VISUAL HABITUATION IN PRETERM INFANTS

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ABSTRACT

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This study examined the effects of early sensori-motor stimulation on preterm infants' visual habituation performance at 4 months corrected age. Groups of 8 preterm infants received the Rice (1977) infant sensori-motor stimulation programme of systematic massage and rocking (RISS), a programme of equivalent handling, rocking, and social stimulation (HRS), or a maternal attention control programme, for their first month at home. At 4 months corrected age the 3 groups were compared to 8 fullterm 4-month-olds on Cohen's (1976) visual habituation task. Infants were shown a warm-up stimulus for 2 trials, a habituation stimulus for 21 trials, and a dishabituation stimulus for 2 trials. No differences were found between preterm groups on the Bayley Scales of Infant Development. Preterm groups differed in mean fixation time but not habituation rate; the RISS group had shorter fixation times than the HRS and control groups. The RISS group also took fewer trials to reach criterion than fullterm infants, but did not differ from them in mean fixation time. Fullterm infants had shorter fixation times than the control group only. Correlational analyses of the preterm data showed that longer fixation times were associated with shorter gestational periods, and with poorer performance on orientation to the examiner's face on the Brazelton Neonatal Behavioral Assessment Scale. Since fixation time rather than trials to criterion differentiated preterm infant group performance, it was concluded that fixation time, but not trials to criterion, is a sensitive index of cognitive functioning.

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It has long been recognized that infants born before term at less than 37 weeks gestational age (GA), are at greater risk for a number of physical and psychological problems than infants born at term, that is, at 40 weeks GA. Investigators who have followed the development of preterm infants during their first two years of life have reported evidence of delays in mental and motor development, even among those of appropriate weight for gestational age (AGA) (Siegel, Saigal, Rosenbaum, Young, Berenbaum, & Stoskopf, Note 1). Whether preterm infants ever do catch up in their development or whether some deficit persists throughout their development is a matter of debate (Caputo, Goldstein, & Taub, 1979). One study, however, that assessed the level of functioning of middle-class prematurely born children showed the continued existence of a subtle deficit into middle childhood in cognitive areas involving the visual system, even among minimally premature children (Taub, Goldstein, & Caputo, 1977). The evidence of early delays in the cognitive development of preterm infants has led to the implementation of early sensori-motor stimulation programmes in an effort to reduce the severity of these impairments. One study conducted by Rice (1977) demonstrated that it is possible for mothers to administer systematic sensori-motor stimulation during the preterm infant's first month at home, in the form of massage and rocking, and still find evidence for longterm effects on neurological maturation as reflected by the appearance as well as disappearance of specific reflexes by 4 months of age. The present study investigated the longterm effects of Rice's sensori-motor stimulation programme on the visual habituation performance of normal preterm infants at 4 months corrected age. Visual habituation was studied using Cohen's (1976) paradigm because it has been argued to be the most sensitive of all the visual attention tasks (DeLoache, 1976).

Premature infants have always been considered as a population at greater risk for physical, neurological, mental, and motor complications than fullterm infants. Early studies found evidence that implicated prematurity in such gross impairments as cerebral palsy, epilepsy, mental retardation, brain damage, as well as vision and hearing defects (Caputo, Goldstein, & Taub, 1979). A review of early studies of infants under 2,500 grams by Caputo and Mandell (1970) found evidence of significant intellectual impairment among heavier and very low birthweight infants in childhood and later adolescence, with the effect being more pronounced for very low birthweight infants (below 1,501 grams). Prematurity, defined on the basis of birthweight alone, was found to be associated with mental retardation, deviant behavior, language and reading delays, physical and neurological defects; these problems were more frequent in very low birthweight infants.

Although these studies indicated the adverse effects of prematurity, they nevertheless were inconsistent in their definition of prematurity. Since 1970, by an international agreement, the term "premature" has been dropped from scientific use, and replaced by the term "preterm" which specifically refers to infants born under 37 weeks GA (Tanner, 1974). Prior to 1970, studies generally defined prematurity on the basis of birthweight, and all infants born under 2,500 grams were designated "premature". This definition of prematurity however, confounded infants who were low birthweight, but small for gestational age (SGA), with those who were low birthweight but of appropriate weight for gestational age (AGA). This distinction between AGA and SGA has been shown to be important. Even though survival rates of infants are a function of birthweight (Pape, Buncic, Ashby, & Fitzhardinge, 1978), the types of problems preterm infants later encounter depend upon whether or not weight is appropriate for GA (Robertson, 1979).

In spite of the recent advances in medical care that have increased the survival rates and "quality" of preterm infants, follow-up studies are still finding evidence that such children suffer from physical and intellectual impairments. A study conducted in Toronto, Canada by Pape et al. (1978) examined the physical and mental development of 97 extremely low birthweight preterm infants, born during 1974, from birth through to the age of 2 years. The sample contained AGA and SGA infants with birthweights under 1,001 grams. Of the 43 surviving infants at the two-year follow-up, seven (16%) had retrolental fibroplasia, four (9%) had major neurological defects, and 16 (37%) had minor neurological defects. Average height at 2 years was between the tenth and twenty-fifth percentiles, while average weight ranged between the third and tenth percentiles. Severe developmental delay was detected in nine (21%) infants between the ages of 18 and 24 months chronological age on the Bayley Scales of Infant Development.

A follow-up study conducted in Hamilton, Canada by Siegel, Saigal, Rosenbaum, Young, Berenbaum, and Stoskopf (Note 1) also reported mental and motor delays on the Bayley Scales of Infant Development for a sample of preterm infants with very low birthweights (below 1,501 grams) when their performance was compared to that of fullterm controls. When scores were corrected for degree of prematurity, the performance of preterm infants who were AGA, was significantly lower than that of fullterm controls on the Motor Scale at 8, 12, 18, and 24 months, but not at 4 months.

Preterm infants' scores on the Mental Scale were lower than those of fullterm infants at 4 and 8 months only. When the scores were not corrected for prematurity, preterm infants performed at significantly lower levels than fullterm infants on both the Motor and Mental Scales at all ages from 4 to 24 months. This study taken in conjunction with the Pape et al. (1978) study raises the question of whether or not preterm infants ever do catch up in their development.

At least one recent study of prematurely born children at later stages of development has provided evidence of a subtle deficit involving cognitive abilities. Taub, Goldstein, and Caputo (1977) compared the intellectual, scholastic, and social functioning in 7- to $9^1/2$-year-old middle-class children who were moderately premature at birth (mean GA was 34.4 weeks, mean birthweight was 2,154 grams) to that of fullterm controls. When performance on the subtests of the WISC-R and on the Bender Gestalt were examined, the prematurely born children showed deficits in visually-mediated functions and in areas of perceptual organization. No differences were found between groups in areas of scholastic and social functioning.

The evidence of early delays in cognitive development has prompted studies of the effects of early sensory stimulation on the preterm infant's development. There are two rationales given for early stimulation programmes. The first states that birth before term deprives the infant of the vestibular, and tactile-kinesthetic stimulation provided in utero by the movements of the mother and of the infant's body, and that early extra stimulation can compensate for these lacks (Masi, 1979). The second states that the hospital environment of the preterm infant does not provide adequate levels of stimulation as in the environment of the fullterm middle-class infant, and that compensatory forms of stimulation should make up for these deficiencies (Cornell & Gottfried, 1976). In both cases early stimulation is believed to be beneficial to the preterm infant.

While studies have differed in the nature of their intervention and have various methodological flaws, they nevertheless show that infants who have received additional sensory stimulation tend to be more advanced than control infants several months after intervention, especially in follow-up tests of sensori-motor and motor skills (Cornell & Gottfried, 1976). Cornell and Gottfried, however, have pointed out that most of these studies were hospital-based, and used a population of preterm infants who came from lower socioeconomic environments. In addition, they reported that it is often the case that prematurity was associated with physiological and neurological disturbances. Thus, it is not clear whether intervention benefits middle-class AGA preterm infants who do not suffer from physiological and neurological handicaps.

One study conducted by Scarr-Salapatek and Williams (1973) compared the effects of a nursery and home stimulation programme designed for socially-disadvantaged low birthweight infants to routine nursery care. All but one of the infants was preterm. The intervention provided visual, auditory, tactile-kinesthetic stimulation coupled with handling and rocking. The in-hospital programme began within the infant's first week of life and terminated when the infant was discharged. Mothers of the experimental infants were visited weekly in the home after the infant's discharge for the first year by social workers who provided them with support. When infants were compared on the Brazelton Neonatal Behavioral Assessment Scale (NBAS) at 1 and 4 weeks chronological age, results indicated better performance for the experimental infants at 4 weeks, although the status of the control group had been superior at 1 week of age. On the Cattell Infant Intelligence Scale at one year chronological age, the experimental infants had significantly higher developmental status (Mean DQ of 95.3), while the control infants were 1 SD below the norm (Mean DQ of 85.7). The results of this study, however, are difficult to interpret because of the loss of 40% of the control infants by the one-year follow-up.

In contrast to hospital-based stimulation programmes carried out in the first weeks of life, Rice (1977) examined the longterm neurophysiological, mental, and motor effects on preterm infant development of a home-based sensori-motor stimulation programme. Rice developed a systematic massage technique which provided infants with sequential cephalocaudal stroking and massage. The massage was administered for 15 minutes four times daily during the infant's first month at home. Following each massage treatment, infants were swaddled and rocked for another 5 minutes. This was the first study in which mothers were trained to administer a sensori-motor stimulation treatment to their infant at home. Mothers were visited daily by nurses who modelled the procedure and then observed, corrected and prompted mothers to look at their infant. Mothers of control infants were given routine instructions regarding infant care and were visited by a nurse on a weekly basis. The nurses provided social reinforcement to mothers of both experimental and control infants for appropriate mothering techniques. Mothers of both groups also received a four-month supply of formula to ensure that nutrition was comparable for all infants. At 4 months chronological age, infants who had received sensori-motor stimulation had greater weight gain, performed better on the Bayley Mental Scale, and attained a level of neurological maturation which was equivalent to that of 4-month-old fullterm infants on a reflex assessment. No differences were found on the Bayley Motor Scale. Rice (Note 2) reported that at 18 months chronological age, differences were no longer evident on either of the Bayley Scales. The form of early stimulation investigated in the present study was Rice's (1977) infant sensori-motor stimulation programme (RISS).

A more recent study conducted by Rose (1980) used a programme very similar to Rice's and demonstrated longterm effects of early sensory stimulation on preterm infants' visual recognition memory. This study was the first to investigate the effects of a stimulation programme on a sensitive cognitive processing task. Rose compared the visual recognition memory performance of experimental and control preterm infants at a corrected age of 6 months to that of 6-month-old fullterm infants. The experimental infants had experienced three 20-minute sessions daily of gentle massaging and rocking for 5 days a week while in the hospital nursery. This programme began at some time within the infant's first two weeks of life, and continued until it was discharged. Control infants had experienced routine nursery care. At 6 months corrected age, the groups' differential responsiveness to novel and familiar stimuli was assessed. Infants were given three trials, one on each set of stimuli. Stimulus sets were multi-dimensional variations, pattern arrangements, and photos of a man, woman, and infant. Each trial began with a familiarization exposure to a pair of identical stimuli, and lasted until the infant looked at the stimuli for a preset amount of time (which varied from 5 to 20 seconds depending on the type of stimulus). Familiarization exposure was followed by a 10-second test period in which one of the familiar stimuli was paired with one of the novel stimuli. The results indicated that preterm infants who had received the massage did not differ from fullterm infants in visual recognition memory performance; that is, infants in both groups spent more time fixating the novel stimulus than the familiar stimulus on all stimulus sets except the pattern arrangements. The results also showed that control preterm infants were slower information-processors than experimental preterm infants or fullterm infants, since evidence for visual recognition memory was found for control infants only when they were given a lengthened familiarization period (that varied from 20 to 30 seconds depending on the type of stimulus).

