREOLA RAISED — 1-2 MM NODULE — 3-5 MM — 5-6 MM — 7-10 MM — 11-12 MM
EAR — FORM	FLAT, SHAPELESS — BEGINNING INCURVING SUPERIOR — INCURVING UPPER 2/3 PINNAE — WELL DEFINED INCURVING TO LOBE
EAR — CARTILAGE	PINNA SOFT, STAYS FOLDED — CARTILAGE SLOWLY RETURNS SLOWLY FROM FOLDING — THIN CARTILAGE SPRINGS BACK FROM FOLDING — PINNA FIRM, REMAINS ERECT FROM HEAD
SOLE CREASES	SMOOTH SOLES NO CREASES — 1/3 ANTERIOR CREASES — 2/3 ANTERIOR CREASES — CREASES ANTERIOR 2/3 SOLE — CREASES INVOLVING HEEL — DEEPER CREASES OVER ENTIRE SOLE
SKIN — THICKNESS & APPEARANCE	THIN, TRANSLUCENT SKIN, PLETHORIC, VENULES OVER ABDOMEN — SMOOTH THICKER NO ERUPTIONS — PINK — FEW VESSELS — SOME DESQUAMATION PALE PINK — THICK, PALE, DESQUAMATION OVER ENTIRE BODY
SKIN — NAIL PLATES	TO FINGER TIPS — NAILS TO FINGER TIPS — NAILS EXTEND WELL BEYOND FINGERTIPS
HAIR	APPEARS ON HEAD — EYEBROWS & LASHES — FINE, WOOLLY, BUNCHES OUT FROM HEAD — SILKY, SINGLE STRANDS LAYS FLAT — FREE PROJECTING HAIR IN DEGREE OF BODY HAIR, SHORT, FINE UNDERNEATH
LANUGO	APPEARS — COVERS ENTIRE BODY — VANISHES FROM FACE — PRESENT ON SHOULDERS — NO LANUGO
GENITALIA — TESTES	TESTES PALPABLE IN INGUINAL CANAL — IN UPPER SCROTUM — IN LOWER SCROTUM
GENITALIA — SCROTUM	FEW RUGAE — RUGAE ANTERIOR PORTION — RUGAE COVER — PENDULOUS
GENITALIA — LABIA & CLITORIS	PROMINENT CLITORIS, LABIA MINORA SMALL, WIDELY SEPARATED — LABIA MAJORA LARGE, NEARLY COVERED CLITORIS — LABIA MINORA & CLITORIS COVERED
SKULL FIRMNESS	BONES ARE SOFT — SOFT TO 1" FROM ANTERIOR FONTANELLE — SPONGY AT EDGE OF TWELFTH CENTIMETER — BONES HARD, SUTURES EASILY DISPLACED — BONES HARD, CANNOT BE DISPLACED
POSTURE — RESTING	HYPOTONIC LATERAL DECUBITUS — HYPOTONIC — BEGINNING FLEXION THIGH — SLIGHTLY HIP FLEXION — FROG-LIKE — FLEXION ALL LIMBS — HYPERTONIC — VERY HYPERTONIC
RECOIL — LEG	NO RECOIL — PARTIAL RECOIL — PROMPT RECOIL
ARM	NO RECOIL — PROMPT RECOIL MAY BE INHIBITED — PROMPT RECOIL AFTER 30 INHIBITION

WEEKS GESTATION: 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48

Appendix B

Intrauterine Weight Chart



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Appendix C

APGAR INDEX FOR NEWBORN INFANTS

All newborn infants will be evaluated by the use of the apgar index. The index should be recorded on the delivery sheet.

The index is obtained as follows:

1. The evaluation is made 60 seconds after birth.

2. Five signs are used in the evaluation:

   a. Heart rate
   b. Respiratory effort
   c. Reflex irritability
   d. Muscle tone
   e. Color

3. Each of the five signs is rated 0 1 or 2. The sum of the rating of the five signs is the index, i.e. an average index is 7 to 9.

