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Developmental Process and Outcome in Preterm Children:

A Transactional Study

by

HEATHER CARMICHAEL-OLSON

A thesis submitted in partial fulfillment
of the requirements for the degree of

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Doctoral Dissertation

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Abstract

DEVELOPMENTAL PROCESS AND OUTCOME IN PRETERM CHILDREN:
A TRANSACTIONAL STUDY

by Heather Carmichael-Olson

Chairperson of the Supervisory Committee:
Associate Professor Mark T. Greenberg
Department of Psychology

Data were gathered on 38 low and very low birthweight preterm and 45 matched fullterm mother-child pairs at five timepoints during infancy, and at four years. Age was corrected for prematurity in infancy, but not at age four. Information was gathered on: biological risk factors; child developmental outcome; family psychosocial function; and mother-child interaction. A multidimensional assessment of social outcome at age four included the "Waiting Task," especially designed to measure social behavior from the perspective of attachment theory.

This study sought to: (1) examine developmental outcome differences between preterms and fullterms at age four; (2) use a transactional approach to the study of development to understand preterm-fullterm differences in the developmental process, over the first four years of life; and (3) describe and predict four-year child social outcome.

Compared to fullterms, preterms showed a specific "academic" deficit in nonverbal cognition and visuomotor skill. They also showed a cluster of temperamental problems and less optimal parental behavior ratings, while male preterms saw themselves as less accepted by their

peers. Notably, the individual preterm child had more chance of significant delay than did his/her fullterm counterpart.

Biological factors were not very useful among these relatively healthy preterms as sole predictors of four-year outcome. However, smallness for gestational age was associated with poorer "academic" scores and maleness with less social skill.

As suggested by a transactional framework, better prediction of four-year social outcome (in preterms and fullterms) was achieved with knowledge of environmental as well as biological data. Different sets of variables predicted outcome in the two groups, and suggested a stronger impact of familial influences on preterm outcome. There was no support for the often-hypothesized "double whammy" effect, since low SES preterms did not perform more poorly than other groups.

Data analysis yielded five social behavior factors at age four, including parent, child and observer viewpoints. Combinations of early biological and environmental data predicted parental views. 12-month security of attachment predicted the child's own view of social acceptance, as well as observed "Waiting Task" behavior.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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DEDICATION

This dissertation is dedicated to my mother and father, and to their parents before them, who believed so strongly in the value of education.

INTRODUCTION

Over recent years, there has been a striking increase in the survival rate of premature infants, especially the smaller babies. In fact, during the 1980's, about 81% of low birthweight neonates are predicted to survive (Bennett, 1984).

But this dramatic drop in mortality is not without consequences for the surviving preterm infant. A premature birth stresses the family, affecting the parent-child relationship. Unhappily, the child's developmental progress is sometimes affected. Over the years, developmental sequelae have changed with improvements in medical techniques. Yet major handicaps, such as cerebral palsy, mental retardation, or sensory difficulties, still occur in about 20% of babies weighing less than 1500g at birth, and 10% of those below 2500g. Minor handicaps continue to be seen in an additional 15 to 25% of the smaller preterm children. Such handicaps include communication disorders, borderline intelligence, and small but persistent neuromotor abnormalities. These children also show behavioral differences, though not much is known about preterm social behavior after infancy. Bennett (1984) states firmly that these minor problems place low birthweight survivors at an increased risk for school dysfunction.

It is important to understand the developmental, family, and school difficulties in the growing population of premature children. Given the evolution of medical practices, there must be a continued, and careful, charting of developmental outcome among preterm children and their families. But there must also be research on the developmental course of the preterm, compared to the fullterm norm. Understanding the preterm developmental process will enable more accurate prediction of outcome and, ultimately, provide a basis for remediation.

The present study provides information on developmental process and outcome in preterms, as a fourth year followup in the "Mother-Infant Project:" a longitudinal comparative study of low and very low birthweight (less than 1800g) preterm and fullterm children. The present study has three main purposes. First, preterm/fullterm group differences in developmental outcome are examined at age four. Second, to generate a detailed picture of preterm social outcome, early childhood social behavior is carefully studied. Third, the developmental course of the preterm and fullterm groups are compared. Note that tracing the developmental process provides data useful to the field of prematurity, but at the same time fulfills a broader goal. The present research uses a "transactional" framework in the study of preterm development. Thus, it explores the value, and the methodological difficulties, of the relatively new transactional approach to conceptualizing development.

To set a context for these data, this paper first discusses the transactional framework for understanding the developmental process. Next is a review of recent literature in prematurity, focusing mainly on very low birthweight premature children born since 1975. Products of the most recent medical techniques, this cohort of preterms is now moving though early childhood and on to school. Following the review is a general model for understanding preterm outcome, and specific study hypotheses. The methodology and findings of the fourth year phase of the Mother-Infant Project are then presented. Finally, these findings are discussed as a contribution to the overall picture of prematurity, and to the study of social development.

A Transactional Framework for the Study of Development

Developmental outcome in high-risk children can be partially understood when a single biological or environmental factor is known, such as the presence of respiratory distress syndrome (Field, 1980). But the course of development is thought to be most completely explained as a transactional process, marked by continual interplay between a changing organism and a changing environment (Sameroff & Chandler, 1975; Sameroff, 1982; Sameroff & Seifer, 1983).

A transactional framework suggests that the developmental process is best represented as a complex feedback system, in which characteristics of the child and the environment reciprocally affect each other over time. Such a complex system would not only show direct causal relationships between variables across development, but would also be characterized by a network of indirect paths of influence. According to the theory, development might appear discontinuous, unless captured in inherently transactional variables (Beckwith, 1983b). A transactional approach also suggests that the developmental process is dynamic, evolving over time, with different developmental factors asserting their importance at different points in time, depending upon the sample under study. Dynamic variables should better predict outcome than static measures. Stable developmental influences should show the most enduring consequences, depending of course upon the child-environment interplay.

A novel focus in the transactional framework involves the mutual influence between child and environment. Another unique idea is the notion of "self-righting," adopted from theories of embryology, suggesting that the developmental process is characterized by a tendency to correct for influences which pull a developing organism off course (McCall, 1981; Sameroff, 1982). Self-righting influences act to compensate for problems or protect the organism. The mechanisms by which self-righting occurs are partially found in the maturational process, and individual action, of the organism. Thus, developmental breakdown might occur if there were a malfunction, probably continuous, which prevented the child from responding adaptively, or self-organizing. However, Sameroff (1982) notes that the most pervasive self-righting influences can be identified from study of the environment.

This transactional framework can be used to understand the developmental process and outcome of the preterm child. With this point in mind, a review of the recent literature on prematurity is presented next. This review begins with several important remarks on the study of preterm children.

Comments on the Study of Prematurity

To evaluate the literature in the field of prematurity, it is necessary to understand the diversity of the preterm population. Preterm children are generally defined on the basis of low birthweight (less than 2500g) and a gestational age of less than 38 weeks. But this definition is not universally used, and even premature children defined in this way do not comprise a homogenous group.

Over the past 40 years, perinatal and neonatal medical practices have changed dramatically, and cohorts of preterm children differ due to variations in the success and sequelae of their early medical treatments (Bennett, 1984; Kitchen, et al., 1982). Even within the same cohort, preterm children differ in many ways, both biological and environmental. They can experience a variety of illnesses, and a range of neurological dysfunction. They can vary in birthweight, falling into three categories: infants weighing less than 1000g or extremely low birthweight (ELBW); those between 1000g and 1500g or very low birthweight (VLBW); and those from 1500g to 2500g or low birthweight (LBW). Preterms can differ in gestational age and severity of intrauterine problems. Finally, premature children can vary demographically, coming from all social classes, ethnic groups, family sizes, and from mothers throughout the childbearing age range.

Given such complexity, Hunt (1981) notes that the definitive study of prematurity cannot be done. Instead, there must be a thoughtful compilation of numerous studies, each providing a small part of the overall, evolving picture. With these comments in mind, this paper begins by reviewing the body of data describing the early biological and environmental status of the preterm infant, highlighting variables predictive of later outcome.

Early Biological Status of Preterm Infants

At birth, preterms are less mature, with a smaller body size and a less well-developed musculature and brain than a fullterm baby (Holmes, Nagy, Slaymaker, Sosnowski, Prinz & Pasternak, 1982). Preterm infants also show early behavioral differences from fullterms, which may constitute a delay, deficit or combination of the two.

A rapidly growing body of data suggests that premature infants have difficulties processing information, which may underlie later developmental problems. Compared to fullterms, premature babies have shown inferior auditory and visual orienting at term age (Ferrari, Grosoli, Fontana & Cavazutti, 1983), as well as difficulties in visual recognition memory through 12 months (Rose, 1983b; Gekoski, Fagen & Pearlman, 1984). Significantly, preterm infants have also proven visually less responsive to social stimuli than are fullterms during the early months of life (Masi & Scott, 1983). High-risk preterm babies, those with illness or neurobehavioral problems, have also shown deficits through six months of age in audio-visual integration, an intersensory skill (Lawson, Ruff, McCarton-Daum, Kurtzberg & Vaughan, 1984). In addition, preterms are less responsive to tactile stimulation (Rose, 1983a).

Transient dystonia, a pattern of abnormal neuromotor signs which may presage later brain disorganization, has been observed in many preterms (more than 50% of VLBW infants) during their first year of life (Bennett, 1984). Several studies suggest that preterms, generally tested at term age, have difficulties with regulation of the autonomic nervous system (ANS), integration of the autonomic and motor systems, and regulation of behavioral state (Ferrari et al., 1983; Leijon, 1982; Rose, 1983a). Compatible with these findings, there is some evidence, discussed in detail later in this paper, that preterm infants have temperamental difficulties compared to fullterms (Field, 1980; Field, Dempsey & Shuman, 1981; Goldberg, Brachfeld & DiVitto, 1980).

Two studies provide a behavioral picture of the early biological status of the primary group of infants targeted in the present study: relatively healthy VLBW infants, who were born after 1975. At term age, compared to fullterms with various medical complications, one research group found that preterm babies showed less motor control, with more abrupt, wider muscle tone fluctuations and a wider muscle tone range. They had poorer autonomic stability and behavioral state regulation: the preterms behaved in an "all or none" fashion. They were harder to wake, but once roused were more active and less variable in state, since they couldn't seem to readily control state change (Telzrow, Kang, Mitchell, Ashworth & Barnard, 1982). McGehee & Eckerman (1983) described these preterms as less "readable" by a social partner. They saw these infants as socially responsive, though less than fullterms. But they also viewed the preterms as more sensitive to stimulation and less organized, unable to control motor movements, vocalizations or state change.

Biological Predictors of Outcome Over Time

Clearly, preterm infants show behavioral differences from babies born at term. The biological origins of the preterm's developmental difficulties, termed the "continuum of reproductive casualty," are still under study. Multiple biological factors are important, some as causal factors, others as predictor variables.

Several biological characteristics have predictive power during infancy, but a less clear association with outcome after the first two years (Bennett, et al., 1982; Lipper, Lee, Garter & Grellong, 1981; Sameroff, 1981). The longterm effect of child gender is as yet unclear, although maleness may be a risk factor (Bennett, 1984; Caputo, Goldstein & Taub, 1981; Cohen & Beckwith, 1979; Drillien, Thomson & Burgoyne, 1980; Dunn, et al., 1980; Sigman & Parmalee, 1979). Lower birthweight and gestational age, traditionally used to define prematurity, are related to early behavioral problems in preterms. These variables sometimes show relationships to longterm outcome problems (Caputo et al., 1981; Ounsted, Moar & Scott, 1984) and sometimes do not (Cohen & Parmalee, 1983; Drillien et al., 1980; Dunn et al., 1980; Hunt, 1981; Kitchen et al., 1983; Stewart, Reynolds, & Lipscomb, 1981). Smallness for gestational age (SGA), sometimes a marker for intrauterine growth problems, has been linked to early and later developmental delay (Allen, 1984). Other markers for intrauterine growth deficits, including a slowed rate of early head growth (Gross, Oehler & Eckerman, 1983) and small head cirumference at birth (Lipper et al., 1981), have been considered predictors of at least early problems. Measures tapping biological processes in babies, such as individual differences in infant attention, have shown promise for predicting later cognitive outcome (Sigman, 1983b).

Illness and neurological problems are biological factors more clearly important to the course of preterm development across time (Bennett, 1984; Cohen & Parmalee, 1983; Dunn et al., 1980; Holmes et al., 1982; Wallace, 1984). Preterms more often suffer from a variety of illnesses, and those who are ill consistently experience more health problems over time. The effect of a specific health problem is complicated by factors which may accompany it, such as malnutrition (Goldson, 1983), obstetric complications (Field, Hallock, Timg, Dempsey, Dabiri & Shuman, 1978) or indicators of intrauterine insult (Drillien et al., 1980). Developmental consequences vary by type of illness, and grow worse with increasing severity and chronicity of the sickness, which may be reflected in the length of the child's hospital stay (Landry, Fletcher, Zarling, Chapieski & Francis, 1984). Note that medical treatment techniques for preterms may have adverse sequelae, such as intracranial hemorrhage associated with high ventilatory pressures, or visual impairment arising from oxygen toxicity (Bennett, 1984).

The most common preterm health problem is ideopathic respiratory distress syndrome (IRDS), afflicting half of the preterms in the Mother-Infant Project. The impact of this syndrome on child outcome is less clear than that of more chronic diseases. Data on preterms only, from a small study (Bennett, et al., 1982) and from the large

National Collaborative Perinatal Study, found no longterm relationships of IRDS to child outcome. Compared to fullterms, however, Field, Dempsey & Shuman (1983) did find clear dysfunction in preterms with severe IRDS. It is possible that the presence of IRDS may mark later learning and behavioral difficulties due to confounding factors, such as medical complications or hospitalization (Bennett, 1984).

Explanations for Biological Differences

Two models have been proposed to explain the biological differences between preterm and fullterm infants. Als, Lester and Brazelton (1979) suggest that an infant undergoing stress, such as the preterm child, has a limited capacity for processing information. To function adequately, such a child may need more time or a different way to handle information. An environment sensitive to the child's special needs becomes important to help the child to compensate.

This "limited capacity" model fits well with the idea of "paradoxical responding" advanced by Krafchuk, Tronick & Clifton (1983). They suggest that preterm infants have an elevated sensory threshold, which serves a protective function and makes them less reactive. But these authors state that preterms also have a lower response threshold, producing a narrow range of receptivity in which these infants will evince optimal and organized responding. Finally, they feel preterms cannot or do not readily habituate, but respond in a global and diffuse manner, making them look more reactive once a response is initiated. They indicate that perinatal stress exacerbates these characteristics, at all levels of gestational age.

Given these biological influences, the infant's caregiving environment becomes important in providing sensory and motor stimulation within the narrow band of the infant's capabilities, and thus compensating for its limited and paradoxical responses. As seen above, this may especially be the case for younger, smaller, SGA, male, neurologically impaired, and/or ill preterms. To fully understand the developmental course and outcome of the preterm child, then, it becomes critical to characterize the environment, or "continuum of caretaking casualty," experienced by the child.

Comments on the Environment of the Preterm Child

The preterm's environment is often described in a global manner, through demographic measures. Environmental status (ES) is often measured by maternal educational level, or by broader socioeconomic status indicators. Measures of ES do summarize critical information about the physical organization and overall social milieu of the premature child's environment, but are perhaps too global and confounded by factors such as ethnic status. Given the theoretical importance of the environment to the preterm's developmental outome, it should be analyzed in a more differentiated way. With more fine-grained information, specific environmental interventions can eventually be devised.

Four more specific dimensions of the environment seem important to later developmental outcome of the preterm child. One is the quality of stimulation in the hospital (Holmes et al., 1982), and then in the home (Siegel, 1983b) which includes both physical and social dimensions. A second dimension overlaps somewhat with the first, and involves the actual behavior of the parent in relation to the child. Such behavior can be described in a number of meaningful ways, from microanalytic parent-child interaction data to the quality of the attachment relationship. According to Sameroff and his colleagues (1975, 1980, 1982, 1983), a third aspect of the environment provides a context for interpreting actual parental behavior, and includes parenting attitudes, knowledge and perceptions about the child. A final dimension arises from a view of the environment as a social network dealing with the stress of a preterm child, and involves the family's formal and informal support systems (Parke & Tinsley, 1982). With these dimensions in mind, the following section carefully describes the preterm's early environment.

Characteristics of the Preterm Child's Environment During the First Year and Environmental Predictors of Outcome Over Time

Demographics and Home Environment

More premature infants are born to families of lower socioeconomic status (Creasy & Herron, 1981). Thus, the preterm group as a whole experiences a less optimal physical environment, different types of cognitive and linguistic stimulation, and less continuity of caregiving (Beckwith, 1983; Beckwith & Cohen, 1980; Bradley & Caldwell, 1980).

Within a middle class population, however, trained observers have not shown the preterm's home environment to be of inferior quality compared to that of matched fullterms (Crnic, Ragozin, Greenberg, Robinson & Basham, 1983; Siegel, 1984). One study did report that mothers of preterms perceive their home environment as less organized and stimulating than do fullterms, but this finding is weakened by the use of an unmatched control group (Barnard, Bee & Hammond, 1984).

Hospital Environment

During their first days of life, almost all premature babies encounter a very different environment than do fullterm infants. A neonatal intensive care unit is busy, populated, brightly lit, and the child often experiences blood sampling, mechanical ventilation, or other aversive medical treatments. As a result, the baby is exposed to initial stimulation different in quality, quantity and organization from that of the home (Holmes et al., 1982), and this situation may be prolonged by illness. The preterm infant is also separated from the caregiver during his or her earliest days. Preterm babies visited less often in the hospital show less optimal patterns of interaction with their parents, and their mothers have less self-confidence, although these effects may not be lasting (Klaus & Kennell, 1976; Leiderman & Seashore, 1975; McGehee & Eckerman, 1983).

Caregiver-Infant Interaction

Out of the hospital and reunited, the preterm baby and the caregiver enter into a different relationship than does the fullterm dyad. In part, the atypical interaction may be a response to behavioral differences the babies themselves display: even relatively healthy preterms show a limited information processing capacity and paradoxical response patterns. More than early separation, problematic infant behavior may lead to differences in preterm-fullterm interaction (Field, 1977). Mothers of premature infants appear to interact in a more patterned, stereotyped manner during the first months of life (Bakeman & Brown, 1980a; Barnard et al., 1984). These mothers are less contingently responsive and play fewer "games" which enhance development in their four-month-olds (Field, 1979). During early infancy, mothers of preterms stimulate their babies more than do mothers of fullterms, appearing to increase efforts to elicit responses from infants who are less active (Bakeman & Brown, 1980a; Field, 1977), and perhaps harder to "read" (Crnic, Greenberg, et al., 1983; McGehee & Eckerman, 1983). The high level of maternal activity and stimulation appears to continue through at least the child's first year (Crawford, 1982; Crnic, Greenberg, et al., 1983).

Such non-normative interaction may be seen as a problem for preterm dyads (Goldberg, Perrotta & Minde, 1984). Greater maternal activity may overstimulate the preterms, as they display more gaze aversion and inattention than do fullterms (Field, 1977, 1980; Crnic, Greenberg, et al., 1983). Thus, preterm dyads may strike an atypical equilibrium with too much maternal activity, or perhaps with inconsistent or poorly timed interaction on the mother's part (McGehee

& Eckerman, 1983). While this atypical interaction does improve during the first year, these interactions do not appear as satisfying as those of fullterm dyads (Crnic, Greenberg, et al., 1983). There is evidence that the mother shows less positive affect, as well as lower effectiveness and sensitivity, toward her premature infant. This seems to be the case through at least the first year (Crnic, Greenberg, et al., 1983; Harmon & Culp, 1981). The preterm baby also shows more negative affect in interaction than do fullterm infants (Crnic, Greenberg, et al., 1983; Goldberg, 1979).

Other interpretations of the characteristic preterm pattern of interaction are possible. Perhaps high levels of maternal activity are an appropriate adaptation to the needs of an unresponsive, high-risk infant. There is evidence for this viewpoint in studies of quality of attachment among preterms, discussed below. The passive interaction style of the preterm baby and early maternal overactivity may be due to child illness, in addition to the fact of prematurity. Compared to both healthy preterms and fullterms at four months corrected age, sick premature infants were significantly more likely to maintain eye contact and play passively, but less likely to orient towards their mothers, or play actively or independently (Barrera, Bronte & Vella, 1984). Beckwith (1983) found that mothers of ill preterms "burn out," more often shifting from high to low responsiveness over time. High levels of maternal activity may even be due to birth order, as Bendersky, Lewis & Fox, (1984) found that firstborn preterms are stimulated by their mothers more than laterborn premature children.

The impact of caregiver-infant interaction is discussed in more detail in the "transactional research" section of this chapter.

Quality of Attachment

Assessment of attachment at the end of the child's first year gives a measure of the quality of the caregiver-infant relationship, in terms of security or insecurity. Given the interactional difficulties noted above, it seems likely that preterms would show insecure attachment relationships at age one. Contrary to expectations, however, most studies find no group differences between preterms and fullterms on the percentage of securely attached infants (Bakeman & Brown, 1980b; Field et al., 1978). Within a premature sample, Rode, Chang, Fisch & Sroufe (1981) reported a similar percentage of insecurity to that seen in normative fullterm samples, and found no relationships between insecurity and measures of severity of insult, such as gestational age or amount of hospitalization. In contrast, Goldberg et al. (1984) did find a relationship in preterms between security and illness, with a history of more neonatal illness among secure babies. These authors also reported more than the expected number of "marginally secure" preterms, for whom earlier maternal behavior (from 3m on) was less optimal than for insecure preterms. These unique findings may well have been due to the large number of twins in their sample. Overall, the attachment data seem to indicate either that early interactional differences among preterms are not deviant enough to affect the robust phenomenon of attachment, or that these preterm/fullterm differences constitute an appropriate adaptation to the high-risk state of prematurity.

Maternal Attitudes

Maternal attitudes, child-related or focused on the support system, are a relatively unstudied aspect of the preterm environment. Little is known about the characteristics of the preterm's early attitudinal environment. Nor is much known about the impact of maternal attitudes on later preterm outcome, although they have been quite useful in studies of fullterms (Bee, Barnard, Eyres, Gray, Hammond, Spietz, Snyder & Clark, 1982; Crockenberg, 1981) and children of schizophrenics (Sameroff & Seifer, 1983).

Stern & Hildebrandt (1984) found that mothers of fullterms respond to an infant labelled as "premature" with more hesitancy and lowered expectations, regardless of actual infant behavior. But parents who actually have preterm children do not differ from fullterm groups in developmental expectations, parenting satisfaction or childrearing attitudes during the first two years (Crnic, Greenberg, et al., 1983; Silcock, no date). Even though the two groups have similar attitudes, those of the preterm parents may be more strongly associated with actual behavior. For parents of premature children, Crnic & Greenberg (1984) noted that negative feelings about the family were more closely related to negative responses toward the child than was true for parents of fullterms. Some data show that family attitudes were moderately associated with later preterm and fullterm outcome (Greenberg & Crnic, 1985), while other research indicates no relationship to outcome, independent of the influence of socioeconomic status (Caputo et al., 1981).

During pregnancy, and at the time of birth, mothers of premature infants report higher levels of stress than fullterm mothers (Laney & Sandler, 1982; Trause & Kramer, 1983). But Crnic and his colleagues saw no differences in stress levels for mothers of fullterms and preterms through the next eighteen months. Social support data have not yet revealed an impact of early attitudes on later preterm outcome. For both groups, stress affected the mother's concurrent satisfaction with life and parenting. During the first months of life, though not at 18 months, a feedback loop appeared to operate: the mother's attitudes seemed to affect her behavior, and that of her infant, which in turn affected her attitudes. Stress generally had a negative effect, while maternal satisfaction with social support had a positive, complex buffering influence (Crnic, Greenberg, Ragozin, Robinson & Basham, 1983; Crnic, Greenberg, Robinson & Basham, 1984).

A Summary of the Impact of Environmental Status on Preterm Child Outcome

The environment of the preterm child can be described globally, or in a more differentiated way. In general, the environment appears important in determining the longterm consequences of developmental difficulties arising from the high risk biological status of the premature infant. The preterm's environment may be appropriately adapted to the child's needs, and may act to compensate for early problems. Yet the environment may also exacerbate the preterm's developmental difficulties. The quality of the preterm environment may exist as a range, from compensatory to detrimental. Aversive hospitalization and early separation experiences may occur. The preterm may suffer illness, which affects interaction, and/or live in a less optimal socioeconomic environment. The first year of interaction with the caregiver may not be very satisfying, and if the preterm's parents hold negative attitudes, parental behavior may be more strongly affected than if the child were fullterm.

Given transactions between biological and environmental influences, at least some premature children may show developmental problems. The next section discusses data on developmental outcome in preterms who have grown past infancy. First, data on social outcome are reviewed in depth, since this area is the focus of the present study. Second, information on cognitive, visuomotor and linguistic outcome is covered more briefly.

Developmental Outcome in Depth: Social/Behavioral Data

Developmental theory suggests that early temperamental and interactional difficulties are precursors to later social outcome problems (Clarke-Stewart, 1973; Martin, 1981; Sroufe, 1983; Thomas & Chess, 1977). This theory can be tested through studies of premature children. With their early behavioral differences, unless the environment compensates, and especially if it is detrimental, preterms would be expected to display relatively lower social outcomes than do fullterms. But the picture of longterm social outcome in premature children is unclear. Existing studies are sparse and difficult to interpret, compared to findings on cognitive outcomes. Data comes from the study of several cohorts of preterm children, corresponding to the four historical phases of preterm medical care, and results differ by cohort (Bennett, 1984). Findings also differ in the way social development is conceptualized and measured. In addition, results vary according to the characteristics of the particular preterm sample (e.g. ill vs healthy).

First Phase of Preterm Medical Care

Prior to the 1950's, medical practitioners made extra efforts to provide basic nursing care to preterms (e.g. providing extra warmth, avoiding exposure to infection), although the children were separated from their parents for long periods in early life. These techniques allowed vigorous LBW infants to survive, with remarkably good outcomes. Not much information is available, but Douglas (1960) did compare Scottish LBW children with fullterms, all born in 1946. He found noticeably more adverse comments by teachers on the LBW group's classroom concentration, discipline, and attitude toward schoolwork. However, Douglas suggested that these problems were of a social, not biological, origin. In his sample, low birthweight was confounded with low socioeconomic status (SES).

Second Phase of Preterm Medical Care

During the 1950's, misdirected medical techniques produced a high number of iatrogenic handicaps among premature children. Parent-child separation for long periods was standard procedure. As reported in Taub, Goldstein & Caputo (1977), a majority of preterms from this period were found to have behavior problems, or were seen as elementary classroom discipline problems. For example, Drillien (1957) reported that one third of his three to nine-year-old sample had emotional handicaps, such as dependence or multiple fears, and that 67% showed a variety of problems abnormal for their age group. Drillien's information was gleaned by clinicians from maternal report.

Third Phase of Preterm Medical Care

Through the 1960's to the mid-1970's, advanced obstetric and neonatal techniques brought an improved prognosis for surviving preterm infants. Yet children were still separated from their parents for long periods while in the hospital. A smaller group of premature children from this era appeared to have behavior problems, usually accompanied by neurological impairment. Researchers of this period measured social outcome in a variety of ways, and not all methods of measurement or statistical analysis uncovered behavioral differences. In a mixed SES, mixed ill and healthy, mostly white sample, Taub et al. (1977) found no group differences between LBW preterm and fullterm children on a 277-item parental checklist of behavior problems. However, the work of Drillien and his colleagues (1980) revealed significantly lower social adjustment, as rated by teachers, in a subsample of neurologically impaired VLBW children, as compared with non-impaired preterms and controls.

Dunn et al. (1980) reported "minimal cerebral dysfunction" as the most common sequelae in this cohort, occurring in 18% of his large sample of LBW children. Clinical diagnosis showed either an attention deficit disorder or some sign of neurological dysfunction among this subset of children, who sometimes appeared hyperactive. Caputo & Mandell (1970), summarizing literature through the third phase, concluded that preterms displayed a variety of deviant behaviors, especially the hyperactivity syndrome, but blended into the normal population as adults. They also mentioned the confounding influence of socioeconomic status, race and pregnancy complications on preterm outcome results.

Hertzig (1984) did indepth parental interviews, generating weighted scores of temperament. 75% of her apparently middle class sample showed some form of illness. From age 6m to three years, compared to non-casematched fullterms, this group of LBW children was less adaptable, less distractible, more intense and had a higher threshold of reponsiveness to sensory stimuli. Age changes occurred similarly for both groups, and individual LBW and fullterm children varied a great deal from one measurement period to the next. Overall, LBW children were not more "difficult." But neurologically impaired LBW children were more difficult, as measured by a linear combination of problems in rhythmicity, adaptability, approach/withdrawal, and intensity/mood.

Fourth Phase of Preterm Medical Care

From 1975 to the present, technology has expanded rapidly, and more aggressive techniques have been used to save preterm infant lives. Separation between parent and child has been minimized as much as possible, although some parents do not often visit their hospitalized infants. Children born during this fourth phase have been studied in a more detailed fashion than were earlier cohorts, with sample characteristics more carefully specified and social outcome measured with varying definitions and from different perspectives (e.g. parent vs observer). However, available findings present a confusing outcome picture, and there is a paucity of longterm outcome data.

Ungerer & Sigman (1983) found a deficit on the personal-social score of the Gesell scales at age 13 1/2m, among their low SES, LBW, mixed ill and healthy preterms. This was too large a deficit to be accounted for by biological immaturity alone, yet by 22m the deficit had disappeared. In contrast, Escalona (1982) followed her low SES, mostly nonwhite and ill LBW sample to age three, finding a growing and unexpectedly large number of children exhibiting behavioral problems. These difficulties were defined by parental report that the child was unable to function normally within the family. It is important to note that neither of these studies used a fullterm control group.

Bakeman & Brown (1980b) followed relatively healthy, black, low SES preterm LBW babies born in 1975 to age three, comparing them to fullterms. As mentioned before, the groups did show early interactional differences, but by 12m had similar attachment ratings. At age three, no differences were found between the groups on "social competence," measured by daycamp staff ratings, or "social participation," assessed by coding videotaped classroom interaction.

Goldberg et al. (1980) found that ill preterm neonates, compared with healthy preterms and fullterms, did worse on the Brazelton scales. At 8m, these ill babies seemed more irritable than would be expected from immaturity alone, although they did improve with time. At 12m, they received lower scores on the components of the Bayley Infant Behavior Record (IBR) Primary Cognition score (object orientation, goal directedness, attention span, reactivity, gross and fine motor coordination). Healthy preterms, while behaving better than their sick counterparts, showed a trend toward lower scores than fullterms. No longterm followup was conducted on this sample.

Field reported preterm behavioral outcome in two different studies. A longitudinal descriptive study, in part, compared fullterms to fairly ill preterm infants (with RDS), over time (Field et al., 1981). Difficult to test as newborns, these sick preterms received lower interaction scores on the Brazelton Neonatal Behavior Scales. At 8, 12 and 24m, they were rated lower on the Primary Cognition score of the Bayley IBR. At 24m, they also received a lower Primary Extraversion score on the IBR, mainly due to negative emotional tone. Yet the ill preterms' 12m attachment ratings were not different from those of the fullterms. Each year from two to five, Field's premature sample received significantly worse scores on parental ratings of behavior problems and temperament, including increased activity, short attention span and irritability (Field et al., 1983). In a second shortterm intervention study, Field focused on the low SES, relatively healthy preterm children of teen versus adult mothers (Field, 1980). At 4 and 8m, study findings revealed that nonintervention children (regardless of mother age) had lower parental ratings of temperament (on the Carey scale), though few differences were found on other measures.

A Summary of the Data on Longterm Social Outcome in Preterms

There have been significant historical changes in the picture of preterm social outcome. One cause lies in the evolution of medical practices, but another may arise from changes in research methodology: as more specific information has been gathered, a wider variety of measures utilized, and mediating variables more carefully studied, a different outcome picture may be emerging. For example, more recent research, using repeated measurements, reveals a more detailed picture of outcome, which changes over time in complex ways.

Research on fourth phase preterms, of most interest here, does resolve some of the methodological difficulties of the earlier cohorts. The confounding factor of SES, though not studied concurrently, is often controlled, or at least defined for the sample being studied. Parent-child separation after birth has been minimized by current medical practices, reducing its importance as a factor for study.

The limited fourth phase data indicate that ill or neurologically impaired preterms demonstrate social outcome problems. However, social behavior approaches normalcy among relatively healthy preterms, at least after the first year. Among even relatively healthy preterms, however, more complete social outcome measurement might reveal longterm social behavior problems, most likely in the area of temperament. This picture of social outcome is surprisingly good, considering the preterm's early biological and interactional difficulties, so self-righting may be occurring. Perhaps the early interactional differences, seen between caregiver and infant, are an appropriate adaptation to the preterm infant's social needs, at least for the healthy baby.

To clearly understand social outcome among fourth phase preterm children, more data is needed. Social outcome should be measured in detail. Preterm/fullterm group outcome differences need further study, as do individual differences (perhaps due to illness or neurological impairment) within the preterm group. In fact, information is needed on the course of development leading to social outcome among preterms. Of special interest is the role of the caregiving environment and the caregiver-infant attachment in explaining later social outcome. Data in these areas would be quite useful in formulating intervention strategies, or determining if intervention is really necessary.

Developmental Outcome in Brief: Cognition, Achievement, Motor Skills (including Visuomotor Abilities) and Language

Most studies of preterm developmental outcome have focused on general infant development, as well as later intelligence and school achievement. As in the data on behavioral outcome, these findings differ by cohort, characteristics of the premature population, and the type of assessment instruments that are used. More work has been conducted here than in the behavioral area. Yet detailed and well-designed research is still needed to present a fine-grained analysis of outcome in these areas, and to determine the vagaries of the preterm developmental process.

As mentioned before, preterms have early problems processing information, especially visual and intersensory stimuli. They display motor problems, and disorganized response patterns. Their environment may be less optimal in providing stimulation that enhances their development. Cognitive, achievement, and linguistic outcome problems might be expected later in life and, as discussed below, generally do appear. However, self-righting may occur, within the organism or the environment, since preterm cognitive outcomes are not as poor as might be expected.

Cognitive Outcome

Earlier researchers noted preterm intellectual delay both during infancy and across childhood, although the extent of cognitive dysfunction may possibly have decreased in groups of children born more recently (Drillien et al., 1980; Kitchen et al., 1982). Examining mental development during the first two years, recent comparative studies have noted developmental delays (Crnic, Greenberg, et al., 1983; Field et al., 1981). Looking at intellectual outcome in later childhood, some investigators have found that preterms score within the normal range according to test norms (Wallace, 1984), though often lower than matched fullterm control groups (Field et al., 1983; Siegel, 1983b, in press). The nonverbal cognitive domain appears to be a weakness for the premature group. Ungerer & Sigman (1983) carefully compared preterms and fullterms, finding three-year outcome difficulties for preterms in cognitive Stanford-Binet items tapping visual information-processing and perceptual motor skills.

Achievement and Visuomotor Skill

The picture of school achievement and visuomotor skill is quite consistent, but updated information is needed on children born during the recent phase of medical care. Achievement difficulties have been found by many researchers, suggesting that preterms may be at risk for learning disabilities (Bennett, 1984; Douglas, 1960; Drillien et al., 1980; Dunn et al., 1980; Nickel, Bennett & Lamson, 1982; Siegel, 1983b). Premature children appear consistently delayed in motor development (Drillien et al., 1980; Field et al., 1981, 1983; Nickel et al., 1982). Longterm studies of earlier cohorts have found specific visuomotor difficulties in the preterm population (Drillien et al., 1980; Siegel, 1983b; Wallace, 1984), at least through age eight and across the entire IQ spectrum (Hunt, 1981). These visuomotor problems may contribute to low school achievement. Self-righting does not seem to be as pronounced in this area.

Linguistic Outcome

Preterms, as a group, also appear to have linguistic problems, though self-righting may also occur in this developmental domain. Earlier research found mixed receptive and expressive difficulties (DeHirsch, Jansky & Langford, 1964; Zarin-Ackerman, Lewis & Driscoll, 1977). Recently, comparisons of preterms and fullterms have revealed expressive delays in prelinguistic communication during the first year (Crnic, Greenberg, et al., 1983), and syntactic language production from age two through five (Field et al., 1983). Research examining social language use among premature toddlers found a subgroup of two-year-olds with problems. These preterms were involved in "asynchronous" caregiver-infant interactions, with mothers who were either too directive or uninvolved (Rocissano & Yatchmink, 1983). Ungerer and Sigman (1983) identified both expressive and receptive language problems in preterms at 22m, presumably due to biological immaturity, but these problems did not reappear at 36m. In other studies, no receptive delays were found at age two (Greenberg & Crnic, 1985) or age six (Siegel, 1984b).

Overall, then, expressive language differences appear to persist, while differences in receptive language disappear. Certain types of expressive language problems may show up in subgroups of preterms, while other differences in linguistic expression may characterize premature children as a whole.

Developmental outcome depends upon the way in which the premature child and the environment function together, over time. Since the transactional framework holds promise for better describing developmental process and outcome in the preterm child, recent research taking a transactional approach is presented in the next section. Earlier findings of the Mother-Infant Project, a transactional study, will be discussed.

The Course of Preterm Development: Transactional Research

Identifying important predictor variables one by one, as discussed earlier in this review, does provide information about the developmental process experienced by the developing preterm child. However, since risk factors are often dynamically interrelated, this approach does not convey the full picture. Research using a transactional framework is needed, but is a complex undertaking. Data on multiple developmental factors is required. In the study of premature children, this includes information from the more biological "continuum of reproductive casualty" (e.g. postnatal health), as well as from the "continuum of caretaking casualty," especially given the self-righting potential of the child's environment. Repeated assessments over time are needed, of both child and environment, to describe relatively stable smaller segments of the developmental process. Variables which capture the dynamics of development (e.g. continuity of caregiving), or are inherently transactional (e.g.

security of attachment), and thus measure the action of critical and/or persistent developmental influences, are expected to be more accurate predictors. Extensive, and even ingenious, statistical analysis is necessary.

Researchers have tried two ways to sketch how important variables combine, during the course of development, to determine later child outcome. First, assuming only that classes of variables interact in their impact on later child outcome, a number of investigators have tried to predict development with empirical risk indices. Second, some authors have done more explanatory research, attempting to describe the impact of the continual interplay between a changing environment and the changing child.

Risk Index Research

Risk indices are empirically weighted combinations of variables, which predict outcome variance in group scores or identify individual children with normal and abnormal outcomes. Designed to predict, not to explain, they are usually created through stepwise multiple regression or discriminant function analysis. Basically, they indicate the relative importance of variables in the developmental process by identifying which variables enter the equations, and their relative weights, for the particular sample under study.

Several risk index systems have predicted preterm development during the first two years, with some degree of success. For example, Field et al. (1978) used differing combinations of variables to predict one-year outcome. For example, she entered the 8m Bayley MDI and PDI, Carey temperament score, and Brazelton motoric process score to classify children's risk status on the 12m MDI. Her system had a 70-94% probability of correctly classifying preterm children with normal and problem outcomes. Other risk indices, of varying degrees of complexity, have predicted outcome past infancy. For example, one set of simpler indices has used information available at birth, including data on reproductive, demographic and child biological variables. This system was able to predict up to 58% of the variance in cognitive group scores at age six, and enabled correct classification of premature children into normal and abnormal outcome groups 61-87% of the time (Siegel, in press). Other systems have been more complex, and/or have used information from later points in time, to make predictions as late as age eight (Hunt, Tooley, & Harvin, 1982; Ramey, Stedman, Borders-Patterson & Mengel, 1978).

Even when used only for the purpose of prediction, the risk index approach has limitations. Many equations rely heavily on the predictive power of the single variable of socioeconomic status. Since the equations are usually empirically-derived, they have two significant weaknesses. First, the equations are affected by the measurement error of the component variables. Second, since equations differ depending upon the sample characteristics, the outcome measure being predicted, the type of predictor variables, and the length of time over which the prediction is being made, generalizability can be a problem. An equation developed for one sample is rarely cross-validated, although Siegel, a Canadian researcher, is currently involved in cross-validating a prematurity risk index.