The visual recognition memory deficit of the control infants in the Rose (1980) study resembles that previously demonstrated in studies of visual attention in young preterm infants who had not experienced any form of early intervention. While various interpretations of the data have been offered the findings in general support the Taub, Goldstein, and Caputo (1977) notion that prematurity is associated with a subtle cognitive deficit involving the visual system. Taub et al. suggest that such a deficit might be explained by a subtle brain dysfunction or a limitation in brain cell growth to which the visual system may be more susceptible.

At the earliest age at which a comparison with fullterm infants of equivalent biological age is possible, preterm infants have been shown to be different in visual attention performance. Sigman, Kopp, Littman, and Parmelee (1977) compared the visual fixation responses of preterm infants at 40 weeks conceptional age to that of fullterm newborns. Infants were presented with a checkerboard pattern for 60 seconds for three consecutive trials. Visual attention was measured by examining length of first fixation, total fixation time over three trials, number of fixations per trial, and mean fixation time per trial. The results indicated that total fixation time on all trials and length of first fixation were significantly greater for preterm infants. Mean fixation time was twice as long for preterm infants than for fullterm infants on each trial. Preterm infants also looked more frequently at the stimulus than fullterm infants. Thus, all the measures appeared to be relevant in discriminating group performance. The authors suggested that the longer fixation time to an unchanging stimulus may represent a more immature response reflecting an inability of the infant to modulate or inhibit its visual responses.

An earlier study had shown a similar difference between preterm infants at 4 months corrected age and fullterm 4-month-olds. Sigman and Parmelee (1974) compared visual preferences of fullterm and preterm infants for complex stimuli, and subsequently tested preference for novelty. The procedure involved 8 trials with paired presentations of four combinations of checkerboards (2x2, 6x6, 12x12, 24x24). Each combination was viewed twice. Preference for novelty was tested by giving all infants a familiarization series (of 40 or 80 seconds) in which the 24 x 24 checkerboard was paired with four patterns (four diamonds, a bow tie, a circular and linear pattern, and a bull's eye). All infants showed the same preference for the more complex checkerboards. When fixation times to novel and familiar stimuli were compared, however, fullterm infants showed preferences for the novel stimuli, whereas preterm infants preferred the familiar, even with the longer familiarization time.

Using a modified version of the visual preference task with preterm infants at 8 months corrected age and fullterm 8-month-olds, Sigman (1976) was also able to demonstrate the same difference in preference for novelty. Sigman used an object exploration technique pairing a bell with ten novel objects. When total contact with the bell was recorded, preterm and fullterm infants differed in the first 2 minutes following a 6-minute familiarization period with the bell, in that preterm infants explored the bell longer than fullterm infants, and showed less preference for novel objects than fullterm infants. This study, considered in conjunction with the others by Sigman and her colleagues, suggests that preterm infants may suffer from a cognitive impairment, at least through 8 months corrected age, in that they appear to need longer periods of time to encode information about stimuli than fullterm infants.

The purpose of the present study was to investigate whether early sensori-motor stimulation enhanced preterm infants' performance on a sensitive cognitive measure of visual information-processing abilities. The only measure that Rice used that reflected enhanced neurological development was the reflex assessment, since she attributed the effect seen on the Bayley Mental Scale to the social stimulation provided by the programme. It was felt that any acceleration of neurological maturation might be reflected in more mature performance on a visual processing task.

The specific paradigm selected in the present study was the visual habituation paradigm developed by Cohen (1976). The task involves repeatedly showing a visual stimulus to infants until fixation time to the stimulus drops to a criterion level of 50% with respect to the length of the first three fixation times. After the infants have reached criterion, a novel stimulus is shown to test for fatigue effects. The decline in fixation time over trials is thought to reflect the infant's ability to establish a memory engram or an internal representation of the stimulus. DeLoache (1976) postulated that the infant compares each incoming stimulus to a memory model of the previously shown stimulus. When the stimulus and model match, fixation time is inhibited. If the infant senses a discrepancy between the novel stimulus and its memory model of the familiar stimulus, the infant's visual fixation time increases or recovers.

The Cohen visual habituation task is thought to be the most sensitive of all the visual attention tasks. First, the task employs single stimulus presentations rather than paired stimulus presentations where the infant must divide its attention between the novel and familiar stimulus. Cohen and Gelber (1975) argued that the paired-presentation procedure is misleading because it makes it difficult to assess to what extent changes in fixation time reflect an increasing interest in the novel stimulus as opposed to a decreasing interest in the familiar stimulus. A second advantage of the Cohen paradigm is that the onset and termination of each trial is determined by the infant rather than being arbitrarily set by the experimenter. This gives the infant maximum control over encoding processes. Those that have employed the Cohen paradigm have typically used a proportional rather than an absolute criterion of habituation, by defining habituation as a 50% decrement in fixation time relative to that of the initial trials. Thus, a third advantage is that the criterion is sensitive to individual differences in initial level of response.

The final advantage of the Cohen paradigm is that it permits the independent assessment of two basic memory processes (Cohen, 1972). One process is "attention-getting", and is reflected in the infant's latency to turn to the visual stimulus, the other process is "attention-holding" and is reflected in the duration of each fixation. Cohen's rationale for the independent examination of these two memory processes involved in visual habituation stemmed from his argument that an infant may orient several times and have the same fixation time as an infant who orients only once but for a longer period of time.

In general, the Cohen paradigm appears to be appropriate for preterm infants in that it provides the infant with greater control over encoding processes, thus allowing preterm infants to take the needed amount of time on each trial to respond to a visual stimulus. The measures of primary interest in visual habituation studies are trials to criterion, mean fixation time, length of first fixation, first latency to orient, and mean latency to orient. One interest in the present study was to examine the sensitivity of trials to criterion (habituation rate) in comparison to mean fixation time as an index of cognitive functioning in preterm infants. DeLoache (1976) has suggested that habituation rate may be sensitive to differences in developmental level.

Cohen (1981), however, has recently reported data which suggest that fixation time and not trials to criterion may reflect cognitive impairment. Cohen found that total fixation time to a checkerboard stimulus differentiated a high-risk population of Down's Syndrome infants and normal fullterm controls at 19, 23, and 28 weeks chronological age. At every age, Down's infants had longer fixation times than their normal controls. At all three ages, however, trials to criterion was approximately the same for both groups. In another study, Cohen (1981) found that trials to criterion failed to differentiate performance of lower-class fullterm infants, and lower-class preterm infants, who had suffered severe perinatal trauma, at 20, 33, and 49 weeks corrected age. Unfortunately, fixation time data were not presented for these subjects.

The present study was part of a larger ongoing project designed to evaluate the longterm benefits to preterm infants of sensori-motor stimulation administered for the infant's first month at home. Three groups of normal preterm infants were tested at a corrected age of 4 months for visual habituation. Each group of infants was assigned to one of three programmes. The first sensori-motor stimulation programme was the RISS, the systematic massage and rocking programme developed by Rice (1977). The second sensori-motor stimulation programme involved comparable amounts of rocking and non-systematic handling. It was designed to test for the effects of massage involved in the RISS. The third programme was a control for the extra amount of maternal attention directed toward the infant that was involved in administering the sensori-motor stimulation four times daily. Mothers in this programme were not instructed in any stimulation technique, but were told to spend daily periods quietly with their infant when not engaged in caretaking activities (Elder, 1981). A comparison group of 4-month-old normal fullterm infants was included to clarify the interpretation of any difference in performance on the visual habituation task between preterm infants who had received sensori-motor stimulation during the first month at home and those who had not.

The primary hypothesis was that sensori-motor stimulation administered to preterm infants in their first month at home by accelerating neurological maturation produces superior performance on a visual habituation task at 4 months corrected age. Thus it was predicted that infants in both sensori-motor stimulation groups would orient to the stimulus faster on each trial, fixate it for a shorter period, and take fewer trials to reach a proportional habituation criterion than infants in the maternal attention control group. A comparison between the massage and handling programmes was planned to test the effects of massage. No specific hypothesis was formulated concerning differences between the two sensori-motor stimulation programmes because both contained a rocking component, and rocking given in the first month of life has been shown to affect subsequent visual performance of normal fullterm infants at 4 months of age (White & Castle, 1964).

The second hypothesis was that normal preterm infants who do not receive additional sensori-motor stimulation in their first month at home show less mature visual habituation performance than fullterm 4-month-old infants even when age at testing is corrected for prematurity. Thus it was predicted that infants in the maternal attention group would take longer to orient to the stimulus on each trial, fixate it for longer periods, and take more trials to reach a proportional habituation criterion than the fullterm infants.

No hypothesis was formulated concerning differences in performance between infants who received either sensori-motor stimulation programme and the fullterm 4-month-olds. Comparisons were planned to investigate the extent to which the performance of the preterm infants who had received sensori-motor stimulation differed from that of the fullterm group.

Method

Subjects

Thirty-four infants served as subjects, 26 preterms and 8 4-month-old fullterms. The preterm infants (11 females, 15 males) were the infants available for a 4-month follow-up, from an original sample of 30 infants who had completed participation in one of three programmes for their first month at home (Elder, 1981). The programmes which mothers were instructed to follow 4 times a day were the RISS programme (Rice, 1977), a "handling" programme referred to as the HRS, and a maternal attention control programme. While the control programme was known to the mothers as the Weekly Weigh-In Programme (WWI), it should be noted that infants in all three programmes received weekly home visits from a visitor who weighed them and made behavioral observations. Appendix A contains a summary of the training and home visit procedures as well as instructions given to the mothers.

Three preterm infants were omitted from the follow-up study because mothers could not be located. Data on one preterm infant were excluded from the follow-up data because of inadequate testing. Three preterm infants required retesting on the visual task either because of the observer's inability to reach an acceptable level of reliability ($n = 2$ cases) or because of the infant's excessive crying or fussiness during the testing session ($n = 1$ case).

Infants in the study were all eligible normal preterm infants born in the Jewish General Hospital in Montreal between October 1, 1979 and November 1, 1980, and cared for in the Neonatal Intensive Care Nursery there, whose mothers agreed to participate. Criteria for selection were that infants have GA's of 36 weeks or less, not be SGA, and have no congenital anomalies or serious medical complications other than those associated with prematurity, such as respiratory distress syndrome (RDS). Other criteria were maternal residence within a 25-mile radius of the hospital and maternal ability to communicate in either English or French. In order to keep the groups participating in the three programmes equivalent on GA, infants were assigned to triads blocked on GA as they became available for study, and each member of the triad was then assigned to a different programme.