4. Each sign is evaluated as follows:

   a. Heart rate

No heart beat seen, felt or heard	0
Heart rate under 100	1
Heart rate 100-140	2

   b. Respiratory effort

Infant apneic after 60 seconds despite initial breath or gasp.	0
Irregular, shallow or poor respiration	1
Normal breathing, normal cry	2

   c. Reflex irritability

No response to external stimuli or suctioning of orpharynx	0
Reduced response	1
Facial grimaces, sneezing or coughing with stimulation.	2

   d. Muscle tone

Completely flaccid infant	0
Reduced tone	1
Spontaneous flexion of arms or legs and resistance to extension	2

   e. Color

Deep cynosis of the entire body or severe pallor	0
Cynosis present in limited amount, including hands and feet	1
Entire child completely pink	2

REFERENCE: Apgar, Virginia, Current Researches in Anesthesia and Analgesia

Appendix D - Brazelton Neonatal Assessment Scale Dimensions

Dimension I (Interactive Processes)

5- Orientation inanimate visual
6- Orientation inanimate auditory
7- Orientation animate visual
8- Orientation animate auditory
9- Orientation animate visual and auditory
10- Alertness
14- Cuddliness
16- Consolability

Dimension II (Motoric Processes)

Reflexes

11- General Tonus
12- Motor Maturity
13- Pull-to-sit
15- Defensive Movements
20- Activity
26- Hand-mouth facility

Dimension III (Organizational Processes - State Control)

Predominant State

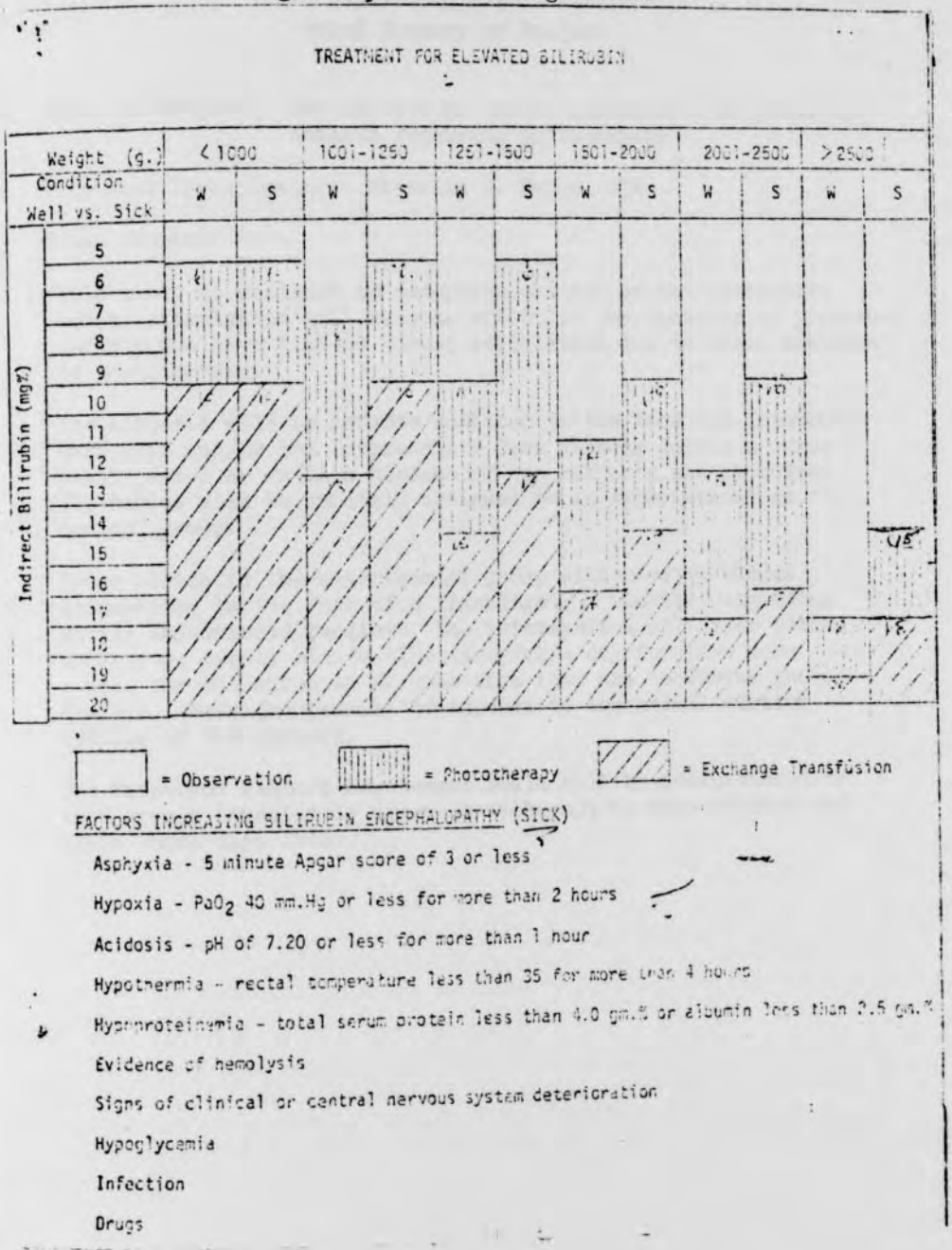
1- Response decrement to light
2- Response decrement to rattle
3- Response decrement to bell
4- Response decrement to pinprick
17- Peak of excitement
18- Rapidity of buildup
19- Irritability
24- Lability of states
25- Self-quieting activity