Explanatory Transactional Research

The most convincing evidence for a transactional developmental framework would come, of course, from intervention studies with a priori transactional hypotheses, such as that of Zeskind and Ramey (1981) with non-preterm high-risk infants. In the non-intervention, naturalistic correlational studies used to study preterms, however, explanatory transactional data must be indirect and cumulative. Researchers have used a variety of ways to gather transactional evidence. The focus of this work has been on cognitive outcome. Only one study, that of Bakeman and Brown (1980b), has examined transactions leading to preschool preterm social outcome.

UCLA transactional research. The research program at UCLA has most thoroughly and convincingly traced transactions in preterm development, using a large sample solely of preterms. Sigman, Cohen, Beckwith & Parmalee (1981) looked at the relative effects of various environmental variables on later preterm child competence. To do so, they used a series of ANCOVAs with longitudinal data, holding constant confounding factors to examine variables of interest. For example, they examined the influence of caregiving and socioeconomic status, holding language background constant. These authors found familial influences, such as birthorder and caregiver-child interaction, of primary importance during the first 18m. Beginning at two years, sociocultural variables (measured by socioeconomic status) emerged as influential and increasingly related to outcome. However, familial influences continued to have an independent impact.

Beckwith, Cohen, Kopp, Parmalee, & Marcy (1976) uncovered dynamic changes in the influence of interactional variables on child outcome. They found caregiver-infant interaction had a differentiated effect on child outcome during early infancy: certain types of interactions predicted certain types of infant skills. By age two, Cohen & Beckwith (1979) found that the quality of both earlier and concurrent exchange between caregiver and preterm child predicted overall child cognitive competence. The earlier interaction between caregiver and infant (at one month) still made a unique contribution to two-year developmental outcome in preterms, beyond the effect of concurrent interaction. Perhaps this was true because early interaction was consistent with later caregiver behavior, and/or reflected qualities of the infant which influenced caregiving. By age five, Beckwith (1981) found that the predictive power of the earliest caregiver-preterm child interchanges was decreasing, even though caregiving was consistent from one month to age two. She also noted transactions between the sociocultural (SES) and familial (caregiver-child interaction) influences. Caregiver interaction at age two was more important in explaining five-year Stanford-Binet performance than was SES. However, the effects of a good caregiver-child interaction were stronger among two-year-old premature children from higher social classes.

Sigman and Parmalee (1979) uncovered additional transactions, this time between health problems and caregiving, using path analysis techniques. She found, most strongly in girls, that early illness was related to later illness and poor developmental outcome, but that early illness was also related to increased caregiving, which in turn was associated with better outcome. Thus, early illness showed no simple and direct association with child outcome, because the two paths had opposite effects, which canceled each other out. Beckwith (1983a) further detailed these transactions, showing that mothers with ill babies were more likely to shift from high to low responsiveness over time.

The UCLA research program has also revealed possible dynamic self-righting mechanisms in the environment, using correlation techniques. In infancy, Beckwith & Cohen (1980) reported that distal social interactions were more important to two-year outcome than proximal ones. Beckwith (1981) noted that contingent, reciprocal interaction in early childhood was associated with positive cognitive outcome at five years. Using a dynamic "consistency of caregiving" measure, Beckwith (1983a) further noted that a better five-year cognitive outcome was related to highly responsive caregiving that remained consistent during the period of infancy. Even inconsistently responsive caregiving (defined as a shift from low to high responsiveness (from 8 to 24m) was better than caregiving that was consistently low in responsiveness. Since more educated mothers were also more consistent caregivers, these data better explained the self-righting mechanism active in the commonly observed relationship between higher SES (as measured by maternal education) and higher child IQ.

Transactional research examining preterm social outcome. Bakeman and Brown (1980a), of Atlanta, carefully analyzed a short segment of caregiver-child interaction during the first few months of life, and then did a brief observation at 20m of age, in both preterms and fullterms. With multiple regression techniques, they found little relationship between these short periods of early interaction and the childrens' later outcome.

Bakeman and Brown (1980b) also attempted to predict three-year cognitive and, in the only existing study, preterm social outcome. With a sample of preterms and fullterms, they examined two dimensions of social behavior in a preschool setting: social participation (observations of child's involvement with others) and social competence (staff ratings of child's ability to "navigate the social world smoothly").

Using stepwise multiple regression across the total sample, they found three-year social outcome was not predicted by biological variables or early measures of the "proximal" environment (caregiver-child interaction). To a small extent, however, measures of early infant social responsiveness did explain preschool child behavior, as did data on 20m caregiver responsivity. Environmental status, measured via maternal education, added only to the prediction of social competence (staff ratings), not social participation (videotaped observation). Three-year cognitive performance, in contrast, was explained most strongly by biological variables, although the interactional variable of 20m caregiver responsivity did add predictive power. Global environmental status did not contribute to the prediction of cognitive scores.

In summary, then, Bakeman and Brown were only somewhat able to predict three-year social outcome. Preterm birth status was not a significant predictor variable, while early infant social responsiveness, later maternal responsivity, and global environmental status did have predictive power. Note that these authors did not try to find different predictive patterns within the preterm and fullterm groups, as they utilized a combined sample.

Other transactional research. In a Canadian study, Siegel (1981, 1984a) noted that premature children seemed more influenced by early experience, while the fullterms appeared developmentally more stable and less affected by the early environment. Preterms showed higher correlations between later cognitive outcome and early environmental measures compared with earlier developmental test scores. On the other hand, in fullterms higher correlations were found between measures of earlier and later cognitive ability.

For both groups, Siegel and Cunningham (1984) noted complex transactions between child characteristics and the environment. In a clever analytic strategy, she looked at earlier and later (three-year) developmental status, identifying four groups of children: true negatives (low scores early and later); false negatives (low early scores, but normal later scores); as well as true positives and false positives. Then she examined data on important developmental influences over time. She found that developmental delay on the part of the child was related to a decrease in the degree of parental stimulation (measured on the HOME scale) over time. At the same time, a more stimulating environment mediated the relationship between earlier and later child outcome scores. Prediction of developmental delay at age three, based on low infant test scores during the first year of life, was less accurate when the child had experienced a more stimulating environment during the intervening period.

Other researchers have noted additional transactions between characteristics of the child and the environment. Using three-factor ANOVAs, Bendersky et al. (1984) found that firstborn premature infants received more parental stimulation. At the same time, she noted that firstborn sick babies (both preterm and fullterm) were stimulated and responded to in a more optimal manner. Thus, she speculated that parental caregiving may be elicited by the illness, rather than the birth status, of the infant.

Field, Walden, Widmayer & Greenerg (1982) studied discordance in twins, a natural experiment for examining transactional processes. It is thought to be a handicap since the smaller infant in a discordant pair weighs less and often suffers more illness. Comparing concordant and discordant VLBW twin pairs, Field and her colleagues discovered that discordant twins, especially the smaller one: had higher developmental outcomes at age one, were viewed as more demanding and affectionate, and were involved more often in caregiver-infant interaction. Looking at mediating variables, parental behavior appeared to compensate for early handicap, and discordance may actually have become an advantage.

Summary of transactional methodology. Several research strategies have been used to gather transactional data in the field of prematurity and other research endeavours. Much work has focused on the cumulative effect of various developmental factors, and how this changes with time. Other studies have scrutinized the interaction, over time, between two constructs, and their joint impact on child outcome. A few studies have examined, over time, the mediating influence of one developmental factor on another, and the consequences for child outcome. In addition, some data have drawn dynamic, detailed patterns of association between developmental factors and child outcome.

A number of research methodologies have been used. In limited instances, with simple hypotheses and large sample sizes, path analysis has been employed. Analysis of covariance has also been used to reveal paths of influence over time. Other procedures have been useful, such as the study of natural experiments like discordance, or an explanation of instances of predictive failure, or developmental delay. Another useful research strategy has divided samples into subgroups who experience qualitatively different and important developmental states, such as a subgroup receiving consistently poor caregiving, or dyads with an insecure attachment relationship. Hierarchical and standard "least squares" regressions have compared the explanatory power of variable sets (Sameroff & Seifer, 1983), and identified the most salient predictor variables within a set. Combining regression data with simple and partial correlations has illuminated transactions, including issues of stability and patterns of predictor-outcome relationships (Bee et al., 1982; Gamble, Belsky & McHale, 1983). Stepwise regressions, and summations of multiple predictor variables, have also been used to create predictive risk or severity indices.

With this transactional work, and the study of individual predictor variables, much has been learned about the course of preterm development. But continued work is needed, especially transactional research and data on preterm social outcome. The next section discusses the Mother-Infant Project (MIP), a research study using a transactional framework. First the findings of the first two years are presented. This is followed by a general model of the preterm developmental process, which incorporates much of the data reviewed in this chapter. Arising from this general model are the specific hypotheses of the current, fourth year followup study, which are presented last.

Examining Developmental Process and Outcome in the Preterm Child: The Mother-Infant Project

Findings from the First Two Years

The Mother-Infant Project (MIP) has traced the course of development and child outcome over the first four years of life, in a recent cohort of VLBW amd smaller LBW preterm and fullterm children. A main contribution of the Mother-Infant Project has been the detailed information gathered over time on developmental outcome in the premature child, especially linguistic and interactional data. An equally important contribution has been a thorough, ecological description of the preterm child's environment, especially the evolution of maternal attitudes and caregiver-child interaction. These data have enabled an examination of the developmental process using a transactional approach.

Child outcome. During the first year of life, the Mother-Infant Project preterms scored significantly lower on measures of mental, motor, and linguistic outcome, even when corrected age scores were used. Engaged in an imbalanced interaction with their mothers, they behaved in a less active manner than their fullterm counterparts. Their mothers appeared less satisfied, and the preterms themselves displayed more negative affect. No group differences were seen in the quality of the home environment, or in parental attitudes about the child and social support system (Crnic, Greenberg, et al., 1983).

By age two, the premature children of the Mother-Infant Project no longer differed significantly from the fullterms on measures of developmental outcome, when corrected scores were used, except for lower scores in the motor area. Differences in mother-child interaction were no longer apparent. The two groups remained similar in attitudes about the child, family, and social network. Preterm and fullterm dyads had reached a similar developmental goal, yet transactional analyses revealed that the two groups had taken different paths to reach it (Greenberg & Crnic, 1985).

Transactional patterns. There were different developmental processes among preterms and fullterms leading to outcome at the end of infancy. Hierarchical regressions were used to uncover differences in variables predictive of outcome, and in the degree to which outcome variance could be accounted for. In general, more variance could be explained among the preterms. Within that group, demographic indicators were most important in predicting preterm outcome: younger mothers with less education, more children, and some form of public assistance, had less competent preterm children. Biological variables were less important, though illness (presence of IRDS) consistently accounted for outcome variance among the premature children. Measures of prematurity (gestational age and birthweight) were not very useful as predictors.

Beyond these background variables, more fine-grained environmental indicators were related to outcomes in both groups, as expected from transactional theory. These environmental variables also accounted for more variance in the outcome of premature children, in the expected direction: more positive parental attitudes and caregiver-infant interactions were related to more positive child outcome (Greenberg & Crnic, 1985).

At age two, family attitudes held by the mother of a preterm were significantly more congruent with her own behavior and attitudes about her child and intimate relationship, when compared to mothers of fullterms. Positive attitudes were related to positive behavior. Preterm family attitudes were also significantly more congruent with concurrent child behavior, though not with child outcome. In fact, family attitudes were not related to concurrent child outcome in either group. Somewhat weaker relationships held over time. Early parental attitudes and, to a lesser extent, mother and infant behavior were significantly more related to later (24m) family attitudes among preterm than fullterm mothers. There seemed to be different patterns of relationships in the two groups. Early satisfaction with parenting, friendship support and general life satisfaction were positively linked to later family attitudes in both groups. But early intimate support, child outcome, and both mother and child behavior were significantly associated with later family attitudes among the preterms only. For the fullterm dyads, however, stress was more often significantly linked to later family attitudes (Crnic & Greenberg, 1984).

A General Model of the Preterm Developmental Process, Using a Transactional Framework

The present study takes a transactional approach to the study of preterm development. In this view, the course of development is seen as a complex feedback system, marked by continual interplay between the growing preterm child and his/her changing environment.

Given the early biological difficulties of the premature child, especially neurological problems, and illness which may continue through childhood, preterm development may well be unstable. Developmental difficulties are hypothesized to occur over the shortterm (during the first year), growing less severe, but persisting as the preterm infant moves into childhood. Early on, the preterm may show information-processing problems and a paradoxical response pattern, as well as early interactional difficulties. Later, in a new developmental phase, the preterm may display academic and social deficits, compared to his/her fullterm peer. Different developmental domains may show different rates of "catch-up" to the fullterm norm. For the preterm, then, biological variables may be important in explaining outcome, while early developmental status may not have as much explanatory power.

The preterm's early environment may be inferior to that of a fullterm, given hospitalization, separation, and atypical interaction experiences. In either case, measures of the early environment may be important in accounting for preterm outcome variability, depending upon the extent of the infant's biological problems. In fact, a transactional approach suggests that characteristics of the child and environment must be considered together, keeping in mind their continual, dynamic interplay. This mutual influence may take the form of a "double whammy," with a vulnerable preterm child more strongly affected by a deprived environment. The effect of the double whammy should be most evident in very vulnerable preterms, such as those who are consistently ill, or those considered small for their gestational age. The double whammy effect should also occur most clearly in developmental areas which jointly show the impact of biological and environmental factors, such as ego control or behavior problems.

Alternatively, the mutual influence of the preterm child and the environment may take the form of self-righting, according to a transactional view. Perhaps the preterm's biological difficulties, especially when persistent, elicit a different response from the environment. Since the global environment is not responsive to child influences, the self-righting most likely takes place in the "proximal" environment, particularly in the behavior, and perhaps child-related attitudes, of the caregiver. Thus, the environmental variables offering an explanation of preterm outcome would be "proximal," rather than global.

According to a transactional view, then, a caregiver's response to a preterm could either be problematic, or an appropriate adaptation to the needs of the infant and growing child. Maternal behavior and attitudes toward a preterm could even be unstable, or inconsistent, compared to the behavior of a mother with a fullterm child. However, enduring caregiving responses, whether consistently poor or consistently good, should have the strongest impact. Note that the caregiver's behavior should be affected by the wider environmental context, such as the caregiver's perception of her social support and/or life stress. This effect may be patterned differently in families with preterm rather than fullterm children. Note also that a particular parent or child behavior may have a different meaning for preterms than for fullterms. This makes the interpretation of comparative data rather difficult, as an action which may predict a negative fullterm outcome may predict positively among preterms.

Finally, the transactional approach suggests that the network of explanatory variables influence each other, directly and indirectly, and evolve over time. Thus, biological variables may recede in importance as the preterm child grows. In addition, compared to a fullterm norm, caregiving may remain important to preterm development, when normally the influence of the wider environment asserts itself with time. Illness may not have a direct effect upon the child, if more positive caregiving mediates this association.

Purposes of the Current Phase of the Mother-Infant Project

Few research programs can sustain transactional research, investigating a model of such complexity. As part of the Mother-Infant Project, however, with its rich data set collected at several timepoints, the present study provides transactional evidence to examine this general model of the preterm developmental process. In doing so, the present study makes several important contributions to the literature on prematurity and, more generally, to the study of social development.

First, transactional research with preterms and fullterms is carried beyond infancy and into childhood. Second, social development at age four is studied intensively, using a multidimensional assessment strategy. This allows a detailed look at the internal structure of 48m social outcome, especially among premature children. Third, the preterm caregiving environment is carefully assessed, even during the preschool period, and examined for stability from birth to age four. Fourth, the preterm developmental process is examined for the presence of either a "double whammy" or self-righting mechanisms. Finally, using prematurity as a natural experiment, the prediction of social behavior is studied, using both microanalytic measures and measures derived from the perspective of attachment theory (in particular, the "Waiting Task").

With these unique contributions in mind, specific hypotheses of the present study are now presented. They are organized into four sections: (A) child social behavior; (B) 48m group differences; (C) individual differences in preterm developmental outcome; and (D) transactional questions.

A. Child social behavior. Child social behavior was studied with three purposes in mind. The first involved an examination of the structure of social behavior at age four. Researchers have stressed the need for a thorough look at the multidimensional construct of child social outcome (Greenspan, 1980; Zigler & Trickett, 1978). However, few studies have analyzed overlapping social outcome measures to understand the structure of this construct (Green, Forehand, Beck & Vosk, 1980; Gresham, 1981). The second purpose involved a test of the hypothesis that early data can be used to predict later social outcome, using prematurity as a natural experiment. Developmental theory suggests substantial continuity in social development, yet the prediction of social behavior has proven difficult (Lewis, Feiring, McGuffog & Jaskir, 1984). The third purpose was to evaluate the utility of a 48m observation situation, called the "Waiting Task," designed for the present study from an attachment theoretical perspective. Measures of the mother-preschool child "partnership," which evolves from the attachment relationship, have been called for (Marvin & Greenberg, 1982).

Hypotheses regarding child social behavior. Multiple measures of child social behavior were gathered, requiring data reduction via factor analytic techniques. In most cases, these factors were then used as summary social outcome measures. It was hypothesized that three factors would emerge, reflecting the three perspectives of those providing the data: parent; observer; and child. With more data available from the mothers than the observer or child, the parental view was expected to differentiate into several subfactors. Overall, the parental factor structure was predicted to reflect Block and Block's (1979) "process" dimensions of ego resiliency and ego control. The observer view was expected to relate to the parental ego control measure, since the 48m observation situation ("Waiting Task") was designed to reliably reveal that dimension of child social behavior.

Combinations of early data on the child's biological and environmental status were expected to significantly predict 48m social outcome in both groups, though child behavior itself (measured in a microanalytic fashion) was expected to appear discontinuous. In contrast, the single, inherently transactional measure of attachment security was expected to reveal developmental continuity, predicting four-year social behavior (especially as measured in the theoretically consistent 48m "Waiting Task" situation). Given the early biological and interactional differences of the preterm child, patterns of prediction were expected to differ from the fullterm norm. However, the robust attachment measure was not expected to show preterm/fullterm differences in predictive power.

B. <u>48m group differences.</u> Group differences were investigated, using subgroups created from the interaction between birth status (preterm/fullterm) and environmental status (low, medium, and high). Thus, the impact of prematurity was examined without the confound of social status, revealing any interaction effects. Note that environmental status was measured both by maternal education and by a broader indicator of socioeconomic status. Of course, sex differences were noted prior to other analyses. Then group differences in child developmental outcome were scrutinized, checking cognitive and visuomotor outcome, and studying social outcome in depth to augment sparse findings on behavioral outcome in premature children. In addition, group differences in a variety of maternal attitudes and, to some extent, caregiver-child interaction were traced beyond infancy to early childhood.

<u>Hypotheses regarding group differences in 48m child developmental outcome.</u> Main effect differences were expected between this recent cohort of preterms, and the fullterm controls, on four-year child outcome. As in earlier cohorts, premature children were predicted to receive lower scores in the areas of visuomotor and nonverbal cognitive skill, since preterms appear to have difficulties in these areas earlier in life. Social outcome differences were also expected, with preterms receiving lower scores on measures of ego control and temperament, reflecting a continuation of the attentional difficulties and less organized emotional output which appear characteristic of

premature infants (especially those with neurological problems). It was possible that the premature children themselves would report lower values on the social outcome measures, indicating that the negative affective tone seen on the child's part during earlier mother-child interaction had carried over to the child's overall view of social relationships.

It was hypothesized that main effect differences would occur between environmental status (ES) subgroups on measures of receptive language, verbal cognitive skill, as well as visuomotor abilities. As expected from the extensive literature on social class, the lower ES groups should receive lower scores. Social outcome differences should also be evident, with more behavior problems (especially on "product" measures) identified in the lower ES groups.

As suggested by Sameroff, interaction effects between prematurity and global environmental status were predicted. Children experiencing both prematurity and a lower socioeconomic environment were expected to suffer a "double whammy," showing lower developmental scores and difficulties in social behavior. In particular, they were predicted to display more behavior problems (a "product" measure), and less ego control (a "process" measure).

Hypotheses regarding group differences in maternal attitudes and mother-child interaction at 48m. Main effect differences for prematurity were hypothesized for measures of parent-child interaction. Given data on patterns of mother-preterm infant interaction, during early childhood the premature dyads were expected to evidence more negative affect and lower measures of satisfaction. A higher incidence of the "oversupportive" maternal style during was possible during the waiting task observation situation. As was true at the 24m timepoint, no differences were expected between biological status groups at 48m on maternal attitude variables such as satisfaction with parenting or life, views of the family environment, childrearing attitudes, stress, or social support.

Differences were predicted for the main effect of environmental status (ES), given the nature of life. More stress, lower social support, and lower life satisfaction were expected in the lower ES groups. Few differences were indicated on other attitudinal measures, with the possible exception of childrearing attitudes. The social class literature pointed to the possibility of higher scores on "restrictive" childrearing attitudes among the lower ES groups, and a higher frequency of the "authoritarian" maternal behavioral style in the lower ES groups (during the waiting task observation situation).

C. Individual Differences in 48m Preterm Outcome

Individual difference findings were expected to concur with the 48m group difference data. Compared to the fullterm sample, a higher percentage of preterm children should show deficits in nonverbal cognition, visuomotor skill, and selected aspects of social outcome, as well as general developmental delay. This information should provide an estimate of the relative chance of deficit or delay for a preterm versus a fullterm child.

There should be biologically-based individual differences within the preterm group. Maleness, as well as indicators of health problems (the presence of IRDS, general postnatal health problems, childhood health ratings, continuing illness from birth to four), were expected to predict poor 48m outcome. If a child with continuing illness did not receive low scores on outcome measures, then the caregiving s/he received was expected to exceed the average level. Smallness for gestational age should be linked with general developmental delay, while birthweight and gestational age were not expected to prove useful as individual predictors.

D. Transactional Questions

Questions suggested by a transactional framework were examined. The developmental process was conceptualized as involving several important "constructs" (characteristics of the child, or the environment, relevant to development). These were: (1) earlier biological status, including health; (2) global environmental status, including some measures of the home environment; (3) earlier and concurrent mother-child interaction; (4) earlier and concurrent maternal attitudes; (5) earlier child developmental status; and (6) earlier child behavior and temperament. Interactions and transactions between these constructs, and with 48m child outcome, were scrutinized in an effort to explain the developmental process in preterms, as compared to fullterms. Dynamics of the developmental process, as well as hypothesized self-righting mechanisms, were investigated.

Stability issues. A transactional framework suggests that stable developmental influences should have a greater impact on child outcome. Therefore, the stability of each important construct was examined, and compared between groups, using standardized pairs of correlations. In general, fullterms were expected to be only somewhat stable in their earlier behavior and developmental test performance. However, preterms were expected to show relatively less stability in early child behavior and developmental status. Partly in response, less consistency over time was expected of mothers interacting with preterm children. The impact of certain stable developmental influences was investigated, by dividing the children into "stable" and "unstable" subgroups. For example, as mentioned earlier, consistently ill children were examined for less optimal outcome compared to those not experiencing stable illness.

Relative importance of developmental constructs over time. The relative importance of various biological and environmental risk factors, in explaining 48m child outcome, was examined within the preterm and fullterm groups, and over time. A number of multiple regressions revealed the weight and identity of variables of importance, and the relative efficacy of different sets of predictors.

As a beginning, the predictive power of biological and global environmental status (ES) were compared between groups. Both variables were expected to predict outcome in all children, but relatively more among preterms. Knowledge of biological status was expected to add more to the prediction of cognitive and visuomotor outcome than of social behavior. Conversely, knowledge of ES was expected to add more to the accuracy of social outcome prediction.

Next, indicators of "proximal" ES (maternal attitudes and mother-child interaction) were added as predictor variables to biological and global ES, and the combination of predictors scrutinized over time. Specifically, sets of these predictor variables, from the 4, 8, 12 and concurrent 48m timepoints, were examined in relation to 48m child outcome. Larger effects were expected both for later measures, and among the premature children (as evidence of a self-righting process). In particular, a strong negative association was hypothesized between preterm child outcome and poor quality of earlier and current mother-child interaction.

Third, measures of earlier child outcome were used as predictor variables, either in combination only with biological data, or combined with biological and global environmental data. Following Siegel (1984a), stronger effects were expected among the fullterms when data on early child outcome were included. In contrast, as mentioned above, stronger prediction was expected for preterms using data on the early environment.

Patterns of association. Using matched pairs of standardized correlations, a variety of indicators for each developmental construct were compared between preterms and fullterms, to discover differences in patterns of association with 48m child outcome. Birth order was expected to be more salient among preterms. Social support was expected to be more salient among preterms, while stress might prove more useful in predicting fullterm outcome. Attitudes (especially about the family) and behavior were hypothesized to link more closely among preterm mothers, perhaps also having a stronger relationship to preterm child outcome. These data was expected to be consonant with, but more detailed than, the regression findings.

Impact of maternal caregiving. Consistent with the emphasis on caregiving in the preterm literature, its importance to child outcome was inspected in several ways. Standardized simple and partial correlation pairs were used to discern stronger effects between caregiving and preterm outcome, with and without the influence of global environmental status. Following Beckwith (1983a), a more powerful, dynamic description of the impact of caregiving was sought. Better 48m outcome was expected in children experiencing consistently good caregiving, compared to those receiving nonoptimal caregiving at some point in time. This was especially expected to be the case with preterms. Finally, an inherently transactional variable, 12m security of attachment classification, was studied as a reflection of maternal caregiving. No preterm/fullterm differences were expected in security of attachment, nor in the predictive power of the attachment measure.

METHODS

Subjects

The Initial Sample

The "Mother-Infant Project" is a longitudinal investigation of an original sample of 105 mother-child pairs. During the project, data were gathered at 1, 4, 8, 12, 18, 24 and 48m. The initial group (seen one month after hospital discharge) was recruited during 1979-1980 from the University of Washington Hospital, and consisted of 52 premature and 53 fullterm dyads. Premature infants, seen in the Neonatal Intensive Care Unit, were defined as those with birthweight less than 1801 grams and gestational age under 38 weeks. Fullterms weighed more than 2500 grams, with a gestational age of 39-42 weeks. The following criteria applied to both groups: (1) singleton birth or single surviving twin; (2) absence of major identifiable abnormality; (3) no rehospitalization greater than five days in the first month following discharge; and (4) residence within two hours driving time of the University of Washington. Acceptance rates were 78% for preterms and 62% for fullterms.

Fullterm infants were case-matched to preterms as to the infant's race (white vs non-white), mother's education (12 years and below, 13-15 years, 16 or more years), and, as much as possible, family structure (single mother vs two-parent family). Groups were balanced for infant's sex, birth order, and type of delivery (caesarean section vs vaginal). In the original data, only one demographic variable distinguished the groups, with somewhat older preterm than fullterm mothers (_t_ (104) = 1.90, _p_ = .06). There was a wide variation of birthweight in both groups (preterms: 840-1,800g; fullterms: 2,600-4,550g), and about half (46%) of the premature infants had ideopathic respiratory distress syndrome (IRDS). Demographic characteristics for the original sample are given in Crnic, Greenberg, et al. (1983).

Intermediate Followup Samples

At each data collection point following the initial visit, there was some sample attrition. Yet for home and laboratory visits the attrition rate was relatively low, progressing from 12.4% at 4m to 33.3% at 24m (for the total sample). For the 18m mailing, there was a higher attrition rate of 38.1%. The preterm group showed somewhat more attrition than did the fullterms: 13.5% (4m) to 42.3% (24m), versus 11.5% (4m) to 24.5% (24m). Since some dyads missed earlier visits, only to return to the study at a later date, the attrition rate was higher for the sample of subjects with complete data over time. Table 1 gives the sample sizes and percentage attrition at each data collection period, as well as across time (e.g. data jointly available at the 1m, 12m and 48m timepoints.)

The 48m Followup Sample

Table 1

Sample Size and Attrition Rate at Each Data Collection Period and Across Time

Child's Age (in months) at Data Collection[a]	Number of Preterms	Preterm Attrition	Number of Fullterms	Fullterm Attrition	Total Attrition
1	52	0.0%	53	0.0%	0.0%
4	45	13.5%	47	11.5%	12.4%
8	41	21.2%	43	18.9%	20.0%
12	37	28.8%	41	22.6%	25.7%
18	29	44.2%	36	32.1%	38.1%
24	30	42.3%	40	24.5%	33.3%
48	38	26.9%	45	15.1%	21.0%
Subjects with essentially complete data at each of these timepoints[b]					
1 - 4 - 48	33	36.5%	38	28.3%	32.4%
1 - 8 - 48	31	40.4%	32	39.6%	40.0%
1 - 12 - 48	31	40.4%	37	30.2%	35.2%
1 - 18/24 - 48	21	59.6%	34	35.8%	47.6%

[a]Month 1 represents one month post-hospital discharge. Months 4, 8, 12, 18 and 24 represent corrected gestational age. Month 48 represents uncorrected gestational age.

[b]Partial data exists for some subjects, making the actual attrition rate for many variables lower than that shown above.

The fourth year followup phase of the Mother-Infant Project, the focus of this paper, involved 83 of the original group: 38 preterm and 45 fullterm dyads. This was actually a higher return than at the 12, 18, or 24m samples, with an attrition rate of only 21.0%. Two dyads refused to participate in this followup, while the remaining families (N=20) could not be located. Four subjects were seen in their homes outside Washington state. The fourth year attrition rate was somewhat lower for fullterms (fullterms: 15.1%; preterms: 26.9%). The fourth year sample was completely representative of the original group, according to an analysis in which dyads not seen in the fourth year phase (N=22) were compared with those subjects who were involved in this followup (see Table 2). There were no significant differences between dropouts and participants on corrected and uncorrected age at the 1m visit, race, sex, birthweight, gestational age, number of hospital days following birth, presence of IRDS and SGA, maternal age and education, presence of an income supplement, as well as family structure (single vs two-parent family). Note that throughout this paper probability levels are indicated in the following way: $p < .001$: ***; $p < .01$: **; $p < .05$: *; and $p < .10$: T.

Demographic characteristics for the fourth year sample are given in Table 3. Table 4 presents differences between environmental subgroups, and between preterms and fullterms, on demographic and biological data. As a whole, the followup sample continued to be largely middle class, but with a full range of socioeconomic scores. Environmental status subgroup (low, middle, high ES) differences varied according to which of three grouping variables was used (MOMED1,

Table 2

Representativeness of 48-Month Sample on Demographic and Biological Data

Variable	Statistic	Effect
Child Characteristics:		
Preterm or fullterm	x^2 = 1.56	-
1m corrected age	t = -1.95	Dropouts younger
1m actual age	t = 0.33	-
Sex	x^2 = 0.45	-
Presence of SGA	x^2 = 0.00	-
Presence of IRDS	x^2 = 0.34	-
Birthweight	t = -1.17	-
Gestational age	t = -1.30	-
Reversed number of days in hospital	t = -0.49	-
Family Characteristics:		
Maternal age	t = -0.87	-
1m maternal education	t = -2.18	Dropouts less educated
Ethnicity	x^2 = 1.58	-
1m family structure	x^2 = 0.86	-
1m presence of income supplement	x^2 = 2.50	-

Note. Representativeness calculations compared the 48m participants with the 22 dropouts from the 48m sample. There were 104 degrees of freedom for all t-tests, and 1 degree of freedom for all chi square statistics.

Table 3

Characteristics of 48 Month Sample by Environmental and Biological Status

A. Characteristics of Environmental Status (ES) Subgroups

	ES Subgroups		
Measure of ES	low	middle	high
1m maternal education in years of school (MOMED1)[a]	(<12 yrs) n=15	(12 yrs) n=35	(≥13 yrs) n=33
48m maternal education in years of school (MOMED48)[a]	(<12 yrs) n=12	(12 yrs) n=26	(≥13 yrs) n=44
48m 4-Factor Family Hollingshead Score (FHHEAD48)[b]	(Classes I and II: 11-30) n=30	(Classes III & IV(partial): 31-45) n=38	(Classes IV (partial) & V: 46-67) n=12

[a]One mother in 48m sample was deceased, so total N=82.

[b]Two Hollingshead scores could not be computed, so total N=80.

Table 3 (continued)

B. Characteristics of Preterms and Fullterms

	Preterms (n=38)			Fullterms (n=45)		
Variable	M or n	low-high	%	M or n	low-high	%
Child Characteristics:						
Uncorrected C.A. (months)	49.24	47-53	-	48.96	47-52	-
Corrected C.A. (months)	47.26	44-51	-	49.02	47-52	-
Sex (male)	22	-	57.9%	21	-	46.7%
Firstborn	22	-	57.9%	27	-	60%
Birthweight (grams)	1388.2	840-1800	-	3488.7	2600-4500	-
Gestation (weeks)	31.37	26-36	-	40.62	39-42	-
Days in hospital from 1m data	34.29	5-106		2.84	1-11	-
Presence of IRDS	19	-	50%	0	-	0%
Presence of SGA	7	-	18.4%	0	-	0%
Postnatal health factors score (higher=better health)	71.94	50-160	-	149.80	87-160	-
Childhood health (higher=better health)	2.29	1-3	-	2.67	1-3	-

Table 3 (continued)

Variable	Preterms (n=38)			Fullterms (n=45)		
	M or n	low-high	%	M or n	low-high	%
Family Characteristics:						
Maternal age (years)	30.43	21-46	-	28.09	21-41	-
48 maternal educational level (years of school)	13.00	10-18	-	13.24	9-19	-
If any, partner's educational level (years of school)	13.86	8-22	-	14.33	9-24	-
4-Factor Family Hollingshead Score	38.32	14-66	-	32.22	12-66	-
Ethnicity (white)	32	-	84.2%	33	-	73.3%
Presence of income supplement	12	-	31.6%	9	-	20.0%
Weighted measure of household change	2.87	0-10	-	3.71	0-12	-

Table 4

Between-Group Differences in Demographic and Biological Data for Biological and Environmental Status Groups

BIOLOGICAL STATUS VARIABLE: GROUP
(Preterm (PT) vs. Fullterm (FT))

Variable	Statistic	Effect
Child Characteristics:		
Corrected age	$t(81) = -5.15$***	PT < FT
Actual age	$t(81) = 0.81$	-
Sex	x^2 (1,N=83) = 0.64	-
Birth order	x^2 (1,N=83) = 0.00	-
Family Characteristics:		
Maternal age	$t(80) = 2.03$*	PT > FT
Maternal education (1m)	$t(80) = -0.69$	-
Paternal education	$t(59) = -0.58$	-
4-Factor Family Hollingshead	$t(80) = 2.11$*	PT > FT
Ethnicity	x^2 (1,N=83) = 0.87	-
Family structure	x^2 (1,N=83) = 0.11	-
Income supplement	x^2 (1,N=83) = 0.91	-
Weighted total of household change	$t(81) = -1.37$	-

Note. Between-group differences were calculated using only the dichotomous biological status predictor variable of GROUP. However, the continuous biological status predictor variables of BIOSUM1 and BIOSUM48 (if dichotomized) yielded identical results. See Appendix A-Table 1 for definitions of these grouping variables.

Table 4 (continued)

Variable	Statistic	Effect
ENVIRONMENTAL STATUS VARIABLE: MOMED1 (1m Maternal Education: LOW (<12 yrs), MID (12 yrs), HIGH (≥13 yrs)		
Child Characteristics:		
Corrected age	$F(2,80) = 2.99$	-
Actual age	$F(2,80) = 2.98$	-
Sex	$x^2(2,N=83) = 3.72$	-
Birth order	$x^2(2,N=83) = 0.05$	-
Presence of SGA	$x^2(2,N=83) = 3.17$	-
Presence of IRDS	$x^2(2,N=83) = 1.97$	-
Birthweight	$F(2,80) = 0.75$	-
Gestational age	$F(2,80) = 0.01$	-
Reversed no. of days in hospital	$F(2,80) = 0.25$	-
Postnatal health	$F(2,80) = 0.36$	-
Childhood health	$F(2,80) = 0.33$	-
BIOSUM1	$F(2,80) = 0.15$	-
BIOSUM48	$F(2,80) = 0.31$	-
Family Characteristics:		
Maternal age	$F(2,79) = 7.40$***	LOW, MID < HIGH
Ethnicity	$x^2(2,N=83) = 3.31$	-
Family structure	$x^2(2,N=83) = 2.07$	-
Income supplement	$x^2(2,N=83) = 9.27$**	LOW < MID, HIGH

Note: See Appendix A-Table 1 for definitions of the three environmental status grouping variables (MOMED1, MOMED48, and FHHEAD48).

Note that the between-group differences for MOMED48 are even fewer than those presented here. For MOMED48, the only significant difference was on maternal age ($F(2,80) = 5.23$** effect: LOW < MID < HIGH).

In contrast, for FHHEAD48, there were a number of significant differences between environmental subgroups. These can be summarized in three points. First, the higher the FHHEAD48 socioeconomic score, the sicker the child in early life. Second, the lower the FHHEAD48 score, the more optimal the child's overall BIOSUM1 score. Third, the lower the FHHEAD48 score, the more likely the mother to be younger, on welfare, living alone, and of minority status.

MOMED48, FHHEAD48, see Appendix A-Table 1 for definitions and descriptive statistics). There were very few differences between ES subgroups according to 1m or 48m maternal education. Mothers with less education were younger and, using the 1m educational level, were more likely to be on welfare. There were a number of significant differences between low, middle and high socioeconomic status subgroups (using FHHEAD48). These can be summarized in three points. The higher the socioeconomic status, the sicker the child in early life. The lower the socioeconomic status, the more optimal the child's overall biological status. Finally, the lower the socioeconomic status, the more likely the mother to be younger, on welfare, living alone, and of minority status.

In the 48m followup study, the mean uncorrected chronological age of the children in the two birth status groups was quite similar: 49.2m for prematures and 49.0m for fullterms. The mean corrected age was 47.3m for prematures and 49.0m for fullterms, a 1.7m difference. As can be seen in Table 4, there were no differences between preterms and fullterms on race, sex, birth order, maternal and paternal education, family structure, presence of an income supplement, or weighted total of household change (see Instruments and Variables section for more information on this last measure). Table 4 shows only three significant demographic group differences, using one-tailed t-tests. As mentioned above, the preterm group had a lower corrected age score ($\underline{t}$ (81) = -5.15, $\underline{p}$ =.000). There was a significant difference on the variable of maternal age, with slightly older preterm than fullterm mothers (mean age difference of 1.6 years, $\underline{t}$ (80) = 2.03, *p* =.046). This difference, along with the difference in mother age according to environmental status, required use of maternal age as a covariate in all between-group statistical analyses. There was also a significant preterm-fullterm difference on the Four-factor Hollingshead Family socioeconomic status score (FHHEAD48), with higher socioeconomic status among the preterms (mean difference of 6.1 units, *t* (80) = 2.11, *p* =.038). This significant difference suggested the use of environmental status, along with birth status, in a two-factor examination of group differences.

Data Collection Procedures

Age of Children at Time of Data Collection

In the study of prematurity, use of the gestational age correction is controversial, especially for children aged two years and older. Advocates for the corrected gestational age score speak from a biological perspective, assuming that early development mainly involves maturation, proceeding as a function of the time since conception. Use of the chronological age criterion arises from an environmental view, which presumes that experiential influences begin at the moment of birth. Typically, the corrected gestational age has been recommended for use in comparing preterms and fullterms, at least during infancy (Hunt, 1981). This practice is based on the idea that infancy is the time when maturational influences are paramount, as well as the notion that an age correction separates immaturity from other sequelae of preterm birth. There is no consensus on a recommended criterion for older children. However, developmental theory suggests use of the chronological age score for this age group, as a reflection of the increasing impact of the environment which occurs as children grow.

Recent research shows that an uncorrected age criterion, used during infancy, enables more accurate prediction of later preterm outcome (Dubowitz, Dubowitz, Palmer, Miller, Fawer & Levene, 1984; Landry et al., 1984), and that the gestational age correction overcompensates when infants are over two months premature (Miller, Dubowitz & Palmer, 1984). Siegel (1983a) systematically examined the merits of corrected vs uncorrected age scores in a preterm-fullterm comparison study, looking both at infants and preschoolers (up to age five). Looking at the preterm group in the early months, she found some correlations were higher when corrected scores were used. For preterms of 12m and up, some correlations were higher when utilizing uncorrected age scores. However, there were basically no consistent significant differences between the predictive ability of the two types of scores, suggesting that either one could be employed. Landry's research group (1984) noted that the choice of a criterion age score may depend on the particular characteristics of a preterm sample, while Miller's group (1984) even suggested that a new measure be devised.