The preterm infants available for follow-up (N = 26 cases) were singletons with a mean birthweight of 1,832.7 g (s.d. = 521.9) and a mean GA of 31.9 weeks (s.d. = 2.9). All were AGA with the exception of one infant who was over 2 SD's above the appropriate weight for his GA. These infants had a mean 1-min. Apgar score of 6.5 (s.d. = 1.9), a mean 5-min. Apgar score of 8.5 (s.d. = 1.3), and a mean score for level of RDS (as rated on a 3-point scale of 1 = mild, 2 = moderate, 3 = severe) of .71 (s.d. = .87), and had spent an average of 38.6 days in the hospital (s.d. = 31.0). They were scheduled for follow-up at a corrected age of 16 weeks, and had a mean chronological age at visual test follow-up of 5.7 months (s.d. = .87). The preterm infants were on the average 1.6 months older than the fullterm infants, but were equivalent to them in terms of conceptional age at testing. In order to test the longterm effects of participation in the three programmes, data from two infants, the infant who was heavy for GA, and the last infant tested were excluded and eight triads of infants reblocked in terms of GA were compared. The maximum discrepancy in GA across any triad was 3 weeks, and the mean discrepancy was 1.2 weeks (s.d. = .80). Table 1 summarizes information on infant characteristics of the preterm

Table 1

Characteristics of Preterm Infant Groups

Variable		Group RISS	HRS	WWI
Birthweight (grams)	$\bar{X}$	1,873.7	1,900.6	1,633.1
	s.d.	632.9	462.0	495.2
	Range	800-2,720	940-2,370	860-2,600
GA (weeks)	$\bar{X}$	31.5	32.4	31.5
	s.d.	3.4	2.7	3.1
	Range	25-36	26.5-35	25-35
1-min. Apgar score	$\bar{X}$	6.9	6.8	6.6
	s.d.	2.2	1.6	1.4
	Range	2-9	3-8	5-8
5-min. Apgar score	$\bar{X}$	8.4	9.0	8.4
	s.d.	2.0	.5	2.9
	Range	4-10	8-10	6-10
RDS rating	$\bar{X}$	.68	.68	.75
	s.d.	.8	.8	1.2
	Range	0-2	0-1.5	0-3
Days in hospital	$\bar{X}$	35.8	33.5	50.0
	s.d.	22.8	31.1	41.3
	Range	14-86	10-104	5-145
Chronological age at visual test (months)	$\bar{X}$	5.9	5.6	5.7
	s.d.	.8	.6	1.0
	Range	4.9-7.1	4.8-6.6	5.7-6
Sex		5 F, 3 M	5 F, 3 M	3 F, 5 M

infant groups. Analyses of variance of birthweight, GA, days in hospital, and chronological age at the visual test showed no evidence of differences between preterm infant groups. There were no significant differences between groups on the Kruskal-Wallis Analyses of Variance by Ranks of 1-min Apgar scores, 5-min Apgar scores, or RDS scores. Source tables of analyses of variance of infant characteristics may be found in Appendix B. Maternal characteristics for the preterm infant groups are shown in Table 2. Analyses of variance of maternal age and maternal education showed no evidence of differences between preterm infant groups. The source tables for the analyses of variance of maternal characteristics may be found in Appendix B.

The eight 4-month-old fullterm infants who served as a comparison group were children of university students and their friends and relatives. They were not recruited at birth, but only when the preterm infant testing was already underway. Data obtained from one additional fullterm infant could not be used because of the infant's fussiness during the testing session. All fullterm infants were vaginally delivered and suffered no prenatal complications. They weighed 2,500 g or more at birth, except for one infant who had a birthweight of 2,450 g. Infants had a mean birthweight of 3,438.2 g (s.d. = 436.6), and the range was from 2,450 to 3,827 g. For the fullterm infants GA's ranged from 37.5 to 41.5 weeks with a mean GA of 40 weeks (s.d. = 1.2); their mean 1-min Apgar score was 8.2 (s.d. = .7), and their mean 5-min Apgar score was 9.8 (s.d. = .7). Information on fullterm infants' perinatal characteristics came from the infants' medical record booklets which were provided by the mothers. Maternal age for the fullterm infant group ranged from 24 to 34 years, with a mean age

Table 2

Selected Maternal Characteristics of Preterm Infant Groups

Variable		Group RISS	HRS	WWI
Maternal age	$\overline{X}$	26.9	28.6	27.6
	s.d.	5.3	4.1	6.8
	Range	24-37	23-34	19-39
Maternal education	$\overline{X}$	10.6	12.4	12.9
	s.d.	1.6	1.7	4.1
	Range	8-13	11-15	8-20
Parity	One child	5	4	6
	> One child	3	4	2
	(Range)	1-3	1-2	1-3
Race	Black	2	1	2
	Caucasian	6	5	6
	Oriental	0	2	0
Maternal language	English	4	2	3
	French	2	2	5
	Other	2	3	0

of 28 years (s.d. = 3.9); mothers of fullterm infants had a higher level of education than mothers of preterm infants, it ranged from 12 to 20 years, with a mean of 16.1 years (s.d. = 2.9). All fullterm infants came from two-parent families, and in most cases infants were the only infants of the family unit (n = 6 cases). Race of parents was Caucasian (n = 7 cases) or Black (n = 1 case). Mothers' first language was English (n = 3 cases), French (n = 4 cases), or Greek (n = 1 case).

Preterm Discharge Assessment

Immediately prior to discharge (n = 23 cases) or soon after their arrival at home (n = 3 cases), preterm infants were given the Brazelton Neonatal Behavioral Assessment Scale (NBAS) (Brazelton, 1973) at approximately 36 to 37 weeks conceptional age by either of two trained examiners. This scale provided information on the preterm infant's level of functioning around the time of hospital discharge. The NBAS is a behavioral assessment scale designed to evaluate the behavioral repertoire of the newborn including orienting and responding to animate and inanimate visual and auditory stimuli, as well as habituation or response decrement to various stimuli, responses to stress, and irritability. The instrument allows for the examination of 20 reflexes scored on a three-point scale (low, medium, high) and 26 behavioral items scored on a nine-point scale. The behavioral items are grouped according to an a priori clustering on four dimensions of newborn organization. Dimension I (Interactive Processes) measures the infant's capacity for attention and social responsiveness. Dimension II (Motoric Process) reflects the infant's motor and tone capacity. Dimension III (Organization Processes, State Control) indicates the infant's capacity for controlling his state of consciousness.

Dimension IV (Organization Processes, Physiological Response to Stress) examines tremulousness, skin color, and startles. Dimensions I to III are rated on a scale from 1 to 3 (1 = superior, 2 = adequate, 3 = worrisome). Dimension IV is dichotomized: a score of 1 indicates good performance, a score of 3 indicates deficient performance. In the present study, Dimension IV was not scored according to the dichotomized procedure because of a desire to increase the sensitivity of the measure, but was rather scored on a scale from 1 to 3. The rescoring procedure did not alter the definition of a score of 3 (worrisome performance), but made the definition of a score of 1 (good performance) more stringent, in that a score reflecting good performance was only assigned if the infant showed good performance on all items (tremulousness, skin color, and startles). Infants showing deficient performance on one of the three items were assigned a score of 2. Cluster scores were analyzed by the Kruskal-Wallis Analysis of Variance by Ranks. There were no significant differences between preterm infant groups on the NBAS cluster scores. Table 3 displays mean scores, standard deviations, and Kruskal-Wallis H values for the NBAS clusters.

Preterm Home Programme Measures

The selected home programme assessment measures examined in the present study were those that were shown to relate to perinatal variables or those that were affected by participation in one of the three home programmes (Elder, 1981). The selected measures included weight gain over the one-month home programme, and observations of sleep, drowsiness, and visual alertness taken every thirty seconds for an eight-minute period at the end of the intervention programme on the final home visit. For the preterm infants available at the time of the

Table 3

Mean Scores, Standard Deviations, and Kruskal-Wallis H Values for NBAS Clusters

NBAS Cluster		Group			
		RISS	HRS	WWI	H
Cluster I: Interactive Processes	$\overline{X}$	1.8	2.1	2.2	1.43
	s.d.	.88	.83	.70	
	number with worrisome score	2	3	2	
Cluster II: Motoric Process	$\overline{X}$	2.1	2.1	2.0	.18
	s.d.	.35	.35	.53	
	number with worrisome score	1	1	1	
Cluster III: Organization Process, State Control	$\overline{X}$	2.1	1.9	2.1	.73
	s.d.	.64	.35	.64	
	number with worrisome score	2	0	2	
Cluster IV: Organization Process: Physiological Response to Stress	$\overline{X}$	1.4	1.5	1.4	.55
	s.d.	.51	0.75	.51	
	number with worrisome score	0	1	0	

4-month follow-up (N = 26 cases) there had been a mean weight gain over the programme period of 1,049.9 g (s.d. = 234.1), and on the final visit mean scores (percent of total observations) for observed sleep of 7.2 (s.d. = 11.6), for observed drowsiness of 10.9 (s.d. = 11.0), and for observed visual alertness of 35.7 (s.d. = 27.3).

4-Month Follow-up Measures:

Developmental Assessment

The Bayley Scales of Infant Development were administered to all preterm infants to provide an evaluation of their cognitive and motor functioning on a standardized test. The Mental Scale which assesses the infant's sensory-perceptual abilities, discriminative abilities, memory, learning, and problem-solving ability yields the Mental Development Index (MDI). The Motor Scale which provides a measure of degree of gross motor and fine motor coordination and skills yields the Psychomotor Development Index (PDI) (Bayley, 1969). The raw scores for each scale were converted to the MDI and PDI by consulting norms for the infant's age at the time of testing, appropriately corrected for prematurity. Performance was also examined according to the infant's level of functioning (age equivalent performance) as indicated by the raw score for each scale.

Visual Habituation Stimuli

Two stimulus patterns were used in the visual habituation task. One was a 12 x 12 black and white checkerboard pattern which was 19.5 x 19.5 cm in size surrounded by a white border. It was used both as a warm-up and as a dishabituation stimulus. The other was a stimulus comprised of four abstract shapes of different colors on a white background. It was used as an habituation stimulus. This stimulus was similar to the stimulus used by DeLoache (1976) with 4-month-old fullterm infants. Both stimuli were constructed to fit the 22.9 x 22.9 cm opening.

Visual Habituation Apparatus

The apparatus used for the visual habituation study was a modified version of Cohen's visual apparatus which allows the independent assessment of latencies to orient to a visual stimulus, and subsequent fixations to that pattern (Cohen, 1972). The equipment was designed to be portable and quickly assembled in the home. The mother sat with her infant on her lap facing a wooden stimulus viewing chamber lined in black felt. The stimulus chamber measured 58.9 x 60.2 x 64.1 cm and was mounted on 71.8 cm wooden legs. The viewing panel measured 32.4 x 60.5 cm. A blinking light was built into the panel. It was a 14.4-V bulb with a translucent white cover (1.5 cm in diameter), which flashed at a rate of .2 sec on and .2 sec off. The light was located at the middle right side of the panel at 27.5 cm from the bottom. Visual stimuli were shown through the 22.9 x 22.9 cm opening on the left of the panel, and were revealed when the shutter that covered the stimulus was opened. The size of the shown image matched the size of the opening. Appendix C contains diagrams of the viewing panel drawn to scale and of the visual testing apparatus showing positions of the mother, infant, and observers.

Two observers recorded the infant's head and eye movements through .6- cm peepholes. One observer (the experimenter) was located behind the panel and looked through a peephole located 18.5 cm away from the light and 27.2 cm from the opening. The other observer recorded infant fixation times by leaning over the roof of the chamber and looking through the peephole at a front surface mirror (6 x 9 cm) located at

3.5 cm to the right of the main observation hole. Fixation times were recorded on two separate channels of a six-channel Lafayette event recorder (Model 56042). Other channels of the event recorder registered when the light was blinking, and when the visual stimulus was revealed. Latency to orient to the stimulus was derived by subtracting the time at which the target was revealed from the time when the infant began to fixate the stimulus. Interobserver reliability for fixation time was .96, $p < .01$. Interobserver reliability for latency to orient was .54, $p < .01$.