Dimension IV (Organizational Processes - Physiologic Responses to Stress)

21- Tremulousness (all states)
22- Startle
23- Lability of skin color

Appendix E

Light Levels and Exchange Levels



FACTORS INCREASING BILIRUBIN ENCEPHALOPATHY (SICK)

Asphyxia - 5 minute Apgar score of 3 or less

Hypoxia - PaO_2 40 mm.Hg or less for more than 2 hours

Acidosis - pH of 7.20 or less for more than 1 hour

Hypothermia - rectal temperature less than 35 for more than 4 hours

Hypoproteinemia - total serum protein less than 4.0 gm.% or albumin less than 2.5 gm.%

Evidence of hemolysis

Signs of clinical or central nervous system deterioration

Hypoglycemia

Infection

Drugs

Appendix F

Brief Summary of Project

1. Title of Project: The effects of visual stimulation of premature infants receiving phototherapy.

2. Principal Investigator: Michelle C. Evans, OTR

3. Brief Summary:

This study is designed to determine whether or not systematic visual stimulation will have an effect on the behavior of premature infants who have limited visual stimulation due to their exposure to phototherapy.

The subjects will be infants admitted to the Neonatal Intensive Care unit and/or the Intermediate Care Nursery during a three month period or until a minimum of ten subjects are recruited. The babies will be randomly assigned to an experimental or control group.

Those babies in the experimental group will receive visual stimulation in the form of a flashlight, a visually appealing mobile and colored paddles. The intervention will take place during one twenty minute time interval a day for five days a week for the duration of time that they are receiving phototherapy. Both groups will be exposed to the normal nursing routine of the nursery.

The Brazelton Newborn Assessment Scale will be administered to both groups immediately after phototherapy is discontinued and again three days later.

Appendix G

Information Letter to Mothers

Date_____

Dear Ms._____:

A project is underway at the North Carolina Memorial Hospital Intensive Care Unit which includes systematic visual stimulation and assessment of premature infants with hyperbilirubinemia who are exposed to flourescent lights.

The project is under the direction of Michelle C. Evans, a registered occupational therapist, and has been approved by the Department of Pediatrics, Occupational Therapy and by the Committee on the Protection of the Rights of Human Subjects at the University of North Carolina at Chapel Hill.

The purpose of the study is to determine whether or not giving additional visual stimulation to infants under flourescent lights will affect their behavior. All of the babies under these lights wear patches to protect their eyes and, therefore, have limited visual experiences. The stimulation will be done each day for about 20 minutes. The lights will be turned off and the babies will be presented with a flashlight, a mobile and colored paddles. When the baby no longer needs to stay under these lights an assessment will be made of the baby's immediate behavior and then this same assessment will be done to look at later behavior.

This assessment includes such things as seeing how your baby moves his arms and legs, how well he or she looks at or listens to things; and how easy it is to comfort your baby if he cries. Although your baby may cry during the assessment, the examination will not harm the child. You will be most welcome to observe the evaluations and the results will be explained to you. The results of the evaluation will be put in your baby's chart so that the doctor will know the results of the test. There will be no charge for this assessment. The assessments will take about 30 minutes to perform. Your baby may receive this extra stimulation and/or he or she may receive the stimulation which is already provided in the nursery by the nursing staff.

It is hoped that information from this project will be helpful in gaining knowledge about visual stimulation and about the enhancement of visual behavior in premature infants. By participating in this study you will have an opportunity to learn ways you can play with your baby at home.

All of the information collected during this project will remain confidential. Michelle C. Evans will be happy to answer any questions you may have. If you are willing to participate in this study with your baby, please read and sign the attached form.

Thank you.

Sincerely,

Michelle C. Evans, OTR

Appendix H

Consent Form

Volunteer's Statement:

I, the undersigned, voluntarily consent to allow my baby to participate in the project concerning visual stimulation of premature infants exposed to phototherapy.