In the Mother-Infant Project, the corrected age score served as a basis for scheduling the five data collection visits, and scoring developmental data, during the first two years of life. This adheres to the notion that maturational characteristics are most significant early in development. At age four, the actual chronological age was employed as the scheduling and scoring criterion, since experiential characteristics increasingly assert their importance over time. But certain pieces of data were calculated using both criteria. At the early ages, this was done to reduce the possibility of overcorrection, since the Mother-Infant Project involves infants a minimum of two months premature. At age four, this was done to see if preterm-fullterm outcome differences were maintained even with an allowance made for a continuing maturational deficit among older premature children.

Type of Data Collected

Throughout the project, data were gathered in the following areas: (A) demographics (global environmental data); (B) child biological characteristics; (C) maternal attitudes (stress, support, satisfaction with parenting and life, childrearing attitudes, family perceptions); (D) mother-child interaction; (E) child developmental outcome: social; and (F) child developmental outcome: linguistic, cognitive and visuomotor). For those variables analyzed in the 48m followup study, variable abbreviations and definitions, as well as selected descriptive statistics, are given in Appendix A. For a complete list of measures used in the Mother-Infant Project (MIP), see Appendix D.

Specific Data Collection Procedures

At 1 and 48m, the mother-child pairs were visited in their homes.

At 4, 8, 12 and 24m, data collection occurred at the Child Development and Mental Retardation Center (CDMRC) at the University of Washington. At 18m, a mailing was sent to participating mothers. Demographic and attitudinal information was collected from the mothers through structured interviews (at 1, 8 and 48m) and questionnaires (at all time periods). The children were tested at 4, 12, 24 and 48m to obtain developmental data. At the 4, 8, 12 and 24m time periods, interactional data were gathered during sessions held in a small CDMRC room equipped with a comfortable chair, infant seat or chair, toys, magazine, microphone and one-way mirror. At each of these videotaped sessions, the pairs engaged in a 10-minute unstructured free-play episode, followed by a semistructured episode which varied in length and content at each age. At the 48m session, the dyads were observed in vivo during a 10-minute semistructured interaction in their homes.

At the 1, 4, 8, 12 and 24m sessions, data were gathered by several female research assistants trained at the graduate level in child testing and adult interview techniques. For the 48m visit, nine female undergraduate students were given six months of training in the principles of developmental testing and parent interview strategies. These students then conducted the home visits, accompanied about half of the time by the female graduate student who had trained them.

Instruments and Variables

In the text, brief information is provided about widely used or well-standardized instruments, while more detailed information is given for less well-known measures.

A. Global Environmental Information

At the 1, 18 and 48m visits, each mother supplied information about her age, her educational level (calculated as number of years of actual schooling), her occupation, the occupation and education of her partner (if any), the family structure, and the presence of a family income supplement (welfare, Social Security, etc.)

At 48m, in addition to the above information, the mothers were asked to describe all times, over the child's lifespan, that someone had moved in or moved out of the household for two months or more. Four developmental psychologists weighted each reported event for the amount of readjustment required by the child, and each family was then given a score for the weighted total of household change (WTCHANGE48). (For example, on a 40-point scale a divorce was rated 34 and a parental death was scored as 40) (Carmichael-Olson, 1984a). This variable gave some idea of the amount of environmental stress created by entrance and loss events in the child's life.

At 8m, additional information was gathered about the home environment. Barnard's (Note 1) questionnaire modification of the infant version of Caldwell's HOME Inventory was used. (The full title of the original tool is the "Home Observation for Measurement of the Environment" (Elardo, Bradley & Caldwell, 1975). Preliminary data on this modified measure showed adequate reliability and validity.

For statistical analysis, global environmental status was summarized in three ways (see Table 3 and Appendix A-Table 1). Two measures were of maternal educational level, at 1m (MOMED1) and 48m (MOMED48). Maternal education has often been used as an indicator of the aspects of a child's environment pertinent to development. A second, broader environmental measure was the Four-factor Hollingshead Family socioeconomic status score (FHHEAD48), based on the weighted occupation and education of gainfully employed parents. Hollingshead (1976) reported a correlation of .927 between the Four-factor index and the extensively researched Siegel Occupational Scale. In addition, Hollingshead found a correlation of .849 with maternal years of education. In this study, the correlation between MOMED48 and FHHEAD48 was .59 (N = 82, p = .001).

B. Child Biological Characteristics

Gestational age was estimated following a system created by Dubowitz, Dubowitz and Goldberg (1970). Additional data obtained from hospital records included the child's birthweight, sex, presence of IRDS and SGA, number of days in the hospital, and infant postnatal medical complications. A postnatal health factors score (PNHEALTH) was created from the data on medical complications, according to a procedure developed by Littman and Parmalee (1978). The child's health from age one-and-a-half to four (KIDHEALTH) was measured by a severity rating of a maternal description of the child's illnesses, accidents and developmental problems over that time period (interrater reliability calculated as percentage of exact agreement was 95%).

For statistical analysis, the child's biological status was measured in three ways. First, it was described as the "psychological" insult of prematurity (GROUP), a dichotomous variable measured by the fact of preterm birth. In addition, it was defined as the "biological" insult of prematurity, two continuous variables (BIOSUM1 and BIOSUM48) constructed by summing the above measures of the child's biological characteristics at two timepoints. Note that all preterms (defined by GROUP) had lower BIOSUM# scores than their fullterm counterparts. See Appendix A-Table 1 for the definitions, descriptive statistics, and internal consistency of the two BIOSUM# scores. The dichotomous variable was employed in group difference questions, while transactional hypotheses were generally tested with the continuous variable.

C. Maternal Attitudes

Stress. At 1, 8, 18 and 48m, maternal perception of major negative life stress was measured using a slightly modified version of the Life Experiences Survey (LES-M) (Sarason, Johnson, & Siegel, 1978). At each administration, the mothers rated stressful events occurring during the previous twelve months. They identified each event as positive or negative, and indicated to what degree these events had affected them. Used in this study was the measure of the total impact of negative life events. The original LES has been used extensively in research, and has adequate reliability and validity data.

<u>Perceptions of social support, satisfaction with parenting, and general life satisfaction.</u> Several maternal attitudes were assessed with the Inventory of Parental Experiences (IPE), which was developed for the Mother-Infant Project. Prior data have shown adequate reliability and validity for the IPE (Crnic, Greenberg, et al., 1983).

Parental perceptions of social support were evaluated with the Social Support Questionnaire, part of the IPE. These questions tap satisfaction with available sources of social support at different ecological levels. Items concerning community and friendship support measure number of contacts and satisfaction with the availability of these contacts. Other questions evaluate the presence of family and intimate relationships and the respondent's satisfaction with them. Data on social support were obtained at 1, 18 and 48m. At 48m, internal consistencies were: community support (COMSAT: $\alpha = .65$); friendship support (FRDSAT: $\alpha = .72$); intimate support (ATTSAT: $\alpha = .66$); family support (FAMSAT: $\underline{r} = .95$). Earlier internal consistency data were similar.

Other rating scales from the IPE were used to ascertain overall life satisfaction and satisfaction with parenting at each time period. The index of general life satisfaction (GLS) is a single five-point scale ranging from very low to very high (Crnic, Greenberg, et al., 1983). Satisfaction with parenting is assessed via 11 items which measure the mother's degree of pleasure in her child (SATISKID) and in her parenting role (SATISPARENT) (Ragozin, Basham, Crnic, Greenberg & Robinson, 1982). 48m scale consistencies were: SATISKID: $\alpha = .66$; and SATISPARENT: $\alpha = .80$, similar to earlier consistency data.

Childrearing attitudes. Data on childrearing attitudes were gathered only at 18 and 48m. At the 18m session, part of the Maternal Attitude Scale (MAS) (Cohler, Weiss & Grunebaum, 1970) was used to glean information on the mother's attitudes towards her developing relationship with her child. The MAS yields three factors, including: (1) appropriate vs inappropriate control of child aggression; (2) encouragement vs discouragement of reciprocity; (3) acceptance vs denial of emotional complexity in childcare. The MAS demonstrates adequate reliability and validity, as well as some interesting relationships to security of attachment.

At 48m, the Rickels and Biasatti (1982) modification of the Block Childrearing Practices Report (CRPR-M) was employed. Originally a 90-item Q-Sort procedure, the modified version contains 40 statements about childrearing attitudes. These are answered according to a six-point Likert scale, ranging from "not-at-all true of me" to "very true of me." Restrictiveness and nurturance factor scores are derived from the parent's answers. According to Rickels and Biasatti, measures of internal consistency for these two factors were both .85. Test-retest reliability was in the .80's for each factor. Little validity data were available. In particular, there were no data relating this self-report of attitudes to actual childrearing behavior, and no information on discriminative validity. These types of data can be provided, to some extent, by the present study.

Parental perceptions of the family environment. Attitudes about the family were assessed only at 24 and 48m. At the two-year session, the widely-used Family Environment Scale (FES) (Moos & Moos, 1981) was utilized. This 90-item scale assesses the social climate of the family, yielding three scales (and 10 subscales) which delineate interpersonal relationships among family members, the directions of personal growth emphasized in the family, and the basic organizational structure of the family. Moos and his colleagues have shown acceptable reliability and validity for the FES.

At age four, the 30-item Family Adaptability and Cohesion Evaluation Scales (FACES II) were utilized. These fairly new scales evaluate parental perception of "family adaptability" and "family cohesion," two theoretically-based dimensions of family behavior (Olson, Portnor, & Bell, 1982). Family cohesion involves the emotional bonding the family members have to one another, and measures the degree to which family members are separated from or connected to their family. Family adaptability addresses the extent to which a family is flexible and able to change. Families with moderate scores on both dimensions are considered to have the most healthy family functioning. As reported by Olson and his colleagues, internal consistency on the FACES II was .87 for cohesion and .78 for adaptability, based on data from a large study of families. Four to five-week test-retest reliability on a student sample was in the .80's. Discriminative validity information indicated that clinic families tended to display more extreme scores.

D. Mother-child Interaction

Interaction between mother and child was assessed in developmentally appropriate situations across the birth to age four time span of this study. Unstructured "free" play, relevant throughout childhood, was observed at each time period, except 48m. A semistructured observational episode was included at each visit, but the task(s) used were different each time. At 4 and 8m, the mothers were asked to encourage their infants to make sounds, and then to imitate the actions of their babies. At 12m, several actions were requested of the mothers, including: (1) looking at picture books with the children; and (2) engaging in a six-minute separation-reunion sequence. At the 24m session, mother-child dyads involved themselves in a series of successively more complicated and frustrating problem-solving tasks, lasting approximately 20 minutes. Termed the "lever task," this situation is described in Matas, Arend & Sroufe (1979).

The interactional data gathered in these situations were analyzed in several ways. At a global level of analysis, "interaction quality ratings" were separately coded for mother and child during the unstructured and semistructured episodes captured on videotape at 4, 8, 12, and 24m. Each measure represented the sum of three five-point scales: mother gratification from interaction (degree of enjoyment), general affective tone (angry/irritated to happy), and sensitivity to infant cues (intrusiveness to synchrony); as well as infant gratification from interaction, general affective tone, and responsiveness to mother (avoidant to active involvement). Interrater reliability was calculated as percentage of exact agreement (4-12m: 76%) and agreement within one scale point (4-12m: 97%), and reliability from 4-24m was similar. Internal consistency was acceptable. Child compliance was assessed at 12 and 24m as the percentage of times the child complied to maternal commands, demands, and requests.

The videotaped 12m separation-reunion sequence was modified from the 21-minute Strange Situation (Ainsworth, Blehar, Waters & Wall, 1978), a task with extensive validity data. In this study, the Strange Situation was shortened, using one three-minute separation followed by a three-minute reunion episode. The separation sequence was coded for amount of infant distress (mild, moderate, severe). In addition, guided by Ainsworth's attachment coding criteria, attachment category (secure vs insecure-avoidant vs insecure-ambivalent) was scored. Interrater reliability was computed as percentage of exact agreement (89.5%-distress score; 85%-attachment category).

See Section E below for a discussion of the mother-child interaction data gathered at 48m.

E. Child Social Outcome

Child social behavior is clearly multidimensional. As Carmichael-Olson (1982) and Greenspan (1980) have pointed out, there are many considerations in assessing this construct. The child's developmental level is one consideration, as is the behavioral context used in assessment. Evaluation will differ depending upon the theoretical approach (e.g. factor analytic vs attachment theory), as well as the "definitional" viewpoint. One "definitional" view is a "product" versus "process" focus, a topic discussed in more detail later in this paper. Another is a "positive" versus "negative" measurement focus, as exemplified by behavior problem versus coping scales. A further consideration is the measurement level of the tool (e.g. microanalysis vs rating scales). A final and most interesting consideration is the "perspective" of the instrument. Different raters construe child social behavior quite differently, with only low moderate congruence between viewpoints. To fully assess social outcome, multiple perspectives are needed including, if possible, the rarely studied child's view of his/her own social skill.

With these points in mind, note that researchers have often assessed infant social behavior with measures of temperament. This was true in the Mother-Infant Project, though the observations of caregiver-infant social interaction described earlier were also included. Later in childhood, researchers have used more varied measures of social behavior, as no one tool adequately captures the child's performance. The present followup MIP study used a multidimensional assessment strategy to describe 48m child social behavior, including an observation of caregiver-child interaction.

Data from the first two years. During the early phases of the Mother-Infant Project, aspects of temperament (mood, distractibility and intensity) were examined. Sostek and Anders' (1977) instrument was used at 1m, and Carey and McDevitt's (1977) test at 8m. Both tools have adequate reliability and validity. As mentioned above, characteristics of the child's social interaction with his/her mother during developmentally salient tasks were observed in the laboratory at 4, 8, 12 and 24m.

Four-year parental and child report data. At 48m, child social behavior was studied in depth. Multiple measures of social behavior were chosen to gather information adequate to assess this multidimensional construct. Parent and child perspectives were assessed "cross-contextually," through parental and child report. (A third perspective, that of an observer, was also assessed. See the next section.) "Product" vs "process" definitions of child social behavior were evaluated. A "product" measure shows how the rater (and the culture) label the child's social behavior (e.g. depressed, delinquent, immature), while a "process" measure generates a theoretical profile of the child's approach to the world (e.g. the child's degree of ego resilience and emotional control). Positive (e.g. coping resources) and negative (e.g. behavior problem) definitions of child social behavior were examined. An age-appropriate measure of temperament was also included.

Five instruments were used to evaluate child social behavior at 48m. Table 5 describes how these tools reflect the multidimensional nature of child social behavior. First was the California Child Q-Set (Block & Block, 1969). To use the Q-Set, mothers sort 100 statements, which describe child behaviors or "personality" characteristics, into nine ordered categories. This procedure scales the items from "most descriptive" (9) to "least descriptive" (1) of the child. By

Table 5

48-Month Measures of Child Social Behavior

Measure	Variables Derived from Measure	Measurement Issues
California Child Q-Set (Block and Block, 1969)	Individual Scales: ego control ego resiliency	parent view cross-contextual "process" focus Q-sort scaling personality theory approach
California Behavior Checklist (CBCL)[a] (Achenbach and Edelbrock, 1983)	Behavior Problem Individual Scales: Both Sexes: aggression depression schizoid sex problems social withdrawal somatic complaints Girls Only: hyperactive obese Boys Only: delinquent immature Social Competence Individual Scales: activities social Summary Scales: externalizing internalizing total social competence	parent view cross-contextual "product" focus positive and negative focus Likert scaling factor analytic approach
Health Resources Inventory (HRI) (Weissberg, Gesten and Ginsberg, 1981)	Individual Scales: frustration tolerance good student gutsy peer sociability rules	parent view cross-contextual "product" focus positive focus Likert scaling factor analytic approach

Table 5 (continued)

Measure	Variables Derived from Measure	Measurement Issues
Perceived Competence Scale (PCS)[b] (Harter and Pike, 1981)	Individual Scales: cognitive competence physical competence maternal acceptance peer acceptance Summary Scores: competence score acceptance score	child view cross-contextual "product" focus Likert scaling
Dimensions of Temperament Scale (DOTS) (Lerner, Palermo, Spiro and Nesselroade, 1982)	Individual Scales: activity adaptability attention span reactivity rhythmicity	parent view cross-contextual "process" focus true-false scaling temperament theory approach
Waiting Task Child Summary Score (Carmichael-Olson, 1984b)	Individual Scales: child affect (negative to positive) child style (facilitating vs. nonfacilitating) Summary Score: sum of standardized child affect plus child style	observer view single context "process" focus Likert scaling "behavioral organization" theory approach

[a]Only the three CBCL summary scores were used in this study.

[b]Only the PCS "acceptance" summary score was used in this study.

correlating a child's pattern of results with criterion patterns, the items are aggregated into two broad-based child personality parameters: ego resiliency and ego control. Concurrent validity data can be provided by this study. For details on Q-Sort methodology and reliability, see Block (1978).

Second was the Child Behavior Checklist (CBCL) (Achenbach & Edelbrock, 1983). Developed through factor analytic techniques, this parental rating form contains 118 behavior problem items, scaled from 0 (not true) to 2 (very true). Item ratings are summarized into individual dimension scores and summary scores. The CBCL also includes 12 social competence items for four-year-olds, which summarize the amount and quality of a child's involvement in activities and social relationships. There are norms for four-year-olds. Achenbach and Edelbrock (1983) reported interparent agreement and one week test-retest reliability in the .90's. Concurrent and discriminant validity are satisfactory. There are apparently no published data on the internal consistency of the CBCL.

The Health Resources Inventory (HRI) (Weissberg, Gesten & Ginsberg, 1981) was the third tool. It contains 54 items, which are rated according to how well they describe the child, on a scale from not at all (1) to very well (5). HRI items attempt to tap competence-related child social behaviors. Originally designed for use by teachers of primary grade children, the HRI yields five factor scores. The scale was slightly modified for this study, so it could be used with parents of younger children, but the five factor scores were still generated. Gesten (1976) reported four to six-week test-retest reliabilities of .72 to .91 for the factor scores. There is some evidence supporting the concurrent and discriminant validity of the HRI, amd more can be provided by this study.

Fourth was the Perceived Competence Scale (PCS) (Harter & Pike, 1981). This tool assesses the young child's perceptions of his or her competence and social acceptance. In the preschool-kindergarten form used here, 24 two-picture plates are presented to the child, showing a competent child in one picture, and an incompetent child in the other. The child rates each item from (1) a lot like the incompetent child to (4) a lot like the competent child. Harter and Pike (1984) reported internal consistency of .86 for the PCS preschool social acceptance scale (labelled KDACCEPT in this study). They also gave preliminary evidence of adequate discriminant, predictive and convergent validity for the PCS subscales. More data on the validity of the PCS are needed, and may be provided by the present study.

The fifth instrument was the Dimensions of Temperament Scale (DOTS), parent report version (Lerner, Palermo, Spiro & Nesselroade, 1982). This rating form tries to capture dimensions of the child's temperament. 34 true-false items are aggregated into five scales, which assess the child's activity level, adaptability, attention span, reactivity and rhythmicity. According to Lerner et al. (1982), some initial validation data are available. More is needed, and may be generated by the present research. Test-retest reliability was reported at about .82. Internal consistency of the five temperament scales, calculated from a somewhat longer version of the DOTS, averaged about .72.

Four-year observational data: the "Waiting Task". Characteristics of child social behavior during semistructured mother-child interaction were observed at the four-year visit. This added an "observer" perspective to the multidimensional evaluation of child social behavior. In addition, this semistructured observation provided parent-child interactional data somewhat similar to that obtained during the first two years of the project.

The brief observational situation developed for the fourth year followup study was called the "Waiting Task." Arising from an attachment theoretical viewpoint (Marvin, 1977; Sroufe & Waters, 1983), it was designed to assess the partnership between a mother and her four-year-old child while the dyad is engaged in a developmentally salient task. During the actual "waiting task" episode, mother and child have to wait for a gift, which is sitting in plain sight, for 10 minutes. To accomplish the task, the dyad have to form some sort of partnership, setting up and carrying out a plan for waiting.

The "waiting task" was coded live at each home visit by a pair of independent observers. Several dimensions were coded, including stylistic characteristics of the mother-child partnership (see Table 6). The style of the mother-child partnership was evaluated by examining how each member of the dyad performed his/her role in the waiting process, and how their roles meshed. The style codes arose from a dyadic perspective, describing how mother or child behaved in relation to the other during the waiting process. "Facilitating" behavior by either member of the dyad enabled the pair to move more

Table 6

48-Month Waiting Task Coding System: Variables, Descriptive Statistics and Interrater Reliability

Variable		Descriptive Statistics			Interrater Reliability[c] (agreement)
QUANTITATIVE RATINGS		*M*	*SD*	low - high	
Frequency of negotiation about the waiting task[a]	Preterm	1.93	(.84)	1-3	73.3%
	Fullterm	2.23	(.86)	1-3	75.6%
	Total	2.10	(.86)	1-3	74.6%
1=very little or no negotiation 2=occasional negotiation 3=frequent negotiation					
Maternal affective tone[b]	Preterm	3.88	(.88)	2-5	100.0%
	Fullterm	3.84	(.70)	2-5	95.1%
	Total	3.86	(.78)	2-5	97.2%
1=negative 2=low intermediate 3=mixed, flat 4=high intermediate 5=positive					
Child affective tone[b]	Preterm	3.62	(1.22)	1-5	93.3%
	Fullterm	3.56	(1.05)	1.5-5	95.1%
	Total	3.57	(1.12)	1-5	94.3%
1=negative 2=low intermediate 3=mixed, flat 4=high intermediate 5=positive					
Dyadic Satisfaction[b]	Preterm	3.72	(1.16)	1-5	86.7%
	Fullterm	3.60	(1.07)	1-5	95.1%
	Total	3.65	(1.10)	1-5	91.6%
1=low 2=low intermediate 3=medium 4=high intermediate 5=high (Defined as: pleasure derived by both members of the dyad from the interaction.)					

Table 6 (continued)

Variable	Descriptive Statistics				Interrater Reliability[c]
Dyadic Facilitation[b]	Preterm	3.68	(1.08)	1-5	96.7%
	Fullterm	3.78	(.98)	1-5	95.0%
	Total	3.74	(1.02)	1-5	95.7%
1=not very facilitating 2,3,4=intermediate 5=facilitating					

QUALITATIVE RATINGS	Preterm	Fullterm	Total	
Maternal Style[a]	% nonfac.: 39	% nonfac.: 36	% nonfac.: 37	
Facilitating				
Not very facilitating				
	n:	n:	n:	80.0% PT
1=Authoritarian	2	4	6	85.4% FT
2=Oversupportive	8	10	18	83.1% Total
3=Ignoring	2	2	4	
4=Unpredictable	2	0	2	
Child Style[a]	% nonfac.: 36	% nonfac.: 29	% nonfac.: 32	
	n:	n:	n:	90.0% PT
Facilitating	23	32	55	92.7% FT
Not very facilitating	13	13	26	91.6% Total
Waiting Task Typicality	% typical: (2+3):83	% typical: 84	% typical: 84	
	n:	n:	n:	(rated by mothers)
1=Not very typical	6	7	13	
2=Somewhat typical	12	12	24	
3=Very typical	17	26	43	

Table 6 (continued)

[a] Exact agreement

[b] Agreement within one scale point.

[c] Interrater reliability calculated as agreement/total number of responses. Reliability computed for 71 of the total (N=83) number of subjects. Twelve subjects were scored by only one rater.

smoothly through the waiting period.

The child's role was to show impulse control during the waiting period, and the style in which the child carried out this role (in relation to the mother's behavior) was coded. If the child showed significant, age-appropriate attempts at impulse control, thus helping the dyad to move through the waiting period, s/he was rated as "facilitating." If not, then a rating of "nonfacilitating" was assigned. For example, a "facilitating" child might talk about a plan for waiting, assuming the mother was receptive to discussion, then sit with the mother's watch waiting for the time to elapse. A "nonfacilitating" child might tear open the gift, unless prevented by the mother or, more subtly, whine and make disturbing noises during the waiting period. A standardized sum of the child's style rating plus a rating of the child's affective tone (discussed below) comprised the observer measure of child social outcome during the waiting task.

The mother's role was to act in relation to her child, either encouraging the child in flexible self control, or assuming the burden of her child's impulse control. The style in which the mother carried out this role was coded. If the mother encouraged the child in self control, she was considered "facilitating." If she took over the child's role, she was considered "nonfacilitating," in one of several qualitatively different ways:

a. "Authoritarian:" commanding the child to wait and to use certain waiting strategies, thereby taking responsibility for the child's impulse control. In this case, all the child need do is comply.

b. "Oversupportive:" distracting the child, and coming up with many strategies for the child to use in getting through the waiting period, thereby taking responsibility for the child's impulse control. In this case, all the child need do is select several strategies and implement them.

c. "Ignoring:" giving the child no help in getting through the waiting period, even when aid is clearly needed, thereby abdicating her role of helping the child to achieve flexible self control.

d. "Unpredictable:" appearing nonfacilitating, but in an unpredictable manner, with characteristics of several of the above-mentioned styles.

In addition to partnership style, the following dimensions were scored (see Table 6). Frequency of negotiation was coded on a three-point scale (low to high), while mother and child affective tone were rated separately on a five-point scale (negative through flat/mixed to positive). Dyadic satisfaction was rated from one to five (low to high). The affect and satisfaction scales were similar to, but not identical with, the "interaction quality ratings" taken from videotape during earlier subject visits.

Reliability figures are given in Table 6. For quantitative categories, percentage of agreement within one scale point was computed for all subjects, ranging from 92% to 97%, with one less important code at 75%. For qualitative categories, percentage of exact agreement was calculated for all subjects, ranging from 83% to 96%.

Summary of four-year child social behavior data. The 17 scales derived from the five parent and child measures of social behavior were factor analyzed, along with the two child indices from the waiting task observational situation. Then the data were summarized in estimated factor scores, which are described in the Results section, and defined in Table 9. These aggregate factor scores were used as the child social outcome measures in many analyses.

F. Child Cognitive, Visuomotor and Linguistic Outcome

Reliability and validity data for the following measures of cognitive and visuomotor skill are well-known and quite adequate.

Early developmental outcome. Early developmental status was assessed via the Bayley Scales of Infant Development (Bayley, 1969) at 4, 12 and 24m, generating indices of mental and psychomotor development.

48m visuomotor and cognitive skills. At age four, visuomotor skills were quantified with an age equivalent score generated by the Developmental Test of Visuomotor Integration (VMI) (Beery, 1967). This was calculated according to both actual and corrected age in preterms. 48m cognitive ability was briefly evaluated with the Information and Block Design subtests of the Wechsler Preschool and Primary Scales of Intelligence (WPPSI) (Wechsler, 1967). These two subtests were chosen for several reasons. According to Sattler (1974), the Information plus Block Design short form of the WPPSI has a reliability coefficient of .835, highest of any two-subtest version. Wechsler credits the Information subtest with the highest correlation between the WPPSI Verbal Score (.83) and the Full Scale Score (.78), while the Block Design subtest is reported to have the highest correlation with the WPPSI Performance Score (.72). Sattler states that the Information subtest evaluates verbal comprehension, and is a useful indicator of the impact of the child's environment upon development. Sattler also writes that the Block Design subtest assesses speeded perceptual organization and spatial visualization skills, which are of interest in studying preterm development.

Receptive language. Receptive linguistic outcome was evaluated at the 24m and 48m sessions via the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1959), yielding a raw score at age two, and a standardized score at age four (mean of 100). The PPVT has extensive and quite adequate reliability and validity data. Note that expressive language was not tested at 48m, and earlier expressive measures were not analyzed in the fourth year followup study.

Data Conditioning and Descriptive Statistics

The 48m data set was subjected to data conditioning procedures. Earlier sets of data (at 1, 4, 8, 12 and 24m) were treated in a similar manner. Conditioning procedures included: (1) evaluating the number and distribution of missing data; (2) choosing a missing data treatment procedure; (3) identifying and dealing with skewness; (4) identifying and dealing with univariate and multivariate outliers; (5) evaluating whether the data met multivariate assumptions, and dealing with any problems in this area.

There was little missing data in the 48m round of data collection, but essentially all that was missing came from the preterm group. Given this nonrandom pattern, the appropriate, conservative missing data treatments were: (1) pairwise deletion in analyses based on correlation matrices; and (2) omission of cases with missing data in group difference calculations. Mean substitution was never used as a missing data treatment.

Multivariate procedures assume data normality. For all fourth year variables used in analyses, skewness was checked for a significant difference from zero. If such a difference occurred, then a square root, arithmetic or logarithmic transformation was performed to produce a normally distributed variable. There were only 11 variables transformed in this way in the 48m data set.

All independent and dependent variables were inspected for univariate outliers, separately for each group. When possible, multivariate outliers were identified in the output of the analyses. Dichotomous variables with more than a 90%-10% split between categories were deleted or transformed. For the very few continuous variables with outlying z scores of ± 3.00, the outliers were deleted or recoded unless there was a logical reason to retain them. Recoding decisions were made on a case-by-case basis, depending upon the variable and analysis under consideration.

Multicollinearity (a nearly perfect correlation between variables) and singularity were dealt with by: (1) creating factors to summarize variables assessing the same hypothesized latent construct; (2) eliminating the one variable in the data set which was correlated .98 with another; (3) using rather conservative tolerance limits in regression analyses (defaults in the NEW REGRESSION program); and (4) omitting interaction effects which were multicollinear with main effects in regression analyses.

For the variables discussed in this paper, abbreviations, definitions and selected descriptive statistics (separately for preterms and fullterms) are given in Appendix A, tables 1 through 5. Table A-1 presents global environmental and biological status data; Table A-2 lists child outcome at 48m; Table A-3 includes 48m maternal attitudes; Table A-4 gives 48m mother-child interaction data; and Table A-5 presents information on measures collected in earlier stages of the Mother-Infant project.

RESULTS

Structure of Child Social Behavior

Statistical Procedures

Table 5 gives an overview of the six instruments and 19 component scales which comprised the child social behavior data.

Several techniques were used to discern the structure of child social behavior. First, the pattern of relationships among variables was revealed in intercorrelations between the 19 component scales from the six measures. Next, factor analytic procedures were used to reduce the data. An exploratory principal components extraction (PCA) generated an initial, empirical solution. Note that this solution was compared to a factor analytic extraction (FA), to assess stability of the PCA solution.

It was hypothesized that the multidimensional 48m data would reflect three perspectives on social behavior (parent, observer, child), but also adhere to Block and Block's proposed (1979) ego resiliency/ego control "process" distinction. Each of the three perspectives was represented by at least two measures, while Block and Block's theoretical approach was marked by Q-sort ego resiliency and ego control measures. Note that the sample did provide sufficient score variability for factor analytic procedures, as most measures displayed the full range of possible scores.

Factor analysis was conducted across the total sample. There were numerous strong, significant correlations between the 19 component measures of social behavior, so the correlation matrix could be factored. Neither socioeconomic nor sex differences were expected in the hypothesized factor structure, as the component social outcome measures were designed to be appropriate for all individuals. There was insufficient sample size to examine factor structure within the preterm/fullterm groups.

Correlations Between Component Social Outcome Scores

Table 7 gives the intercorrelations between component measures of social outcome, across the total sample. Only correlations significant to the $p < .05$ level are discussed. Note that Table 7 presents intercorrelations between the original outcome scores: on some of the scales, higher values meant more optimal scores; on other scales, more optimal scores received lower values. For Table 8, which gives factor analytic results, all social outcome scores were transformed so that higher values meant more optimal scores.

As expected, the two CBCL behavior problem scales were highly correlated with each other ($r = .78$), and somewhat correlated with the CBCL social competence scale (INTERNAL and EXTERNAL: $r = -.32$). The three CBCL scales showed similar strength of association with most component social outcome measures, except those from the child's perspective.

The two Block and Block scores, true to their design, were

Table 7

Intercorrelations Between Component Social Outcome Measures over the Total Sample

	CBCL Internalizing	CBCL Ext.	CBCL Soc. Compt.	WT Child Style	WT Child Affect	HRI Gutsy	HRI Rules	HRI Peer Soc.	HRI Frus. Tol.	HRI Good Student	DOTS Activity Level	DOTS Attention Span	DOTS Adaptability	DOTS Rhythmicity	DOTS Reactivity	Ego Control	Ego Resilience	Peer Acceptance
CBCL Externalizing	.78***																	
CBCL Social Competence	-.32**	-.32**																
WT Child Style	.16	.24**	-.04															
WT Child Affect	-.18	-.17	.01	-.68***														
HRI Gutsy	-.43***	-.46***	.47***	-.06	.25*													
HRI Rules	-.37***	-.53***	.47***	-.21*	.31**	.76***												
HRI Peer Sociability	-.44***	-.37***	.52***	-.08	.22*	.76***	.73***											
HRI Frustration Tolerance	-.54***	-.46***	.49***	-.20*	.32**	.75***	.72***	.77***										
HRI Good Student	-.43***	-.45***	.43***	-.14	.23*	.71***	.64***	.66***	.78***									
DOTS Activity Level	.28**	.21*	.05	.10	-.00	.02	-.10	.05	-.16	-.11								
DOTS Attention Span	-.33**	-.39***	.22*	-.17	.13	.34***	.35***	.24*	.37***	.58***	-.11							
DOTS Adaptability	-.18	-.04	.17	-.07	.07	.21*	.14	.41***	.44***	.34***	-.09	.10						
DOTS Rhythmicity	-.30**	-.28**	.22*	.01	-.03	.26**	.24*	.22*	.21*	.20*	-.17	-.02	-.01					
DOTS Reactivity	.32**	.45***	-.26***	.16	-.18	-.37***	-.39***	-.31**	-.40***	-.28**	.15	-.32**	-.00	-.22*				
Ego Control	-.12	-.48***	.12	-.33***	.30**	.30**	.48***	.19*	.28**	.21*	-.10	.38***	-.03	.04	-.40***			
Ego Resilience	-.66***	-.59***	.48***	-.08	.15	.68***	.52***	.58***	.73***	.67***	-.14	.40***	.39***	.22*	-.35***	.16		
PCS Peer Acceptance	-.29**	-.20*	-.01	-.20*	.17	.16	.11	.07	.15	.16	-.00	.13	.23*	-.03	-.02	.10	.18	
PCS Mom Acceptance	-.14	-.11	.05	-.13	.13	.18	.17	.22*	.17	.17	.12	.05	.28**	.03	.00	.12	.19*	.62*

orthogonal to one another (_r_ = .16). The ego resiliency measure was highly negatively correlated with both CBCL behavior problem scales (INTERNAL: _r_ = -.66 and EXTERNAL: _r_ = -.59), while the CBCL social competence score was highly positively related (_r_ = .48). The ego control measure was related only to the externalizing CBCL scale _r_ = -.48).

The component DOTS scales showed few interrelationships, and had fairly independent patterns of relationships with other social behavior measures. On the other hand, the HRI individual scales were highly intercorrelated (_r's_ ranging from .64 to .78) and, with the exception of the Rules score, related as a block with other measures of social outcome.

There was a high intercorrelation between the two child-focused observational measures taken during the waiting task (_r_ = -.68 between child style (KIDSTYLE) and child affect (KDAFFECT)). Note that a more optimal score is higher for KDAFFECT but lower for KIDSTYLE. These two scores were moderately associated with other social outcome measures in expected, but divergent, patterns. The more positive the child's affect in the waiting task, the higher were all parental ratings of coping skills (HRI _r's_ of .22 to .32) and ego control (_r_ = .30). The more nonfacilitating the child's style during the waiting task, the lower were certain coping skills (RULES: _r_ = -.21; FRUSTOLERANCE: _r_ = -.20), the child's perceived peer acceptance (_r_ = -.20), and the child's ego control (_r_ = -.33), while the higher was the parental report of externalizing behavior problems (_r_ = .24).

The intercorrelation of the PCS peer and mother acceptance scores was .62. The child's view of his/her own acceptance by peers was somewhat positively related to the DOTS adaptability score (*r* = .23), and somewhat negatively associated with behavior problems (INTERNAL: *r* = -.29 and EXTERNAL: *r* =-.20), as well as the child's waiting style (KIDSTYLE: *r* : -.20). The child's view of maternal acceptance was positively related to only a few measures of social behavior, including peer sociability (*r* = .22), the DOTS adaptability score (*r* =.28), and ego resiliency (*r* =.19).

Principal Components Analysis

The social outcome data was empirically summarized using principal components extraction (PCA), a technique which distributes all available variance among several distinct components. The default strategy of varimax orthogonal rotation (with Kaiser normalization) was selected, producing maximally simple, distinct and equalized factors to describe the data.

The number of interpretable factors was determined by finding those with eigenvalues greater than one, then performing a scree test (graphing variance accounted for by each factor, and examining the slope of the line), and finally examining the pattern of variable intercorrelations to decide about two-variable factors. To accept factors defined by only two variables, the component variables must be highly intercorrelated, yet still distinct from other variables. This pattern was true for the two 2-variable factors emerging from these analyses.

Table 8 gives factor loadings, communalities, percents of variance, and descriptive labels for the PCA analysis. A cutoff point of .40 (16% of the variance) was used for inclusion of a variable in interpretation of a factor, with one exception, and these loadings are underlined for each factor in Table 8. Five interpretable factors emerged, accounting for 69% of the variance. The first factor appeared to be the strongest, as expected from PCA, accounting for 36% of the explained variance. The five factors were labelled as follows, in order of variance accounted for:

(1) parent view: child positive social skills/ego resilience (PSOCSKILL)

(2) parent view: child self control (PCONTROL)

(3) child view: social acceptance (KDACCEPT)

(4) observer view: child in self control situation (OCONTROL)

(5) parent view: child behaving well (a measure of the absence of various behavior problems) (PBEHWELL)

Note that the five empirically-derived factors correlated equal to or less than .3 with one another, confirming that an orthogonal rotation was appropriate.

Based on the loadings from Table 8, estimated factor scores were computed. This was accomplished by summing the standardized social outcome scores loading highly on each factor, after each component measure had been scaled in the correct direction. (See Table 9 for descriptions of the estimated factor scores, and Table A-2 in the

Table 8

Factor Loadings, Percent of Variance and Descriptive Labels for Principal Components (PCA) Extraction with Varimax Rotation on 48-Month Child Social Outcome Scores

48m Social Outcome Variables	F_1	F_2	F_3	F_4	F_5
CBCL Internalizing	.39	.30	.28	-.06	.62
CBCL Externalizing	.33	.66[a]	.20	.01	.42
CBCL Social Competence	.62	.15	-.05	-.08	-.06
WT Child Style	.00	.16	.13	.88	.13
WT Child Affect	.18	.09	.05	.88	-.00
HRI Gutsy	.83	.26	.09	.05	-.04
HRI Rules	.72[a]	.40	.03	.24	-.06
HRI Peer Sociability	.89	.02	.07	.09	-.05
HRI Frustration Tolerance	.87	.10	.07	.18	.25
HRI Good Student	.81	.20	.09	.10	.20
DOTS Activity Level	-.05	.03	-.15	.14	.81
DOTS Attention Span	.33	.56	.05	.03	.22
DOTS Adaptability	.55[a]	-.47	.27	.07	.28
DOTS Rhythmicity	.22	.10	-.02	.02	.16
DOTS Reactivity	.33	.59	-.08	.08	.19
Ego Control (arithmetic transformation)	.18	.73	.07	.34	-.06
Ego Resilience	.72	.19	.18	-.08	-.45[b]
PCS Peer Acceptance	.02	.07	.89	.10	.09
PCS Mom Acceptance	.15	-.03	.86	.08	-.13
% of variance	35.9	10.1	9.5	7.7	6.1
Label	PSOCSKILL	PCONTROL	KDACCEPT	OCONTROL	PBEHWELL

Note. Communality value for all variables is 1.00. Total variance accounted for is 69.3%.

[a]These scores are part of two factors.

[b]The ego resiliency score is a unique marker of a theoretical construct. Thus, it is only included in one factor (PSOCSKILL), even though it loads above the cut-off point for PBEHWELL.