Procedure

The developmental status of the preterm infants who had participated in the home stimulation programmes was assessed by giving all infants the Bayley Scales of Infant Development and the visual habituation task when they reached 16 weeks corrected age. The Bayley Scales and the visual habituation task were administered by two independent testers. The testers and the second observer for the visual habituation task were blind with respect to preterm infants' assignment to group treatment. Visits were usually scheduled independently by each tester and usually took place on two separate occasions. Fullterm infants were assessed on the visual habituation task only, when infants were 4 months of age. All assessments were conducted in the home and were usually scheduled within a week of the infant's due date for testing.

Prior to the visual testing session, the experimenter briefly explained the nature of the study to the mother, and showed her the blinking light and the patterns her infant was about to see. She was informed that she should not attempt to influence her infant in any way during the presentation of the stimuli. During the task the mother sat with her infant on her lap facing the viewing panel of the stimulus chamber. The infant's head was approximately 58.5 cm away from the viewing panel. At the onset of each trial the infant was shown a blinking light to control for looking location when the pattern was revealed. When the experimenter judged that the infant was fixating the light, she manually opened the shutter and revealed the stimulus. This automatically turned off the blinking light. When the infant turned its head and fixated the pattern, the observers pressed a button that independently recorded fixation times to the stimulus. They released the button when they independently judged that the infant had turned its head and eyes away from the stimulus. The experimenter then closed the shutter which automatically turned on the blinking light at a .2-sec delay for the next trial.

On the first two trials the infant was shown the checkerboard pattern as a warm-up to control for startle effects. Then the habituation trials began, and the infant was shown the pattern comprised of abstract colored shapes for 21 trials. The testing session concluded with two dishabituation trials using the checkerboard pattern to test for possible fatigue effects.

After the testing session had ended, the infant's habituation rate was computed using a 50% proportional criterion. Total fixation time to the habituation stimulus on the three consecutive trials had to equal no more than one half of the total fixation time on the three initial habituation trials to infer that habituation had occurred. Equipment limitations did not permit the experimenter to compute the infant's proportional criterion of habituation during the testing session; instead it was decided that infants should be given enough habituation trials to insure that habituation might occur.

Results

Analysis of the follow-up measures began with F max tests to test for differences in within-cell variance. When the F max test was found to be significant, the data were converted to log scores to reduce the within-cell variance. The measures converted to log scores were first fixation time to the habituation stimulus, and mean fixation time on the habituation trials. Analyses of variance were then conducted to compare the three preterm infant groups on the visual task measures. These measures included first fixation time to the warm-up stimulus, first latency to orient to the habituation stimulus, first fixation time to the habituation stimulus, mean fixation time on the habituation trials, mean latency to orient to the habituation stimulus, and trials to criterion. Analyses of variance were also conducted to compare the preterm infant groups on the measures derived from the Bayley Mental and Motor Scales. The analyses of variance of the visual task measures were then repeated on the data for all infant groups simply to compare full-term and preterm infant performance. The fullterm group was not included in the first set of analyses because fullterm infants were not selected while in the hospital nursery, and mothers of fullterm infants significantly differed from mothers of preterm infant groups on level of education. All comparisons following significant main effects were conducted using Scheffé tests. The acceptable level of significance for the Scheffé test was set at .10 as was recommended by Scheffé, because this test is considered to be conservative and might lead to too many Type II errors (Ferguson, 1981, pp. 307–309). Means and standard deviations for the visual task measures are presented in Table 4. The source tables for the analyses of variance comparing the

Table 4

Means and Standard Deviations for Visual Task Measures

Measure		Group			
		RISS	HRS	WWI	FT
First fixation time to warm-up stimulus (sec)	$\bar{X}$	4.67	8.62	5.82	3.30
	s.d.	2.80	4.13	4.64	1.41
First latency to orient to habituation stimulus (sec)	$\bar{X}$	1.17	1.20	1.32	1.10
	s.d.	.25	.30	.26	.32
First fixation time to habituation stimulus (sec)	$\bar{X}$	3.58	7.32	7.85	4.02
	s.d.	1.59	5.82	8.65	2.17
Mean fixation time on habituation trials (sec)	$\bar{X}$	2.32	4.40	5.52	2.70
	s.d.	.71	1.48	3.34	1.63
Mean latency to orient to habituation stimulus (sec)	$\bar{X}$	1.44	1.21	1.61	1.80
	s.d.	.72	.12	1.00	1.05
Trials to criterion	$\bar{X}$	9.5	10.8	12.8	17.6
	s.d.	4.03	6.84	5.25	5.28

three preterm infant groups on the visual task measures can be found in Table 5, while those comparing all four infant groups on these measures can be found in Table 6.

The analysis of the performance of the three preterm groups indicated that the only visual task measure that differentiated the groups was mean fixation time. The analysis of variance of fixation time log scores showed a significant group effect, $F(2, 21) = 7.63$, $p < .01$. Scheffé tests indicated that the RISS group had shorter mean fixation times than the HRS group ($p < .10$) and the WWI group ($p < .01$). These results partially supported the hypothesis that preterm infants in the RISS and HRS groups would show shorter fixation times than infants in the WWI group. In contrast to what was expected, no significant differences were found when the HRS and WWI groups were compared on mean fixation time.

The analyses of variance performed on trials to criterion, first fixation time to the habituation stimulus, first latency to orient and mean latency to orient to the habituation stimulus indicated that no differences existed between preterm infant groups. Thus the predictions that preterm infants in the RISS and HRS groups would take fewer trials to reach criterion, have shorter fixation times on initial trials, and shorter latencies to orient than preterm infants in the WWI group were not supported.

Four one-way analyses of variance were also carried out for the preterm infant groups on the data derived from the Bayley Scales of Infant Development. Means and standard deviations for the MDI, PDI, and age equivalent performance on each scale can be found in Table 7. Table 8 shows the analysis of variance source tables. Analyses of

Table 5

Source Tables for Analyses of Variance of Visual Task

Measures for Preterm Infant Groups

Measure	Source	df	MS	F
First fixation time to warm-up stimulus	Between	2	33.000	2.12
	Within	21	15.500	
First latency to orient to habituation stimulus	Between	2	.045	.60
	Within	21	.074	
First fixation time to habituation stimulus	Between	2	.090	1.15
	Within	21	.800	
Mean fixation time on habituation trials	Between	2	.145	7.63*
	Within	21	.019	
Mean latency to orient to habituation stimulus	Between	2	.005	.50
	Within	21	.010	
Trials to criterion	Between	2	21.500	.66
	Within	21	32.500	

*$p < .01$

Table 6

Source Tables for Analyses of Variance of Visual Task Measures for All Infant Groups

Measure	Source	df	MS	F
First fixation time to warm-up stimulus	Between	3	.160	3.47*
	Within	28	.046	
First latency to orient to habituation stimulus	Between	3	.066	.75
	Within	28	.088	
First fixation time to habituation stimulus	Between	3	.063	.93
	Within	28	.068	
Mean fixation time on habituation trials	Between	3	.140	7.36**
	Within	28	.019	
Mean latency to orient to habituation stimulus	Between	3	.009	.72
	Within	28	.012	
Trials to criterion	Between	3	102.100	3.44*
	Within	28	29.670	

*$p < .05$

**$p < .01$

Table 7

Means and Standard Deviations of Measures derived from the Bayley Scales for Preterm Infant Groups

Measure		Group RISS	HRS	WWI
MDI	$\overline{X}$	99.8	103.3	108.1
	s.d.	18.2	15.8	23.2
PDI	$\overline{X}$	104.2	108.6	117.3
	s.d.	23.3	11.9	20.2
Mental Scale age equivalent (months)	$\overline{X}$	4.0	4.1	4.4
	s.d.	.8	.8	1.1
Motor Scale age equivalent (months)	$\overline{X}$	4.1	4.3	4.6
	s.d.	1.2	.8	.6

Table 8

Analyses of Variance of Measures derived from Bayley Mental and Motor Scales for Preterm Infant Groups

Measure	Source	df	MS	F
MDI	Between	2	141.10	.37
	Within	21	374.68	
PDI	Between	2	334.60	.91
	Within	21	365.40	
Mental Scale Age Equivalent	Between	2	.40	.50
	Within	21	.79	
Motor Scale Age Equivalent	Between	2	.60	.72
	Within	21	.83	

variance of the MDI and PDI scores provided no evidence that groups differed on either the Mental or the Motor Scale. Furthermore, the analyses of variance conducted on the age equivalent scores for the Mental and Motor Scale also failed to demonstrate significant group differences.

The series of one-way analyses of variance that contrasted full-term and preterm performance on the visual task revealed significant group effects only for trials to criterion, mean fixation time, and first fixation to the warm-up stimulus. The analyses of variance conducted on first fixation time to the habituation stimulus, first latency to orient and mean latency to orient failed to show differences between fullterm and preterm infants.

The analysis of variance on trials to criterion indicated a group effect, $F(3, 28) = 3.44$ significant at the .05 level. Scheffé tests showed that the effect was accounted for by the fact that the RISS group took fewer trials to reach criterion than the fullterm group ($p < .05$). Although the fullterm infants' scores on trials to criterion were higher than all preterm infant groups' scores, the difference was only significant in the case of the RISS group. Results also showed that seven out of eight preterm infants in each group reached habituation criterion as opposed to only four out of eight infants in the fullterm sample.

In addition, the one-way analysis of variance conducted on mean fixation time on the habituation trials indicated a significant group effect, $F(3, 28) = 7.36$, $p < .01$. Fullterm infants were shown to be superior only to the WWI group, as was evidenced by the fullterm infants' shorter fixation times ($p < .05$). Scheffé tests indicated that there were no significant differences between the RISS group and fullterm infants, nor between the HRS group and fullterm infants in mean fixation time.

The analysis of variance performed on first fixation time to the warm-up stimulus also showed a significant group effect, $F(3, 28) = 3.47$, $p < .05$. This effect was attributable to the fact that the HRS group had longer first fixation times than the fullterm group ($p < .05$). Neither the RISS nor the WWI group, however, differed from the fullterm group.

To analyse fixation time data further, a two-way repeated measures analysis of variance was performed on trial blocks of fixation time and infant groups to investigate whether fixation time decreased across trial blocks on the habituation phase of the task. Means and standard deviations for each trial block can be found in Appendix D. The analysis of variance source table is shown in Table 9. The analysis of variance indicated that infant groups exerted a significant effect, $F(3, 28) = 4.33$, $p < .05$, and that there was also a significant decrease in fixation time for all infant groups across trial blocks as seen in Figure 1, $F(3, 28) = 7.73$, $p < .01$. No evidence of an interaction was found between infant groups and trial blocks.