I understand that Michelle C. Evans, OTR, is in charge of the project and will be responsible for my baby's welfare while participating in the study.

I understand further that the study has been approved by the School of Medicine of the University of North Carolina at Chapel Hill and by the Committee on the Protection of the Rights of Human Subjects and that I can contact the Committee chairman or any member of the Committee if I have questions about the study.

The nature of the study, the precautions involved, the benefits and the risks have been explained to me fully by Michelle C. Evans.

I also understand that by baby may or may not be receiving additional visual stimulation while in the Intensive Care Nursery or Intermediate Care Nursery. I understand that this stimulation will be given for 20 minutes a day for five days a week for as long as my baby is exposed to flourescent lighting. I understand that an assessment of his behavior will be done immediately after he is discontinued from the lights and again three days later.

I understand that the benefits from the study may be enhancement of my child's visual behavior. I also understand that I may benefit from the suggestions and pamphlet regarding infant stimulation at home.

I understand that my baby may become upset by being touched during the stimulation or assessment byt that every precaution will be taken to insure his or her health, safety and comfort.

I understand that all the information regarding by baby will be confidential and that the assessment results will be charten in the infant's medical chart in the hospital.

I understand that I am free to withdraw from this study at any time.

_____ _____

Interviewer Date

_____ _____

Volunteer's Signature Date

_____

Witness (when necessary)

Appendix I

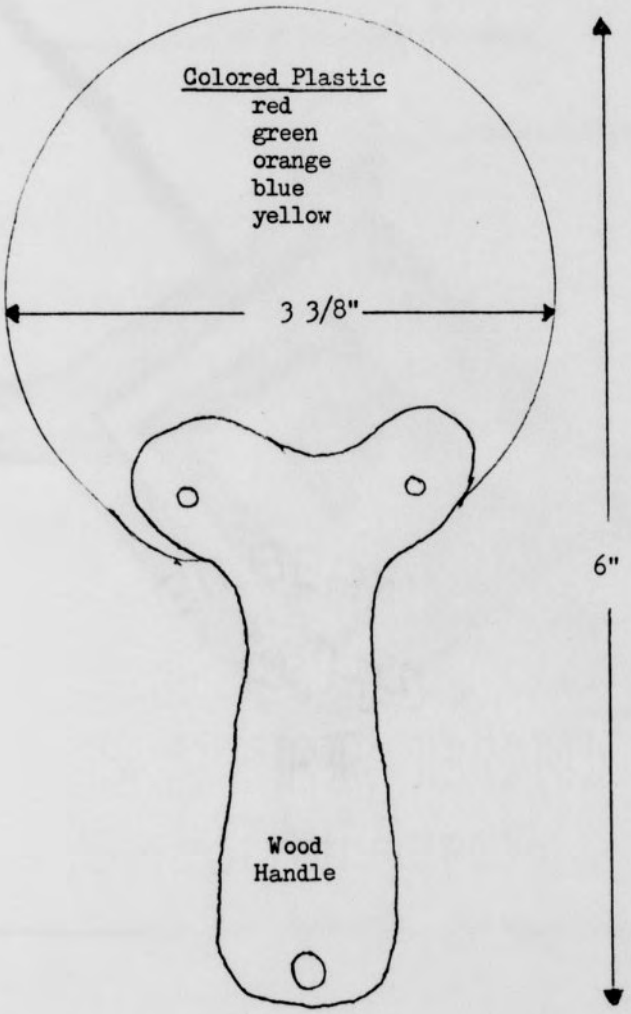
Sample Schedule of Testing and Intervention for Experimental and Control Groups

Birth	Day 1	Day 2	Day 3	Day 4	Day 5
am: Apgar EGA To Nursery	am: Bilirubin level	am: Bilirubin level	am: Bilirubin level Under lights Second stimulation	am: Bilirubin level Under lights	am: Bilirubin level Under lights
pm:	pm:	pm: Under lights First stimulation	pm:	pm: Third stimulation	pm:

Day 6	Day 7	Day 8	Day 9	Day 10
am: Bilirubin level Bilirubin lights discontinued	am: Bilirubin level No lights	am: Bilirubin level No lights	am: Bilirubin level No lights	am: Discharged or Transferred
pm: Fourth stimulation	pm: First Brazelton	pm:	pm: Second Brazelton	pm:

Appendix J

Colored Paddle



Appendix K

Yarn Gods Eye
(4 per mobile)