Table 9

48-Month Child Social Outcome Factor Descriptions and Reliabilities Over the Total Sample

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PSOCSKILL: parental view of child positive social skills/ego resilience.

A child receiving a high PSOCSKILL is reported to: participate in social interactions and activities; be a good student; follow rules; be sociable with peers; have high frustration tolerance; be gutsy; be adaptable; and be ego resilient.

Reliability: unstandardized α = .908 (N=75)

PCONTROL: parental view of child self-control.

To be given a high PCONTROL score, a child will have few externalizing behavior problems; follow rules; have a longer attention span; not overreact to stimuli; not be very adaptable; and have balanced ego control.

Reliability: unstandardized α = .731 (N=75)

PBEHWELL: parental view of lack of behavior problems.

With a high PBEHWELL score, a child has few internalizing and externalizing behavior problems, and a low activity level.

Reliability: unstandardized α = .703 (N=75)

OCONTROL: observer view of child in a self-control situation.

A child rated as high on OCONTROL would be "facilitating" and show positive affect during the waiting period.

Reliability: r = .683 (N=81)

KDACCEPT: child view of social acceptance.

A child with a high KDACCEPT score rates him/herself as highly accepted by mother and peers.

Reliability: r = .620[a] (N=75)

Table 9 (continued)

ALLSC: Overall view of social competence.
A child with a high ALLSC score sees him/herself as socially accepted; is seen by observers as facilitating and positive; and is viewed by his/her parents as socially skilled, self-controlled, behaving well (few problems), as well as rhythmic.

Reliability: unstandardized α = .878 ($\underline{N}$=75)

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[a]This measure is part of the Perceived Competence Scale (Harter and Pike, 1981, 1984). The authors report the internal consistency of this scale as .640.

appendices for descriptive statistics.) Use of the RELIABILITY and PEARSON CORR programs confirmed the reliability of these factor scores, which ranged from .62 to .91, as listed in Table 9.

As hypothesized, three perspectives were represented in the factors arising from the PCA, and the parent view was the most differentiated. The parental factor structure exhibited the expected ego resiliency/ego control "process" dichotomy, but showed an additional "product" factor (PBEHWELL). It is important to note that all 19 measures, scaled from less optimal behavior (low values) to more optimal behavior (high values), could be summed to provide an overall child social competence score (ALLSC). The reliability of this overall measure was .88.

To evaluate the stability of the factor structure emerging from the PCA, it was compared to a more conservative factor analytic solution (FA). On the whole, the FA findings confirmed the results of the PCA. Four of the five FA factors were interpretable, and were similar to four of the PCA factors. However, the PCA factor labelled PCONTROL (the parent's view of the child's self control) did not completely emerge from the FA procedures, demonstrating its instability. Results of the FA analyses may be found in Appendix C.

Factor Characteristics

An examination of factor correlations (from an oblique procedure) revealed correlations no greater than .27 between factors from the three perspectives (parent, observer, child). Typically, estimated factor score correlations between perspectives showed stronger relationships, averaging .30, and as high as .57. As hypothesized, the observer view (OCONTROL) was more highly correlated with PCONTROL than any other estimated factor score ($\underline{r}$ = .31). The pattern of factor score correlations was fairly similar in the preterm and fullterm groups, arising from the rather similar patterns of intercorrelation between the component social outcome measures in the two groups.

Even though the PCA factors were relatively stable, and showed expected intercorrelations, the actual factor structure was not completely clear and simple. Rotated factor plots revealed the complexity of several factors. In addition, several variables were complex, loading on more than one factor. The externalizing scale of the CBCL loaded on two factors: PBEHWELL and PCONTROL. The HRI rules scale and the DOTS adaptability scale also loaded on two factors: PSOCSKILL and PCONTROL. Given these double loadings, the parental factors actually were surprisingly stable. Note that the ego resiliency score could have been included in two different factors, but a decision was made to maintain it as a unique marker of ego resilience on PSOCSKILL.

The five HRI scales loaded heavily upon the initial factor (PSOCSKILL), which partially accounted for the strength of this factor. The DOTS scales apparently contained a considerable amount of unique variance. In part, this may have created instability in the PCONTROL factor, which included three DOTS scales. Given the independence of the DOTS scales, they will be analyzed separately, as well as within the PCONTROL factor.

Group Differences at 48m

Comments on Statistical Procedures

Multivariate techniques were used to examine group differences. Procedures were performed with SPSS ANOVA, using the default strategy, which weights cells by their sample sizes in order to deal with unequal-cell sample sizes. The covariate of maternal age was used in all ANCOVAs to statistically equate preexisting group differences. Since the covariate was used for this purpose, significant interactions between the covariate and the criterion (independent) variables did not render the analyses ineffective. However, such interactions did exist, similarly for preterms and fullterms, and Table 10 lists significant covariate-predictor variable correlations. Clearly, the majority of these linear covariate interactions were with measures of global environment and selected aspects of the proximal environment (maternal attitudes and behavior). Thus, covarying maternal age reduced the effect of the environmental predictor variables. Note that only one of 29 standardized pairs of correlations in Table 10 was significantly different between groups.

Sex Differences in the 48m Data

Before analyzing 48m group differences, the possible confound of sex differences was investigated, across the total sample. Hotelling's t2 was used to examine the effect of the single independent variable of

Table 10

Correlations of Covariate (Maternal Age) with Various Predictor Variables Within the Preterm and Fullterm Groups

Predictor Variable	Correlation with MOMAGE in Preterms	Correlation with MOMAGE in Fullterms
Biological Status:		
BIOSUM1	-.12	.12
BIOSUM48	.18	.04
Global Environment:		
MOMED1	.50***	.59***
MOMED48	.40**	.52***
FHHEAD48	.34*	.46***
TOTAL HOME8	.14	.23
Mother-Child Interaction:		
MOMBEH4	.20	.42*
MOMBEH8	.48***	.42*
MOMBEH12-F	.31*	.23
MOMBEH12-S	.59***	.35*
MOMBEH24-F	.22	.21
MOMBEH24-S[a]	-.38*	.33*
MOMBEH48-S	.06	.10
Maternal Attitudes:		
TOTAL SUPPORT1	.16	.27*
TOTAL SUPPORT48	-.17	.07
STRESS1	-.29*	-.05
STRESS18	.03	-.13
STRESS48	.12	-.32*
SATISKID1	.23	.18
SATISKID8	.53***	.27*
SATISKID18	.35*	.32*
SATISKID48	.33*	.23
SATISPARENT1	.26*	.18
SATISPARENT8	-.11	.17
SATISPARENT18	.22	.19
SATISPARENT48	-.10	.14

Table 10 (continued)

Predictor Variable	Correlation with MOMAGE in Preterms	Correlation with MOMAGE in Fullterms
Child Development:		
MDI12	.16	-.05
PDI12	-.06	-.26

[a]This is the only pair of correlations that is significantly different between preterms and fullterms. Older mothers with preterms showed more negative behavior during the 24m lever task, while older mothers with fullterms showed more positive behavior.

child sex on three categories of dependent variables: child developmental outcome; maternal attitudes; and mother-child interaction.

The Hotelling's t2 statistic was not significant for the set of 48m child developmental variables (cognitive, linguistic, and overall social outcome) ($\underline{t2}$ = 9.13, $\underline{F}$ (5,67) = 1.72, $\underline{p}$ = .141) or for the set of social outcome variables alone ($\underline{t2}$ = 9.05, $\underline{F}$ (5,69) = 1.71, $\underline{p}$ = .144). Thus, no overall sex differences in child developmental outcome were revealed. A priori, however, males were expected to score lower on at least some measures of social outcome, but only one significant mean difference was found between males and females on any measure of social outcome. As expected, there were no sex differences for 48m maternal attitudes ($\underline{t2}$ = 14.38, $\underline{F}$ (12,65) = 1.02, $\underline{p}$ = .437) or 48m mother-child interaction variables ($\underline{t2}$ = .974, $\underline{F}$ (4,75) = .234, $\underline{p}$ = .918).

Group Differences in 48m Child Developmental Outcome: Factorial ANCOVAs, Using MOMED48

The prematurity literature has generally examined the impact of biological status on child outcome, while controlling for environmental status. Sameroff (1982) has suggested the use of a "factorial" group difference analysis with risk populations, a method which examines the impact of prematurity within an environmental context. Responding to this suggestion, a series of factorial ANCOVAs were performed. Under investigation were the main effects of both biological and environmental status, as well as the interaction between these two factors. Between-groups factors included two levels of biological status (preterm vs fullterm birth), and three levels of environmental status (low, medium, and high maternal education).

The factorial ANCOVA results, using MOMED48 as the environmental status indicator, are given in Table 11. Overall, academic and social outcome differences were found between preterms and fullterms, though fewer than hypothesized. As expected, preterms performed more poorly. There were also fewer environmental effects than expected, though the differences which occurred were generally in the predicted direction, with better performance among those of higher social status. Of 19 analyses, seven showed significant birth status effects, while nine showed significant environmental effects. Six interaction effects emerged, providing only some support for a modified "double whammy" hypothesis.

Main effects for prematurity (using MOMED48). Main effects for biological status were revealed, using factorial analyses with MOMED48 as the environmental measure. It is important to note that "simple" ANCOVAs, which covary environmental status and are the usual procedure with preterm/fullterm data, generated similar results. (See Appendix C for details.)

In the academic area, as hypothesized, premature children received lower nonverbal cognitive scores (BD: $\underline{F}$ (6,73) = 7.15, $\underline{p}$ = .009). Preterms also showed a trend toward lower visuomotor scores, calculated according to actual age (VMIAQ: $\underline{F}$ (6,71) = 3.39, $\underline{p}$ = .070), but not

Table 11

Factorial ANCOVA Comparisons of Child Outcome Between Biological and Environmental Status Categories (Using MOMED48)

Outcome Variable	Source of Variation	SS	df	MS	F
Academic Outcome:					
PPVT	MOMAGE	124.69	1	124.69	.508
	GROUP	120.36	1	120.36	.490
	MOMED48	2867.94	2	1433.97	5.84**
	Interaction	1416.96	2	708.48	2.89[T]
	Residual	18164.53	74	245.47	
BD	MOMAGE	24.28	1	24.28	3.37[T]
	GROUP	51.50	1	51.50	7.15**
	MOMED48	12.22	2	6.11	.848
	Interaction	11.42	2	5.71	.793
	Residual	525.72	73	2.55	
VMIAQ	MOMAGE	182.26	1	182.26	.692
	GROUP	891.54	1	891.54	3.39[T]
	MOMED48	1681.52	2	840.76	3.19*
	Interaction	119.75	2	59.87	.227
	Residual	18690.42	71	263.24	
VMICQ	MOMAGE	273.13	1	273.13	.989
	GROUP	168.41	1	168.41	.610
	MOMED48	1927.90	2	963.95	3.49*
	Interaction	145.81	2	72.91	.264
	Residual	19615.15	71	276.27	
Summary Social Outcome:					
PCONTROL	MOMAGE	31.22	1	31.22	2.50
	GROUP	26.59	1	26.59	2.13
	MOMED48	80.04	2	40.02	3.21*
	Interaction	24.02	2	12.01	.963
	Residual	910.58	73	12.47	

Table 11 (continued)

Outcome Variable	Source of Variation	SS	df	MS	F
PBEHWELL	MOMAGE	19.94	1	19.94	4.95*
	GROUP	6.88	1	6.88	1.71
	MOMED48	55.85	2	27.93	6.93**
	Interaction	52.07	2	26.04	6.46**
	Residual	294.22	73	4.03	
KDACCEPT	MOMAGE	6.66	1	6.66	2.04
	GROUP	9.16	1	9.16	2.80^{T}
	MOMED48	5.58	2	2.79	.854
	Interaction	.332	2	.166	.051
	Residual	228.76	70	3.27	
Component Social Outcome:					
ACTIVITY	MOMAGE	0.00	1	.000	.000
	GROUP	3.61	1	3.61	2.36
	MOMED48	2.87	2	1.43	.936
	Interaction	20.03	2	10.01	6.54**
	Residual	111.78	73	1.53	
ATTENTION	MOMAGE	5.12	1	5.12	.560
	GROUP	43.19	1	43.19	4.73*
	MOMED48	61.92	2	30.96	3.39*
	Interaction	1.96	2	.979	.107
	Residual	667.10	73	9.14	
REACTIVITY	MOMAGE	13.44	1	13.44	6.42*
	GROUP	8.81	1	8.81	4.20*
	MOMED48	4.33	2	2.17	1.03
	Interaction	11.66	2	5.83	2.78^{T}
	Residual	152.88	73	2.09	
EXTERNAL	MOMAGE	433.38	1	433.38	4.82*
	GROUP	1.69	1	1.69	.02
	MOMED48	1227.64	2	613.82	6.82**
	Interaction	437.73	2	218.86	2.43^{T}
	Residual	6657.98	74	89.97	

Table 11 (continued)

Outcome Variable	Source of Variation	SS	df	MS	F
Component Social Outcome:					
INTERNAL	MOMAGE	698.12	1	698.12	7.98**
	GROUP	98.38	1	98.38	1.12
	MOMED48	976.00	2	488.00	5.58**
	Interaction	532.84	2	266.42	3.05[T]
	Residual	6471.98	74	87.46	
EGORESILIENCE	MOMAGE	.058	1	.058	1.73
	GROUP	.106	1	.106	3.16[T]
	MOMED48	.265	2	.132	3.95*
	Interaction	.040	2	.020	.599
	Residual	2.51	74	.034	
PEERACCEPT	MOMAGE	1.03	1	1.03	2.54
	GROUP	1.93	1	1.93	4.74*
	MOMED48	.225	2	.112	.277
	Interaction	.022	2	.011	.027
	Residual	28.83	71	.406	

according to corrected age (VMICQ: *F* (6,71) = .610, *p* = .438). Note that all academic scores, for both groups, were within normal limits, excepting preterm visuomotor skill, calculated according to actual age.

In the social area, parents of preterms did not describe their children as having significantly poorer self control (PCONTROL: *F* (6,73) = 2.13, *p* = .149), although there was a borderline effect. There was a trend toward child reports of lower acceptance by others among the preterms (KDACCEPT: *F* (6,70) = 2.80, *p* = .098). Looking at the components of KDACCEPT, maternal acceptance did not differ between groups, while peer acceptance did (PEERACCEPT: *F* (6,71) = 4.74, *p* = .033). There was also a trend toward lower ego resilience among preterms (EGORESILIENCE: *F* (6,74) = 3.16, *p* =.080).

A priori differences on components of the unstable factor of PCONTROL were examined between preterms and fullterms. As expected, two temperamental (DOTS) measures showed significant group differences. Premature children showed a shorter attention span (ATTENTION: *F* (6,73) = 4.73, *p* = .033) and overreacted to stimuli (REACTIVITY: *F* (6,73) = 4.20, *p* = .044). Surprisingly, measures of ego control and externalizing problems did not differ between groups (EGOCONTROL: *F* (6,74) = .000, *p* = .992 and EXTERNAL: *F* (6,73) = .019, *p* = .891). Again, note that all social scores, for both groups, were within normal limits.

Main effects for environmental status (using MOMED48). Environmental main effects are also presented in Table 11, and relevant descriptive statistics are listed in Table 12. Note that all

Table 12

Pairwise Comparisons of Environmental Effects on 48-Month Child Outcome (Using MOMED48)

Outcome Variable	*n*	Adjusted *M*	*df*	*t*
PPVT effect: low, middle < high				
low education	11	91.25	53	3.26**
high education	44	109.16		
middle education	26	100.38	68	2.18**
high education	44	109.16		
			$s_e^2 = 264.84$	
VMIAQ effect: middle < high (low = mid, high)				
middle education	24	88.41	65	2.44**
high education	43	98.74		
			$s_e^2 = 275.09$	
PCONTROL effect: low, middle < high				
low education	12	-1.51	53	2.10*
high education	43	.97		
middle education	25	-1.01	66	2.18*
high education	43	.97		
			$s_e^2 = 13.02$	
PBEHWELL effect: low, middle < high				
low education	11	-.92	52	2.56*
high education	43	.84		
middle education	26	-1.00	67	3.53**
high education	43	.84		
			$s_e^2 = 4.41$	

Table 12 (continued)

Outcome Variable	n	Adjusted M	df	t
EGORESILIENCE effect: low < middle, high				
low education	12	.350	36	1.96*
high education	26	.480		
middle education	12	.350	54	2.91**
high education	44	.530		
		s_e^2 = .036		

Note. The residual mean square (s_e^2) is adjusted for the effect of the covariate.

Using FHHEAD48 as an environmental indicator, the following effects emerged:

PPVT effect: low < middle < high
(Ms: 97.96, 105.87, 112.97)
VMIAQ effect: low < middle (high = low, mid)
(Ms: 90.03, 98.89, 91.93)
ALLSC effect: low < middle, high
(Ms: -6.19, 4.47, 4.56)
PSOCSKILL effect: low < middle, high
(Ms: 3.12, 1.91, 1.82)
PCONTROL effect: low < middle, high
(Ms: -1.90, 0.45, 1.77)
PBEHWELL effect: low < middle, high
(Ms: -1.28, 0.61, 1.28)

These results were fairly predictable extensions of the MOMED48 findings, with the exception of VMIAQ. For this variable, it appeared that the few subjects (n=11) in the "high" FHHEAD48 group had relatively poor visuomotor skills (M=91), as poor as those in the "low" group (M=90). In contrast, the many subjects (n=43) in the "high" MOMED48 group had relatively good visuomotor skills (M=99).

environmental status subgroups achieved academic and social scores essentially within normal limits.

As predicted, the three environmental groups differed on a measure of receptive language (PPVT: F (6,74) = 5.84, p = .004). There were no significant differences in measures of verbal cognitive ability (INFO: F (6,74) = 2.21, p = .117), but visuomotor skill did differ, calculated according to actual age (VMIAQ: F (6,71) = 3.19, p = .047) and corrected age (VMICQ: F (6,71) = 3.49, p = .046).

In the social area, there were unexpected environmental effects on the parental view of self control (PCONTROL: F (6,73) = 3.21, p = .046). As hypothesized, the three environmental groups were different in the area of behavior problems, a "product-type" measure (PBEHWELL: F (6,73) = 6.93, p = .002). Scrutinizing the components of the PBEHWELL summary score, significant environmental differences appeared on both types of behavior problems (EXTERNAL: F (6,74) = 6.82, p = .002 and INTERNAL: F (6,74) = 5.58, p = .006), but not on the more biologically-based measure of ACTIVITY level (F (6,73) = .936, p = .397).

Pairwise comparisons for environmental effects (using MOMED48). Followup t-tests, listed in Table 12, compared the three environmental subgroups within the preterm and fullterm groups. For receptive language, the parental view of behavior problems (PBEHWELL) and child self control (PCONTROL), as well as the component INTERNAL and EXTERNAL behavior problem measures, the high education subgroup had significantly more optimal scores than did the low and middle education subgroups. These latter two subgroups did not differ from each other. For ego resiliency, the low education subgroup was significantly lower. For visuomotor skill, calculated according to actual age, the middle education subgroup was significantly lower than the other two subgroups.

Interaction effects (using MOMED48). Interaction effects were examined to test the "double whammy" hypothesis, in which children experiencing both prematurity and lower environmental status are expected to exhibit the poorest developmental outcome. This hypothesis is important as a test of a prediction of the transactional approach to the study of prematurity. In addition, the notion of a double whammy is of practical importance, as a basis for intervention strategies. To obtain support for this hypothesis, group difference analyses, and followup pairwise comparisons, must yield significant interaction effects showing the lowest scores in the subgroup of low education preterms.

Table 11 lists the group difference interaction effects, while Figure 1 and Table 13 present relevant pairwise comparisons. From the 10 main child outcome measures, one trend and one significant effect appeared, though no other interactions even approached significance. However, five of the 19 component social measures showed at least interactional trends. It is important to remember that spurious interaction effects were highly unlikely, since all multivariate outliers were removed from the analyses.

Hypothesized interaction effects did not appear for the parental

Figure 1

Means and Graphic Display of Interaction Effects (Biological x Environmental Status, Using MOMED48) on 48-Month Outcome

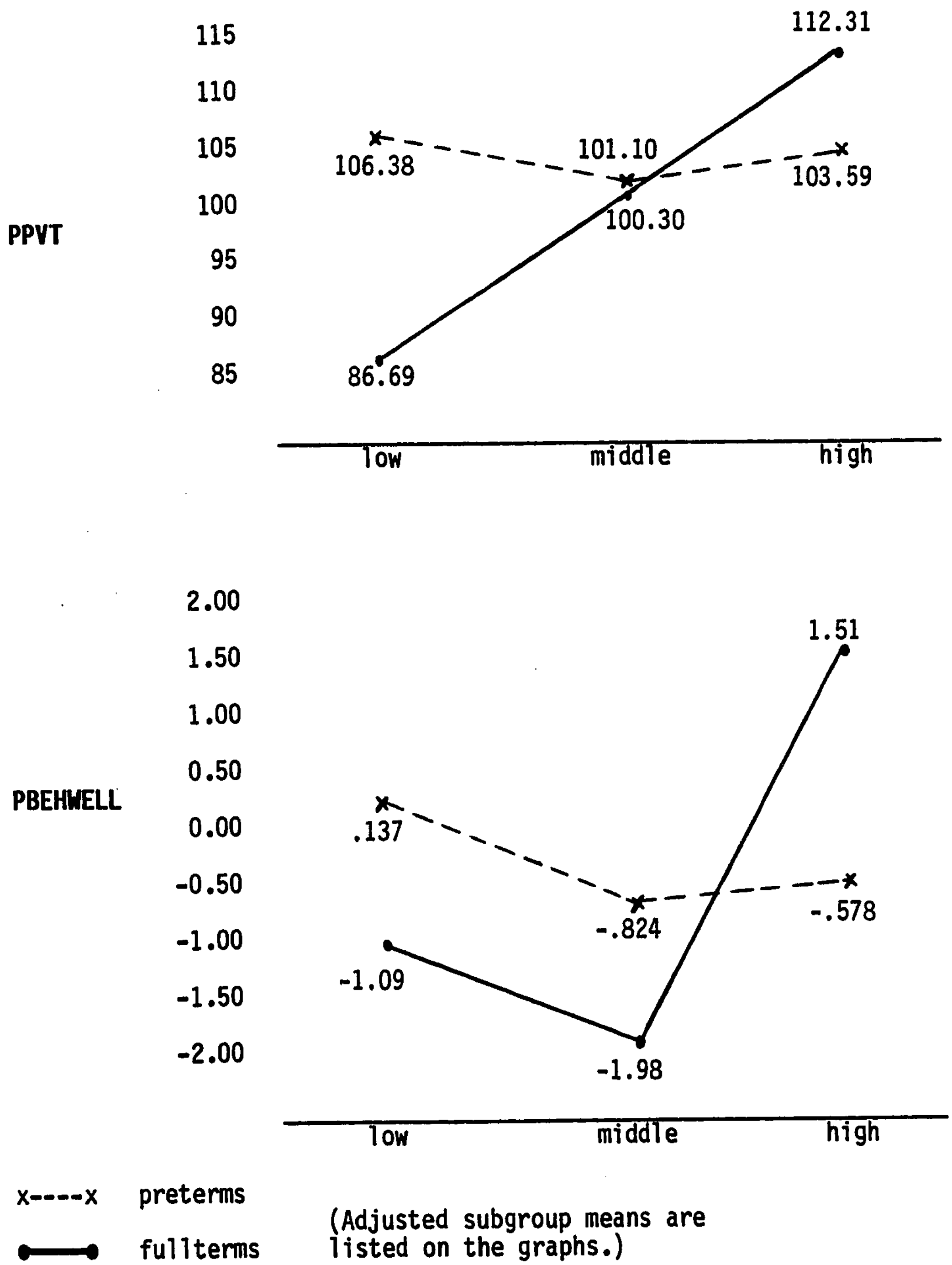

Table 13

Pairwise Comparisons of Interaction Effects (Biological x Environmental Status, Using MOMED48) on 48-Month Outcome

Subgroup Abbreviations

ES = environmental status
LP = low ES preterm
MP = middle ES preterm
HP = high ES preterm

LF = low ES fullterm
MF = middle ES fullterm
HF = high ES fullterm

Pairwise Comparison on PBEHWELL	n	Adjusted M	df	t	Effect
For PPVT:					
LP	3	106.55	5	-1.81[T]	LF<LP
LF	7	86.74			
LF	7	86.74	12	1.75[T]	LF<MF
MF	10	100.38			
MF	10	100.38	32	2.03*	MF<HF
HF	27	112.27			
HP	15	103.48	37	1.73*	HP<HF
HF	27	112.27			

Table 13 (continued)

Pairwise Comparison on PBEHWELL	n	Adjusted M	df	t	Effect
For PBEHWELL:					
LP	3	.137	5	-.870	-
LF	7	-1.09			
LP	3	.137	26	-.615	-
combined MP & HP	28	-.693			
combined LF & MF	17	-1.61	39	4.75**	combined LF&MF<HF
HF	27	1.51			
HP	15	-.58	37	3.17**	HP<HF
HF	27	1.51			
	s_e^2 = 4.17				

Note. Results emerging from analyses using FHHEAD48 showed no PPVT interaction effect and only a trend toward an interaction effect on PBEHWELL. Of the PBEHWELL component scores, using FHHEAD48, the INTERNAL and EXTERNAL interaction effects were reduced to trends, and the ACTIVITY effect disappeared.

view of child self control or for visuomotor skills (PCONTROL: $\underline{F}$ (6,73) = 1.36, $\underline{p}$ = .263 and VMI: $\underline{F}$ (6,71) = .227, $\underline{p}$ = .797). Unexpectedly, there was a trend toward an interaction effect in receptive language (PPVT: $\underline{F}$ (6,74) = 2.89, $\underline{p}$ = .062). The single significant effect lay in the interaction for the parental view of child behavior problems (PBEHWELL: $\underline{F}$ (6,73) = 6.46, $\underline{p}$ = .003). It was unlikely that this was a chance finding. It was expected a priori, and all three PBEHWELL components showed at least trends toward an interactional difference (ACTIVITY: $\underline{F}$ (6,73) = 6.54, $\underline{p}$ = .002; EXTERNAL: $\underline{F}$ (6,74) = 2.43, $\underline{p}$ = .095; INTERNAL: $\underline{F}$ (6,74) = 3.05, $\underline{p}$ = .054). Note that an unexpected interactional trend also existed for the temperamental measure of reactivity (REACTIVITY: $\underline{F}$ (6,73) = 2.78, $\underline{p}$ = .068).

Pairwise comparisons for interaction effects (using MOMED48). Graphs were made to visually display the interaction effects for the main outcome measures: PPVT and PBEHWELL. Pairwise comparisons were conducted to ascertain the statistical nature of the interaction effects, and thus test the double whammy hypothesis. Figure 1 contains the graphs (and subgroup means), and Table 13 gives the results of a series of pairwise comparisons.

For both PPVT and PBEHWELL, as might be expected, the high education, fullterm subgroup (experiencing no whammies at all!) showed the most optimal mean scores on the measure of behavior problems. But the low education preterm subgroup, those suffering the presumed "double whammy," did not receive the lowest scores, and instead ranked second. Surprisingly, middle ES fullterms (dealt half a whammy?)

displayed the most behavioral difficulties.

For PBEHWELL, in the first pairwise comparison, the relative impact of a poor environment was compared between preterms and fullterms. Though lower ES preterms were expected to do more poorly, they actually did not differ from lower ES fullterms. In the second comparison, environmental effects within the preterm sample were examined by comparing lower ES preterms with the combined mean of middle and higher ES preterms. There were no differences, indicating that ES did not have a strong impact within the premature group. In the third comparison, environmental effects within the fullterm group were studied. The combined mean of the lower and middle ES fullterms was significantly lower than the mean score of the higher ES fullterms, showing a strong environmental effect. Finally, the relative impact of a positive environment for preterms and fullterms was tested. Higher ES preterms scored significantly lower than did higher ES fullterms, showing that preterms did not benefit as much from a positive environment.

The PPVT findings were different in two ways. First, low ES preterms actually showed better receptive language than did low ES fullterms, directly in contrast to the double whammy hypothesis. Second, there was a significant linear environmental effect among the fullterms, with low ES fullterms doing most poorly. In essence, then, the PPVT and PBEHWELL findings were similar, though the PPVT data were more striking. Overall, the double whammy hypothesis was not supported.

Group Differences in 48m Child Developmental Outcome: Factorial ANCOVAs, Using FHHEAD48

There is controversy about the best measure of global environmental status to use in pinpointing environmental effects. To compare the utility of the maternal education measure with a broader socioeconomic indicator, a second series of factorial ANCOVAs was performed. This second set used FHHEAD48, rather than MOMED48, as the environmental factor. Table 14 presents the data, and can be compared to the MOMED48 findings in Table 11. With only a few exceptions, the effects seen in MOMED48 analyses, for both biological and environmental status, also emerged when FHHEAD48 was used. In most cases, in fact, effects were more pronounced when the FHHEAD48 measure was employed. (Notably, however, interaction effects were less strong using FHHEAD48.) Only findings unique to the FHHEAD48 analyses will be discussed below.

Note that the two different outcome pictures arose because, compared to MOMED48, the FHHEAD48 measure identified more subjects as problems: FHHEAD48 grouped more subjects into the "low" and "middle" environmental status subgroups, making the "high" subgroup quite small and special (see Table 3). It is important to remember that all birth status and environmental status subgroups created using FHHEAD48 achieved scores essentially within normal limits.

Main effects for prematurity (using FHHEAD48). Effects using the broader FHHEAD48 environmental indicator were closer to those expected

Table 14

Factorial ANCOVA Comparisons of Child Outcome Between Biological and Environmental Status Categories (Using FHHEAD48)

Variable	Source of Variation	SS	df	MS	F
Academic Outcome:					
PPVT	MOMAGE	119.93	1	119.93	.449
	GROUP	624.04	1	624.04	2.34
	FHHEAD48	1901.02	2	950.51	3.56*
	Interaction	1053.03	2	526.52	1.97
	Residual	19492.19	73	267.02	
INFO	MOMAGE	2.51	1	2.51	.294
	GROUP	12.91	1	12.91	1.52
	FHHEAD48	35.13	2	17.57	2.06
	Interaction	19.13	2	9.56	1.12
	Residual	622.22	73	8.52	
BD	MOMAGE	25.58	1	25.58	3.58[T]
	GROUP	68.82	1	68.82	9.78**
	FHHEAD48	26.42	2	13.21	1.85
	Interaction	5.43	2	2.71	.380
	Residual	514.26	72	7.14	
VMIAQ	MOMAGE	155.32	1	155.32	.580
	GROUP	1914.44	1	1914.44	7.15**
	FHHEAD48	1249.80	2	624.90	2.33
	Interaction	261.80	2	130.90	.489
	Residual	18752.76	70	267.90	
Summary Social Outcome:					
ALLSC	MOMAGE	350.61	1	350.61	4.02*
	GROUP	620.17	1	620.17	7.12**
	FHHEAD48	1686.76	2	843.38	9.68***
	Interaction	126.90	2	63.45	.728
	Residual	5839.70	67	87.16	

Table 14 (continued)

Variable	Source of Variation	SS	df	MS	F
PSOCSKILL	MOMAGE	11.16	1	11.16	.308
	GROUP	145.55	1	145.55	4.02*
	FHHEAD48	388.29	2	194.14	5.37**
	Interaction	8.23	2	4.12	.114
	Residual	2604.88	72	36.18	
PCONTROL	MOMAGE	25.33	1	25.33	2.90^{T}
	GROUP	38.24	1	38.24	4.38*
	FHHEAD48	110.53	2	55.27	6.33**
	Interaction	6.39	2	3.20	.366
	Residual	628.18	72	8.73	
PBEHWELL	MOMAGE	19.27	1	19.27	4.52*
	GROUP	35.65	1	35.65	8.36**
	FHHEAD48	68.61	2	34.31	8.04***
	Interaction	25.60	2	12.80	3.00^{T}
	Residual	307.05	72	4.26	
Component Social Outcome:					
ACTIVITY	MOMAGE	.001	1	.001	.000
	GROUP	7.07	1	7.07	4.07*
	FHHEAD48	6.16	2	3.08	1.77
	Interaction	1.52	2	.760	.437
	Residual	125.18	72	1.74	
ATTENTION	MOMAGE	5.01	1	5.01	.571
	GROUP	97.26	1	97.26	11.07***
	FHHEAD48	88.18	2	44.09	5.02**
	Interaction	9.68	2	4.84	.551
	Residual	632.65	72	8.79	
REACTIVITY	MOMAGE	12.76	1	12.76	5.99*
	GROUP	13.95	1	13.95	6.56*
	FHHEAD48	12.68	2	6.34	2.98^{T}
	Interaction	.607	2	.304	.143
	Residual	153.25	72	2.13	

Table 14 (continued)

Variable	Source of Variation	SS	*df*	MS	*F*
EXTERNAL	MOMAGE	408.62	1	408.62	4.66*
	GROUP	256.58	1	256.58	2.93^{T}
	FHHEAD48	1389.87	2	694.93	7.93***
	Interaction	392.49	2	196.25	2.24
	Residual	6400.48	73	87.68	
INTERNAL	MOMAGE	670.50	1	670.50	8.19**
	GROUP	539.88	1	539.88	6.59*
	FHHEAD48	1147.08	2	573.54	7.00**
	Interaction	775.20	2	387.60	4.73*
	Residual	5978.20	73	81.89	
EGO RESILIENCE	MOMAGE	.051	1	.051	1.55
	GROUP	.200	1	.200	6.13*
	FHHEAD48	.300	2	.150	4.59*
	Interaction	.008	2	.004	.121
	Residual	2.42	74	.033	
EGOCONTROL	MOMAGE	2.66	1	2.66	.497
	GROUP	1.15	1	1.15	.215
	FHHEAD48	39.08	2	19.54	3.65*
	Interaction	12.31	2	6.16	1.15
	Residual	396.26	74	5.36	
PEER ACCEPTANCE	MOMAGE	.914	1	.914	2.48
	GROUP	1.70	1	1.70	4.61*
	FHHEAD48	.605	2	.302	.822
	Interaction	1.51	2	.754	2.05
	Residual	25.76	70	.368	

a priori from the prematurity literature. New effects for birth status emerged in the social area. As hypothesized, preterms received lower ratings on the overall indicator of social competence (ALLSC: $\underline{F}$ (6,67) = 7.12, $\underline{p}$ = .010), and on several aspects of developing social behavior (PSOCSKILL: $\underline{F}$ (6,72) = 4.02, $\underline{p}$ = .049; PCONTROL: $\underline{F}$ (6,72) = 4.38, $\underline{p}$ = .040; and PBEHWELL: $\underline{F}$ (6,72) = 8.36, $\underline{p}$ = .005). New effects appeared on component social outcome scores, as well. As predicted, preterms displayed a higher level of activity (ACTIVITY: $\underline{F}$ (6,72) = 4.07, $\underline{p}$ = .047), as well as more internalizing and externalizing behavior problems (INTERNAL: $\underline{F}$ (6,73) = 6.59, $\underline{p}$ = .012 and EXTERNAL: $\underline{F}$ (6,73) = 2.93, $\underline{p}$ = .091).

Environmental main effects and pairwise comparisons (using FHHEAD48). As hypothesized, new environmental effects were seen on the overall social competence score (ALLSC: $\underline{F}$ (6,73) = 9.68, $\underline{p}$ = .001), positive social skill (PSOCSKILL: $\underline{F}$ (6,73) = 5.37, $\underline{p}$ = .007), and several component social outcome scores (REACTIVITY: $\underline{F}$ (6,72) = 2.98, $\underline{p}$ = .057; EGOCONTROL: $\underline{F}$ (6,74) = 3.65, $\underline{p}$ = .031). Given differences in the way MOMED48 and FHHEAD48 grouped the subjects, followup t-tests revealed environmental effects generally consonant with those revealed in the MOMED48 pairwise comparisons listed in Table 12 (see the note at the bottom of Table 12).

Interaction effects (using FHHEAD48). No new interaction effects emerged using FHHEAD48. In fact, compared to the MOMED48 analyses, the findings for PPVT and REACTIVITY vanished. In addition, the PBEHWELL interaction was diminished, probably due to the reduction (to nonsignificance) of the component ACTIVITY and EXTERNAL effects.

Summary of Group Differences in 48m Child Outcome

Overall, more pronounced effects emerged when the broader FHHEAD48 environmental indicator was used. Factorial group difference analyses revealed poorer performance for four-year-old preterm children in two academic areas: nonverbal cognition and visuomotor skill, calculated according to actual age. In addition, social outcome deficits were seen in overall social competence, as well as parental ratings of the child's positive social skill, self control and behavior problems. These relatively healthy preterms also rated themselves as lower in peer acceptance and showed temperamental deficits, including a shorter attention span, overreactivity, and overactivity.

Environmental effects were uncovered for four-year-olds in the academic areas of receptive language and visuomotor ability. In the social area, there was an environmental impact on 48m overall social competence, as well as on parental ratings of the child's positive social skill, self control, and behavior problems. The temperamental measure of reactivity also showed an environmental effect. In general, children of higher environmental status enjoyed better 48m outcome.

Overall, the interaction effects did not support the double whammy hypothesis. In the areas of receptive language and the parental view of behavior problems, it was clear that the preterms did not benefit quite as much from a positive environment. Yet they did not suffer any more than a fullterm peer in a less optimal environment. However, these effects only showed up strongly when maternal education was used as the indicator of environmental status. Perhaps self-righting is taking place, at least among the low ES preterms, through the action of the caregiver, as reflected in her educational level, rather than in the wider socioeconomic environment. This topic will be discussed in greater detail in the Discussion chapter.

Group Differences in 48m Maternal Attitudes

A factorial MANCOVA was used to examine the effects of biological and environmental status, as well as the interaction between these two factors, on the entire set of maternal attitude variables. For these analyses, outcome variables included measures of stress, social support, satisfaction with parenting, childrearing attitudes, and perceptions of the family environment.

Main effects for prematurity. The MANCOVAs showed, as expected, no differences between preterm and fullterm groups (Wilks λ = .906, Exact F (11,61) = .576, p = .841). Differences were apparent for environmental status (Wilks λ = .546, Exact F (22,122) = 1.96, p = .011). There was not a significant interaction effect (Wilks λ =.681, Exact F (22,122) = 1.18, p = .283).

Main effects for environmental status (using MOMED48). A series of 3(MOMED48) X 2(GROUP) ANCOVAs were performed to test the main effects of environmental status. Significant environmental effects were seen in seven of 13 analyses. See Table 15 for these findings.

Table 15 .

Factorial ANCOVA Comparisons of Parental Attitudes between Biological and Environmental Status Categories (Using MOMED48)

Outcome Variable	Source of Variation	SS	df	MS	F
SATISPARENT	MOMAGE	.276	1	.276	.418
	GROUP	.000	1	.000	.000
	MOMED48	3.401	2	1.701	2.58
	Interaction	1.769	2	.884	1.34
	Residual	48.780	74	.659	
TOTSAT	MOMAGE	.005	1	.005	.014
	GROUP	.120	1	.120	.370
	MOMED48	2.602	2	1.301	4.01*
	Interaction	.611	2	.305	.941
	Residual	23.677	73	.324	
FRDSAT	MOMAGE	.001	1	.001	.003
	GROUP	.066	1	.066	.440
	MOMED48	1.511	2	.755	5.04**
	Interaction	.140	2	.070	.466
	Residual	11.252	75	.150	
STRESS	MOMAGE	14.521	1	14.521	4.46*
	GROUP	8.613	1	8.613	2.64
	MOMED48	23.211	2	11.605	3.56*
	Interaction	6.163	2	3.081	.946
	Residual	237.67	73	3.256	
RESTRICT	MOMAGE	115.479	1	115.479	.578
	GROUP	3.874	1	3.874	.019
	MOMED48	1637.065	2	818.532	4.10*
	Interaction	669.111	2	334.556	1.68
	Residual	14,582.592	73	199.762	
FAMCOHESION	MOMAGE	14.560	1	14.560	.769
	GROUP	3.439	1	3.439	.182
	MOMED48	178.308	2	89.154	4.71*
	Interaction	48.832	2	24.416	1.29
	Residual	1362.508	72	18.924	

Table 15 (continued)

Outcome Variable	Source of Variation	SS	*df*	MS	*F*
LIFESAT	MOMAGE	.170	1	.170	1.790
	GROUP	.002	1	.002	.017
	MOMED48	.799	2	.399	4.19*
	Interaction	.707	2	.353	3.71*
	Residual	7.142	75	.095	

Note. Effects emerging with the use of FHHEAD48 were different in several ways. There was no environmental effect for SATISPARENT or TOTSAT. There was an environmental effect for ATTSAT and NURTURE. An interaction effect emerged for FRDSAT and COMSAT, with middle-class preterms achieving lower scores. The environmental effects remain the same for STRESS, RESTRICT and COHESION, as did the environmental and interaction effects for LIFESAT.