To understand the course of habituation, as recommended by Cohen (1976), fixation time data were plotted backwards from habituation criterion for each infant group, using only data for those infants who showed evidence of habituation. This can be seen in Figure 2. Means and standard deviations are shown in Appendix D. In general, 50% or more of infants in each infant group are represented at each data point, except for the fullterm infants on trial -6 where only 38% of the sample is represented. Upon closer examination of Figure 2, it appears that

Table 9

Analysis of Variance of Fixation Time as a Function of Group and Trial Block

Source	df	MS	F
Between subjects			
infant groups (G)	3	.82	4.27*
error	28	.19	
Within subjects			
trial blocks (T)	6	.26	8.05**
T x G	18	.01	.37
error	168	.03	

*$p < .05$

**$p < .01$

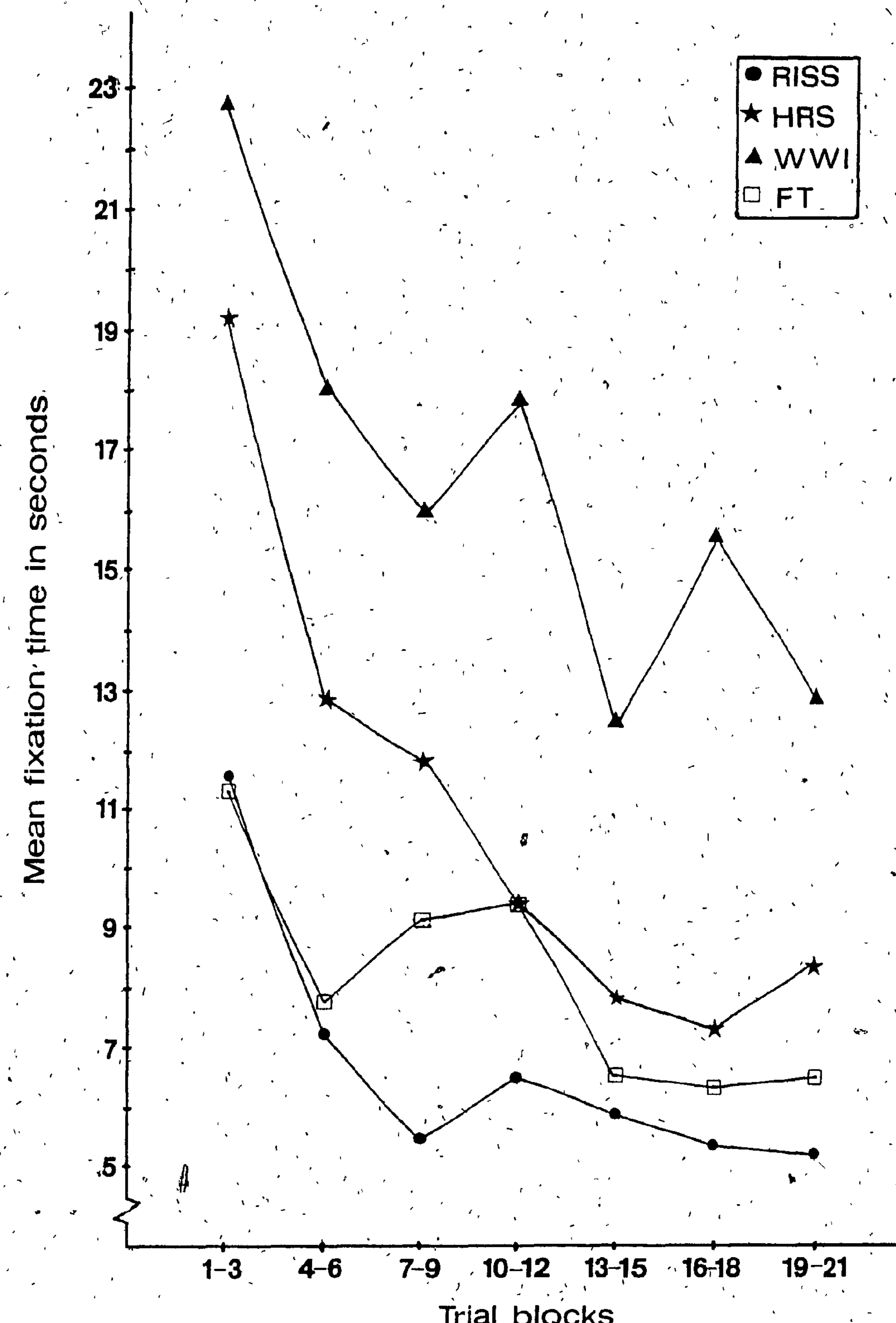

Figure 1. Forward habituation curve showing the decrease in fixation time across trial blocks.

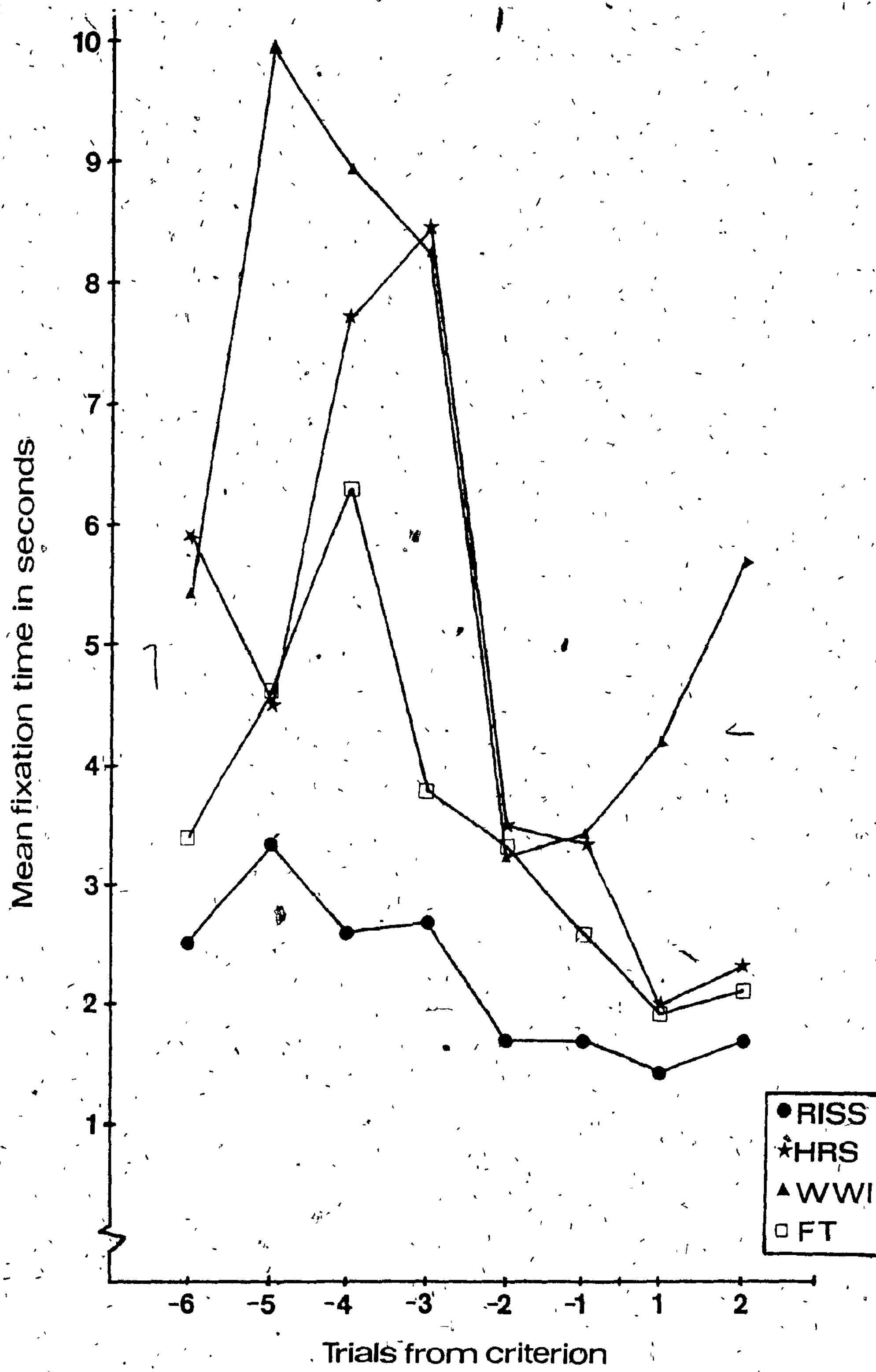

Figure 2. Backward habituation curve for those infants who reached habituation criterion.

habituation does not occur in a gradual fashion. Fixation times increased over one or more trials for all infant groups, and then dropped suddenly on a single trial prior to habituation criterion. In addition, regardless of how long infant groups looked initially, once they did habituate, fixation times tended to remain low through post habituation trials. This decrease in fixation time subsequent to reaching criterion was evident for the RISS, HRS, and fullterm groups, but not for the WWI group.

Two-way analyses of variance were conducted on preterm infant group data to test for a fatigue effect by comparing mean fixation times on the two warm-up trials and the two dishabituation trials, and to test for dishabituation by comparing mean fixation time on habituation trials 20 and 21 to mean fixation time on the two dishabituation trials. Fixation time data were converted to log scores, since the F max test indicated that there were significant differences in within-cell variance. Means and standard deviations for these measures can be found in Table 10. The source table for the analysis of fixation times on warm-up and dishabituation trials is shown in Table 11. The source table for the analysis of variance of scores reflecting dishabituation is shown in Table 12. These analyses were carried out in order to verify that the decrease in fixation time that occurred over the habituation trials did not simply reflect increasing fatigue as the session continued.

The two-way analysis of variance of the three preterm infant groups comparing differences between mean fixation time on warm-up and dishabituation trials showed only a significant group effect, $F(2, 21) = 5.95$, $p < .01$ that reflected the fact that the RISS group had relatively

Table 10

Fixation Time: Means, Standard Deviations for Warm-up Trials, Habituation Trials 20 and 21, and Dishabituation Trials

Measure (log scores)		Group RISS	HRS	WWI	FT
Fixation time on warm-up trials	$\overline{X}$	.65	.91	.70	.60
	s.d.	.17	.21	.21	.16
Fixation time on trials 20 and 21	$\overline{X}$	.38	.54	.65	.46
	s.d.	.09	.16	.22	.17
Fixation time on dishabituation trials	$\overline{X}$	.51	.89	.77	.58
	s.d.	.14	.27	.31	.16

Table 11

Source Table of Analysis of Variance of Preterm Infant Groups' Mean Fixation Times for Warm-up and Dishabituation Trials

Source	df	MS	F
Between subjects			
infant groups (G)	2	.405	5.95*
error	21	.068	
Within subjects			
trials (T)	1	.010	.33
T x G	2	.040	1.33
error	21	.030	

*$p < .01$

Table 12

Source Table of Analysis of Variance of Preterm Infant Groups' Mean Fixation Times for Habituation Trials 20 and 21 and Dishabituation Trials

Source	df	MS	F
Between subjects			
infant groups (G)	2	.385	6.42*
error	21	.060	
Within subjects			
trials (T)	1	.470	16.78**
T x G	2	.065	2.32
error	21	.028	

*$p < .01$

**$p < .001$

shorter fixations on these trials than the HRS group ($\underline{p} < .10$). There was no evidence of a significant difference in fixation time between the warm-up and dishabituation trials, nor any evidence of an interaction between infant groups and trials. This indicated that there was no evidence of fatigue affecting performance at the end of the session in any preterm infant group.

The two-way analysis of variance comparing differences between mean fixation time on habituation trials 20 and 21, and mean fixation time on the two dishabituation trials indicated a significant effect of group, $\underline{F}(2, 21) = 6.42$, $\underline{p} < .01$; again this effect reflected the shorter fixation times of the RISS group on these trials as compared to those of the HRS group ($\underline{p} < .10$).

More importantly, however, the results showed that there was a significant increase in fixation time from habituation trials 20 and 21 to the two dishabituation trials, $\underline{F}(2, 21) = 16.78$, $\underline{p} < .001$. No evidence of an interaction was found between infant groups and trials.