In the areas of social support and life satisfaction, as hypothesized, there were two significant differences: satisfaction with friendship support (FRDSAT: F (6,75) = 5.04, p = .009) and total support (TOTSAT: F (6,73) = 4.01, p = .022). Yet no differences were revealed in the areas of satisfaction with community and intimate support. As predicted, a significant difference occurred for the measure of general life satisfaction (LIFESAT: F (6,75) = 4.19, p = .019).

There were significant differences in other attitudes. These included negative life stress (STRESS: F (6,73) = 3.56, p = .033), as well as restrictive childrearing attitudes (RESTRICT: F (6,73) = 4.10, p = .021), perceived family cohesion (FAMCOHESION: F (6,72) = 4.71, p = .012), and a trend for satisfaction with the parental role (SATISPARENT: F (6,74) = 2.58, p = .083). An interaction effect was found for general life satisfaction (LIFESAT: F (6,75) = 3.71, p = .029).

<u>Pairwise comparisons for environmental main effects and interaction effects (using MOMED48).</u> Followup t-tests were performed to examine pairwise comparisons, and results are given in Table 16. For the social support satisfaction measures, as expected, the low education mothers received significantly lower scores than the middle and high education groups. Yet the latter two groups were not different from each other. The same pattern was true for perceived family cohesion. As expected, restrictive childrearing attitudes and general life dissatisfaction were significantly stronger among the low

Table 16

Pairwise Comparisons of Environmental Effects on 48-Month Maternal Attitudes (Using MOMED48)

Outcome Variable	n	Adjusted M	df	t
SATISPARENT effect: middle < low, high				
low education	11	2.77	35	-1.71*
middle education	26	2.26		
middle education	26	2.26	68	2.14*
high education	44	2.70		
			s_e^2=.691	
TOTSAT effect: low < middle, high				
low education	11	1.77	34	1.80*
middle education	25	2.16		
low education	11	1.77	53	2.77**
high education	44	2.33		
			s_e^2=.360	
FRDSAT effect: low < middle, high				
low education	12	1.38	36	2.36*
middle education	26	1.71		
low education	12	1.38	54	3.18**
high education	44	1.80		
			s_e^2=.160	
STRESS effect: middle < high (low=mid & high)				
middle education	26	3.34	67	-2.76**
high education	43	2.07		
			s_e^2=3.42	
RESTRICT effect: low, middle < high				
low education	11	70.84	52	-2.58*
high education	43	58.20		
middle education	26	66.02	67	-2.17*
high education	43	58.20		
			s_e^2=210.97	

Table 16 (continued)

Outcome Variable		n	Adjusted M	df	t
COHESION effect: low < middle, high					
low education		10	5.18	34	2.95**
middle education		26	10.11		
low education		10	5.18	51	2.66*
high education		43	9.38		
				s_e^2=20.16	
LIFESAT main effect: low, middle < high					
low education		12	1.60	54	1.65*
middle education		44	1.76		
middle education		26	1.52	68	3.07**
high education		44	1.76		
				s_e^2=0.10	

LIFESAT Interaction effect: (cell frequencies)		n	M	SD
Preterm education (n=37)				
low	(LP)	5	1.41	.327
middle	(MP)	15	1.63	.350
high	(HP)	17	1.72	.262
Fullterm education (n=45)				
low	(LF)	7	1.72	.287
middle	(MF)	11	1.38	.311
high	(HF)	27	1.79	.306

(apparent order of effects:
MF = LP<MP = HP = LF = HF)

Note. The residual mean square (s_e^2) is adjusted for the effect of the covariate. Effects emerging with the use of FHHEAD48 were different in several ways. The effects of SATISPARENT and TOTSAT disappeared. New effects arose for ATTSAT and NURTURE (low, mid<high), and interaction effects were seen on FRDSAT and COMSAT (mid preterms lower).

and middle education subgroups. Surprisingly, the middle education subgroup alone showed significantly higher negative life stress and dissatisfaction with the parental role. In fact, mothers of the middle education fullterms were lowest in life satisfaction.

Findings using the FHHEAD48 indicator of environmental status. Effects emerging with the use of FHHEAD48 were different in several ways. There was *no* environmental effect for SATISPARENT or TOTSAT, as there was using MOMED48. However, an environmental effect did emerge for ATTSAT and NURTURE, with more satisfaction with intimate support and expression of nurturant childrearing attitudes among mothers of higher social status. There was also an interaction effect for FRDSAT and COMSAT, with middle class preterms expressing less satisfaction with friendship and community support. Other effects were similar for both MOMED48 and FHHEAD48.

Group Differences in 48m Mother-Child Interaction

Group differences in 48m mother-child interaction were examined with a set of 3(MOMED48) X 2(GROUP) ANCOVAs, and a set of 3(FHHEAD48) X 2(GROUP) ANCOVAs. See Table 17. An omnibus MANCOVA was deemed unnecessary, since there were a small number of criterion variables, and only a priori hypotheses were scrutinized.

Main effects for prematurity. Using MOMED48 and FHHEAD48, no significant preterm-fullterm differences appeared at 48m on measures of

Table 17

Selected Analyses Examining 48-Month Maternal Behavior Effects

Chi-Square Comparisons of Environmental Effects (Using MOMED48)[a] Over Total Sample:

Variable	Statistic	Effect
WTMOMSTYLE (overall)	$x^2(2, n=81) = 6.22^*$	low, mid<high
Authoritarian Style	$x^2(2, n=81) = 8.43^*$	mid, high<low
Oversupportive Style	$x^2(2, n=81) = 6.08^*$	low, high<mid

Factorial ANCOVA Comparisons (Using FHHEAD48):

Outcome Variable	Source of Variation	SS	*df*	MS	*F*
WTMOMAFFECT	MOMAGE	.449	1	.449	.762
	GROUP	.235	1	.235	.399
	FHHEAD48	3.64	2	1.82	3.08†
	Interaction	1.08	2	.540	.917
	Residual	43.02	73	.589	
WTDYADSTYLE	MOMAGE	1.18	1	1.18	1.14
	GROUP	1.58	1	1.58	1.52
	FHHEAD48	5.08	2	2.54	2.44†
	Interaction	.012	2	.006	.994
	Residual	74.94	72	1.04	

Table 17 (continued)

Pairwise Comparisons of Environmental Effects (Using FHHEAD48):

Outcome Variable	n	Adjusted M	df	t
WTMOMAFFECT effect: low<middle, high				
low socioeconomic status	30	3.55	66	2.47**
middle socioeconomic status	38	4.02		
low socioeconomic status	30	3.55	40	1.87*
middle socioeconomic status	12	4.05		
WTDYADSTYLE effect: low > middle (high = low & middle)				
low socioeconomic status	29	4.06	65	-2.32*
middle socioeconomic status	38	3.47		

Percent of Nonfacilitating Dyadic Behavior in Each Biological & Environmental Status (Using MOMED48)[b] Group:

	% nonfacilitating WTDYADSTYLE	
Preterm's education		
low	0%	(n = 0)
middle	64.3%	(n = 9)
high	35.7%	(n = 5)
total preterm	38.9%	(n = 14)
Fullterm's education		
low	31.3%	(n = 5)
middle	31.3%	(n = 5)
high	37.5%	(n = 6)
total fullterm	35.6%	(n = 16)

[a]Using FHHEAD48, only an interaction effect exists on WTMOMSTYLE.

[b]Using FHHEAD48, a similar (though more pronounced) picture emerges of the WTDYADSTYLE interaction effect.

dyadic facilitation, dyadic satisfaction, maternal and child affect, or the styles used by the mother and child during the waiting task.

Main effects for environmental status. Using MOMED48, the only environmental group difference (of six analyses) was in maternal style (type of facilitation) during the waiting task. This was tested further with several chi square statistics. These showed environmental differences in maternal ability to facilitate flexible child self control, during a waiting period demanding inhibition of impulses (WTMOMSTYLE: corr. $\chi^2(2, n = 81) = 6.22$, $p = .045$). Investigation of cell frequencies suggested that mothers with a higher level of education were more likely to be facilitating in style. Mothers with less than a high school education, as predicted, more often displayed an authoritarian style during the waiting task, assuming responsibility for their childrens' waiting role by commanding their children to wait (WTAUTHOR: raw $\chi^2(2, n = 81) = 8.43$, $p = .015$). The middle education subgroup, surprisingly, seemed relatively more often oversupportive in style, assuming responsibility for the waiting role by inappropriately distracting and interacting with their children (WTOVERSP: raw $\chi^2(2, n = 81) = 6.08$, $p = .048$).

Note that use of FHHEAD48 uncovered trends toward significant environmental effects on WTMOMAFFECT (F (6,73) = 3.08, $p = .052$) and WTDYADSTYLE (F (6,73) = 2.44, $p = .094$). Pairwise comparisons revealed lower maternal affect, and a less facilitating dyadic style, among dyads of lower social status.

Interaction effects. The use of MOMED48 also uncovered a trend toward one interaction effect (WTDYADSTYLE: F (6,73) = 3.04 , p = .054), out of six analyses. This finding was not easy to explain, and might have occurred by chance. It did not appear using FHHEAD48. The sample size of the six biological X environmental groups made it difficult to identify the effect using pairwise comparisons. Inspection of the cell frequencies revealed opposing environmental effects among the preterms and fullterms. Surprisingly, preterm dyads with the least amount of education tended to show better performance. More predictably, fullterm dyads tended to show better performance with an increasing level of education.

Individual Differences in Preterm Developmental Outcome at 48m

Comparing Group and Individual Differences

It is important to know whether the group difference data accurately reflect the performance of individual preterm children. To find out, a comparison was made of the percentage of preterm and fullterm children achieving test scores below two cutoff points. On standardized tests, a scaled score of less than 8 (or IQ of 80) represents a significant delay. A scaled score of less than 9 (or IQ of 90) indicates performance below normal limits, a milder delay. Data presented in Table 18 shows a greater percentage of preterms, than of fullterms, falling below these cutoff points on both academic measures

Table 18

Percent Delayed on 48-Month Outcome Scores: Preterms and Fullterms

Outcome Variable	Preterm %	Fullterm %	Expected[a] %
PPVT IQ score			
less than 80	5.4	11.1	6.7
less than 90	24.3	**11.1**	30.9
INFO scaled score			
less than 80	8.1	4.4	6.7
less than 90	**18.9**	**13.3**	30.9
BD scaled score			
less than 80	11.1	6.7	6.7
less than 90	**19.4**	**8.9**	30.9
VMI developmental quotient			
less than 80	**42.9**	**22.7**	6.7
less than 90	**51.4**	31.8	30.9
ALLSC score			
1 s.d. below mean	**25.8**	15.5	16.0
General delay[b]	13.5	5.7	--

Note. Those percentage values written in boldface differed significantly from the expected values.

[a]These "expected" percentages are based on the normal curve.

[b]Defined as subjects for whom at least three of the above outcome scores were less than 8, 80 or 1 s.d. below the mean. Note that two of these preterm subjects, and one of the fullterms, were consistently ill from birth to age four.

and overall social competence. The individual difference data confirmed (and made more dramatic) the group difference findings of preterm deficits in nonverbal cognition, visuomotor skill, and overall social competence. In addition, the individual difference data uncovered more preterm than fullterm children with difficulties on verbal outcome measures, though not more than expected from test norms.

In the area of receptive language, 5.4% of the preterms received a PPVT IQ score of less than 80, and 24.3% less than 90. Fullterm children, on the other hand, either scored below 80 (11.1%) or in the normal range. Note that the fullterm percentages differ from those expected from a normal curve.

In the areas of verbal and nonverbal cognition, 4.4% (INFO) and 6.7% (BD) of the fullterm children showed noticeably delayed performance, with scaled scores of 8 or less. This is just about the number expected from a normal curve. Unfortunately, preterm children were twice as likely to show significantly delayed performance in these areas, with 8.1% (INFO) and 11.1% (BD) achieving scaled scores of 8 or less. Including those with less severe cognitive delay, the pattern was a little different. Preterm children were more than twice as likely as fullterms to score below 9 on a test of nonverbal cognition (preterms: 19.4%; fullterms: 8.9%). But the number of preterm children falling below normal limits in verbal cognition (18.9%) did not differ as markedly from the fullterm amount (13.3%).

In the area of visuomotor skill, children in both groups did more poorly than would be expected from the normal curve. Preterm children were again two times as likely to show significant delay, with a remarkable 42.9% receiving a VMI actual age quotient of less than 80, compared to the fullterm percentage of 22.7%. The group with a less significant delay, achieving scores below 90, were about half of the preterms (51.4%) and a third of the fullterms (31.8%).

On overall social competence, 15.5% of the fullterm children achieved scores at least one standard deviation below the mean, the amount expected from a normal curve. In contrast, one quarter of preterms (25.8%) exhibited this overall delay in social skill, as evaluated from the parent, child and observer perspectives.

Finally, individual preterm children were almost three times as likely to show general delay (scores of less than 80 or 1 s.d. below the mean in three areas). 13.5% ($\underline{n}$ = 5) of the preterms were designated as generally delayed, compared to 5.7% ($\underline{n}$ = 2) of the fullterms.

Biologically-Based Individual Differences

Comments on statistical procedures. Biologically-based individual differences were examined within the preterm group at 48m, and Table 19 summarizes these findings. Only a priori hypotheses were investigated, using several series of t-tests and simple correlations. In cases where a large number of t-tests were necessary to examine the hypotheses, Hotelling's t2 was used first to test the overall significance of conceptual groupings of dependent variables. Note that a multiple regression approach to the question of individual

Table 19

Biologically-based Individual Differences Within the Preterm Group

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Significant Differences for Each Biological Variable on Demographic and Other Biological Measures[a]

SGA group (n=7) had better biological status (BIOSUM1) both using the original group: $t(48)=-1.91^T$ and the 48m participants: $t(37)=1.80^T$

SGA group had lower FHHEAD48 SES: $t(35) = -2.33$*

IRDS group (n=17) had poorer early health (PNHEALTH): $t(38) = 4.06$***

IRDS group had lower FHHEAD48 SES: $t(35) = -2.50$*

PNHEALTH "good" health group (n=15) had lower FHHEAD48 SES: $t(35) = 2.61$*

KIDHEALTH "fairly good/poor" group (n=18) had younger mothers: $t(35) = 1.81^T$

KIDHEALTH "poor" group (n=9) had more boys: $X^2(1,n=38) = 3.13^T$

Significant Differences for Each Biological Variable on 48m Outcome Measures

Outcome Variable/ Predictor Variable	Statistic	Effect
Academic Outcome:		
PPVT		
SGA	$t(35) = 2.79$**	SGA < no SGA
INFO		
SGA	$r(37) = -.28$*	The presence of SGA is associated with problems in verbal cognition

Table 19 (continued)

Outcome Variable/ Predictor Variable	Statistic	Effect
BD		
SGA	*r*(36) = -.37*	The presence of SGA is associated with problems in nonverbal cognition
VMIAQ		
SGA	*r*(35) = $-.25^{T}$	The presence of SGA is associated with problems in visuomotor skill calculated according to both actual age and age corrected for prematurity
VMICQ		
SGA	*r*(35) = $-.27^{T}$	
Summary Social Outcome:		
ALLSC		
GA	*r*(30) = .40*	longer GA is associated with better social competence
PNHEALTH	*t*(28) = -2.25*	poor health< good health
SEX	*r*(30) = .41*	maleness is associated with lower social competence
PSOCSKILL		
GA	*r*(35) = .34*	longer GA is associated with more positive social skill
PNHEALTH	*t*(33) = -2.21*	poor health< good health
SEX	*t*(33) = -2.35*	male < female

Table 19 (continued)

Outcome Variable/ Predictor Variable	Statistic	Effect
PCONTROL		
SEX	t(33) = -2.39*	male < female
STAYILL	t(33) = -2.39*	consistently ill< healthier
PBEHWELL		
SEX	t(33) = -3.02**	male<female
KDACCEPT		
IRDS	t(30) = 3.74***	IRDS < no IRDS
PNHEALTH	t(30) = -3.65***	poor health< good health
STAYILL	t(33) = 2.93*	consistently ill< healthier
SEX	t(33) = -4.18***	male < female

[a]All t-tests were two-tailed.

[b]All t-tests were one-tailed.

differences was undesirable, due to multicollinearity within the set of biological predictor variables, as well as small sample size.

Eight biological variables were investigated, including: birthweight; gestational age; smallness for gestational age (SGA); presence of IRDS; postnatal health (PNHEALTH); childhood health (KIDHEALTH); continuing illness (STAYILL); and sex. The continuous variables of birthweight and gestational age were investigated with correlations. Dichotomous variables were created for the six remaining predictors, by dividing the group of preterm children into subgroups appropriate to each biological measure.

These biological predictors have been linked to early outcome problems, but more data have been needed to clearly establish their longterm impact. Overall, these data showed that 48m preterm outcome problems were predicted by several of these biological variables. Four-year academic difficulties were seen in SGA children, while social problems were generally seen in ill and/or male preterms.

Notable demographic and biological differences. Before looking at 48m outcome differences for each predictor, analyses were performed to check for confounds. On the whole, there were few differences, using two-tailed t-tests, on demographics or other biological measures for any of the eight predictor variables. In fact, the similarities on those variables not deliberately balanced in this study are of interest. None of the biological subgroups differed on maternal education (using MOMED48), though they did differ in socioeconomic status (using FHHEAD48). Children of minority status, or with younger mothers, showed no greater incidence of health problems, either early or later in life. Children with SGA were similar to those considered AGA in age, race, sex and health, including the presence of IRDS and the presence of health problems, postnatally and from age 1 1/2 to 4 years. In addition, they had mothers of about the same age and educational level.

Birthweight and gestational age. Using correlations, birthweight and gestational age were examined for relationships with 48m child outcome. Gestational age was moderately associated only with overall social competence (ALLSC: r (30)= .40, p = .015), and the parental view of child social skill (PSOCSKILL: r (35)= .34, p = .023). The more normal the child's gestational age, the better their social skill at age four. Birthweight showed no significant relationships with 48m social or academic outcome.

Smallness for gestational age (SGA). There were seven children considered SGA in the preterm group, and 30 rated AGA. Interestingly, the SGA children actually showed a trend toward more optimal biological status on the summary score of gestational age, birthweight, and postnatal health problems (BIOSUM1: t (37) = -1.80, p = .062, two-tailed). As a group, they were of lower SES than the AGA children, as measured by the summary variable (FHHEAD48: t (35) = -2.33, p = .026).

One-tailed t-tests and correlations were needed to examine the a priori hypotheses concerning academic outcome. As expected, t-tests revealed significantly lower scores for SGA preterms in receptive language (*t* (35) = 2.79, *p* = .004). As a group, SGA preterms received a mean PPVT score of 87.7, while AGA preterms achieved a mean of 104.7. Predicted relationships between the presence of SGA and lower outcome scores appeared in the areas of: verbal cognition (INFO: *r* (37) = -.28, *p* = .048), SGA *M* : 9.4, AGA *M* : 11.5); nonverbal cognition (BD: *r* (36) = -.37, *p* = .013), SGA *M* : 8.7, AGA *M* : 11.0), and in trends in the area of visuomotor skill, whether calculated according to actual age (VMIAQ: *r* (35) = -.25, *p* = .070, SGA *M* : 80.3, AGA *M* : 91.4) or age corrected for prematurity (VMICQ: *r* (35) = -.27, *p* = .060), SGA *M* : 83.2, AGA *M* : 95.4). It was notable that SGA preterms accounted for much of the preterm/fullterm "academic" group difference.

Note that a multivariate test found no significant differences between SGA and AGA preterms on 48m social outcome (*t2* = 8.19, *F* (5,24) = 1.40 , *p* = .258).

Presence of IRDS. Children born with IRDS received lower postnatal health scores (PNHEALTH: *t* (38) = 4.06, *p* = .000, one-tailed), but were not more ill during childhood. Those with IRDS came from lower SES families (FHHEAD48: *t* (35) = -2.50, *p* = .017, two-tailed).

Two Hotelling's t2 analyses were performed, since a wide variety of outcome measures were of interest. As expected on the set of 48m academic outcome variables (cognitive, linguistic, visuomotor), no significant differences arose between those born with and without IRDS. Surprisingly, however, there was a significant difference on the 48m social outcome measures (t2 = 19.25, F (4,24) = 3.21, p = .021). Followup t-tests revealed a single significant effect. The IRDS group received lower scores on the child's view of acceptance by others (KDACCEPT: t (30) = 3.74, p = .001, two-tailed, IRDS M : 5.4, no IRDS M : 6.5, out of a total of 8.0).

Postnatal health (PNHEALTH). To conduct t-tests, PNHEALTH was converted to a dichotomous variable, with a "poor" postnatal health group (n =23), and a group with "good" postnatal health (n =15). The "poor" PNHEALTH group was of lower SES (FHHEAD48: t (35) = 2.61, p = .006, one-tailed). Boys were not found more commonly in the "poor" PNHEALTH group. Though sick in early infancy, the low PNHEALTH group did not continue to show more illness during childhood.

Omnibus Hotelling's t2 statistics revealed significant differences on the set of social outcome measures (t2 = 18.05, F (5,24) = 3.10, p = .027) but, surprisingly, not on the academic measures. Following up with t-tests, significant effects emerged on the parental view of child social skill (PSOCSKILL: t (33) = -2.21, p = .017, one-tailed), poor health M : -2.45 (s.d. 5.24), good health M : 1.45 (s.d. 4.89), the child's own view of his/her social acceptance (KDACCEPT: t (30) = -3.65, p = .000, one-tailed), poor health M : 5.54 (s.d. 0.71), good health M : 6.59 (s.d. 0.92) as well as overall social competence (ALLSC: t (28) = -2.25, p = .016, one-tailed). As hypothesized, the children with more postnatal health problems received lower scores.

Health from age 1 1/2 to 4 years (KIDHEALTH). KIDHEALTH was measured by parental report of the severity of health problems during childhood (poor health=1, fairly good health=2, good health=3). The correlation of KIDHEALTH and PNHEALTH in the preterm group was .14, indicating that premature children with postnatal health problems did not necessarily show continuing childhood illness. For the individual difference questions, the group of children with good health (n = 19) were contrasted with a group having either fairly good or poor health (n = 18). The "fairly good/poor" group did tend to have younger mothers (t (35)= .181, p = .079).

Two Hotelling's t2 analyses were performed to look at group differences across multiple dependent variables: one using a set of academic outcome measures, and one using a set of social outcome measures. Unexpectedly, neither t2 statistic was significant, indicating that children with fairly good or poor childhood health do not differ from those with good health on academic or social outcome at age four.

Similar findings emerged in a reanalysis contrasting preterms with poor childhood health with those having either good or fairly good health. It should be noted that there were significantly more preterm boys reported to be severely ill during childhood (KIDHEALTH: corr. χ^2 (1, n = 38) = 3.13, p = .077): 8 (36%) of the boys, and 1 (6%) of the girls. This was not true of the fullterms. It is interesting to note that minority status, SGA, IRDS, and lower SES (measured with FHHEAD48) were not found more commonly among the preterms with poor childhood health.

Continuing illness. The transactional model predicts that consistent illness would have a relatively greater impact of developmental outcome than would intermittent sickness, unless another factor intervened. Prior research at UCLA (Sigman & Parmalee, 1979) has found that continuing illness was a significant predictor of deficits in preterm cognitive outcome. In this study, there was one subgroup of children (n = 10) who were consistently ill. These children received a PNHEALTH score less than or equal to 72 as well as a KIDHEALTH score of 1 or 2. This subgroup was contrasted with children who were not consistently ill, though they might have been ill either postnatally or in childhood.

There were no early outcome differences between these two subgroups, nor did they differ on early temperament (except for lower 8m mood). The children with continuing illness were more often white and almost all male, but did not differ on social class. At 48m, there were only two significant differences between children with consistent versus intermittent or no illness, both in the social area: PCONTROL: t (33) = 2.93, p = .003; and KDACCEPT: t (30) = 2.71, p = .005. Children with continuing illness were seen as less balanced in self-control, and believed themselves to be less socially accepted. Note that both effects may be confounded by sex.

Given the good 48m outcome of these very ill children, there were surprisingly few differences in the "proximal" environment (caregiving and maternal attitudes), a potential self-righting influence suggested by a transactional framework. The two subgroups did not differ on the mothers' satisfaction with parenting or childrearing attitudes, across time. Mothers of consistently ill children were more positive and responsive only at 12m in the picture book situation (MOMBEH12-S: *t* (34) = -2.96, *p* = .003). The ill children were more positive and responsive only in the 24m structured lever task (KIDBEH24-S: *t* (18) = -2.26, *p* = .018). A careful look at the 48m structured waiting task did reveal a higher frequency of a nonfacilitating style in mothers of children with consistent illness although, surprisingly, the mothers were not significantly more often oversupportive. Note that the three children who were consistently ill, and showed general academic delay at age four, all received consistently poor caregiving.

Sex differences. Among the preterms, there were 21 males and 16 females. Two Hotelling's t2 analyses were conducted to scrutinize overall sex differences on multiple academic and social outcome variables. As expected, t2 was not significant for the set of academic outcome variables, indicating no sex differences within the preterm group for cognitive, linguistic and visuomotor skills. In contrast, the hypothesized difference did emerge for the set of social outcome measures (*t2* = 32.35, *F* (5,24) = 5.54, *p* = .002). Followup one-tailed t-tests showed significantly lower scores for males on the parental views of: positive social skills (PSOCSKILL: *t* (33) = -2.35, *p* = .012), boys *M* : -2.63 (s.d. 5.7), girls *M* : 1.43 (s.d. 4.1) child self control (PCONTROL: *t* (33) =-2.39, *p* = .011), boys *M* : -2.01 (s.d. 3.8), girls *M* : 1.88 (s.d. 4.6), and behavior problems (PBEHWELL: *t* (33) = -3.02, *p* = .002), boys *M* : -1.17 (s.d. 1.5), girls: 0.56 (s.d. 1.9). Premature boys also scored significantly lower on a measure of their own view of social acceptance by others (KDACCEPT: $\underline{t}$ (33) = -4.18, $\underline{p}$ = .000), boys $\underline{M}$: 5.5 (s.d. 0.80), girls $\underline{M}$: 6.69 (s.d. .74) and male gender was related to poor overall social competence (ALLSC: $\underline{r}$ (30) = .41, $\underline{p}$ = .013), boys $\underline{M}$: -0.48 (s.d. 8.8), girls: 3.09 (s.d. 9.3).

As a contrast, it was interesting to look for sex differences within the fullterm group. There were essentially no differences by sex on any of the academic or social outcome measures, except a single finding of better receptive language in fullterm boys ($\underline{t}$ (43) = 2.20, $\underline{p}$ = .016, boys $\underline{M}$: 111.5 girls $\underline{M}$: 100.2).

Transactions Leading to Child Developmental Outcome in Preterms and Fullterms

Overall Statistical Procedures

As discussed in the Introduction, researchers have tested hypotheses arising from a transactional framework with a variety of analytical strategies. The present study used a combination of five procedures to examine transactional ideas. Note that these procedures were conducted using data "across time" (selected from the 1, 4, 8, 18, 24 and/or 48m timepoints).

#1: Equalized, standardized sets of simple correlation pairs. The transactional framework suggests that development is best visualized as a complex network of developmental influences, with stable influences exerting a greater effect on child outcome. The first procedure provided evidence for evaluating these notions. Standardized correlations were used to: (1) compare the stability of important developmental constructs between the preterm and fullterm groups (e.g. maternal attitudes); and (2) examine, over time and between groups, the patterns of association between important developmental constructs and 48m child outcome.

Six sets of matching correlation pairs were examined, separately for the preterm and fullterm groups. Differences in the patterns of the two groups were uncovered by comparing the magnitude of the two correlations within each pair. This was done for each of the six sets of correlations. Coefficients reaching a significance level of $p < .10$ (for at least one of the groups) were converted to z-scores, and a _Z_ test was used to assess the significance of the difference between the z-scores (Edwards, 1976).

For this procedure only, the confounding effect of maternal age was handled by "equalizing" the sample: deleting one fullterm subject with a young mother (chosen randomly from three possibilities). This strategy was chosen in preference to the more standard use of partial correlations, which could statistically equate for maternal age. Using an "equalizing" rather than partialling technique, the correlation coefficients retained all their original outcome variance. This generated a more realistic picture of the patterns of relationships holding across measures, when each association was considered individually. Note that the pattern of "equalized" correlations was very similar to that of simple correlations using the entire sample, while the pattern of partial correlations was somewhat dissimilar.

#2: "Least squares" regressions. A transactional view also suggests that the developmental network evolves over time, with different developmental factors asserting their importance at different timepoints, and possible self-righting influences. One way to study important variables in the network, and to learn more about its dynamics, was to use regression procedures. In the present study, the regression procedures were meant to accomplish three objectives: (1) to confirm the identity, and determine the weighting, of variable sets explaining various aspects of 48m child outcome (compared between preterms and fullterms); (2) to contrast, over time, the "active" ingredients of one set of predictor variables, within and across groups; and (3) to compare the efficacy of different sets of predictor variables, within and across groups.

Following a series of hypotheses, several sets of regression analyses were performed. As a covariate, maternal age was always entered on the first step, to see if it alone accounted for a significant amount of outcome variance. On the second and final step, all variables (including mother age) were considered to be entered last. This was a "least squares" regression approach, which treats each of the predictors as though it were the last to be entered, thereby examining the size of the overall relationship between all component variables, and revealing the relative, unique weights of each predictor variable in explaining outcome variance.

The regression procedures were used to compare three variable sets of theoretical importance in explaining 48m child outcome. These were:

(1) biological and global environmental status; (2) the variables in the first set plus measures of the "proximal" environment; and (3) two combinations of variables from the first set, adding earlier child developmental status to both. The first set of variables were those traditionally used to explain preterm outcome. The second set included more detailed measures of the environment which, according to the transactional viewpoint, should better explain outcome, especially among preterms. The third set included measures of earlier child outcome (such as the Bayley MDI). According to a transactional view, adding data on early outcome should improve the explanation of later child outcome, especially among the fullterm children.

Note that the second variable set, which included measures of the "proximal" environment, was examined using data from several timepoints. This allowed a preliminary look at the evolution of developmental influences over time. Variables uniquely explaining a significant portion of outcome variance were considered to be "active," and therefore especially important developmental influences. In these regressions,"active" variables were compared over time, and between groups.

It is important to note that comparison "hierarchical" regressions were conducted. These analyses did not covary maternal age, and entered biological status alone on the first step. Results were similar to those generated by the "least squares" regressions which are reported here.

#3: Dynamic variables. The transactional approach emphasizes the dynamic nature of development, suggesting that static measures should have less explanatory power than measures which assess change over time. To test this notion, a third procedure aggregated selected variables to produce measures of the same dimension across time. These dynamic measures were then studied in relation to child outcome.

Specifically, the impact of "continuing illness" on 48m outcome was examined within the preterms, contrasting the subgroup of consistently ill preterms with the remaining preterm children. In addition, preterm/fullterm group differences in the effect of "consistently poor caregiving" on 48m outcome were explored.

#4: Equalized, standardized sets of partial correlation pairs. In the transactional view, the action of one variable is affected by the actions of other variables. Thus, there is a network of developmental forces, with both direct and indirect paths of influence. Of particular interest in the study of prematurity are the relative impact of the wider environment versus the more proximal environmental influence of maternal caregiving. The actions of the caregiver are thought to be especially salient to the vulnerable preterm, perhaps acting as a self-righting mechanism.

To some degree, this idea can be assessed using the technique of partial correlations. Partialling was used to determine the impact of maternal caregiving, independent of the effect of global environmental status. Specifically, the global environmental effect was partialled out of the effect of maternal caregiving, generating a set of equalized standardized partial correlation pairs. The pattern generated by partial correlations was contrasted with the pattern yielded by simple correlational data. This revealed preterm/fullterm differences in patterns of association.

#5: Dynamic versus inherently transactional caregiving measures. According to the transactional view, variables which capture an important child-environment transaction should better explain child outcome. One such measure, discussed above, captures a dynamic of the caregiver-child interplay in a microanalytic way: "consistency of caregiving." A second measure, more global and dyadic in nature, captures a caregiver-infant transaction critical to the child's developmental progress: security of attachment. The relative effectiveness of these two transactional measures was assessed.

A fifth and final procedure, then, used the attachment measure to discern differences between preterms and fullterms in transactions leading to 48m child outcome. Over the total sample, a comparison was made of the efficacy of the two transactional measures ("security of attachment" and "consistency of caregiving") in predicting 48m child outcome, especially in the social area. In particular, the relationship between security of attachment and behavior in a theoretically consistent 48m situation (the "Waiting Task") was inspected. This was done across the total sample, and between groups. Note that the "Waiting Task" was devised for the present study.

Stability of Maternal Attitudes, Maternal Behavior, as well as Child Temperament and Behavior, in Preterms and Fullterms

In searching for transactions, a necessary first step was to examine the stability of constructs hypothesized to be important to development. Presumably there is a greater effect on child outcome when maternal attitudes or behavior, or the child's characteristics, are more stable. Note that preterms have been hypothesized to be less stable than fullterms in some outcome areas.

The constructs under investigation included maternal attitudes, maternal behavior, as well as child behavior, temperament and developmental status. As discussed in detail above, equalized, standardized correlations were generated, separately for preterms and fullterms, between measures of these constructs taken at different points in time. Significant differences were noted between groups in the magnitude of correlation pairs, and patterns of findings were interpreted.

Maternal attitudes about stress, social support, general life satisfaction and satisfaction with parenting. Each of these attitudes were assessed with repeated measures at 1, 8, and 18m. The scores generated by these measures are described in the Methods section, and stability results for these three constructs are given in Table 20. With a few exceptions, there was moderate stability across time for each of these maternal attitudes. Surprisingly, measures close in time did not reveal a higher degree of stability, as expected from a transactional model. For example, correlations between 1 and 8m satisfaction with the child (SATISKID) were about the same magnitude as correlations between 1 and 48m SATISKID. There were few significant

Table 20

Stability of Maternal Attitudes about Social Support, Stress, Life Satisfaction, and Satisfaction with Parenting: Preterms and Fullterms

	SATISKID1		SATISKID8		SATISKID18	
	PT	FT	PT	FT	PT	FT
SATISKID8	.35*	.43**				
SATISKID18	.32^T	.50***	.38**	.37*		
SATISKID48	.31*	.47***	.47**	.34*	.44*	.21

	COMSAT1		MCOMSAT8		COMSAT18	
	PT	FT	PT	FT	PT	FT
MCOMSAT8	.31*	.18				
COMSAT18	--	--	-.34*	.01		
COMSAT48	.40**	.27*	.24^T	.09	[.42**	-.07]

	FRDSAT1		FRDSAT18	
	PT	FT	PT	FT
FRDSAT18	.40*	.20		
FRDSAT48	[.59***	.14]	[.62***	.21]

Table 20 (continued)

Note. If any, brackets indicate significantly different standardized correlations within a matching pair. Note that SATISKID shows a pattern of moderately high and consistent stability across time. Other maternal attitudes show a similar pattern. These include: SATISPARENT; LIFESAT; ATTSAT; and STRESS. Note that 14 of 15 possible pairs of correlations had at least one significant ($p<.10$) component correlation. Of these 14, 4% were significant for fullterms, and 100% were significant for preterms.

differences between matching correlation pairs in the premature and fullterms groups, indicating similar patterns of attitudinal stability. However, slightly more stability was seen among the preterm mothers in satisfaction with friendship support and, to a lesser extent, satisfaction with support from the community.

Childrearing attitudes. Childrearing attitudes were measured differently at two timepoints. See Table 21. At 18m, the Maternal Attitude Scale (MAS) provided three attitudinal scores: appropriate control of aggression; encouragement of reciprocity; and acceptance of emotional complexity. At 48m, the Modified Childrearing Practices Report (CRPR-M) generated attitudinal measures of restrictiveness and nurturance. In general, equalized correlations revealed moderate to high stability in childrearing attitudes: 18m attitudes were associated positively with 48m nurturance, and negatively with 48m restrictiveness. However, compared to mothers of fullterms, there appeared to be somewhat less stability between earlier and later childrearing opinions among preterm mothers. Among these preterms, 48m restrictive childrearing opinions were only somewhat negatively related to earlier attitudes about control of aggression and emotional acceptance.

Perceptions of the family environment. Family attitudes were measured at 24m using the Family Environment Scale (FES), which yielded three summary scores: relationship dimensions (e.g. cohesion, and others); personal growth dimensions (e.g. independence and others); and

Table 21

Stability of Childrearing Attitudes and Family Perceptions: Preterms and Fullterms

	RESTRICT48		NURTURE48	
	PT	FT	PT	FT
AGGCONTROL18	[-.26	-.64***]	.32^{T}	.21
RECIPROCITY18	-.53**	-.60***	.41*	.56***
EMOTACCEPT18	-.27	-.64***	.23	.37*

	FAMCOHESION48		FAMADAPTABILITY48	
	PT	FT	PT	FT
RELATIONSHIPS24	[-.10	.38*]	-	-
GROWTHORIEN24	-	-	-.08	.31*
SYSTEMMAIN24	[-.49**	.13]	-	-

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that for childrearing all possible pairs of correlations had at least one significant component correlation, while half of the possible pairs (3) were significant for family perceptions. Of the total 9 pairs, 78% were significant for fullterms, and 44% were significant for preterms.

system maintenance dimensions (e.g. organization and control). At 48m, the same latent construct was evaluated using the Family Adaptability and Cohesion Scales (FACES II), which produced two summary scores: perceived adaptability and perceived cohesion. See Table 21.

The fullterm group showed clearly understandable associations, and stability over time. 48m family cohesion was positively related to the 24m relationship dimension of the family environment, while 48m family adaptability was associated with the 24m dimension of family growth orientation. Early system maintenance in fullterms was unrelated to later family style. The preterm group did not show the same stable and predictable pattern. In fact, the preterms showed a single, strong negative association between 48m family cohesion and the 24m dimension of system maintenance. In other words, the more organized and controlled the mother perceived the family to be when the child was aged two, the less optimal the perceptions of family togetherness when the child reached age four.

Maternal behavior. The mother's behavior was assessed in various ways over the course of the Mother-Infant Project. Stability in maternal behavior could be evaluated with global interaction quality ratings, which were repeated at 4, 8, 12, 24 and (to some extent) at 48m. These aggregate scores were comprised of several interaction scales, coded from videotapes during both a free play segment and an age-appropriate semi-structured observational period. At 4 and 8m, the two aggregate scores were summed, while at 12 and 24m the scores were kept separate. At 48m, slightly different measures were used. See the

Methods section for a description of these measures, and Table 22 for these findings.

Equalized correlations in both groups revealed moderately stable maternal behavior, at least in the free play situation, during the first two years. It was somewhat surprising that the preterm mothers showed behavior just as stable as their fullterm counterparts. Greater stability generally occurred between observations made closer in time, as predicted by the transactional model, though this was not always true. The 24m "lever task" structured interaction sequence apparently elicited unique maternal behavior, with few significant relationships to earlier behavior. This was also true of the 48m "waiting task" segment. Z tests on standardized correlation pairs indicated only one significant difference in the stability of maternal behavior between the preterm and fullterm groups. Interaction during the 24m "lever task" was related to 48m "waiting task" behavior quite differently in the two groups, showing an r of -.26 in the preterms, and an r of .51 in the fullterms. Thus, fullterm maternal behavior appeared more stable in these two structured situations, both of which were somewhat stressful. Note that 48m "waiting task" behavior was relatively consistent with maternal behavior in the 12m free play and structured play sequences, especially for the fullterms.

Child temperament and behavior. Of great interest was the lack of association, in both premature and fullterm children, between 48m measures of child temperament and earlier temperament scores. At 1 and 8m, temperament was described by mood, intensity and distractibility

Table 22

Stability of Maternal Behavior: Preterms and Fullterms

	MOMBEH4		MOMBEH8		MOMBEH12-F		MOMBEH12-S		MOMBEH24-F		MOMBEH24-S	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
MOMBEH8	.47***	.50***										
MOMBEH12-F	.11	.40**	.42**	.62***								
MOMBEH12-S	.39**	.30*	.44**	.57***	.42**	.54***						
MOMBEH24-F	.41*	.49***	.44**	.68***	.49**	.65***	.45*	.38*				
MOMBEH24-S	$.37^T$	.34*	-	-	-.12	$.25^T$	-.11	.34*	.50*	.42**		
MOMBEH48-S	.04	$.21^T$	-	-	.12	.40**	.34*	.32*	.21	$.27^T$	[-.26	.51**]

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that 19 of 21 possible pairs of correlations had at least one significant ($p<.10$) component correlation. Of these 19, 100% were significant for fullterms, while 63% were significant for preterms.

scores from two different instruments. At 48m, child temperament was measured with a third tool, yielding five scores. Only a chance number of significant equalized correlations were found across time, and no predicted relationships appeared. For example, 4 and 8m distractibility scores had no association in either group to 48m attention span.

Child behavior was assessed similarly to maternal behavior, in a microanalytic fashion. Observations made closer in time did not show greater stability. Behavior at 8m, and in free play at 24m, seemed unrelated to behavior at other times. Both groups had erratic patterns of equalized correlations. Though it was not clear, there appeared to be low moderate stability among the fullterms, and in the standardized correlation data the preterms seemed to have somewhat less stability than their fullterm peers.

Note that the 12m security of attachment, in both preterms and fullterms, did show relationships to child behavior at 24 and 48m. This contrasted sharply with the lack of stability apparent when microanalytic measures were used. The attachment data are discussed in more detail later in the paper (see Table 37).

Summary of Group Differences in Stability

Overall, preterm and fullterm mothers showed similar stability in their behavior and their attitudes. However, mothers with premature children were more stable in their satisfaction with friendship and community support, and less stable in their childrearing opinions.

Mothers of preterms differed from the fullterm group in the stability of their family perceptions, apparently in the area of control. Possibly related to this was the finding that mother-child interaction appeared less stable among preterm dyads trying to function in more stressful situations.

Neither preterm nor fullterm children showed stability in the area of temperament. Using microanalytic measures, the behavior of fullterm children appeared somewhat stable over time, while the preterms behaved in a less stable manner. Using measures of attachment, on the other hand, children from both groups demonstrated behavioral stability, at about an equal level.

Transactional Explanation of Preterm and Fullterm Outcome: Contribution and Relative Importance of Several Constructs Considered Simultaneously

To understand the developmental course of the preterm child, one must study the complex network of developmental forces as it evolves over time. Of interest, for example, is the relative importance of "biological" versus "global environmental" factors in determining preterm outcome. Of interest also is the increase in explanatory power offered by more detailed "proximal" environmental measures. These and several other transactional questions were tested, and are discussed in more detail in the three sections below.

The "least squares" regression method was chosen to examine these questions, which require several developmental constructs to be considered simultaneously. Important regression data included: (1) the size of the multiple _R_ , for both preterms and fullterms (significant to at least the $p < .10$ level; and (2) the beta weight of each "active" regression component (with "active" components identified by a _p_ of at least $< .10$, within an overall significant regression equation).

These regression analyses must be considered exploratory in nature. The "least squares" regression method is a relatively conservative way to pinpoint meaningful findings. However, at times, the number of variables entered into the equations exceeded the "10 subjects per variable" rule of thumb for regression procedures. In addition, interaction effects were not entered. In part, this was because of small sample and effect sizes, as well as problems of multicollinearity with any interaction effect including the BIOSUM# variable, since the fullterm sample showed little variation in biological status. Given that previous ANCOVA analyses had uncovered few significant interaction effects, omitting interactions in the regression procedures seemed somewhat justified.

<u>Relative importance of maternal age, biological status and global environmental status.</u> The first step was to assess the overall contribution, and relative importance, of early biological and global environmental status to an explanation of 48m child outcome. These are the standard predictor variables used in the prematurity literature. A set of "least squares" regressions were conducted separately for the

preterm and fullterm groups, using BIOSUM1 and MOMED1 as predictor variables. FHHEAD48 was not used in the regression procedures.

The results, presented in Table 23, clearly demonstrate several points. First, the covariate of maternal age only once appeared as a significant component in the final regression equation for any of the outcome variables (fullterms: KDACCEPT). Second, for both preterm and fullterm groups, the summary biological variable, based on data available at birth, often had only slight predictive power. This was true even for nonverbal cognition and visuomotor skill among the preterms, though they were expected a priori to be predicted by biological variables.

Surprisingly, few significant findings appeared in the premature group, even when the criterion of 10 subjects per predictor variable was met, and therefore small sample size was not a problem. The three predictor variables explained only selected aspects of preterm social outcome, including 22% of the overall variance in the four-year-old preterm's view of his/her own social acceptance, and dimensions of preterm temperament: (ATTENTION: 20%; and REACTIVITY: 32%). Biological status appeared to be the salient predictor in the KDACCEPT and REACTIVITY regressions, with more optimal outcomes for preterms related to better biological status early in life. Quite unexpectedly, note that global environmental status was not very important in explaining four-year preterm academic or even social outcome, with the exception of preterm attention span.

In contrast to the preterm findings, the regression equations explained both academic and social outcome among four-year-old fullterm

Table 23

Multiple Regression of 48-Month Child Outcome on Early Biological and Environmental Status (With Maternal Age as a Covariate): Preterms and Fullterms

Outcome Variable/ Predictor Variables	Preterms Covariate R^2	Preterms Final R^2	Preterms β	Fullterms Covariate R^2	Fullterms Final R^2	Fullterms β
Academic Outcome:						
PPVT				.03	.25**	--
MOMAGE1						-.16
BIOSUM1		---				.04
MOMED1						.57**
INFO				.00	.16^T	--
MOMAGE1						-.18
BIOSUM1		---				-.20
MOMED1						.45*
BD						
MOMAGE1						
BIOSUM1		---			---	
MOMED1						
VMIAQ				.05	.15^T	--
MOMAGE1						.03
BIOSUM1		---				-.16
MOMED1						.35^T
VMICQ				.05	.16^T	--
MOMAGE1						.04
BIOSUM1		---				-.20
MOMED1						.34^T

Table 23 (continued)

Outcome Variable/ Predictor Variables	Preterms Covariate R^2	Preterms Final R^2	Preterms β	Fullterms Covariate R^2	Fullterms Final R^2	Fullterms β
Summary Social Outcome:						
ALLSC				.16**	.31**	--
MOMAGE1						.17
BIOSUM1		---				-.21
MOMED1						.41*
PCONTROL				.13*	.28**	--
MOMAGE1						.12
BIOSUM1		---				-.22
MOMED1						.43*
PBEHWELL				.19**	.37***	--
MOMAGE1						.11
BIOSUM1		---				.02
MOMED1						.53**
OCONTROL						
MOMAGE1						
BIOSUM1		---			---	
MOMED1						
KDACCEPT	.02	$.22^{T}$	--	.10*	.10	--
MOMAGE1			.15			.31
BIOSUM1			.44*			-.07
MOMED1			-.02			.02
Component Social Outcome:						
ACTIVITY (higher scores less optimal)			--	.11*	.23*	--
MOMAGE1						-.10
BIOSUM1						-.18
MOMED1						-.36*

Table 23 (continued)

Outcome Variable/ Predictor Variables	Preterms Covariate R^2	Preterms Final R^2	Preterms β	Fullterms Covariate R^2	Fullterms Final R^2	Fullterms β
ATTENTION	.04	.20^T	--	.07^T	.13	--
MOMAGE1			-.03			.17
BIOSUM1			-.02			-.20
MOMED1			.46*			.19
REACTIVITY (higher scores less optimal)	.10^T	.26*	--	.14*	.32**	--
MOMAGE1			-.28			-.12
BIOSUM1			-.40*			.24^T
MOMED1			-.04			-.45**
EGORESILIENCE (higher scores less optimal)	.12*	.23*	--	.06^T	.16^T	--
MOMAGE1			.18			.04
BIOSUM1			.17			-.11
MOMED1			.32^T			.36*

Note. Simple correlations between the outcome variables and BIOSUM1 and MOMED1 can be found in Table 28. For preterms, note that 29% of the possible regressions (4 of 14) generated a significant R^2 ($p<.10$). For fullterms, 86% of the possible regressions (12 of 14) generated a significant R^2.

children. The predictor measures explained about 25% of the variance in receptive language, 16% in verbal cognition, and about 15% of visuomotor ability. With regard to social outcome, the three predictor variables accounted for about 31-36% of the variance in the parental view of social behavior, and 23 to 32% of the variance in certain aspects of child temperament was explained. Maternal education, the environmental indicator, was almost always the only "active" predictor variable in the fullterm group.

Relative importance of maternal age, biological status and three measures of environmental status. A second set of regressions were performed. These regressions included not only the standard variables of the preceding analyses (Table 23), but also more detailed environmental measures assessed over time: maternal attitudes and behavior at different ages. Thus, this set of regressions indicated what additional predictive power could be gained by using measures of the "proximal" environment at different points in time.

Indicators of the "proximal" environment included: maternal attitudes (SATISPARENT-parental role satisfaction; SATISKID-satisfaction with child); and maternal behavior (MOMBEH#-varying ratings of maternal interaction quality). These regressions were performed separately with data from 4, 8, 12 and, concurrently, at 48m. Findings were inconclusive for the 24m data, due to small sample size. (Note that the effect of these predictor variables was examined independent of earlier child outcome. The impact of earlier developmental outcome is discussed in the next section.)

Results are given in Tables 24 through 26. These tables present both the overall R square and those "active" variables generating a significant t in the equation, and should be compared to Table 23. Three points should be noted. First, more variance was accounted for in both groups when "proximal" measures were a part of the equation, in spite of a loss in degrees of freedom. Second, there were relatively few significant results for academic outcomes in both groups. Third, and not surprisingly, the observer's view of the child's behavior in a 48m self-control situation was predicted strongly by maternal behavior in the same situation (OCONTROL: $R2$ of 44% (preterms) and 28% (fullterms)). Notice that the behavior of the preterm mother and child seem more closely linked, during the waiting task, than that of their fullterm counterparts.

Table 24 gives the academic outcome findings. In neither group were 48m nonverbal cognition and visuomotor ability explained by this set of predictor measures, although these skills were explained somewhat in preterms by the SGA biological variable (see Preterm Individual Differences section). The only finding for preterms, possibly a chance result, was for 48m receptive language, using 1/4m information. Fullterm verbal cognition was explained only with concurrent data ($R2$ increase from 16% to 29%). In contrast, fullterm receptive language was consistently predicted across time. Though global environmental status was clearly the active variable, measures of the "proximal" environment appeared to account for at least some additional variance ($R2$ increase from 25% to 28%-40%).

Table 24

Multiple Regression of 48-Month Child Academic Outcome on Biological, "Proximal" and Global Environmental Status (With Maternal Age as a Covariate): Preterms and Fullterms

48m Academic Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint			
	1/4m	8m	12m	48m
		Preterms		
PPVT	total $\underline{R}^2$ = .39* β's for: SATISPARENT1 .54**	---	---	---
INFO	---	---	---	---

Table 24 (continued)

48m Academic Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint: 1/4m		8m		12m		48m	
	Fullterms							
PPVT	total R^2	= .34*	total R^2	= .28[T]	total R^2	= .38*	total R^2	= .40**
	β's for:		β's for:		β's for:		β's for:	
	MOMED1	.48*	MOMED1	.54*	MOMED1	.53*	MOMED48	.54**
					MOMBEH12-S	.43*		
INFO	---		---		---		total R^2	= .29*
							β's for:	
							MOMED48	.50**

Note. R^2 for regressions entering only biological and global environmental status can be found in Table 23. Relevant simple correlations can be found in Tables 28, and 32 through 35. For preterms, note that 6% of the possible regressions (1 of 16, including BD and VMI) generated a significant R^2 ($p < .10$). This is less than a chance level. For fullterms, note that 31% of the possible regressions (5 of 16) generated a significant R^2 ($p < .10$).

Table 25 presents the social outcome findings for preterms. Explanation of preterm social outcome was generally not improved by the addition of very early indicators (4 or 8m) of "proximal" environmental status. The single exception was the child's own view of his/her social acceptance (KDACCEPT: *R2* increase from 22% to 54%), with 8m maternal satisfaction with the parental role as the active predictor variable. However, addition of 12m data did improve the explanation of preterm child social behavior, with significant findings for overall social competence, positive social skill, and the parental view of child self control (ALLSC: *R2* increase from 18% (NS) to 57%; PSOCSKILL: *R2* increase from 16% (NS) to 61%; PCONTROL: *R2* increase from 13% (NS) to 44%). Though the pattern was not clear, due to an effect of mother age, preterms with better early biological status and better 12m caregiving did show relatively better social outcome. Concurrent 48m information also added to the explanation of the parental view of social outcome, though not as much as data from the end of the first year (ALLSC: *R2* increase from 18% (NS) to 52%; PSOCSKILL: *R2* increase from 16% (NS) to 37%; PCONTROL: *R2* increase from 13% (NS) to 50%; no findings for KDACCEPT).

Table 26 lists the social outcome findings for fullterms. In general, information on the "proximal" environment, gleaned during infancy or concurrently (48m), added somewhat to the prediction of the parental view of child social behavior in fullterms: the average *R2* increase ranged from 8.5% to 24%. "Active" predictor variables changed over time for indicators of the parental view of child social outcome (ALLSC, PSOCSKILL), although the parental view of behavior problems

Table 25

Multiple Regression of 48-Month Child Social Outcome on Biological, "Proximal" and Global Environmental Status (With Maternal Age as a Covariate): Preterms

48m Social Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint			
	1/4m	8m	12m	48m
ALLSC	---	---	total R^2 = .57* β's for: MOMAGE $-.46^T$ BIOSUM1 .64** MOMBEH12-F .46* MOMBEH12-S $.43^T$	total R^2 = .52** β's for: BIOSUM48 = $.28^T$ MOMBEH48-S = .44*
PSOCSKILL	---	total R^2 = $.38^T$ β's for: BIOSUM1 $.33^T$ MOMBEH8 .50* MOMED1 $.38^T$	total R^2 = .61** β's for: MOMAGE -.61* BIOSUM1 .62** MOMBEH12-F .48* MOMBEH12-S .58*	total R^2 = .37* (no active variables)

Table 25 (continued)

48m Social Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint			
	1/4m	8m	12m	48m
PCONTROL	---	---	total R^2 = .44^T β's for: MOMAGE -.69* BIOSUM1 .59** SATISKID8 .38^T	total R^2 = .50** β's for: BIOSUM48 = .50**
PBEHWELL	---	---	---	---
OCONTROL	---	---	---	total R^2 = .44** β's for: MOMBEH48-S = .68***
KDACCEPT	---	total R^2 = .54** β's for: BIOSUM1 .51** SATISPARENT8 .57**	total R^2 = .55* β's for: BIOSUM1 .51* SATISPARENT8 .57**	---

Note. R^2 for regressions entering only biological and global environmental status can be found in Table 23. Correlations can be found in Tables 28, and 32 through 35. Note that 42% of the possible regressions (10 of 24) generated a significant R^2 ($p<.10$).

Table 26

Multiple Regression of 48-Month Child Social Outcome on Biological, "Proximal" and Global Environmental Status (With Maternal Age as a Covariate): Fullterms

48m Social Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint: 1/4m		8m		12m		48m	
ALLSC	total R^2	= .47***	total R^2	= .45**	total R^2	= .39*	total R^2	= .46***
	β's for:		β's for:		(no active variables)		β's for:	
	BIOSUM1	$-.22^T$	MOMBEH8	.31*			SATISKID48	.32*
	MOMED1	$.29^T$						
	SATISPARENT1	$.28^T$						
PSOCSKILL	total R^2	= .44**	total R^2	= .34*	---		total R^2	= .29*
	β's for:		β's for:				β's for:	
	SATISPARENT1	.34*	MOMBEH8	.40*			SATISKID48	$.31^T$
	SATISKID1	$.31^T$						
PCONTROL	total R^2	= .39**	total R^2	= .35*	---		total R^2	= .29*
	β's for:		β's for:				β's for:	
	MOMED1	$.34^T$	MOMBEH1	$.35^T$			MOMED48	$.29^T$
							SATISKID48	$.30^T$

Table 26 (continued)

48m Social Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint			
	1/4m	8m	12m	48m
PBEHWELL	total R^2 = .45** β's for: MOMED1 .42* SATISPARENT1 .33*	total R^2 = .38* β's for: MOMED1 .49*	total R^2 = .42* β's for: MOMED1 .44*	total R^2 = .42** β's for: MOMED48 .36*
OCONTROL	---	---	---	total R^2 = .28* β's for: MOMBEH48-S .41*
KDACCEPT	---	---	---	total R^2 = .28* β's for: MOMAGE .44* BIOSUM48 .39*

Note. R^2 for regressions entering only biological and global environmental status can be found in Table 23. Correlations can be found in Tables 30, and 34 through 37. Note that 67% of the possible regressions (16 of 24) generated a significant R^2 ($p<.10$).

(PBEHWELL) and self control (PCONTROL) were consistently predicted by maternal education. Interestingly, explanation of the fullterm child's own view of social acceptance was improved only by concurrent data (R^2 increase from 10% (NS) to 28%). The "active" variable was 48m biological status, which included an assessment of health during childhood. Note that this was not true of preterms, who were actually more ill than fullterms from age one to four.

Relative importance of earlier child outcome. The next two sets of "least squares" regressions assessed the relationship of earlier child developmental status to 48m child outcome. By comparing these findings to the regression data reported in the two previous sections, the efficacy of different sets of predictor variables could be ascertained. The findings were complicated. (In these regressions, note that only 12m developmental data were utilized, as it provided better sample size than 24m information, and developmental status from earlier than 12m would not be expected to predict later outcome.)

In the first set of regressions, data on earlier child outcome were added to knowledge of early biological and global environmental status. This enabled a comparison between the predictive power of child characteristics and that of "proximal" environmental indicators, in the presence of biological and global demographic data. Table 27 presents these findings, but includes only results for fullterms, since none of the preterm regressions were significant.

Once again, 48m nonverbal cognition and visuomotor skill were not explained in either group by this set of predictor variables, even with

Table 27

Multiple Regression of 48-Month Child Outcome on 12-Month Child Outcome and Two Different Sets of Predictor Variables (With Maternal Age as a Covariate): Fullterms

Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint — Fullterms	
Type of Regression:	**(MOMAGE) → (BIOSUM1 + MOMED1 + MDI12 + PDI12)[a]**	**(MOMAGE) + (BIOSUM1) → (MDI12 + PDI1)[b]**
PPVT	total R^2 = .30*	total R^2 = .22[T]
	β's for:	β's for:
	MOMED1 .41[T]	MDI12 .39*
		PDI12 -.38*
INFO	total R^2 = .25[T]	total R^2 = .21[T]
	β's for:	β's for:
	MDI12 .36[T]	MDI12 .45*
ALLSC	total R^2 = .38**	total R^2 = .22[T]
	β's for:	β's for:
	MDI12 .33[T]	MOMAGE .37*
		MDI12 .42*
PCONTROL	total R^2 = .32*	total R^2 = .27*
	(no active variables)	β's for:
		MOMAGE .31
		MDI12 .29

Table 27 (continued)

Outcome Variable	Total variance accounted for and "active" predictor variables at each timepoint	
	Fullterms	
PBEHWELL	total R^2 = .35**	total R^2 = .43**
	β's for:	β's for:
	MOMAGE .38*	MOMAGE $.40^T$
	MDI12 .43*	MDI12 $.31^T$
		PDI12 $-.27^T$

Note. For fullterms, note that 50% of the possible regressions (10 of 20) generated a significant R^2 ($p<.10$). For preterms, there were no significant regressions.

[a]For the first set of regressions, measures of early (12m) outcome, as well as biological and global environmental status, were entered after the covariate of maternal age. In all cases, the addition of the set of variables (beyond maternal age) generated a significant increase in incremental R^2, beyond the R^2 of the covariate.

[b]For the second set of regressions, measures of early (12m) outcome were entered after the covariates of maternal age and biological status. In all cases, the addition of early outcome generated a significant increase in incremental R^2, beyond the R^2 of the covariates.

the inclusion of a measure of earlier physical development (PDI). It is remarkable that this set of predictors, even with the addition of data on earlier child outcome, did not explain any aspect of later preterm academic or social outcome.

Information on fullterms can be gained by comparing the first column of findings in Table 27 to those in Table 23. Including data on early fullterm child outcome did add to the prediction of later verbal skills, beyond the prediction achieved by the standard variables of biological and global environmental status (PPVT: R2 increase from .25 to .30; INFO: R2 increase from .16 to .25). In addition, data on earlier fullterm child outcome added to the prediction of parental measures of social skills (ALLSC: R2 increase from .31 to .38; PCONTROL: R2 increase from .28 to .32; PBEHWELL: R2 increase from .37 to .43).

When the first column of Table 27 is compared to the 12m fullterm data in Tables 24 and 26, several facts are evident. The increase in predictive power gained from knowledge of earlier (12m) fullterm outcome was sometimes greater than the increase gained from knowledge of the early or concurrent "proximal" environment of the fullterm child. This was true in the areas of verbal cognition (INFO) and the parental view of the child's behavior problems (PBEHWELL). However, knowing about the child's early "proximal" environment aided more in prediction of the child's later receptive language (PPVT). Either set of predictors contributed to knowledge of later overall social competence (ALLSC) and the parental view of the child's self control (PCONTROL).

In the second set of regressions, earlier child outcome was entered after only maternal age and biological status. No information on the environment, even global environmental status, was entered into these analyses. Findings are given in the second column of Table 27. Comparing these results to the 12m columns of Tables 24 through 26 allows examination of the relative importance of early outcome data, versus knowledge of the early environment (global and "proximal"), in predicting later outcome. Remarkably, in preterms, knowledge of 12m child development, even accompanied by data on biological status and maternal age, did not explain later academic or social outcome.

For fullterms, on the other hand, knowledge of earlier child outcome (12m MDI and PDI) was active in explaining: receptive language (PPVT: both); verbal cognition (INFO: MDI only); parental view of child self control (PCONTROL: MDI only); parental view of child behavior problems (PBEHWELL: both); as well as overall social competence (ALLSC: MDI only). Maternal age was also active in explaining PCONTROL, PBEHWELL and ALLSC. A comparison of Tables 24, 26 and the second column of 27 uncovers an interesting developmental finding. For fullterms, beyond data on biological status and maternal age, knowing about the global and "proximal" environment was generally more useful than knowing only the earlier child outcome (an average R^2 increase of .12).

Summary of the Effects of Several Constructs Considered Simultaneously

For both groups, social outcome was more often significantly explained than was academic outcome. More successful prediction was achieved for fullterms than for preterms. For fullterms, within the academic area, verbal skills were more successfully predicted than were nonverbal or visuomotor abilities. For both groups, within the social area, parental ratings were more often explained.

The covariate of maternal age rarely appeared as a significant predictor variable. In general, the biological status predictor was important only to preterms, and then not often. Alone, it was significantly associated with preterm reactivity and self report of social acceptance (KDACCEPT). In association with maternal behavior, it was significantly related to overall social competence and parental ratings of social behavior. The global environmental status indicator was quite salient among the fullterms, though not among their preterm peers.

As the transactional framework suggests, measures of the "proximal" environment definitely improved prediction over that achieved using only global environmental status. This occurred largely in the area of social outcome. The improvement was quite dramatic for the preterms in the degree of variance accounted for, if not in the number of variables significantly predicted. For the premature group, maternal behavior was the most notable "proximal" contributor. For the fullterms, both types of "proximal" measures (attitudes and behavior) added to an explanation of 48m outcome. Note that the identity and weighting of "proximal" environmental variables did change over time, as suggested by a transactional approach. In the prediction of 48m outcome, also note that knowing about both the global and "proximal" environment was generally more useful than knowing only the child's earlier developmental status.

Transactional Explanation of Preterm and Fullterm Outcome: Contribution of Multiple Indicators of Constructs, Considered Individually

In the regression analyses presented so far, several explanatory constructs (e.g. earlier child outcome, mother-child interaction, etc.) were considered simultaneously as they related to 48m child outcome. As a consequence, each construct could only be represented by one or two variables. For example, maternal attitudes were represented solely by measures of satisfaction with parenting (SATISPARENT and SATISKID). With regressions, it was not possible to look at the relationship between child outcome and a number of other maternal attitudes, such as perceptions of stress or childrearing beliefs. Nor could the interrelationships between two explanatory constructs, such as maternal attitudes and mother-child interaction, be explicated.

To sketch a more detailed picture of the developmental process leading to 48m child outcome, and thus supplement the findings of the regressions, the following procedure was used. A number of equalized correlation matrices were generated, separately for preterms and fullterms. Significant correlations were noted, as were significant differences between groups in the magnitude of matching correlation pairs. From these findings, patterns of tranactions over time were discerned within the preterm and fullterm groups. Each of the following sections summarizes the relationships between 48m outcome and several conceptually-related predictor variables. This wealth of results will be distilled further in the Discussion chapter.

Relationships of 48m outcome with biological and global environmental status, and quality of the home environment. Confirming the results of the regression analyses were equalized correlations of biological and global environmental status with 48m child outcome. These data can be found in Table 28. Correlations with biological status, as measured at 1m and at 48m, were generally positive, but fairly low. Exceptions to this were a strong impact of biological status on preterm PCONTROL, and KDACCEPT in both groups. Global environmental status, no matter how assessed, was clearly more important to the fullterm group. Fullterms in a better environment acheived higher academic and social scores at 48m. The only exception to this rule was a low moderate effect of environmental status on 48m preterm visuomotor skill.

Note that more optimal 8m characteristics of the home environment (environmental organization, availability of play materials, and variety of stimulation) predicted certain aspects of positive social outcome (PSOCSKILL, OCONTROL, KDACCEPT) somewhat more among preterms, even when correlations with the global environment were somewhat lower among the premature children. The same pattern was true of environmental change during childhood (WTCHANGE48), which may also reflect the kind of home environment experienced by the child.

Relationships of 48m outcome with child demographics and health.

Table 28

Relationships of Biological Status and Global Environmental Status with 48-Month Child Outcome: Preterms and Fullterms

Predictor Variables	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
BIOSUM1	-	-	-	-	-	-	-	-
BIOSUM48	.06	.23^T	-.05	.21^T	-	-	.09	.22^T
WTCHANGE48	-	-	-	-	-.24^T	.05	-	-
MOMED1	.18	.48***	.14	.37**	-	-	.31*	.32*
MOMED48	[.10	.56***]	[.05	.45***]	-	-	.26^T	.31^T
FHHEAD48	[.02	.51***]	.08	.36**	-	-	-	-

Table 28 (continued)

Predictor Variables	PSOCSKILL		PCONTROL		PBEHWELL		OCONTROL		KIDACCEPT	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
BIOSUM1	[.29*	-.17]	[.36*	-.16]	-	-	-	-	[.44**	-.05]
BIOSUM48	.33*	.23^{T}	[.56***	.09]	.10	.28*	-	-	.24^{T}	.37**
WTCHANGE48	-.36*	-.13	-.26^{T}	-.14	-.26^{T}	-.38**	-	-	.03	-.24^{T}
MOMED1	.28^{T}	.26*	.13	.47***	[.21	.58***]	-	-	.06	.23^{T}
MOMED48	.17	.29*	.06	.42**	[.09	.54***]	-	-	-	-
FHHEAD48	.17	.40**	.27^{T}	.39**	[.01	.51***]	-	-	-	-
ENVORGANIZ8	.30^{T}	.25^{T}	.17	.35*	.26^{T}	.52***	-	-	[.35*	-.19]
PLAYMATERIAL8	.26^{T}	.06	.01	.30*	.08	.28*	[.39*	-.02]	-	-
STIMVARIETY8	.42*	.16	-	-	.29^{T}	.29*	.29^{T}	.14	[.35*	-.29*]

<u>Note</u>. Brackets indicate significantly different standardized correlations within a matching pair. Note that 45 of 69 possible correlation pairs had at least one significant ($p<.10$) component correlation. Of these 45, 73% were significant for fullterms, while 51% were significant for preterms.

A variety of demographic and health measures were considered in relation to child outcome. These measures varied in predictive power, and showed somewhat different patterns in the preterm and fullterm groups. Results can be found in Table 29.

In the academic area, postnatal health indicators were slightly more important among fullterms. Fullterm children with better postnatal health performed more optimally at age four. Child age was clearly more salient among premature children, with younger preterms at the time of the fourth year data collection showing better academic outcome. Since the girls in this study were younger and showed better academic scores, this may have been a confound by sex. Ethnicity had an impact in both groups, though slightly greater among fullterms, with nonminority children showing better academic achievement. Note that birth order functioned similarly in the two groups, with a slight academic advantage to both the preterm and fullterm firstborn.

48m social skill, from both the child and parental perspectives, was better explained in preterms than in fullterms by biological status and measures of early health. Better postnatal health was, not surprisingly, associated with more optimal preterm social outcome. Data on childhood health predicted differently in the two groups. For fullterms, better childhood health predicted higher ratings of the parental view of social skills (PSOCSKILL) and the child's view of social acceptance (KDACCEPT). For preterms, better health from age one to four predicted only more optimal scores on PCONTROL (which has a large temperamental component). Poor 48m social skill, as mentioned earlier, was predicted by maleness, but only in preterms. (Note that

Table 29

Relationships of Child Demographics with Health and 48-Month Child Outcome: Preterms and Fullterms

Predictor Variables	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
KIDAGE48 (actual)[a]	[-.42**	.14]	-.21	.24^T	[-.36*	.24^T]	[-.43**	.21^T]
ETHNICITY[b]	[-.15	-.43**]	[-.17	-.46***]	-.10	-.32*	-	-
BIRTHORDER	-.18	-.30*	-.24^T	-.27*	-	-	-.17	-.25^T
SEX[c]	.01	.32*	-	-	-	-	.23^T	-.07
PNHEALTH	-	-	[.08	-.31*]	-	-	.06	-.31*
KIDHEALTH	.00	-.21^T	-.03	-.25*	-	-	-	-

Table 29 (continued)

Predictor Variables	PSOCSKILL PT	PSOCSKILL FT	PCONTROL PT	PCONTROL FT	PBEHWELL PT	PBEHWELL FT	OCONTROL PT	OCONTROL FT	KIDACCEPT PT	KIDACCEPT FT
KIDAGE48 (actual)[a]	[-.28^T	.11]	-	-	-.38*	-.06	-	-	-	-
ETHNICITY[b]	.11	-.20^T	-	-	[.33*	-.17]	-	-	-	-
BIRTHORDER	-	-	-	-	-	-	.18	.24^T	.16	.22^T
SEX[c]	[.38*	-.10]	[.43**	-.19]	[.47**	-.21^T]	-	-	[.61***	.11]
PNHEALTH	[.44**	-.18]	[.37*	-.17]	.24^T	.01	-	-	[.37*	-.07]
KIDHEALTH	.10	.35**	.36*	.17	.16	.23^T	-	-	.13	.46***

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that 34 of 54 possible correlation pairs had at least one significant ($p<.10$) component correlation. Of these 34, 62% were significant for fullterms, while 50% were significant for preterms.

[a]Correlations with KIDAGE48 (corrected) are almost identical.

[b]Higher values mean minority status.

[c]Higher values indicate female gender.

male preterms were more often severely ill.)

Relationships of 48m outcome with earlier child outcome. These data can be found in Table 30. The 12m mental developmental index (MDI) showed low moderate correlations with 48m academic and social outcome measures. Positive early MDI scores predicted more optimal 48m outcome for both groups, though to a slightly lesser extent for the preterms. By 24m, better MDI scores were highly predictive of better four-year academic outcome for both preterms and fullterms, though only moderately predictive of better 48m social behavior. At 12m, the physical developmental index (PDI) was not related to later academic outcome for either group, yet by 24m the PDI was a stronger predictor for preterms. Better PDI performance at age two was related to better verbal skills and, surprisingly, to poorer visuomotor skills in four-year-old preterms.

Relationships of 48m child outcome and child behavior. It was difficult to summarize the relationship of 48m outcome with temperament and child behavior, especially given the instability of these characteristics over time. Results, presented in Table 31, showed low to moderate correlations with 48m developmental outcome. This was true for both groups, though there did appear to be differences in the predictive patterns of the preterms and fullterms.

Basically, early dimensions of temperament were more broadly associated with later outcome among fullterm children. Positive mood early in life seemed to be important among the fullterms, predicting

Table 30

<u>Relationships Between Earlier and 48-Month Child Outcome: Preterms and Fullterms</u>

Predictor Variables	"Academic" Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
MD112	.26^T	.22^T	.22	.35*	.12	.43**	.19	.36*
MD124	.60***	.44**	.63***	.61***	.62***	.39**	.47**	.32*
PD124	.37*	-.06	.31^T	.16	-	-	-.30^T	.14
PPVT24	.58**	.50**	.65**	.61**	-	-	.16	.43*

Table 30 (continued)

Predictor Variables	Social Outcome Variables									
	PSOCSKILL		PCONTROL		PBEHWELL		OCONTROL		KIDACCEPT	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
MDI12	.38*	.33*	.27^{T}	.32*	.37*	.35*	-	-	-	-
MD124	.55***	.39**	.21	.28^{T}	.44*	.30*	.19	.37*	.11	.40**
PDI24	[.34^{T}	-.22]	-	-	[.43*	-.03]	-	-	-.12	.31*

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that 25 of 31 possible correlation pairs had at least one significant ($p<.10$) component correlation. Of these 25, 80% were significant for fullterms, while 68% were significant for preterms.

Table 31

Relationships of Earlier and Concurrent Child Behavior with 48-Month Child Outcome: Preterms and Fullterms

Predictor Variables	"Academic" Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
MOOD1	-.36*	-.36**	-.26^T	-.29*	[-.09	-.52***]	[.28^T	-.33*]
DISTRACTIBILITY1	-.05	-.26*	.01	-.23^T	-.01	-.30*]	-	-
KIDBEH4	-	-	.25^T	.14	-	-	-	-
MOOD8	[.15	-.46**]	-.10	-.41*	[.19	-.30^T]	-	-
DISTRACTIBILITY8	-.30^T	.02	[-.47**	.09]	-.48**	-.06	-.33*	.00
KIDBEH8	.25^T	.13	.33*	.24^T	-	-	-	-
NONCOMPLIANCE12	.11	-.32*	-.00	-.26^T	[.28^T	-.30*]	[.42*	-.21]
KIDBEH24-S	-	-	-	-	[.05	.35*]	[-.01	.30^T]
PSOCSKILL48	.28^T	.52***	.25^T	.41**	.39*	.19	.34*	.31*
PCONTROL48	.20	.34*	.16	.34*	.14	.21^T	-.03	.39**
PBEHWELL48	.25^T	.55***	.18	.44**	.31*	.26*	.46**	.46***
OCONTROL48	-.05	.19	.04	.15	.14	.09	.02	.09
KDACCEPT48	-.05	.11	-.06	.24^T	.12	.17	-.01	.22^T

Table 31 (continued)

Predictor Variables	Social Outcome Variables									
	PSOCSKILL		PCONTROL		PBEHWELL		OCONTROL		KIDACCEPT	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
INTENSITY1	-.35*	.01	-	-	-.31*	-.10	-	-	-	-
MOOD1	-.09	-.21	-	-	.00	-.30*	-	-	-	-
KIDBEH4	.17	.33*	.24^{T}	.30*	.07	.21^{T}	.16	.40**	-	-
MOOD8	-.14	-.39*	-.00	-.32*	-.24	-.30^{T}	-	-	.27^{T}	.21
DISTRACTIBILITY8	-	-	.09	-.27^{T}	-	-	-.06	-.22^{T}	.25	.45**
KIDBEH8	.40*	.36*	.12	.44**	.34*	.25^{T}	-	-	-	-
KIDBEH12-F	-	-	.06	.32*	.42**	.42*	.31*	.20	-	-
KIDBEH12-S	.29^{T}	-.04	.30^{T}	-.09	.34*	.01	.39*	.30*	.34*	.14
KIDBEH24-S	-	-	[-.53*	.26^{T}]	-	-	.12	.39*	-	-

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that 71 of 97 possible correlation pairs had at least one significant ($p<.10$) component correlation. Of these 71, 66% were significant for fullterms, while 46% were significant for preterms.

better academic outcome and parental views of child social behavior. For four-year-old preterms, 8m distractibility was a significant predictor. Lower preterm distractibility scores were highly related to better 48m outcome in the academic area, but were not related to social outcome. For four-year-old fullterms, 8m distractibility was related only to poorer self-control (measured from two perspectives: PCONTROL and OCONTROL). Noncompliance at age one (but not at age two) predicted poorer overall 48m academic outcome in fullterms but, surprisingly, better 48m nonverbal cognitive and visuomotor skill in preterms.

During the first year of life, for both preterms and fullterms, more positive child behavior in a free play situation predicted better social outcome at age four. Oddly enough, free play behavior at age two did not predict social outcome at age four. Data on a child's behavior in structured play gave different information about the two groups. Knowing how a 12m-old child behaved when reading a picture book with his/her mother told more about later preterm social outcome, from the parent's and child's own perspectives. Yet these same data predicted the observer's viewpoint on 48m child social behavior moderately well in both groups. Knowing how a 24m-old child behaved in a frustration situation revealed somewhat more about the fullterms at age four. It should be noted that there were no significant relationships for either group between noncompliance and 48m social outcome.

Relationships between maternal attitudes and mother-child interaction. Before looking at the direct effects of two important explanatory constructs, maternal attitudes and maternal behavior, on 48m child outcome, relationships between these constructs were explored. Of interest were preterm-fullterm differences over time in the patterns of association between attitudes and behavior. The picture was very complex. Only a brief overview of the data is given, and no table is presented.

Overall, both groups showed low to moderate relationships between these two constructs. For both preterms and fullterms, mothers endorsing more positive attitudes displayed more positive behavior over time. However, there were a few variations in the pattern of attitude-behavior relationships in the two groups.

Satisfaction with parenting was somewhat more positively related to early maternal behavior among fullterms, though this difference faded at the end of the first year. Surprisingly, stress was not very related to behavior in either group over time. In contrast, attitudes toward social support showed variable associations with the mothers' behavior between groups: similar early in life; more in fullterms at 12m; more in preterms at 24m; and again more in fullterms at 48m. Concurrent family attitudes and maternal behavior were more closely tied in preterms beginning around 8m, reaching a peak at 24m, and decreasing to become more similar to the fullterm level at 48m. Finally, childrearing beliefs were related differently to maternal caregiving in preterms and in fullterms. Earlier childrearing attitudes (18m) were somewhat more tied to maternal behavior among fullterms, while later opinions (48m) were more connected to behavior among preterms. This may have been a function of the different tools used at 18 and 48m.

<u>Relationships of 48m outcome and maternal attitudes.</u> As can be seen in Tables 32 and 33, there were a number of significant, moderate correlations between measures of maternal attitudes from 1m to 48m and measures of child development at 48m. As suggested by the regression findings, relationships were usually significantly stronger in the fullterm group, indicating greater sensitivity of fullterm children to the impact of the early attitudinal environment. Though there were a few exceptions, this seemed to be true for both academic and social outcome. Note that in general, maternal attitudes were more predictive of 48m verbal skill and parental views of social behavior than of other outcome measures.