The source table for the analysis of variance of fixation time on warm-up and dishabituation trials that included the fullterm group is shown in Table 13. Results, like those derived from the analysis of preterm infant groups only, indicated a significant group effect, $\underline{F}(3, 28) = 6.0$, $\underline{p} < .01$, again reflecting the RISS group's shorter fixation time compared to that of the HRS group ($\underline{p} < .10$). The fullterm group's fixation time did not differ significantly from those of any other group. There was no evidence of a trial effect, nor of an interaction.

Data derived from the two-way analysis of variance of fullterm and preterm infant groups' mean fixation time on habituation trials

Table 13

Source Table of Analysis of Variance of all Infant Groups' Mean Fixation Times for Warm-up and Dishabituation Trials

Source	df	MS	F
Between subjects			
infant groups (G)	3	.360	6.20*
error	28	.058	
Within subjects			
trials (T)	1	.010	.34
T x G	3	.023	.79
error	28	.029	

*$p < .01$

20 and 21; and dishabituation trials, like those derived from the analysis of preterm infant groups only, indicated that there was a significant increase in fixation time from habituation trials 20 and 21 to dishabituation trials. The source table for the analysis of variance of fixation times on warm-up and dishabituation trials is shown in Table 14. Results indicated that there was a significant group effect, $F(3, 28) = 6.0$, $p < .01$, accounted for by the fact that the RISS group had shorter fixation times than the HRS group ($p < .10$), and of more importance, a trial effect, $F(1, 28) = 25.5$, $p < .001$. There was no evidence of an interaction between infant groups and trials.

Supplementary Correlational Analysis

A supplementary correlational analysis was conducted on data for the total sample of preterm infants (N=26) to investigate how indices of preterm infant functioning at stages of development prior to follow-up related to the visual task measures and to performance on the Bayley Scales of Infant Development. The analysis consisted of computations of Pearson Product-Moment correlations. Because of the number of correlations computed, the acceptable level of significance was set at .02, as it had been for the Elder (1981) study. A multiple regression analysis of the various independent variables on mean fixation time would have been of interest in this study, but because mean fixation time was found to discriminate infant groups on the analysis of variance, the multiple regression analysis would have had to have been carried out within each infant group on a sample size of 8 infants, and the number of independent variables that would have entered the regression analysis would have exceeded the size of the sample.

Data derived from the perinatal variables reflecting preterm

Table 14

Source Table of Analysis of Variance of all Infant Groups' Mean Fixation Times for Habituation Trials 20 and 21, and Dishabituation Trials

Source	df	MS	F
Between subjects			
infant groups (G)	3	.300	6.00*
error	28	.054	
Within subjects			
trials (T)	1	.510	25.50**
T x G	3	.050	2.50
error	28	.026	

*$p < .01$

**$p < .001$

infant state and level of functioning at birth were correlated with the follow-up measures (visual task measures and data derived from the Bayley Scales of Infant Development) to investigate whether variables reflecting risk at birth influence performance on the follow-up tasks as late as 4 months corrected age. The major perinatal variables included birthweight, GA, Respiratory Distress Syndrome (RDS) level, length of hospital stay, and 1-min. Apgar and 5-min. Apgar scores. Intercorrelations of perinatal variables are shown in Appendix E.

The correlations computed between perinatal variables and visual measures revealed that preterm infants who had a longer hospital stay tended to show longer fixation times on the first habituation trial, $\underline{r}(24) = .68$, $\underline{p} < .001$, as did infants with shorter gestational periods, $\underline{r}(24) = -.54$, $\underline{p} < .01$, and infants with lower birthweights, $\underline{r}(24) = -.45$, $\underline{p} < .02$. GA, however, was significantly correlated with birthweight, $\underline{r}(24) = .88$, $\underline{p} < .001$, and with hospital stay, $\underline{r}(24) = -.89$, $\underline{p} < .001$. Because mean fixation time was found to differentiate preterm infant groups on the analysis of variance, mean fixation time data were correlated separately with GA for each preterm infant group using Spearman's Rank-Order correlational method. The results indicated that shorter gestational periods were associated with longer fixation times for the WWI group only, rho(6) = $-.92$, $\underline{p} < .001$. Trials to criterion, latency to orient, and fixation time on the first warm-up trial did not correlate significantly with any of the perinatal variables.

When data for the perinatal variables were correlated with data derived from the Bayley Scales of Infant Development, only one significant relationship was found. Greater severity of RDS was associated with less mature performance on the Bayley Mental Scale,

$\underline{r}(24) = -.43$, $\underline{p} < .02$.

An additional correlational analysis was carried out between items derived on the Brazelton Neonatal Behavioral Assessment Scale (NBAS) administered around the time of the preterm infant's discharge from the hospital, and the follow-up measures. Intercorrelations of the orientation items and response decrement items of the NBAS are shown in Appendix E. The purpose was to investigate whether performance on orientation items of the NBAS which include an orientation component to animate and inanimate visual stimuli, and performance on the response decrement items of the NBAS which reflects the infant's capacity for habituation were related to the visual task measures and to performance on the Bayley Scales of Infant Development. The results indicated that better performance on the response decrement item of the NBAS reflecting habituation to the light was related to longer first latencies to orient, $\underline{r}(24) = .43$, $\underline{p} < .02$. In addition, faster habituation to the pinprick was associated with longer latencies to orient on the first habituation trial, $\underline{r}(24) = .52$, $\underline{p} < .01$, and longer mean latencies to orient, $\underline{r}(24) = .44$, $\underline{p} < .02$. The habituation items of the NBAS did not significantly correlate with trials to criterion or with fixation time measures. In contrast, superior ability to orient to the examiner's face on the NBAS was associated with shorter fixation times on the first habituation trial, $\underline{r}(24) = -.49$, $\underline{p} < .01$. Mean fixation time and trials to criterion were not found to be related to orientation to the examiner's face on the NBAS. When scores on the orientation items of the NBAS were correlated with scores on the Bayley Scales of Infant Development, the NBAS item reflecting orientation to the examiner's face as she talked to the infant was found to be related to age equivalent performance on the Mental Scale, $r(24) = -.47$, $p < .01$; better performance on the orientation item was associated with less mature Mental Scale performance.

The last correlational analysis to be carried out was between selected measures taken in the infant's first month at home and the follow-up measures. These measures either reflected growth during the period the home programme was administered or functioning at the conclusion of the programme as reflected in home observations of visual alertness and drowsiness during the last home visit. The purpose of including the visual alertness and drowsiness measures was to determine whether any of the home programme measures affected by the stimulation were in any way related to later performance on the follow-up tasks. There was a special interest in determining whether weight gain during the first month at home was related to the follow-up measures, since Elder (1981) found evidence of a relationship between weight gain in the first month at home and days in hospital with her larger sample. For the follow-up sample the correlation between weight gain in the first month at home and days in hospital was, $r(24) = -.52$, $p < .01$.

In the correlations computed between the home programme measures and the 4-month follow-up measures, no significant correlations were found. One weak relationship emerged. The correlation between weight gain and first fixation time to the habituation stimulus was $r(24) = -.39$, $p < .05$. This correlation, however, failed to reach the predetermined level of significance. Trials to criterion, mean fixation time, and mean latency to orient also failed to correlate significantly with the home programme measures. Moreover, no evidence of significant correlations were found between the scores on the Bayley Scales of Infant Development and the home programme measures.

Other correlations were computed to examine the relationship between performance on the visual habituation task and measures of infant development derived from the Bayley Scales. Intercorrelations of the visual task measures are shown in Appendix E. No significant correlations were found. Evidence of a weak relationship, which did not reach the predetermined acceptable level of significance was found between trials to criterion and the Bayley measures. A greater number of trials to reach habituation criterion tended to be associated with better performance on the Mental Scale, $r(24) = .41$, $p < .05$, better performance on the Motor Scale, $r(24) = .38$, $p < .05$, better age equivalent performance on the Mental Scale, $r(24) = .43$, $p < .05$, and better age equivalent performance on the Motor Scale, $r(24) = .38$, $p < .05$. No evidence was found of any kind of relationship between performance on the other visual task measures (first fixation time on the warm-up stimulus, first fixation time on the habituation stimulus, mean fixation time, and latency to orient) and scores derived from the Bayley Scales of Infant Development.

Discussion

The present study showed that on a visual attention task, preterm infants in the RISS group performed better than infants in the HRS group, and better than infants in the control group (WWI group) on mean fixation time only. When performance of the RISS group was contrasted to that of the fullterm group, the RISS group was found to perform better than fullterms on trials to criterion, and, as well as fullterms on mean fixation time. The results provided some evidence that early sensori-motor stimulation programmes like the RISS programme can compensate to some extent for prematurity, and can contribute to the enhancement of visual attention at 4 months corrected age. These results also suggest that differences between preterm infant groups are subtle, and can only be detected on more sensitive cognitive tasks, such as the visual habituation task, since no differences between preterm infant groups were found on the Bayley Scales of Infant Development. In view of these findings, it might be argued that the Bayley Scales, although widely used, are not an appropriate research tool to use with this population of infants, since the scales appear to be insensitive to subtle differences in cognitive performance, at least at this age.

Although these results demonstrated that the RISS group was affected by early intervention, the meaning of this effect remains unclear. It is difficult to isolate the components of this programme that were responsible for the effect seen on visual attention performance, since preterm infants in the RISS group not only received the components specific to the programme, but may have received more stimulation than preterm infants in the HRS group. Although differences in level of compliance in different home programmes were not found to be significant, Elder (1981) indicated that there appeared to be a higher level of maternal compliance in the RISS programme than in other programmes, thus suggesting that infants in the RISS programme may have received more stimulation than infants in other programmes. Consequently, it is difficult to verify whether it was the handling, level of compliance, or the massaging per se that accounted for the effect seen on visual attention performance of the RISS group. These findings, however, support those reported earlier by Rose (1980), who found that preterm infants who had received sensori-motor stimulation similar to the RISS at an earlier age (in the hospital) performed at a level that was indistinguishable from that of fullterm infants on a visual recognition memory task administered at 6 months corrected age. In view of the practical significance of these findings, further investigation will be conducted to determine whether the effects of the RISS programme are maintained at 8 months corrected age.

Another finding of this study which supported previous findings reported by Sigman et al. (1977) and Rose (1980) was that preterm infants who did not receive sensori-motor stimulation showed evidence of a cognitive impairment on the visual habituation task. Preterm infants in the WWI group had longer mean fixation times than infants in the RISS group, and than fullterm infants. In addition, correlational analyses indicated that visual habituation performance was negatively affected by prematurity. The results showed that longer fixation times to the habituation stimulus were associated with very short gestational periods, lower birthweight, and longer hospital stay, with shorter GA's being the best predictor of longer fixation times. These findings supported the interpretation that longer fixation time is a more immature response, and as Sigman et al. (1977) pointed out, could either be attributed to the preterm infant's failure to inhibit or modulate fixation responses, or to slower information-processing abilities. The results of this study, as well as those reported by Rose (1980) suggest that preterm infants who fail to receive sensori-motor stimulation are at greater risk for future cognitive impairment than preterm infants who do receive such intervention.

Another purpose of this study was to verify whether or not trials to criterion is a more sensitive index of cognitive functioning than more commonly used measures such as mean fixation time. The results indicated that mean fixation time was a more meaningful measure since it was the only measure sensitive to differences between preterm infant groups. In addition, it differentiated preterm infant groups' performance from that of fullterm infants, and was shown to relate to measures reflecting preterm infant functioning at birth. Trials to criterion, in contrast, only differentiated preterm infant groups in relation to fullterm infants, and was not related to any measure of preterm infant functioning at birth, or at the time of hospital discharge, or at the end of the home programmes.