For both groups, the relatively stable construct of satisfaction with parenting (SATISKID, SATISPARENT) was more often significantly positively related to child outcome, than were other maternal attitudes. Childrearing opinions, more stable among fullterms, were clearly far more salient to that group's academic and social outcome. In preterms, however, 18m aggression control and 48m nurturance (which were correlated with one another) were highly related to positive social behavior at age four. Attitudes about social support, represented only by satisfaction with intimate support (ATTSAT), did not display a clear pattern. However, these attitudes did seem more important to preterm academic and fullterm social outcome. Note that findings using other types of social support, such as satisfaction with community support, might have yielded different results. Higher levels

Table 32

Relationships of Earlier and Concurrent Maternal Attitudes with 48-Month Child Academic Outcome: Preterms and Fullterms

Predictor Variables	"Academic" Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
Social Support:[a]								
ATTSAT1	.24[T]	.49***	.30*	.15	-	-	-	-
ATTSAT8	.39*	.23[T]	[.63***	-.03]	[.45**	-.10]	-	-
ATTSAT18	-	-	-	-	-	-	-	-
ATTSAT48	-	-	-	-	-	-	-.33*	.01
Childrearing Attitudes:								
AGGCONTROL18	-.02	.37*	.13	.47**	.24	.35*	-	-
RECIPROCITY18	[-.24	.53***]	[-.11	.56***]	[.05	.49**]	-.05	.36*
EMOTACCEPT18	.09	.42*	[.02]	.49**]	.26	.39*	.11	.28[T]
RESTRICT48	[-.21	-.60***]	-.32*	-.48***	-.24[T]	-.17	-	-
NURTURE48	.22	.28*	.19	.33*	.18	.23[T]	.26[T]	.14
Stress:								
STRESS1	-	-	-	-	-	-	-.29*	.00
STRESS18	[-.39*	.20]	-.27[T]	.03	-.37*	-.22	-.22	-.24[T]
STRESS48	-	-	-.08	-.21[T]	[.27[T]	-.19]	[.12	-.31*]
Family Perceptions:								
RELATIONSHIPS24	-	-	-.02	.26[T]	[-.43*	.15]	[-.61**	.20]
FAMCOHESION48	.12	.25[T]	.01	.27*	.32*	.39**	.24*	.29*

Table 32 (continued)

Predictor Variables	"Academic" Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
Satisfaction with Parenting:								
SATISKID1	.00	.33*	.01	.31*	[-.15	.26*]	.00	.29*
SATISKID8	-	-	-	-	-	-	-	-
SATISKID18	[-.53**	-.07*]	-.50**	.07*	[-.40*	.07]	-	-
SATISKID48	-.08	.26*	-.08	.29*	-	-	-	-
SATISPARENT1	.32*	.40**	.30*	.29*	-.09	$.21^T$	[$-.26^T$	.28*]
SATISPARENT8	-	-	[$.26^T$	-.18]	[$.29^T$	-.06]	-	-
SATISPARENT18	.14	.30*	$.26^T$	.26*	-.08	.28*	[-.17	$.24^T$]
SATISPARENT48	.07	$.23^T$	.10	$.21^T$	-.09	$.21^T$	-	-
MOMFEEL1	.15	.40**	.14	.37**	[-.03	.40**]	[.06	.45***]

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that 65 of 92 possible correlation pairs had at least one significant ($p<.10$) component correlation. Of these 65, 74% were significant for fullterms, while 42% were significant for preterms.

[a]While other social support variables showed significant findings, they are not included here.

Table 33

Relationships of Earlier and Concurrent Maternal Attitudes with 48-Month Child Social Outcome Preterms and Fullterms

Predictor Variables	Social Outcome Variables									
	PSOCSKILL		PCONTROL		PBEHWELL		OCONTROL		KDACCEPT	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
Social Support:[a]										
ATTSAT1	.11	.26*	[-.02	.37**]	[-.02	.52***]	-	-	-	-
ATTSAT8	.27^{T}	.23^{T}	-	-	.14	.25^{T}	-	-	.32^{T}	.04
ATTSAT18	.03	.32*	-.02	.30^{T}	[-.33^{T}	.23]	-	-	-	-
ATTSAT48	-	-	-	-	[-.10	.29*]	[.51***	-.06]	-.06	-.35**
Childrearing Attitudes:										
AGECONTROL18	.53**	.21	.43*	.34*	.07	.42**	.37*	-.02	.39*	.38*
RECIPROCITY18	.17	.54***	.13	.32*	[.15	.61***]	-	-	.07	.26^{T}
EMOTACCEPT18	.13	.35*	.22	.52**	[.12	.64***]	-	-	-	-
RESTRICT48	[-.16	-.50***]	-.11	-.37**	-.18	-.45***	-	-	-	-
NURTURE48	.62***	.61***	.51***	.36**	.24^{T}	.36**	-	-	.25^{T}	.06
Stress:										
STRESS1	-	-	-	-	-	-	-	-	[.29^{T}	.01]
STRESS8	-.12	-.28*	-.29^{T}	-.13	-.41*	-.34*	-	-	[-.40*	.06]
STRESS18	-	-	-.29^{T}	-.61***	-.36*	-.58***	-.20	-.23^{T}	-	-
STRESS48	-	-	-.17	-.21^{T}	-.13	-.43**	-	-	[.17	-.24^{T}]
Family Perceptions:										
RELATION-SHIPS24	[-.11	.41*]	[-.15	.40*]	-.02	.41*	-	-	-	-

Table 33 (continued)

Predictor Variables	Social Outcome Variables									
	PSOCSKILL		PCONTROL		PBEHWELL		OCONTROL		KDACCEPT	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
Satisfaction with Parenting:										
SATISKID1	[.09	.52***]	-	-	-.03	.20^T	-	-	.04	.20^T
SATISKID8	.16	.37**	-	-	-	-	-	-	-	-
SATISKID18	-	-	-	-	-.04	.29^T	-	-	-	-
SATISKID48	.46**	.45***	.43**	.39**	.22^T	.35**	.22^T	.35**	.42***	.10
SATISPARENT1	[-.19	.54***]	.04	.33*	-.20	.41**	-.28^T	.06]	-	-
SATISPARENT8	-	-	-	-	-	-	-.18	.22^T	[.48*	-.01]
SATISPARENT18	.30*	.37**	.04	.32**	.12	.26*	.21	.40**	.32*	-.04
SATISPARENT48	.22	.38**	.24^T	.19	.06	.31*	-	-	.33*	-.04
MOMFEEL1	[.23^T	.56***]	-	-	.22	.34*	-.28^T	.00	[-.03	.39**]
General Life Satisfaction:										
LIFESAT1	-.02	.34*	-	-	-.12	.24^T	-.30^T	.07	-	-
LIFESAT8	.29^T	.38**	-	-	.25^T	.41**	-	-	-	-
LIFESAT18	.05	.43**	.35*	.44**	.08	.46**	-	-	-	-
LIFESAT48	.42**	.42**	.45**	.38**	.19	.48***	-	-	.29^T	.02

Note. Brackets indicate significantly different standardized correlations within a matching pair. Note that 86 of 135 possible correlation pairs had at least one significant ($p<.10$) component correlation. Of these 86, 77% were significant for fullterms, while 44% were significant for preterms.

[a]While other social support variables showed significant findings, they are not included here.

of stress, across time, were related to lower 48m outcome scores in both groups, and strongly predicted less optimal parental ratings of child behavior problems (PBEHWELL). Attitudes toward stress did seem to be somewhat more related to 48m social outcome among the preterms, a surprising finding.

Relationships of 48m outcome and maternal behavior observed in the laboratory and the home

As discussed earlier, maternal behavior was assessed in multiple ways during the Mother-Infant Project. Several different ratings of the quality of interaction were made in free and structured play at 4, 8, 12, 24 and 48m. In addition, an 8m assessment of the home environment, which included maternal behavior variables, was made. Knowledge of earlier and concurrent maternal behavior were important in predicting four-year outcome in both preterms and fullterms. See Tables 34 and 35 for these findings. Note that measurements closer in time were more highly related, as expected from the transactional model, except for relatively low relationships between concurrent behavior and outcome.

Relationships with 48m academic outcome. There were low to moderate correlations between positive early and concurrent maternal behavior, and more optimal 48m academic behavior. The mother's actions were consistently more important to her child's verbal skills in both groups. For academic measures, transactional patterns appeared fairly

Table 34

Relationships Between Earlier and Concurrent Mother-Child Interaction and 48-Month Child Academic Outcome: Preterms and Fullterms

Predictor Variables	Academic Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
4 months:								
EMOTFOSTER								
with SES	[-.18	.30*]	[-.29^T	.24]	-	-	-	-
w/o SES	-.23	.16	-.36	.19	-	-	-	-
CUECLARITY								
with SES	-	-	-.09	-.22^T	-	-	[.31*	-.13]
w/o SES	-	-	-.05	-.26^T	-	-	.24	-.16
MOMBEH4								
with SES	.09	.31	.07	.23^T	-	-	[-.14	.31*]
w/o SES	.16	.15	.13	.04	-	-	-.12	.22^T
8 months:								
COGFOSTER								
with SES	-	-	.18	.24^T	-	-	.10	.23^T
w/o SES	-	-	.18	.19	-	-	.10	.15
EMOTRESPONSE								
with SES	.14	.38*	-.08	.30*	.04	.26^T	-	-
w/o SES	.36^T	.24^T	.01	.14	.21	.25^T	-	-

Table 34 (continued)

Predictor Variables	Academic Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
MOMBEH8								
with SES	.05	.26^T	.04	.34*	-	-	-	-
w/o SES	.19	.03	.25	.17	-	-	-	-
12 months:								
MOMBEH12-F								
with SES	.11	.25^T	.04	.25^T	-	-	-	-
w/o SES	.34^T	.04	.30^T	.07	-	-	-	-
MOMEBEH12-S								
with SES	.29^T	.40**	.22	.36*	-	-	.14	.26^T
w/o SES	.30^T	.25^T	.24	.22	-	-	.12	.13
24 months:								
GIVES HINTS								
with SES	.28	.32*	.34^T	.33*	.19	.32*	[-.02	.45*]
w/o SES	.26	.22	.18	.30*	.13	.32*	.06	.39
MOMBEH24-F								
with SES	.11	.30*	.04	.28^T	-	-	-	-
w/o SES	-.08	.10	-.18	.11	-	-	-	-

Table 34 (continued)

Predictor Variables	Academic Outcome Variables							
	PPVT		INFO		BD		VMIAQ	
	PT	FT	PT	FT	PT	FT	PT	FT
MOMBEH24-S								
with SES	.29^{T}	.38*	-	-	-	-	-	-
w/o SES	.03	.25^{T}	-	-	-	-	-	-
48 months:								
MOMBEH48-S								
with SES	**.07**	**.42****	-	-	-	-	-	-
w/o SES	**.12**	**.30***	-	-	-	-	-	-
DYADSATIS								
with SES	.12	.30*	-	-	.17	.23^{T}	-	-
w/o SES	.08	.17	-	-	.02	.19	-	-

Note. Brackets indicate significantly different standardized correlations within a matching pair. Boldface type indicates those correlation pairs for which covarying SES led to a reduction in the fullterm effect, with no reduction (or an increase) in the preterm effect. Note that 58 of 104 possible pairs of correlations had at least one significant ($p<.10$) component correlation. Of these 58, 60% were significant for fullterms, while 26% were significant for preterms.

Table 35

Relationships of Earlier and Concurrent Mother-Child Interaction with 48-Month Child Social Outcome: Preterms and Fullterms

Predictor Variables	Social Outcome Variables									
	PSOCSKILL		PCONTROL		PBEHWELL		OCONTROL		KIDACCEPT	
	PT	FT	PT	FT	PT	FT	PT	FT	PT	FT
4 months:										
EMOTFOSTER										
with SES:	.13	.35*	.19	.36**	[-.13	.33*]	-.08	.24^{T}	-	-
w/o SES:	.11	.30	.07	.29	-.10	.22	-.14	.18	-	-
CUECLARITY										
with SES:	.42*	.21^{T}	.12	.23^{T}	.38*	.20	-	-	-	-
w/o SES:	.36*	.20	.00	.20	.31^{T}	.15	-	-	-	-
MOMBEH4										
with SES:	.25^{T}	.37**	[.01	.41**]	.06	.32*	[-.10	.35*]	.25^{T}	.03
w/o SES:	.35**	.31*	.09	.28*	.12	.15	-.13	.32*	.27^{T}	-.07
8 months:										
EMOTRESPONSE:										
with SES:	.30^{T}	.20	17	.21^{T}	.26^{T}	.18	-	-	.35*	.10
w/o SES:	.29^{T}	.11	.32^{T}	.07	.05	-.00	-	-	.21	.03
MOMBEH8										
with SES:	.38*	.42**	[.02	.43**]	.34*	.36*	-	-	-	-
w/o SES:	.44*	.36*	.05	.28*	.36*	.15	-	-	-	-

Table 35 (continued)

Predictor Variables	PSOCSKILL PT	PSOCSKILL FT	PCONTROL PT	PCONTROL FT	PBEHWELL PT	PBEHWELL FT	OCONTROL PT	OCONTROL FT	KIDACCEPT PT	KIDACCEPT FT
	Social Outcome Variables									
12 months:										
MOMBEH12-F:										
with SES:	.31[T]	.28*	.05	.34*	.26[T]	.45**	-	-	-	-
w/o SES:	.31[T]	.18	.07	.20	.19	.27[T]	-	-	-	-
MOMBEH12-S:										
with SES:	.46**	.32*	.20	.34*	.18	.31*	.31[T]	.36*	-	-
w/o SES:	.34[T]	.22[T]	.05	.19	.11	.08	.11	.40**	-	-
24 months:										
MOMCONTROL24:[a]										
with SES:	-.41*	.04	[-.61**	.06]	-	-	-	-	-.22	.32*
w/o SES:	-.35[T]	.03	-.62**	.02	-	-	-	-	-.34[T]	.33*
MOMBEH24-F:										
with SES:	-	-	.04	.26[T]	.08	.36*	-	-	.04	.26[T]
w/o SES:	-	-	.00	.15	-.18	.20	-	-	.01	.09
MOMBEH24-S:										
with SES:	-	-	[-.13	.40*]	[-.03	.50**]	[-.49*	.35*]	[-.29	.30*]
w/o SES:	-	-	.09	.28[T]	-.09	.36*	-.54*	.33*	-.32	.19

Table 35 (continued)

Predictor Variables	PSOCSKILL PT	PSOCSKILL FT	PCONTROL PT	PCONTROL FT	PBEHWELL PT	PBEHWELL FT	OCONTROL PT	OCONTROL FT	KIDACCEPT PT	KIDACCEPT FT
48 months:										
MOMBEH48-S:										
with SES:	**.44****	**.36****	.38*	**.24^T**	**.10**	**.39****	.62***	.40**	.44**	.10
w/o SES:	**.48****	**.28***	.39*	**.08**	**.14**	**.29^T**	.60***	.39**	.39**	.06
DYADSATIS:										
with SES:	**.32***	**.31***	.29*	**.46*****	**.08**	**.30***	.84***	.75***	[.32*	-.13]
w/o SES:	**.45****	**.24^T**	.34*	**.39****	**.11**	**.16**	.80***	.75***	[.26*	-.17]

Social Outcome Variables

Note. Brackets indicate significantly different standardized correlations within a matching pair. Boldface type indicates those correlation pairs for which covarying SES led to a reduction in the fullterm effect, with no reduction (or an increase) in the preterm effect. Note that 92 of 120 possible pairs of correlations had at least one significant ($p<.10$) component correlation. Of these 92, 47% were significant for fullterms, while 38% were significant for preterms.

[a]For MOMCONTROL24 (control during the lever task), a lower score is more optimal.

similar between preterms and fullterms, with few significant differences between standardized correlation pairs. Surprisingly, however, maternal caregiving was generally more important to fullterm scores, showing consistent relationships to the fullterm child's developmental level over time. No one dimension of the mother's behavior appeared especially important to fullterm academic outcome. For preterms, the 12m structured picture book reading situation seemed more related to later academic outcome than maternal behavior at any other timepoint (average r = .22).

Relationships with 48m social outcome. Early and concurrent maternal caregiving was associated with 48m social skill, with low to fairly strong correlations in both groups, most of which were positive. The child's view of his/her own social skill was more highly associated with maternal behavior in preterms. Among the fullterms, prediction of PCONTROL and PBEHWELL, two parental measures, were especially related to earlier maternal behavior. The pattern was fairly consistent across time, although the helpfulness of the mother in the 24m structured "lever task" more often explained later positive fullterm social behavior, and later negative preterm actions. In contrast, 48m maternal behavior in the structured "waiting task" was related fairly similarly to concurrent preterm and fullterm social behavior.

Covarying global environmental status (ES). The influence of maternal behavior, apart from the effect of social class, was examined by covarying ES (measured by MOMED1), and looking again at the pattern of equalized correlations. The picture was quite different, and is shown in Tables 34 and 35 by contrasting sets of equalized correlation pairs ("with ES" and "without ES" (ES covaried)). Note that certain correlation sets are typed in boldface. These are the sets in which the covariate of ES decreases the fullterm coefficient, but leaves the preterm coefficient unchanged (or enhanced).

For fullterm children, relationships between maternal behavior and academic outcome clearly decreased, across time, when ES was covaried. Preterms showed a different pattern. Looking at 48m preterm verbal skills, the influence of caregiving actually increased (at least during the first year) when ES was covaried. Relationships with 48m preterm nonverbal outcome remained about the same.

Among preterms, beyond the effect of social class, positive caregiving remained important in predicting 48m social outcome. Removing the effect of ES, the impact of maternal behavior on preterm social outcome usually did not decrease, and was sometimes enhanced. For the fullterms, removing the effect of social class reduced the association between maternal behavior and 48m social outcome. Maternal caregiving from all points in time showed a decreased impact (average reduction in *r* at each timepoint ranged from .16 to .29). After covarying ES, maternal caregiving was less related to fullterm PSOCSKILL and PCONTROL, though there was still a significant association. Fullterm maternal behavior remained related to OCONTROL, even with the effect of ES removed. However, covarying eliminated the connection between maternal caregiving and the fullterm child's own view of his/her social acceptance (KDACCEPT). Note that covarying ES induced a clear decrease among fullterms in the concurrent relationship between 48m outcome and mother-child interaction.

Relationships of 48m outcome with consistency of caregiving (dynamic effects of maternal behavior)

Prior transactional research from UCLA showed that the consistency of caregiving was quite important in accounting for variability in later preterm cognitive outcome (Beckwith, 1983a). Consistency of caregiving captures a dynamic of the developmental process. According to the predictions of the transactional model, such a variable might be expected to show more predictive power than do static measures of maternal behavior collected at several points in time.

Two "consistency of caregiving" variables were created. CARE1F was composed of data from free play across the first year. (Note that preterm children were less stable in behavior during this timespan, but both groups of mothers were similar in stability.) CARE14S was comprised of data from behavior in structured situations at age one and four years. (Note that these data showed similar behavioral stability for both mothers and children in the preterm and fullterm groups.) CARE1F and CARE14S were created by dividing maternal caregiving (at relevant timepoints) at the median, giving a "+" or "-" score. These "+" and "-" valeus were then used to separately classify the preterms and fullterms into four groups: consistently poor caregiving; shift from good to bad caregiving; shift from bad to good caregiving; and consistently good caregiving. For example, consistently poor caregiving might be defined by a "- (1 yr), - (4 yrs)" or a "- (4m), - (8m), - (12m)". Analyses of variance, followed by pairwise comparisons, were run with both CARE1F and CARE14S, with and without covarying environmental status (ES), using MOMED48. The results of these analyses are given in Table 36.

Note first that there seemed to be somewhat more consistently poor caregiving than might be expected in the preterm group. The same was true of the fullterms, who also showed a lower percentage than might be expected in the "shift to bad" category (though this might have been due only to missing data). The consistency of caregiving ANOVAs basically confirmed findings derived from the equalized correlations reported earlier for the relation of child outcome to maternal behavior (Tables 34 and 35). However, the ANOVAs were a more conservative approach and highlighted only the stronger results. The dynamic consistency of caregiving variable did not appear to be a more sensitive predictor of 48m outcome than were more static measures, contrary to the transactional hypothesis. However, it did make the timing of caregiving effects more clear.

First, there were no main effects for consistency of caregiving on 48m academic outcome for either group, using either CARE1F or CARE14S. In fact, CARE1F did not reveal group differences on social outcome, with or without covarying ES. Apparently, consistency of caregiving during the child's first year of life, no matter how defined, independent or not independent of social status, does not predict either preterm or fullterm outcome at age four.

Consistency of caregiving, measured in structured play from one

Table 36

Pairwise Comparisons of the Effects of Consistency of Caregiving (in Structured Play from 12m to 48m) on 48-Month Social Outcome: Preterms and Fullterms

Preterms

Maximum frequencies of caregiving groups (12m to 48m in structured play):

	actual	possible[a]	expected
consistently bad	11	15	7
shift to bad	6	12	7
shift to good	7	12	7
consistently good	5	8	7
	29		

PSOCSKILL:

main effect: F (2,24) = 7.94**

cons. bad < cons. good, shift in caregiving

	n	M	df	t
cons. bad	9	-5.53	12	2.59*
cons. good	5	0.24		
cons. bad	9	-5.53	20	3.87**
shift	13	1.18		

effect adjusted for ES: F(2,23) = 10.32***
ES covariate effect: F(1,23) = 2.92
with covariate, same effect as above

PCONTROL:

main effect: F (2.24) = 4.37*

cons. bad < shift in caregiving
(consistently good = consistently bad & shift in caregiving)

Table 36 (continued)

	n	M	df	t
cons. bad	9	-3.01	20	2.95**
shift	13	0.87		

effect adjusted for ES: F(2,23) = 4.79*
ES covariate effect: F(1,23) = .379
with covariate, same effect as above

PBEHWELL:

main effect: F (2,24) = 3.22[T]

cons. bad < shift in caregiving
(consistently good = consistently
bad & shift in caregiving

	n	M	df	t
cons. bad	9	-1.57	20	2.50*
shift	13	0.43		

effect adjusted for ES: F(2,23) = 3.22[T]
ES covariate effect: F(1,23) = .001
with covariate, same effect as above

OCONTROL:

main effect: F (2,26) = 4.77*

cons. bad < cons. good,
shift in caregiving

	n	M	df	t
cons. bad	11	-1.00	14	1.89*
cons. good	5	0.63		
cons. bad	11	-1.00	22	2.99**
shift	13	0.96		

effect adjusted for ES: F(2,25) = 4.56*
ES covariate effect: F(1,25) = .072
with covariate, same effect as above

Table 36 (continued)

KDACCEPT:

main effect: $F(2,23) = 3.13^{T}$

cons. bad, shift in caregiving < consistently good

	n	M	df	t
cons. bad	10	5.74	12	2.50**
cons. good	4	6.93		
shift	12	5.99	14	2.02*
cons. good	4	6.93		

effect adjusted for covariate: $F(1,22) = 3.00^{T}$
ES covariate effect: $F(1,22) = .020$
with covariate, same effect as above

Fullterms

Maximum frequencies of caregiving groups: (12m to 48m in structured play)

	actual	possible[a]	expected
consistently bad	14	15	9
shift to bad	2	12	9
shift to good	10	13	9
consistently good	11	14	9
	37		

PSOCSKILL:

main effect: $F(2,34) = 5.07^{*}$

cons. bad < shift in caregiving consistently good

	n	M	df	t
cons. bad	14	-2.35	24	2.37*
shift	12	3.13		

Table 36 (continued)

cons. bad	14	-2.35	23	2.97**
cons. good	11	4.69		

effect adjusted for ES: F(2,33) = 3.76*
ES covariate effect: F(1,33) = 2.41
with covariate, same effect as above

PCONTROL:

main effect: F (2,34) = 4.10*

cons. bad < cons. good (shift in caregiving = consistently bad & consistently good)

	n	M	df	t
cons. bad	14	-0.93	23	2.84**
cons. good	11	2.42		

effect adjusted for ES: F(2,33) = 1.91(NS)
ES covariate effect: F(1,33) = 6.30*
with covariate, no main effect for consistency of caregiving

PBEHWELL:

main effect: F (2,34) = 2.61[T]

cons. bad < cons. good (shift in caregiving = cons. bad & cons. good)

	n	M	df	t
cons. bad	14	0.01	23	2.25*
cons. good	11	2.01		

effect adjusted for ES: F(2,33) = .319(NS)
ES covariate effect: F(1,33) = 13.78***
with covariate, no main effect for consistency of caregiving

OCONTROL:

main effect: F (2,34) = 4.85*

cons. bad < cons. good, shift in caregiving

Table 36 (continued)

	n	M	df	t
cons. bad	14	-0.82	23	2.27*
cons. good	11	0.58		
cons. bad	14	-0.82	24	2.94**
shift	12	0.95		

effect adjusted for ES: $F(2,33) = 5.59$**
ES covariate effect: $F(1,33) = .007$
with covariate, same effect as above

Note. Among preterms, the scores of the "shift" group were often equal to or greater than those of the "consistently good" group. When the "shift to good" group was included with the "consistently good" group, the preterms showed a different pattern for nearly all variables: consistently bad < shift to bad < consistently good + shift to good. For the fullterms, this procedure made the "shift to bad" group (n=2) too small for reliable analyses.

[a]There were nine missing preterm cases and 12 missing fullterm cases. The numbers given under "possible" are estimates of the maximum number of subjects in each group, had missing data been available.

year to concurrently (CARE14S), did predict later outcome in both groups. There seemed to be slightly more prediction among preterms, even though data on global ES were included along with caregiving information. However, the findings did not jibe fully with the predictions of Beckwith (1983). Transactional theory suggests a hierarchical relationship (from poor to better outcome) in the performance of children whose mothers provide consistently poor versus inconsistent versus consistently good caregiving. These effects emerged for fullterms only. Preterms did show poorer performance when receiving consistently poor caregiving, but there was no significant difference in outcome between those receiving inconsistent or consistently good maternal care.

It is possible that children whose mothers shift to better caregiving later in life, especially preterms, do just as well as those receiving consistently good care. Reclassifying the group in this way did reveal this effect for preterms. However, the fullterm results using this recoded measure were confusing, with the very small (n = 2) group of "shift to bad caregiving" achieving the best 48m scores.

Analyses covarying environmental status supported, and somewhat extended, the information gained from the equalized correlations reported earlier. The covariate reduced the main effect of consistency of caregiving in fullterms on PCONTROL and PBEHWELL, but left the impact among preterms essentially unchanged. A comparison between preterms and fullterms (using the original CARE14S) showed slightly stronger effects among the preterms, once ES was covaried. Apparently consistently poor maternal caregiving from age one to four, a dynamic measure of the "proximal" environment, is somewhat more important to preterms than fullterms once the strong effect of global environmental status for fullterms is removed.

The characteristics of those mothers providing "consistently poor" caregiving are of interest, since their preterm and fullterm children were performing poorly at age four. In fact, of seven children experiencing general delay, at least three (42.9%) received consistently poor caregiving. In general, the consistently poor caregivers more often had less education and came from a lower socioeconomic class. They more often expressed negative attitudes about parenting (lower SATISPARENT (fullterms only), lower SATISKID), and childrearing (higher RESTRICT (fullterms), lower NURTURE (preterms)). In fact, these mothers gave the clinical impression of being quite hostile toward their sons and daughters. Though their children experienced more environmental change (WTCHANGE48: loss and entrance events), the mothers themselves did not report greater life stress (STRESS).

Relationships of 48m outcome with earlier attachment classification (effects of the mother-child "relationship")

Early mother-child interaction was measured in one additional way: with an attachment classification derived from a modified separation-reunion sequence at 12m. Table 37 presents information on the validity of the attachment classification, as well as its relationship to various 48m measures. Analyses were of two types.

Table 37

Mean Differences Between Secure and Insecure Attachment Categories: Validity Data and 48-Month Outcome Scores

Variables	Secure		Insecure			Effect
	M	*SD*	*M*	*SD*	*r* or *t*	
Concurrent 12m Behavior:						
MOMBEH 12-F	10.48	3.30	9.32	3.17	1.52^{T}	S>I
KIDBEH 12-F	10.68	2.38	9.32	2.75	2.28*$_{T}$	S>I
KIDBEH12-S	--	--	--	--	*r*=.16^{T}	S ↑
DISTRESS12	--	--	--	--	*r*=.24*$_{T}$	S ↑
NONCOMPLY12	--	--	--	--	*r*=-.16^{T}	S ↓
Demographics:						
MOMAGE	25.16	5.22	24.90	4.54	.22	-
MOMED48	13.35	1.96	13.53	2.25	-.35	-
FHHEAD48	34.81	12.70	35.71	14.07	-.27	-
Child Characteristics:						
KIDAGE	48.84	1.39	48.90	1.37	-.17	-
KIDHEALTH (from age 1-1/2 to 4 years)	1.66	.676	1.35	.769	1.71*	S>I
Earlier Temperament:						
INTENSITY1	2.07	.492	2.10	.488	-.21	-
MOOD1	1.67	.288	1.67	.360	-.02	-
DISTRACTABILITY1	1.96	.385	1.96	.369	.02	-
Concurrent 12m Child Outcome:						
MDI12	115.68	14.33	112.32	11.90	1.07	-
PDI12	99.80	16.30	98.10	14.77	.46	-
Other Early Variables:						
SATISPARENT1	--	--	--	--	*r*=.22*	S ↑
SATISPARENT18	--	--	--	--	*r*=.15^{T}	S ↑

Table 37 (continued)

Variables	Secure *M*	Secure *SD*	Insecure *M*	Insecure *SD*	*r* or *t*	Effect
RECIPROCITY18	--	--	--	--	*r*=.22^T	S ↑
NONCOMPLY24	--	--	--	--	*r*=-.32**	S ↓
48m Academic Outcome:						
PPVT	106.22	14.00	105.93	16.24	.08	-
INFO	12.11	2.52	11.59	2.51	.83	-
BD	11.94	2.77	12.17	2.79	-.33	-
VMIAQ	93.98	18.05	98.87	16.43	-1.13	-
VMICQ	95.57	18.02	100.91	16.28	-1.24	-
48m Social Outcome:						
PSOCSKILL	.569	6.31	.536	6.04	.02	-
PCONTROL	.196	3.33	-.035	3.41	.27	-
PBEHWELL	.362	2.24	.231	2.32	.23	-
OCONTROL[a]	.412	1.65	-.122	1.86	1.22 (*r*=.17^T)	- (S ↑)
KDACCEPT	6.38	.999	6.05	1.04	1.30^T	S>I
ATTENTION	--	--	--	--	*r*=.22*	S ↑
48m Child's View of Outcome:						
COGNITIVECOMP	3.28	.532	3.08	.579	1.44^T	S>I
PHYSICALCOMP	3.21	.490	2.91	.540	2.30**	S>I
PEERACCEPT	3.18	.535	2.91	.632	1.86*	S>I
MOMACCEPT	3.20	.602	3.14	.517	.38	-
48m Mother-Child Interaction:						
WTMOMAFFECT	4.09	.725	3.64	.826	2.34**	S>I
WTDYADSATIS	3.93	1.02	3.55	1.04	1.47^T	S>I
WTDYADSTYLE	--	--	--	--	*r*=.17^T	S ↑
48m Maternal Attitudes:						
SATISKID	6.98	1.53	6.46	1.58	1.32^T	S>I
SATISPARENT	2.67	.871	2.26	.781	2.01**	S>I

Table 37 (continued)

Note. One-tailed t-tests were used in these analyses.

[a]The OCONTROL measure was an assessment of child behavior during the 48m waiting task, and so could be placed in either the "48m Child Social Outcome" or "48m Mother-Child Interaction" category. Note that the t statistic for OCONTROL comes close to significance (p = .114), with secure children appearing more facilitating during the 48m waiting task.

One-tailed t-tests, contrasting secure with insecure attachment groups, were performed. Correlations were also conducted, using a "degree of security" variable created by placing dyads with insecure attachments (A, C, D) in group #1, dyads with fairly secure attachments (B1, B2, B4) in group #2, and dyads showing optimal B3 attachments in group #3.

It is quite interesting to note that the children's attachment classification was consistent with later social behavior. This contrasts sharply with the absence of a relationship between early microanalytic observations of child behavior and later social outcome.

Background information. There were no differences between infants with secure and insecure attachment relationships according to: family demographics; child age; early temperament; or concurrent developmental level (12m MDI and PDI). Insecure children were significantly more ill during childhood, extending the finding of more neonatal illness among insecure children by Goldberg and her colleagues (1984). Concurrent validity was evident in significant differences in maternal and child behavior, during free play, according to attachment classification. Dyads with a secure relationship showed more positive maternal and child behavior during the concurrent 12m free play sequence.

Preterm-fullterm differences. As expected, there were no preterm-fullterm differences in the quality of the attachment relationship ($\chi^2(1, N = 75) = .04$, $p = .833$). In addition, there were very few differences between groups in the way in which the attachment measure predicted 48m child outcome. Thus, the attachment classification was not very useful in elucidating differences in the transactional patterns of preterm and fullterm children.

Relationships with earlier child behavior and maternal attitudes. Across the total sample, the predictions of security of attachment were quite interesting, and fit well with previous reports in the attachment literature. Children with secure attachments tended to behave more positively in the structured 12m play situation, and to show significantly more distress during separation. Noncompliance was associated with secure attachment at 12m, and even more so at 24m. Mothers of securely attached children also tended to report more encouragement of reciprocity, as measured at 18m by the Maternal Attitude Scale.

Relationships with 48m outcome and mother-child interaction. While attachment classification did not predict 48m academic outcome, it did predict aspects of 48m social outcome. Specifically, children with secure attachment relationships early in life had more positive views of their own physical and cognitive competence, as well as their social acceptance by peers. Yet securely attached children did not endorse higher ratings of maternal acceptance. While children rated as secure at 12m were not significantly different on most parental ratings of 48m social behavior, their mean scores were consistently higher or approached statistical significance. Secure attachment was significantly related to longer attention span at 48m.

Of particular interest were relationships of the earlier attachment classification with maternal and child behavior, over the total sample, during the waiting task. As mentioned before, the waiting task was designed to assess dimensions of behavior important to attachment theory. Consonant with theoretical expectations, securely attached pairs showed significantly more positive maternal affect and more dyadic satisfaction, and tended toward more optimal child affect and style of facilitation (OCONTROL). Thus, consistency in social behavior is shown over a three year timespan in the present study. Note that at 48m, mothers with securely attached children were also more satisfied with their child and their parenting role.

DISCUSSION

The Mother-Infant Project (MIP) findings added significantly to the evolving, complex picture of developmental process and outcome in premature children. Preterm social outcome at age four was described in detail, showing subtle deficits, and confirming the value of a multidimensional assessment of social behavior. Expected "academic" deficits were uncovered in preterm nonverbal cognition and visuomotor skill. A variety of predictions about the course of preterm development, derived from a transactional framework, were examined. Differences in the stability of the preterm's caregiving environment were pinpointed, and the complex network of developmental influences was investigated. In particular, the "double whammy" hypothesis was tested, and some support obtained for an alternative interpretation of the caregiving environment as a "self-righting" influence on the course of preterm development. Finally, social behavior was successfully predicted by several kinds of early data. Most striking was the significant association between two measures of social development derived from attachment theory: (1) 12m security of attachment and (2) maternal, child and dyadic behavior in the "Waiting Task." The "Waiting Task" was devised especially for the present study.

The findings of the present study will be discussed in three major sections: (1) group and individual differences in 48m child outcome; (2) transactions leading to child outcome among preterms and fullterms; and (3) comments on child social behavior. At the end of this chapter are presented the study conclusions.

Group and Individual Differences in Child Outcome

To integrate the present outcome findings with the existing literature, it is important to remember that the MIP sample of preterms and fullterms came from a recent cohort, born in 1979-80. They were of mixed socioeconomic status (with the greatest percentage designated as middle class), and were 22% of minority status. The preterms were primarily VLBW and smaller LBW infants. Through their four years, the preterm children were relatively healthy. All began life without major identifiable abnormalities, and only half suffered from IRDS. During the postnatal period, as would be expected, the health of the preterms was inferior to that of their fullterm peers, but in childhood their health improved nearly to the fullterm level.

Group Differences in "Academic" Outcome

48m findings. At age four, the MIP preterms did differ from fullterms on a number of outcome measures. The preterm children scored lower on the WPPSI Block Design subtest, a measure of nonverbal cognition, and the Beery VMI, a test of visuomotor skill. Only visuomotor ability fell below normal limits, and then only when calculated according to the preterm child's actual chronological age, and not according to age corrected for the extent of prematurity. Note that a weakness in the visuomotor area may be a significant problem for a four-year-old child, who is likely to be entering a preschool environment. Siegel (1985) found that the 48m Beery VMI score had the highest correlation of any earlier outcome measure with 6yr achievement scores. At age four, then, these VLBW preterms were showing a specific "academic" deficit. Yet they did not show difficulties in verbal skills, as assessed through the PPVT, a test of receptive language, and the WPPSI Information subtest, one measure of verbal cognition.

Explanation of preterm nonverbal and visuomotor outcome. As in earlier historical phases of preterm medical care, "academic" difficulties occurred over the longterm. This was true even though improved medical techniques are being used with "fourth phase" preterms, who are only now being followed into early childhood. Yet such minor handicaps are not surprising, given reports in the literature of preterm problems during infancy, as well as findings of motor problems through age two in the MIP study. Preterms have shown early deficits in information-processing, especially visual and intersensory stimuli, as well as early motor problems through age two. Though considerable developmental "catch-up" occurs, later outcome data have stressed the poor performance of preterms in the nonverbal cognitive and visuomotor domains. Note that both the Block Design and the VMI assess visual organization, as well as visuomotor coordination, though Block Design involves more complex reasoning about problems of spatial relationships. Poor performance on these tests may arise from difficulties with vision, motor ability, the coordination of these skills, and/or analytical skill.

Perhaps these persistent problems are "hard-wired," arising from subtle neurological difficulties and slower maturation among these children. Such problems, which may reside in the visual or association pathways, or be hippocampal or possibly even intracerebellar in origin, might underlie later learning disabilities (Fuller et al., 1983). Future research needs to establish how preterms process information later in life, and whether they continue the "paradoxical response" pattern described earlier in this paper. Neuropsychological assessment, such as that carried out by Siegel (1984b, 1985) might shed light on this hypothesis, and enable compensatory educational planning.

Note that these "hard-wired" problems may be due simply to inborn neurological problems. Alternatively, they may arise from the very unusual early stimulation premature children receive in the hospital environment (Davidson Ward, personal communication, August 8, 1985). This factor was not addressed in the Mother-Infant Project. However, an excellent intervention study of stimulation in the hospital environment has been conducted by Barnard and her colleagues (Barnard & Bee, 1983). Their data do show the powerful positive effects, on shortterm developmental outcome in preterms, of an improvement in the quality of the hospital environment.

<u>Explanation of 48m preterm verbal outcome.</u> The similarity of preterms and fullterms in receptive language skills fits well with findings that receptive language is not a persistent preterm problem area, among recent preterm cohorts. However, it was somewhat

surprising to find the preterms' normal performance in the area of verbal cognition, assessed by the WPPSI subtest (INFO) most highly correlated with the WPPSI Full-Scale IQ score. Perhaps the INFO subtest is not sufficiently sensitive to the nuances of preterm cognitive difficulties, or possibly the overall extent of cognitive dysfunction has indeed decreased in recent preterm cohorts, as suggested by Kitchen et al. (1982). This finding does support earlier findings in the MIP study finding no preterm/fullterm differences in general cognitive functioning or in language skill at 24m. More extensive cognitive and expressive language assessment is needed.

Group Differences in Social Outcome

48m findings. Compared to fullterms, these relatively healthy preterms showed a shorter attention span, overreactivity, and a less optimal view by the preterm child of his/her social acceptance, specifically by peers. More subtle deficits were also seen. Premature children were characterized as more active, while parents of preterms reported poorer positive social skill (a "process" measure) and more behavior problems (a "product" measure). In addition, preterm children showed a deficit in overall social competence (a summary of measures from all three perspectives). Contrary to expectations, no group differences were evident in the parental or observer views of child self-control. While there are no norms for the five summary social outcome measures, the preterms as a group did not appear to be below normal limits on those component social scales for which norms exist (the three CBCL scales).