The findings that fixation time is a more sensitive index of cognitive functioning are consistent with those of Cohen (1981). Using the same paradigm, Cohen found that total fixation time, but not trials to criterion, differentiated Down's Syndrome infants' performance from that of fullterm infants at 19, 23, and 28 weeks chronological age, in that, at all ages, Down's Syndrome infants had longer fixation times than their normal controls. In a second experiment, Cohen (1981) found that trials to criterion failed to distinguish performance of lower-class preterm infants who had suffered severe perinatal trauma from performance of lower-class fullterm infants at 20, 33, and 44 weeks corrected age.

The results of the present study, like those of Cohen (1981), call into question the use of trials to criterion as a sensitive index of cognitive functioning with a population of high risk infants. One explanation for the failure of the trials to criterion measure to differentiate preterm groups' performance might be that the measure is solely based on the infant's initial response rate, and fails to take into account individual infants' fluctuations in fixation time on subsequent habituation trials. Some infants might have reached habituation criterion as a result of a steady decrease in fixation time, while others might have reached habituation criterion as a result of more abrupt fluctuations in fixation time. Differences between preterm infant groups seem to stem from variations in fixation time rather than variations in number of trials to reach criterion; this suggests that a criterion sensitive to fluctuations in fixation time over trials might be a more sensitive criterion than one that is solely based on infants' initial response rate. More research, however, is needed to determine how measures of fixation time fluctuation can be used as a criterion of habituation.

Although trials to criterion was shown to be insensitive to differences between preterm infant groups, one cannot argue that there was no evidence of habituation. Results from the analyses of variance of fixation time on warm-up and dishabituation trials showed that the decrease in fixation time could not be accounted for by fatigue effects.

The question that remains is what the trials to habituation criterion measure reflects.

The most intriguing findings of this study arose from the comparisons of preterm infant groups and fullterm infants on trials to criterion and mean fixation time. Results showed that only 50% of fullterm infants, in contrast to 88% of preterm infants in each group, reached habituation criterion. It appears that there was very little evidence for the superior performance of the fullterm group in relation to the RISS group, since fullterm infants took more trials to criterion than the RISS group, and did not significantly differ from the RISS group on mean fixation time, although as of trial blocks 7-9 fixation time of fullterm infants appeared to be longer than those of the RISS group. Furthermore, fullterm infants did not differ from infants in the HRS group on trials to criterion, or on mean fixation time. Fullterm infants' superior performance was demonstrated only when their mean fixation times were compared to those of preterm infants in the WWI group. The results indicated that fullterm infants had shorter fixation times than the WWI group only. Fullterm infants, however, did not significantly differ from the WWI group on trials to criterion. These findings taken altogether cannot be readily explained, but seem to indicate that fullterm infants might have experienced more difficulty in getting involved in the task than the preterm groups. One hypothesis that needs to be validated is that fullterm infants took longer to process information as of trial blocks 7-9 because they were less aroused by the task, and consequently took more trials to get involved because they looked at the stimulus without remembering it. This could have made their fixation times more comparable to those of the RISS and HRS groups. It could be postulated that fullterm infants' fixation times would have been shorter than those of the RISS and HRS groups had they performed at a more optimal level. Nevertheless, it can still be argued that even at this non-optimal level of performance, fullterm infants still performed better than infants who did not receive sensori-motor stimulation.

It might also be that the fullterm infants selected for study were not representative of the same infant population, and did not represent an adequate control group for the preterm infants. Fullterm infants in the present study were not selected at birth as were preterm infants, and mothers of fullterm infants clearly differed from mothers of preterm infants in level of education. Mothers of preterm infants received on the average 12 years of education whereas mothers of fullterm infants had a mean level of education of 16.1 years. Maternal level of education of mothers of fullterm infants might have influenced the quality of care they gave to their infants, as mothers with a higher level of education are thought to be more aware of their infant's needs than mothers who have received less education. It could be that fullterm infants might have received large amounts of maternal stimulation which could have affected their interest in the visual habituation task.

Results of the present study suggest that the visual habituation paradigm does appear to be the most sensitive of all the visual attention tasks, and seems to be a useful screening device to detect subtle cognitive differences, especially with this population of preterm infants who receive the highest quality of medical care, and who show only subtle evidence of impairment on cognitive tasks, which are not readily detected on more global tests such as the Bayley Scales.

Although the paradigm is sensitive, recent evidence has shown that the processes governing habituation remain unclear. Cohen and Menten (1981) showed that contrary to what was previously believed, habituation cannot be described in terms of an exponential decreasing process nor by an all-or-none phenomenon. It appears that the processes involved in habituation are more complex than previously believed, and might not only involve attention and encoding, but short-term and long-term memory (Cohen & Gelber, 1975). There is no doubt that simple models of infant memory are inadequate, and that more research is needed to determine what causes the decrease in fixation time, and how infants make use of various information-processing strategies to reach habituation.

Even though infant memory involves various stages of information-processing, it seems as if even at the initial stages of information-processing, preterm infants show evidence of a cognitive impairment, in that they take longer to process information about an unchanging stimulus on each trial than fullterm infants. This suggests that preterm infants suffer from an impairment at the encoding stage of information-processing. One possible research strategy would be to test whether preterm infants as compared to fullterm infants also suffer from impairments at later stages of information-processing. One way of investigating this would be to introduce a delay task at the initial phase of habituation, while giving preterm infants ample opportunity to look on each trial (as in the Cohen paradigm), and verify whether or not the delay task interferes with encoding (by possibly rendering fixation times longer on each trial), and with short-term memory (by possibly producing forgetting, making infants take more trials to store information about the stimulus). This research strategy would permit one to verify the extent of preterm infants' cognitive impairments.

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Appendix A

Summary of Training and Home Visit Procedures

Instructions to Mothers

Appendix A

Summary of Training and Home Visit Procedures

Training began within 72 hours of the infant's discharge from the hospital nursery. Mothers in all groups were instructed in the programme to which their infants had been assigned by the same trainer. The initial training took place in the course of two home visits on two consecutive days for the RISS and HRS groups, and during one home visit for the maternal attention group. On the next day, the home visitor (Elder), who like the trainer had been trained by Rice in her copyright programme, paid the first of 5 visits. Subsequent visits took place at weekly intervals for the purposes of weighing the infant, observing infant and maternal behaviors, and in the RISS and HRS groups, observing and correcting the mother's administration of the stimulation programme. Observations were made for a total of 8 minutes. The first 5 minutes was structured in such a way to arouse the infant and elicit irritability: infants were observed for 1 minute and held by the mother; 1 minute being undressed by the mother; 1 minute nude on the visitor's lap; 1 minute being weighed, nude on the scale; and 1 additional minute on the scale with a tissue paper held over the eyes to elicit a defensive reflex. The mother was then asked to take the infant and the behaviors of both were recorded for the next three minutes.

Appendix A

Instructions to Mothers

(reproduced from Elder, 1981)

The instructions to all experimental mothers were as follows: "The purpose of the programme of which you are a part is to provide your baby with extra sensory stimulation in a variety of areas — touch, visual, auditory and vestibular (movement). Research has shown that these types of stimulation can be beneficial to babies.

"The programme has two parts: the first part provides the tactile stimulation, and the second, through rocking, provides the vestibular, or movement stimulation. Both sections will provide visual and auditory stimulation, as, while your baby is lying on his back on your lap, and while you are rocking him in your arms, you should look in his eyes, say his name, and talk to him in any way that you find comfortable."

Mothers of the infants in the RISS group then received the following instructions: "Unwrap your baby. Place a lightweight blanket under him and have a diaper handy. Lie him on your lap while you sit in a comfortable chair. You and your baby should be in a face to face position while the baby is on his back. Make sure that your fingernails are short and have no rough edges. Each stroke is to be repeated three times. Continue stroking, even if the baby goes to sleep.

"Using the entire palm surface of your hands, stroke from the top of the head down to the chin. Using two fingertips of both your hands, stroke from the centre of the forehead out to the temples. Using one fingertip of each hand, stroke around the eyes, pressing a little more firmly on the inside of the bridge of the nose. With two fingertips of each hand, stroke from the bridge of the nose over the cheeks and over the ears. With one fingertip stroke around the mouth. Lifting the baby's head with one hand and tilting it back slightly, with two fingertips of the other hand, stroke the chin and down the throat. With one hand still supporting the baby's head, use the other hand to stroke the baby's head, starting at the forehead and stroking to the nape of the neck. If the baby has a lot of hair, stroking the hair might pull it. In such a case, put your fingers under the hair and stroke the scalp.

"Raise the baby's arm with one hand, and with a circular motion, massage the entire arm. Press firmly on the palm of the baby's hand with your thumb. Repeat this procedure on the baby's other arm. Using your entire palm surface, stroke from the neck down over the baby's chest, abdomen and genitals in one gliding movement. Then, with two fingertips, stroke the midline from chin to genitals. Lift one of the baby's legs with one hand, and with the other, encircle the leg and with a rotating motion, massage the leg and press firmly on the sole of the foot with your thumb. Repeat this procedure for the other leg. Gently turn the baby over on his stomach and massage his scalp again, spreading your fingers so that you cover as much of the skin surface as possible, stroking from the forehead to the nape of the neck. Then, using your entire palm surfaces, stroke from the nape of the neck, down the back and over the buttocks. With two fingertips, massage the entire spine in a circular motion over the spinal bones. Lift one of the baby's legs, and with the other hand massage the entire leg in a circular movement, finishing by pressing your thumb firmly on the sole of the foot. Repeat the procedure on the other leg.

"Remember that each movement must be repeated three times. Each time the movement changes, be sure to change the position of only one hand at a time, so the baby is never out of contact with you, always being touched by at least one of your hands. While the baby is on his back, remember to look in his eyes, say his name, and talk to him. The massage section of the programme should take 10 minutes to perform. If you find it takes less time, you may repeat it."

Mothers of infants in the HRS experimental group were given the following instructions: "Unwrap your baby. Place a lightweight blanket under him, and have a diaper handy. Lie him on your lap while you sit in a comfortable chair. You and your baby should be in a face to face position while the baby is on his back. Make sure your fingernails are short and have no rough edges. Continue, even if your baby goes to sleep. Place your hands on your baby's body, and gently rub, pat or stroke him, in any way that seems pleasurable to both of you. After $2^1/2$ minutes, turn him over on to his front, and repeat the procedure on his back. After $2^1/2$ more minutes return him to lying on his back, and continue to pat or stroke him, and finally, turn him back to lying on his tummy. In all, he should be patted, rubbed and stroked for 10 minutes. Be sure to change the position of only one hand at a time, so that the baby is never out of contact with you, always being touched by at least one of your hands. While the baby is on his back, remember to look in his eyes, say his name, and talk to him in any way that is comfortable for you."

Mothers in both experimental groups were given the following instructions for the rocking part of the programme: "The second part of the treatment consists of rocking your baby for 5 minutes. Rocking supplies vestibular stimulation, and continues to supply visual and auditory stimulation. Wrap your baby snugly in his blanket, hold him closely in your arms and rock him briskly back and forth. You may continue to sit, or you may walk about with him, whichever appears more comfortable to you. Continue to look in his eyes and talk to him. Keep doing this for 5 minutes."

Mothers of infants in the WWI control group were given the following instructions: "Sometimes mothers of new babies are so busy that they do not take time to enjoy them. Will you take four 10-minute periods a day, when you are not dressing, feeding or bathing your baby, to sit and relax with him (or her)?"

Appendix B

Source Tables for Analyses of Variance of

Infant and Maternal Characteristics

Table A

Source Tables for Analyses of Variance of

Infant Characteristics

Variable	Source	df	MS	F
Birthweight	Between subjects	2	173,572.00	.60
	Within subjects	21	286,450.30	
GA	Between subjects	2	2.00	.20
	Within subjects	21	9.90	
Days in hospital	Between subjects	2	635.50	.59
	Within subjects	21	1,066.00	
Chronological age at visual test	Between subjects	2	.23	.34
	Within subjects	21	.66	

Table B

Kruskal-Wallis *H* Values for Analyses of Variance

by Ranks of Infant Characteristics

Variable	*df*	*H*	*p*
1-min. Apgar score	2	.27	n.s.
5-min. Apgar score	2	.06	n.s.
RDS rating	2	.03	n.s.

Table C

Source Tables for Analyses of Variance of

Selected Maternal Characteristics

Variable	Source	df	MS	F
Maternal age	Between subjects	2	4.15	.14
	Within subjects	21	30.60	
Maternal education	Between subjects	2	11.10	1.51
	Within subjects	21	7.34	

Appendix C

Diagram of Viewing Panel Drawn to Scale and of Visual Testing Apparatus Showing Positions of the Mother, Infant, and Observers

1. Shielded light on stimulus
2. Mirror
3. Blinking light
4. O_1 peephole
5. O_2 peephole

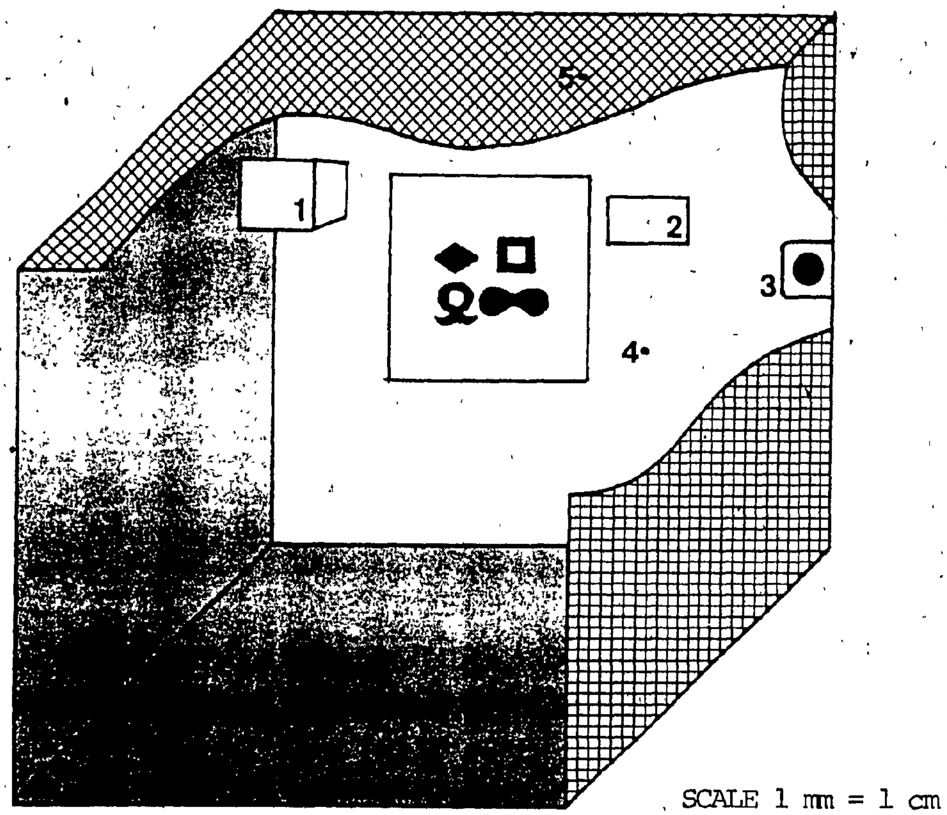
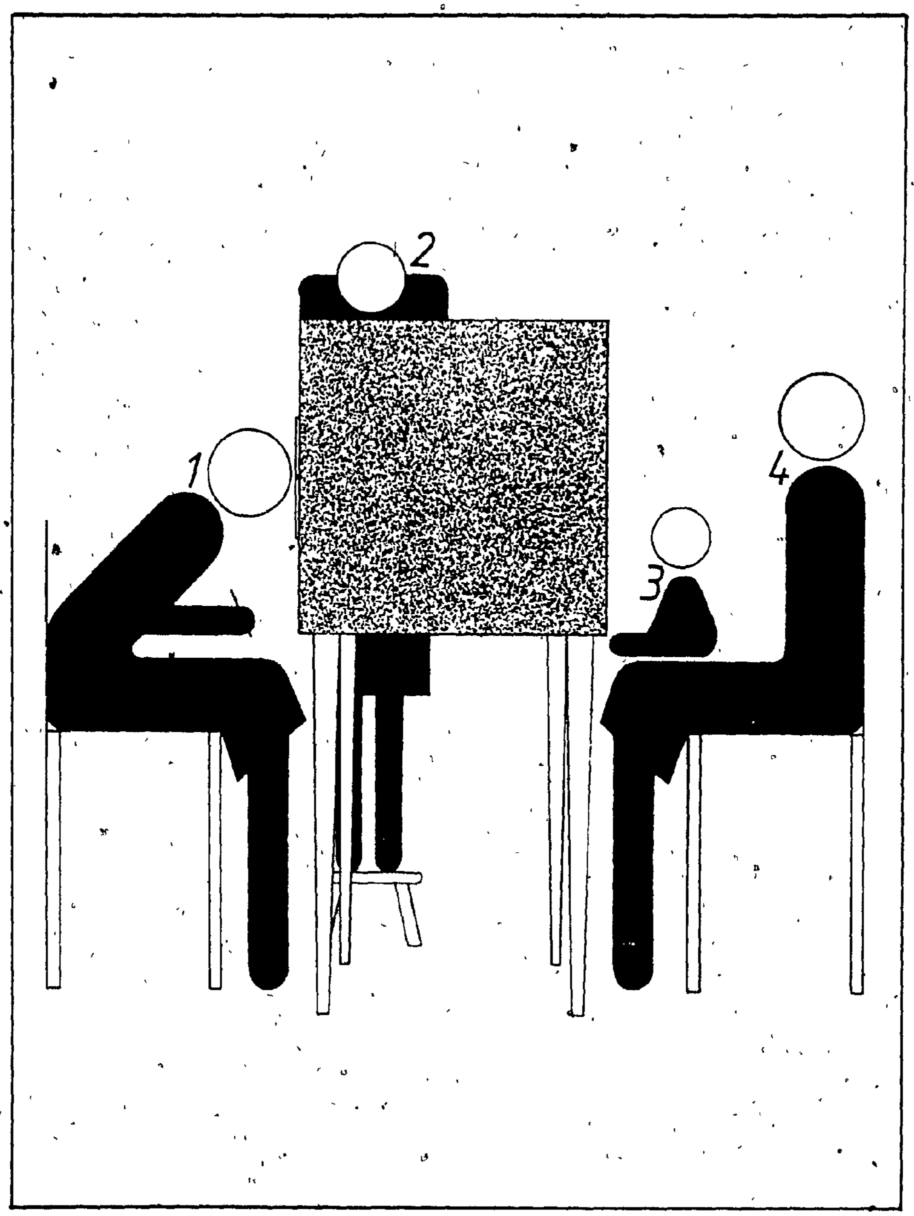


Diagram of visual habituation apparatus drawn to scale



1:Observer 1
2:Observer 2
3:Infant
4:Mother

Schematic representation of visual habituation apparatus showing the positions of the observers, the infant, and the mother.

Appendix D

Group Means and Standard Deviations for Fixation Time Data

Table A

Fixation Time: Means and Standard Deviations For

Trial Blocks in Seconds

Trials		Group RISS	HRS	WWI	FT
1-3	$\bar{X}$	11.6	19.2	22.7	11.4
	s.d.	5.13	9.51	11.5	9.13
4-6	$\bar{X}$	7.3	12.9	18.0	7.8
	s.d.	3.27	7.81	12.6	3.8
7-9	$\bar{X}$	5.5	11.8	10.6	9.1
	s.d.	2.0	9.58	14.4	5.86
10-12	$\bar{X}$	6.5	9.4	17.9	9.45
	s.d.	4.37	3.87	10.5	5.28
13-15	$\bar{X}$	5.9	7.9	12.5	6.5
	s.d.	3.29	3.07	7.6	2.28
16-18	$\bar{X}$	5.4	7.3	15.6	6.3
	s.d.	1.53	3.11	19.0	2.9
19-21	$\bar{X}$	5.2	8.32	12.9	6.5
	s.d.	2.27	3.58	11.8	4.0

Table B

Fixation Time: Means and Standard Deviations for Trials from Criterion in Seconds

Trials from Criterion		RISS	HRS	WWI	FT
		Group			
-6	$\overline{X}$	2.53	5.90	6.45	3.40
	s.d.	1.17	4.09	2.59	1.20
-5	$\overline{X}$	3.30	4.48	9.88	4.65
	s.d.	1.69	.62	5.41	2.40
-4	$\overline{X}$	2.57	7.72	8.97	6.35
	s.d.	.82	7.76	9.16	7.16
-3	$\overline{X}$	2.69	8.37	8.22	3.80
	s.d.	1.15	5.98	5.47	2.12
-2	$\overline{X}$	1.72	3.51	3.20	3.30
	s.d.	.60	1.74	1.46	1.46
-1	$\overline{X}$	1.68	3.31	3.37	2.65
	s.d.	.79	2.60	2.02	1.64
+1	$\overline{X}$	1.44	2.0	4.17	1.90
	s.d.	.65	.47	2.41	.96
+2	$\overline{X}$	1.68	2.33	5.68	2.10
	s.d.	.41	.68	5.41	1.28

Appendix E

Intercorrelations for the Perinatal Variables, the NBAS Response Decrement and Orientation Items, and the Visual Task Measures

Table A

Intercorrelations of Perinatal Variables

	Birthweight	RDS	1-min. Apgar	5-min. Apgar	Days in hospital
GA	.89****	-.48**	.41*	.48**	-.89****
Birthweight		-.37	.32	.45**	-.85****
RDS			-.45**	-.44*	.56***
1-min. Apgar				.77****	-.33
5-min. Apgar					-.43*

*$p < .05$
**$p < .02$
***$p < .01$
****$p < .001$

Table B

Intercorrelations of Orientation Items of the NBAS

	Inanimate Visual	Animate Auditory	Animate Visual	Animate Auditory-Visual
Inanimate Auditory	.46**	.43*	.65****	.59****
Inanimate Visual		.39*	.54***	.53***
Animate Auditory			.43*	.54***
Animate Visual				.88****

*$p < .05$
**$p < .02$
***$p < .01$
****$p < .001$

Table C

Intercorrelations of Response Decrement Items of the NBAS

	Rattle	Bell	Pinprick
Light	.23	.37	.50*
Rattle		.54*	-.12
Bell			.15

*$p < .01$

Table D

Intercorrelations of Visual Task Measures

	First latency to orient to hab. stim.	First FT to hab. stim.	X FT on hab. trials	X latency to orient to hab. stim.	Trials to criterion
First FT to warm-up stim.	.17	.33	.48**	.02	.39*
First latency to orient to hab. stim.		.09	.05	.28	.15
First FT to hab. stim.			.72***	-.18	-.18
X FT on hab. trials				-.18	.12
X latency to orient to hab. stim.					-.16

*$p < .05$
**$p < .02$
***$p < .001$