Explanation of preterm social outcome. It is not surprising to see minor handicaps in the area of temperament. Finding a shorter attention span among preterms follows logically from Als et al's (1979) notion of their limited capacity for information processing as infants. Overreactivity in preterm children is entirely consistent with the suggestion of Krafchuk and his colleagues (1983) that preterms look more reactive once a response is initiated. It is also consistent with the idea that preterms have early difficulties in regulation of the autonomic nervous system. The finding of overactivity among preterms is quite predictable from earlier literature describing preterms as less able to control motor movements, vocalizations, and state change. It is possible that these temperamental differences are another manifestation of subtle, "hard-wired," neurological differences between preterms and fullterms. Note that at least some preterms may actually manifest a mild attention deficit disorder (which is characterized in the DSM-III classification system by inappropriate attention, impulsivity and, sometimes, overactivity).

It was surprising that child self-control, as assessed in this study by PCONTROL and OCONTROL, did not emerge as more of a problem for preterms, given their continuing difficulties with some of the dimensions of temperament relevant to self-control. However, the PCONTROL group difference did closely approach statistical significance, with preterms performing more poorly. Perhaps four years is an age when parents do not expect their children to have mastered the skill of impulse control, so that the PCONTROL ratings mask subtle group differences which may become more pronounced later on. Alternatively, the PCONTROL factor may have been too unstable to reliably reveal preterm-fullterm differences, as it emerged as a factor only in the empirical principal components analysis (PCA), and was not confirmed by a factor analysis (FA) procedure. The OCONTROL factor, derived as it was from the "Waiting Task" situation, revealed child self-control when the child was not acting alone, but involved in a partnership and assisted by the mother. The lack of preterm-fullterm differences on OCONTROL could indicate that parental behavior is particularly important in regulating the functioning of preterms, bringing their behavior more closely in line with that of a same-age fullterm. The no-difference finding could also suggest that a 48m measure quality of the mother-child partnership (the "Waiting Task"), like the 12m measure of the quality of attachment, is robust to perturbations even as severe as preterm birth. These ideas could be tested by contrasting the "Waiting Task" with a delay of gratification situation in which the children waited for a gift alone. In that way, it might be possible to distinguish between the child's self-control, and control in interaction with others attuned to the child's skills.

It is important to note that parental reports of deficits in both positive social skill and behavior problems (and the near-finding of difficulties in the parental view of child self-control) may arise from early interactional problems between infant and caregiver, as well as from mild neurological immaturity or impairment. Preterm dyads do experience early separation, and both clinical and research observations (including the earlier portions of the MIP study) have revealed a more negative and unsatisfying interaction between caregiver and child during the first year of life (Crnic, Greenberg, et al., 1983). In addition, preterms seem to be less socially responsive and harder to "read" (McGehee & Eckerman, 1983). The subtle behavioral difficulties reported by parents of four-year-old preterms may, in part, be a continuation of these interactional problems, now pervading the child's entire social world. Alternatively, however, the reported problems may reflect only parental perception, at least in part, and not a problem inherent in the child. There is ample evidence that tools collecting data though parent report reflect characteristics of the parent as well as the child (Maccoby, Snow & Jacklin, 1984; Pettit & Bates, 1984). The views of teachers and peers would help to clarify the breadth of the preterm child's social problems.

Results indicating poorer preterm self reports of social acceptance, particularly by peers, are not easily interpreted. This may be the one example of a sex difference confounding a main effect of prematurity. It appears that male preterms are the ones likely to experience this problem, sharing that experience with the less-affected male fullterms. Since males experience more illness, and are generally considered to be more vulnerable to early experience, perhaps this is reflected in their lack of feelings of success among those with whom they are beginning to compare themselves: their peers. For three reasons, this sex difference explanation seems more likely than the a priori hypothesis that the negative affective tone shown by preterm children during the first year has carried over into their own view of social acceptance as preschoolers. One, only male preterms seemed to report lower social acceptance. Two, preterm males may actually be smaller in physical size than a fullterm peer, which may account for their less optimal perceptions of peer acceptance. Three, the premature children did not endorse lower maternal acceptance scores, the variable most likely to be influenced by early relationship difficulties.

Comparison with existing fourth phase literature on preterm social outcome. The multiple perspectives of the MIP data did augment the sparse results on social outcome in "fourth phase" preterms, assessed over time. In the relatively healthy MIP sample, no early deficits on measures of temperament were found. In contrast, Field et al. (1983) did find temperamental deficits in ill infants. Note that no early measure of "difficult" temperament was collected in the MIP study. The construct of "difficultness" appears to be stable (Bates & Bayles, 1984), and to predict later behavior problems in middle class, nonproblem samples (Lee & Bates, 1985). "Difficultness" might have shown preterm-fullterm differences, or pinpointed neurologically-impaired preterms (Hertzig, 1984), and should be used in future research.

In mother-child interaction during the first year, the MIP preterms were more likely to show negative emotional tone and share in lower dyadic satisfaction. This fits well with Ungerer and Sigman's (1983) preterm data showing personal-social delays at 13m. At age one year, the MIP preterms were similar to fullterms when rated on security of attachment, consonant with the findings of other studies.

At age two, the MIP preterms did not differ from fullterms in the quality, duration, or linguistic complexity of interaction with their mothers during free play. It is possible that new analyses, using as a covariate a more powerful environmental status measure, or uncovering subgroups of children with problems (Rocissano & Yatchmink, 1983), might still reveal subtle 24m group differences in the MIP sample. The no-difference MIP findings at age two are somewhat discrepant with the negative emotional tone (with an examiner) seen in Field, Dempsey & Shuman's (1979) study of ill 24m-old preterms, but agree with Ungerer and Sigman's data on relatively unimpaired preterms showing no 22m personal-social deficits on the Gesell Scales. Perhaps future analysis will uncover differences between the two-year-old MIP prematures, and their fullterm peers, in a structured problem-solving situation. This would fit with Ungerer & Sigman's statement that play in a structured setting could reveal larger deficits than would free play, since a wider range of skills might be assessed. Note that no behavior problem or temperament ratings were gathered on the MIP preterms at age two.

By age four, when measured against children of the same chronological age, the MIP preterms had not achieved a completely normal social outcome. Unique data from the MIP sample included the self reports, by male preterms, of lower social acceptance, as well as subtle deficits in the parental view of the preterm child's positive social skills and overall social competence. Other MIP data corroborated existing findings, and are discussed below.

The 48m temperamental problems seen among the relatively healthy

MIP preterms extended Goldberg et al's (1980) 12m results of shorter attention span and overreactivity in ill preterms, and confirmed at one age level Field's report of increased activity level, short attention span, and irritability in ill preterms from age two to five (Field et al., 1983).

The subtle behavior problems shown at 48m by the MIP preterms confirmed, though to a lesser extent, Field et al.'s (1983) parental report of behavioral difficulties, and fit with Escalona's (1982) frequent parental reports of behavior problems among three-year-old LBW preterms. The illness of both Field's and Escalona's groups, and the low social class and minority status of Escalona's sample, may have contributed to the greater extent of their behavioral difficulties. (Note that in the present sample the parental perception of behavior problems was affected by SES, as well as by birth status.) The present data were discrepant with Bakeman and Brown's (1980b) report on low SES, black, LBW children, who were not found to display a social deficit at age three. Perhaps this was due to the fact that their sample was not assessed by parental report of temperament or behavior problems, but through ratings of "social competence" by daycamp teachers, and of "social participation" by observers of peer interaction.

These augmented "fourth phase" findings can be set into the overall context of data on preterm social outcome over the last 40 years. Over this time period, medical techniques have improved, and psychological research methods have become more sophisticated. During this same period, it appears that the social outcome problems of preterms have become more subtle, but have not disappeared. Some of the remaining problems are in the area of temperament, and may be "hard-wired." Others may be repercussions of early interactional difficulties. However, much of the data has come from parental report, which may provide a limited picture. In sum, these social outcome problems do seem to arise, at least in part, from premature birth, whether LBW or VLBW. The transactions of premature birth with other developmental forces, and the consequences for developmental outcome, are discussed in detail later in this paper.

Individual Differences in Preterm and Fullterm Child Outcome: Comparison to Group Difference Data

The group difference findings reported above generally did reflect the performance of individual preterm children. This is an important distinction to make (Ungerer & Sigman, 1983). Group differences did not reflect only the effect of a few deviant children, as group median and mean values gave fairly similar information. However, the group differences underestimated, mostly in the verbal area, the problems experienced by the preterms at age four. Compared to their fullterm peers, about twice as many premature children scored in the lowest 25th percentile on overall social skill, as well as below 80 (or a scaled score of 8) on tests of verbal abilities, nonverbal cognition and visuomotor skill. In both the preterm and fullterm groups, there seemed to be a small subgroup of children experiencing a general developmental delay. Yet among the preterms, this subgroup was about three times as large. In some ways, as Rocissano & Yatchmink (1983) have suggested, the preterm population appeared to have greater heterogeneity. Note, however, that the two groups fluctuated on test score variability: sometimes the preterms showed greater variability, and sometimes the fullterms received more extreme scores.

Overall, the majority of preterms, at age four, were competent academically and socially. But the sample of preterm children did differ from a fullterm group. In addition, an individual premature child was more at risk for outcome problems, perhaps multiple problems, than was his or her fullterm peer. Those with multiple difficulties were more likely to be of minority status and, among preterms, to have experienced serious physiological sequelae such as cerebral palsy, hearing loss, as well as significant growth or communication disorders. The origins of individual and group variation will be discussed in more detail later in this paper.

Group Differences in Child Outcome: Methodological Points

The preterm outcome literature has traditionally used "simple" ANCOVA analyses, looking at the effects of birth status only after covarying environmental status. In this paper, "simple" ANCOVAs were constrasted with factorial analyses, which simultaneously examined prematurity and environmental status. ("Simple" ANCOVAs were reported in Appendix C.) The two procedures yielded similar main effects for prematurity. However, interaction effects in receptive language and the parental view of the child's behavior problems (PBEHWELL), as well as the PBEHWELL component scores, were uncovered only by the factorial approach. Future research might best employ the factorial technique, which provides more information about the process of development among preterm children.

Recent literature has questioned the utility of alternative indicators of environmental status (Mueller & Parcel, 1981). Many preterm outcome studies have simply used the variable of maternal education to represent environmental effects. Broader measures of SES, including occupational information and data from the father, have been used, but less often. This study used both types of measures, to compare their usefulness.

The two measures divided the sample differently. The broader SES measure, FHHEAD48 (range 12-66), targeted a small number of socioeconomically privileged children in the "high" group, while the maternal education (at 1 or 48m: MOMED#, range 9-19) measure isolated in the "low" group a small number of the least developmentally-stimulated subjects. In general, both indicators showed poorer performance in children of lower environmental status, as predicted. However, the MOMED# variable was supposed to pinpoint those children with the most severe developmental impact, revealing important environmental effects on child outcome. Yet the FHHEAD48 measure brought out the strongest group differences, both directly, in the environmental main effects, and indirectly, by allowing more subtle preterm-fullterm differences to emerge. The choice of an environmental indicator will depend on the purpose of the study in which it is used, but these findings illustrate potential differences in results depending on which measure is selected.

Group Differences: Environmental Main Effects

The impact of environmental status (ES) was interpreted from data using both MOMED# and FHHEAD48. In this study, it is important to remember that both the "high" and "middle" ES subgroups were derived from a predominantly middle class population, while the "low" ES subgroup did come from a low socioeconomic group with relatively little education.

Environmental effects on child outcome. Most environmental effects were predictable, given previous literature on the impact of socioeconomic status. Children of high ES showed better receptive language, and their parents credited them with better social behavior (in the areas of self control and behavior problems) than did the other subgroups. Surprisingly, the measure of verbal cognition did not differ between ES subgroups. Although the INFO subtest is supposed to be sensitive to environmental differences, it did not seem to discriminate well in this study. Oddly, children in the middle ES subgroup did most poorly on the visuomotor test. This may have been a chance finding, since Siegel (1984b) found no relationship between environmental stimulation (using the HOME inventory) and VMI scores.

Environmental effects on maternal attitudes. In the area of maternal attitudes, most 48m findings were again predictable from prior research on maternal education and social class. Low ES mothers reported less adequate support systems, including a perception of their families as less cohesive. The middle ES subgroup, who may be trying to "get ahead," reported more life stress, lower family cohesion, and more dissatisfaction with the parental role. Both middle and lower ES mothers endorsed more restrictive childrearing attitudes, and more general life dissatisfaction, than did higher ES mothers. The high ES group (based on FHHEAD48) reported more satisfaction with intimate support and nurturant childrearing beliefs.

Environmental effects on maternal behavior (using MOMED48). Data on maternal behavior also fit well with existing literature on social class. Using the MOMED48 measure, the only environmental main effect was in the area of maternal style during the 48m waiting task. Only low ES mothers appeared more "authoritarian" during the 48m waiting task. Interestingly, middle ES mothers more often behaved in an "oversupportive" manner, taking too much responsibility for their child's self-control. One might expect these lower and middle ES children to learn more "dependent" styles of impulse control: the low subgroup complying with the mother and the middle subgroup relying upon the mother. The group of high ES mothers were more often "facilitating" in style: encouraging communication; responding to their childrens' questions and suggestions; yet helping their children to show more "independent" initiative and impulse control during the waiting period.

Environmental effects on maternal behavior (using FHHEAD48). There were differences in the utility of the MOMED# and FHHEAD48 environmental indicators. Using the FHHEAD48 measure, additional environmental effects were uncovered in behavior during the 48m "Waiting Task." When interacting with their children, the low ES mothers evinced more negative affect and were less facilitating during the waiting period than were mothers from a higher ES. The high ES mothers more often displayed both a "facilitating" style and relatively positive affect. Interestingly, however, these high ES were members of dyads which functioned in a style intermediate to the low and middle subgroups, and had children showing no greater positive affect than those in other ES subgroups. Presumably, however, the child with a "facilitating" mother, and a chance to learn independent self-control, would wait better alone, and would show better self-control as s/he grew older. This could easily be tested by examining these children in self-control situations later in life.

These environmental effects will be discussed from a different perspective in the "Waiting Task" section. In addition, maternal behavior interaction effects will be addressed in the transactional portion of this paper.

Transactions Leading to Child Outcome Among Preterms and Fullterms

The present findings confirm prior data suggesting that preterm and fullterm children are engaged in a somewhat different process of development and, in fact, reach somewhat different developmental goals at age four. The data fit within a transactional approach to the study of development, which describes the process through which children move as complex, dynamic, and characterized by interplay between child and environment, as well as a tendency toward self-righting. Important details of these transactional patterns, compared between preterms and fullterms, are presented below and placed in the context of existing literature. First the stability of selected developmental constructs is examined, since the transactional model predicts that more stable domains should have a relatively greater impact on child outcome. In particular, the child's caregiving environment is scrutinized.

Developmental Constructs: Preterm-Fullterm Group Differences and Stability

Conditions within the child. Biological/health status, a developmental factor clearly different between the groups early in life, grew more similar as time passed. Over time, then, it appeared unstable among both preterms and fullterms. In the MIP sample, contrary to the data of Littman and Parmalee (1978), preterm children with early illness generally did not remain ill. However, there was one stable subgroup of premature children, more often white and male, who were consistently sick from birth through childhood.

Behavior did differ between preterm and fullterm children, as discussed earlier. In both groups, however, social behavior across the first four years was marked by instability. Early temperament was not related to later temperament, and a microanalytic analysis of the actions of both preterm and fullterm infants during the first year gave little information about their behavior during the preschool time period. Interestingly, however, an analysis of child social behavior at 12m, yielding the "security of attachment" measure derived from attachment theory, did predict social behavior at age four in both groups.

Developmental status did differ between preterms and fullterms, but was moderately stable in both groups even during the first year. Increasing in stability as both groups of children moved into their second year, developmental status became more specific to particular developmental domains as the children reached age four. As other authors have noted (Hammond & Bee, 1983), the fullterms did show slightly greater stability during the first two years.

Conditions external to the child. For both preterms and fullterms, global environmental status, as measured by maternal education (MOMED#), was similar in degree and stability over time. Both groups of mothers did slightly upgrade their education over the years of the study. Measured by the broader SES variable (FHHEAD48), global environmental status differed between groups (preterms were of higher socioeconomic status), but the preterm and fullterm families both showed stability in their social class membership over time.

At age four, there were no overall attitudinal differences between groups of preterm and fullterm mothers, consistent with MIP findings during the first two years. Apparently having a premature child did not have an overall impact on the way in which a mother, at several points in time, viewed the stresses and support of her social world, or her beliefs about parenting. This is consonant with other findings, indicating that families with preterm infants adapt quickly and maintain these attitudes as their children grow. It is interesting that preterm mothers rated their satisfaction with intimate relationships (ATTSAT) similarly to the mothers of fullterms, at all timepoints during the overall MIP study. Among preterms only, note that this ATTSAT rating was highly predictive of 24m developmental status (MDI and PDI), as well as 24m receptive and expressive language and 48m cognition (INFO and BD)

Maternal attitudes were quite consistent in both groups, from the child's birth on, although there were a few group differences in stability. Preterm mothers consistently showed more satisfaction with the support of their friends and community, as their children passed from infancy to early childhood. Perhaps mothers of preterms consistently receive more support from their friends and community, especially medical personnel, because of their preterm child. During this same time period, fullterm mothers seemed more consistent in their family perceptions and attitudes toward childrearing, a pattern of stability expected in normal populations (Hock & Lindamood, 1981). It is notable that preterm mothers seemed to change their beliefs about control-related childrearing issues, but not issues concerning warmth, as their children moved through the transition to childhood.

Contrary to expectations, preterm dyads at 48m did not show greater maternal negative affect, lower dyadic satisfaction, or a higher incidence of "oversupportive" maternal behavior than did fullterms. Note that this finding was taken from a structured situation and not from free play, as were earlier findings. It appears that the negative, overstimulating quality of preterm mother-child interaction may indeed fade after the first year. By the fourth year, in fact, preterm dyads looked very similar to their fullterm counterparts in a situation (the "Waiting Task") assessing skills quite central to development during the preschool years. (However, please see the Conclusion for a discussion of possible preterm/fullterm differences surrounding the issue of control in the mother-child relationship during the child's second year. Perhaps important transactions have not yet been measured.)

Note that the overall quality of mother-child interaction was moderately stable among both groups during the years of infancy, especially in free play. This was somewhat surprising, in light of the hypothesis suggesting less stability in maternal behavior among preterms. Dyads were consistent in the affective tone of their interaction across the first four years. This finding supports hypotheses suggesting that the quality of early interaction builds a basic foundation for later interaction.

Overall, then, important developmental variables generally showed similar stability within the preterm and fullterm groups. If the prediction of the transactional model is true, then stable developmental influences should have a greater impact on child outcome. The few areas in which only the preterm mothers' behavior and attitudes were unstable (family perceptions, control issues) may signal developmental areas influenced by prematurity, and may possibly be important to individual variation in preterm child outcome.

But the differences in stability revealed above are not sufficient to explain group and individual variation in 48m outcome. First, total group stability may not be the best way to assess transactional hypothesis about the impact of stable influences. It may be that subgroups of preterm and/or fullterm children may experience unstable developmental influences, a possibility which could be tested using dynamic variables such as "consistency of caregiving" or "continuity of illness." Second, beyond the issue of stability, the transactional model also predicts that certain developmental influences (such as caregiving) may be more important to the course of preterm development. All these issues are explored in the remainder of the transactional section.

Predictive Power of the Developmental Constructs, Considered Simultaneously

The transactional framework emphasizes the dynamic interplay between developmental influences during development including, for the preterm child, a possible "double whammy" effect or "self-righting" process. ANCOVA interaction effects were employed to test the double whammy hypothesis. Regressions were used to simultaneously consider transactions between important developmental constructs affecting 48m child outcome. Sets of predictor variables were identified, and their relative efficacy explored. Particularly salient developmental factors were pinpointed. Note that the regression procedures were handled very conservatively, so the results were probably quite robust. In fact, the amount of outcome variance accounted for by the predictor variables may have been underestimated.

Biological status, including preterm biologically-based individual differences. Considered simultaneously with other developmental variables, early biological status was relatively more important to 48m outcome in preterms. This within-child factor did contribute to an explanation of temperamental aspects of the preterm social behavior. To a lesser extent, it explained the fullterm child's social skill. Measures of birth status plus a measure of later childhood health also predicted preterm temperament at age four, as well as fullterm "academic" and social outcome. However, as predicted in the transactional model, and found in other studies, biological status did not have much predictive power, especially measured early in life. In general, biological status assumed importance for preterms when considered in concert with measures of the "proximal" environment, particularly maternal behavior toward the end of the first year.

The indicator of early biological status (BIOSUM1) yielding these predictions included only the traditionally-used measures of birthweight and gestational age, as well as measures of early health. To draw in more detail the impact of biology on 48m preterm outcome, these and other variables were examined individually.

Findings first showed that the measures of birthweight and gestational age, used alone, were not very useful as 48m predictors, consistent with 24m MIP data (Greenberg & Crnic, 1985). Given the importance attached to these variables, their lack of utility was notable in this population of relatively healthy, VLBW and smaller LBW preterms. Second, it was clear that an increased incidence of early health problems (presence of IRDS, SGA and poorer postnatal health) occurred in lower SES children, consonant with previous reports (Bennett, 1984). Third, both maleness and poor postnatal health were associated with less optimal ratings of social behavior in premature children at the age of four, both from the maternal perspective and the child's own viewpoint. Since preterm boys were sicker than fullterms both postnatally and in childhood, these sex and health effects were undoubtedly confounded. Note that gender was not an important predictor among fullterms. This suggests that future research should analyze preterm/fullterm differences separately by sex.

IRDS did appear to be transient phenomenon, as children born with respiratory distress did not remain ill in childhood. This medical problem, as seen in other studies, did not have lasting consequences except to contribute (with other early health problems, and perhaps lower socioeconomic status) to the preterm males' poorer view of their peer acceptance. As suggested by Bennett (1984), IRDS may only be a marker for other developmental influences which create outcome problems.

In contrast, the presence of SGA was clearly important to later outcome. SGA children received higher BIOSUM scores, since they had a relatively longer gestational age (for their birthweight) and showed few early health problems. Yet SGA children were actually delayed in all "academic" areas. In fact, SGA was the only variable identified in this study that contributed to an explanation of the nonverbal cognitive and visuomotor problems of the preterms. Perhaps SGA was salient as a marker for possible neurological damage. A thorough neurological battery would have been very useful in exploring this hypothesis.

Health during childhood was not very helpful in explaining preterm outcome, though it was useful among the fullterms. Nor was a measure of consistent illness, a dynamic measure reflecting a stable phenomenon, that the transactional framework suggested would have a relatively greater influence.

Early illness and neurological deficits did appear to be important in determining preterm outcome at 48m. A word about the possible impact of biological immaturity (delay, not deficit) is needed. In this study, this point can be evaluated only by looking at the preterms' performance on the VMI, a normed test of visuomotor skill, calculated according to both actual and corrected age. The preterms scored lower only on the actual age quotient. This may mean that immaturity is the only factor operative here. Perhaps this finding is specific to visuomotor skills, or applies generally to all preterm problems. Note that the actual age quotient has been found to be the better predictor of future performance.

<u>Global environmental status, including group difference interaction effects.</u> The child's global environmental status was also considered simultaneously with other measures, as it has been advanced

as a critical developmental variable for preterms, especially by proponents of the transactional model. Some authors have construed the environment as a self-righting mechanism, with a positive impact on later preterm outcome. Others have hypothesized that the environment has a negative influence, exerting a "double whammy" effect.

In general, the regressions showed that global environmental status, whether assessed as maternal education or by a broader SES measure, had a quite powerful impact on four-year "academic" and social outcome, but only among the fullterms. This fits with previous findings in the Mother-Infant Project, which did not find an effect of maternal education, but only of birth order (firstborn/laterborn). Note that birth order is a measure often associated with marked differences in caregiving. Caregiving was treated separately from global environmental status in the present study, and is discussed in the section of "proximal" measures of the environment.

Relationships between child outcome and global environmental status have already been found among fullterms (Hammond & Bee, 1983). Yet the findings of the Mother-Infant Project, revealing the absence of a global environment-child outcome relationship, clearly run counter to previous data on premature children. Perhaps this discrepancy is due to the distinction made in the Mother-Infant Project between global and "proximal" measures of the environment. In the normal course of development, sociocultural influences emerge as important beginning at age two. But among preterms, familial influences may remain more important than global ES, as suggested by the transactional research conducted at UCLA. Note also that with a predominantly middle class sample (especially among the preterms), the effects of global environmental status may be muted to begin with, relative to familial influences, at least in relation to certain outcome areas.

Sameroff's speculation that preterms suffer from a "double whammy," becoming more vulnerable to environmental deficits as a result of their prematurity, was not supported. In the main outcome areas, only receptive language (PPVT), and the parental view of child behavior problems (PBEHWELL), gave evidence of an interaction effect between measures of biological and global environmental status. Premature children in a home with a highly educated (or higher social class) mother showed significantly less optimal behavior, and somewhat poorer receptive language, than did fullterms in a similar social situation. However, preterm children whose mothers had less education (or lower social class) showed behavior problems similar to those of their fullterm peers, and their receptive language skills were actually better.

In these outcome areas, then, preterms apparently benefit somewhat less from a good environment. In a poor environment, they are also affected somewhat less (or just as much), as fullterms in the same situation. Certainly they are not more affected by a deprived environment, as predicted by the double whammy hypothesis. Note that all three component scales of PBEHWELL, using MOMED#, show the interaction effect, although the biological component of activity level shows it most strongly. Perhaps preterms cannot benefit from more optimal surroundings in part because they cannot decrease their activity level, a biological limitation. If preterms are biologically vulnerable, perhaps something is buffering the impact of a poor environment and self-righting is taking place. Most likely the self-righting influence lies in positive caregiver behavior, which may show the most dramatic effects within a more deprived global environment. The impact of maternal behavior is discussed in much more detail later in this section.

Comments on maternal age. Maternal age did not emerge as a direct, important predictor of 48m preterm or fullterm outcome, except in a few cases in which it appeared to act as a suppressor variable. This fit with the 24m MIP findings, which revealed few maternal age effects. Perhaps the effect of maternal age occurs early in the infant's life and is indirect, mediated through maternal attitudes and behavior. In infancy, Ragozin et al. (1982) found that the older the mother, the higher the role satisfaction and positive caregiving behavior.

"Proximal" measures of the environment. "Proximal" environmental constructs have been advanced as important self-righting influences in the developmental process, particularly maternal behavior (Beckwith, 1981, 1983; Olson, Bates & Bayles, 1984; Sameroff, 1982). Confirming this idea, maternal attitudes and the quality of maternal behavior did add to an understanding of both preterm and fullterm outcome, primarily in the social area and more often among fullterms, when considered simultaneously with other measures. But patterns of influence in the two groups were different, and did not grow more similar over time, supporting the transactional notion that preterms and fullterms do indeed follow different developmental trajectories.

As hypothesized, these "proximal" measures explained some aspects of preterm outcome, primarily in the social area, helping to bring previously nonsignificant results to significance (increasing R square an average of 32%). This usually occurred in cases where biological status was already an important predictor, and maternal behavior (at 8m or later) was the salient contributor to an explanation of outcome variance. This did not seem due only to consistently ill preterms eliciting needed caregiving. In fact, consistently ill children did not seem to receive better caregiving, but perhaps experienced less facilitating maternal care, at least at age four.

Given the fact that the atypical mother-infant interaction seen in preterm dyads early in life slowly settles into a more typical pattern as the child ages, it is interesting that very early (4m) maternal behavior was not salient to 48m outcome in preterms, but that later (8m and older), and concurrent, interaction was important. This finding, however, supports McCall's (1981) suggestion that social and familial influences become more important to individual variation as the child moves out of infancy, a time dominated by maturation, and through the transition to childhood. Note that this pattern was seen only in the social area, indicating that biological factors may be paramount in the "academic" area.

Measures of the "proximal" environment also contributed to an understanding of fullterm outcome, increasing R square an average of 12%. Compared to the preterm group, these measures accounted for a smaller degree of variance, but in a wider range of outcome variables, including receptive language ability and all perspectives on social skill. Information from all points in time was useful, with the exception that concurrent data best explained the observer and child view of social outcome. No pattern of "active" predictor variables was evident.

The impact of earlier developmental status (12m MDI and PDI) was studied, simultaneously with biological status and maternal age, and beyond those variables with measures of the environment. While not adding anything to an explanation of 48m preterm outcome, knowing a fullterm's earlier developmental status did help to explain 48m verbal abilities and social skill. In fact, for fullterms, knowing the earlier developmental scores was nearly as useful as knowing the child's global environmental status. This may be a consequence of the greater degree of developmental stability apparent in the fullterms' early life. Beyond data on maternal age and biological status, knowledge of earlier child characteristics was the combination most useful for fullterms in some outcome areas, while data on both the global and "proximal" aspects of the environment were useful to explaining other areas. This was not so for preterms. Clearly, more useful for preterms were data on the environment (global and "proximal"), at least for some aspects of 48m social behavior.

These data partially supports Siegel & Cunningham's (1984) contention that transactional processes operate differently in preterms and fullterms. Within the preterms, the early environment ("proximal" aspects, at least) did show greater influence than did earlier developmental status. (This may indicate a self-righting influence.) But within the fullterms, earlier developmental status was not usually more salient than early environmental information. The preterm data, but not the fullterm findings, fit well with recent developmental literature, which argues that early infant competence does not contribute statistically to longitudinal relationships between early environment and later child competence (Coates & Lewis, 1984; Olson et al., 1984). But the fullterm findings are consonant with research like that of Hammond & Bee (1983), which shows that second grade cognition is predicted as well by 24m and 48m interaction data as by 48m developmental data (cognition, motor development and health). To resolve this issues, more research is needed, in the Mother-Infant Project and other research programs. For example, better prediction would undoubtedly be achieved in the MIP study if 24m, rather than 12m, measures of developmental outcome were included in the regressions. By age two, development has stabilized in both preterms and fullterms, and the PDI is particularly salient for preterms.

Impact of Differing Measures of Developmental Constructs, Considered Individually

The transactional model describes the developmental process as a complex network of influences, some direct, and some indirect. The "least squares" regression approach generating the above findings was quite conservative, pinpointing only the most robust effects with a limited number of variables. Much of the complex preterm developmental process was left unexplored. To further examine the network of influences, and complement the regression data, standardized, equalized correlation matrices were used to look at the impact of the developmental constructs, measured in multiple ways, upon child outcome. This procedure was highly exploratory. Multicollinearity was a problem, so several precautions were taken. At times, the effect of environmental status (ES) was partialled out, and the overall patterns of results were examined and interpreted carefully. Note that few standardized pairs of correlations were significant, even to the $p < .10$ level, mostly due to the very stringent sample size requirements for a Z test. Only a few of the findings are discussed here.

Impact of child characteristics, other than biological and health measures. Early temperament was generally more important to fullterm 48m outcome, though distractibility at 8m was crucial to later preterm "academic" achievement. This latter finding fits well with the limited capacity model of the preterm infant discussed earlier. Interestingly, child characteristics were more strongly associated with 48m academic outcome within the fullterm group. Yet for social outcome, there were more associations among the preterms. Certain results could be predicted from the developmental literature, and were true of both preterms and fullterms. For instance, nonminority and firstborn status were related positively to 48m academic outcome. In addition, negative child behavior in free play during the first year of life, as well as a disrupted environment (high WTCHANGE48), were related negatively to 48m social outcome. Note that lack of environmental stimulation in the home at 8m was predictive of 24m and 48m child outcome.

Impact of maternal attitudes. In both preterms and fullterms, maternal attitudes showed low to moderate, generally predictable associations with later maternal behavior. For example, in both groups satisfaction with social support was related to expressions of positive maternal affect in free play. These findings are consonant with the suggestions of Gamble, Belsky and McHale (1983), who suggest that support is linked to better parenting in a "cumulative effects" model.

Preterm/fullterm group differences in attitude/behavior relationships were complicated, but there were a few notable findings. First, among mothers of preterms, perceptions of the family were more strongly associated with maternal behavior only at 24m (Greenberg & Crnic, 1985), and not at 48m. This decreased effect may have been due to the use of a new measure of family attitudes, or perhaps to developmental change as the child and family grow away from the preterm birth. Note that the 48m family measure, FACES-II, showed that the preterm families did not see themselves as more cohesive than the fullterms. Second, those mothers giving "consistently poor" care appeared to create an environment in which the child experienced a lot of change, and had less positive attitudes toward their children and toward childrearing. In mothers of preterms giving consistently poor care, this took the form of less satisfaction with the child and less nurturant childrearing attitudes, and a clinical impression of hostility.

Overall, maternal attitudes were relatively less important to preterm than to fullterm outcome. Perhaps attitudes are linked to global environmental status, which was of more importance to the fullterms. However, for both groups, those attitudes directed toward the child (satisfaction with the parental role, satisfaction with the child, childrearing attitudes) were most salient. As in earlier MIP data, family perceptions were not related to 48m child outcome. The impact of maternal attitudes remains an interesting topic. Future work might consider in more detail the joint influence of maternal attitudes toward stress and support on maternal behavior and, indirectly, on child outcome. Measures of maternal attitudes might possibly identify those mothers likely to provide consistently poor caregiving, which clearly has detrimental effects on child outcome.

Impact of maternal behavior, considered individually and examined in three different ways. Maternal behavior data certainly support a transactional description of the developmental process as a complex network of influences. Assessed first by standardized, equalized correlation matrices (using interaction quality ratings), maternal behavior was most relevant to the verbal skills of both preterm and fullterm children. However, the mothers' actions appeared far more important to the academic behavior of fullterms. Perhaps fullterm children are more able to show individual variation in academics due to environmental influences. The academic performance of preterms, in contrast, may not be as affected by the environment, given their biologically-based information-processing problems and paradoxical response patterns. Maternal behavior influenced different dimensions in preterms and fullterms. Notably, maternal behavior was quite important to the premature child's view of his/her own social acceptance, but not to the fullterm child's view. It is odd that no self-righting interaction effect emerged in this outcome area.

When global ES was partialled out, the "proximal" relationship of mother behavior to fullterm verbal outcome was reduced to below the preterm level, and the connection with fullterm social outcome was altered and diminished. The preterm pattern was different. When covarying ES, the association between maternal behavior and preterm social outcome usually did not decrease, and the behavior-outcome association was actually slightly enhanced in the verbal "academic" domain. For fullterms, perhaps, maternal behavior becomes a more important self-righting influence as the global environment becomes more optimal. For preterms, on the other hand, maternal behavior may act as a self-righting mechanism, within the childrens' biological limitations, no matter what the social class. Maternal caregiving may be acting as a buffer for preterms in a more deprived environment, as maternal actions may be relatively less effective among preterms of higher social status, yet relatively more important in the lower social strata.

The potential self-righting action of maternal behavior was explored in more depth, by looking next at the differential association of preterm and fullterm outcome with a dynamic measure: consistency of caregiving. In contrast to previous findings (Beckwith, 1983a), this measure did not actually give much more information, failing to confirm a tenet of the transactional approach suggesting that dynamic measures should reveal effects more clearly than do static measures.

In both groups, mothers with consistently unresponsive, negative caregiving had children with poorer social skill. Interestingly, this included children receiving poorer ratings of temperament. There are several interpretations for this finding. Children with poorer temperament may be harder to parent, and/or consistently poor caregiving may induce less optimal temperament. Alternatively, consistently poor caregivers may simply perceive their children as temperamentally difficult. Note that there were somewhat more consistently poor caregivers than expected in both preterm and fullterm groups.

When ES was covaried, the relationships between consistency of caregiving and social skill remained unchanged for the preterm children. For the fullterms, however, taking out the effect of ES removed the association between consistency of caregiving and parental ratings of self control (PCONTROL) and behavior problems (PBEHWELL). Consistency of caregiving during the first year was less salient to preterm outcome than was indicated by the static measures. (Note that during the first year, preterm children were relatively less stable in behavior and developmental status.) Consistency of caregiving from age one to four to both preterms and fullterms.

Finally, the self-righting action of maternal behavior was looked at from the perspective of an explicitly dyadic measure of mother-child interaction: the attachment classification. The quality of attachment was not different between preterms and fullterms, nor were there many group differences in its predictive power. Attachment security was apparently too robust to be affected by preterm birth. Thus, it was not useful as a measure for discerning preterm/fullterm group differences in transactions between mothers and children, though very useful as a general predictor of child social outcome.

The influence of maternal behavior upon preterm child outcome bears further investigation. Caregiving may have a differentiated effect upon outcome. Maternal care may also have both unique and stable aspects which may differ between preterms and fullterms (Cohen & Beckwith, 1979). Implicitly dyadic variables, such as "difficultness," or "goodness-of-fit" between parent and child, may be what is important (Belsky, 1984). A "topographical" model of caregiving, proposed by Roberts (1983) and generating new hypotheses (such as a threshold effect for maternal warmth), may shed new light on this topic. Perhaps it is also time to go beyond a discussion of mother-child interaction, and discuss the impact of the entire family system upon the development of the preterm child (Furstenberg, 1985).

Comments on Child Social Behavior

Child social behavior was the focus of the fourth year phase of the Mother-Infant Project. Besides giving information about preterm social outcome, there were three reasons for this emphasis. First, a thorough description of the structure of preschool social behavior was provided. Second was a test of the hypothesis that early data on the child and his/her environment could predict childhood social outcome, using prematurity as a natural experiment. Third, an evaluation of the usefulness of the "Waiting Task" as a tool for assessing child social behavior from an attachment theoretical perspective.

Note that Table 9 gives definitions of the 48m social behavior factors, and might be useful to consult when reading this section.

The Structure of Child Social Behavior

Factor analytic findings delineated the structure of the four-year-old's social behavior as multidimensional, yet also forming a single construct. The overall factor structure of child social behavior was consonant with study hypotheses. Revealed in the output of the strictly empirical principal components analysis (PCA), four of the five factors were confirmed by the output of a more conservative factor analysis (FA) technique.

As expected, parent, observer and child measures clustered in quite independent factors, supporting the concept of "perspective" as meaningful in defining child social behavior. In general, over the total sample, correlations between measures from different viewpoints were in the low moderate range. This confirmed the data of other authors showing only low moderate congruence between ratings from different perspectives (Achenbach & Edelbrock, 1981; Greenspan, 1980), and argued against an interpretation of these findings as due only to method variance. Across perspectives, the highest correlation (r = .31**) was found between the parental rating of child self-control (PCONTROL), and the observer rating (OCONTROL), designed as a limited assessment of child behavior in a self-control situation. Yet the association of the child's viewpoint (KDACCEPT) with that of the most similar parental factor (PSOCSKILL) was fairly low ($\underline{r}$ = .22*). This relatively low agreement between parent and child perspectives might be due to the fact that the child scores were generated by preschoolers with limited test-taking understanding and skill, and only a beginning awareness of themselves or others (Harter & Pike, 1984).

As expected, only the parental viewpoint was differentiated, with three factors emerging. Note first that the presence of PSOCSKILL and PBEHWELL confirmed the use of competency versus problem approaches to the measurement of social behavior. Second, the "process" versus "product" measurement distinctions were confirmed, with PBEHWELL as the "product" factor. PSOCSKILL and PCONTROL illustrated Block and Block's (1979) division between the "process" dimensions of ego resiliency and ego control. PSOCSKILL, a conglomerate of positive social skills marked by the ego resilience measure, seemed to be the predominant, stable "process" dimension. Note that the theoretical "process" distinction diverged from the factor analytic "product" distinction traditionally used in behavioral assessment of children (e.g. internalizing/externalizing/social competence). The ego resiliency variable correlated highly with all three product-oriented scales, while the ego control variable was significantly associated with only the externalizing scale.

Differentiating child social behavior into areas of competency, such as peer sociability or frustration tolerance, did not appear to be a fruitful measurement strategy at this age. The individual competency-based HRI scales were strongly intercorrelated, basically fell into the same factor (PSOCSKILL) and, in general, showed similar associations to other aspects of social behavior. The single CBCL Social Competence scale more efficiently defined competent preschool social behavior (although this scale may also measure other constructs, as indicated by its relatively low communality with PSOCSKILL in the FA extraction procedure).

Temperament has been portrayed as a biologically-based, separable component of social behavior (Greenspan, 1980; Thomas & Chess, 1977). This notion was supported, in the preschool age group, by the patterns of association of the 48m temperament subscales. The five subscales did not correlate highly with other measures of social behavior, nor were there strong intercorrelations between these temperament subscales.

There was evidence to support the validity of the five social behavior factors, as well as the ALLSC measure. (Validity of the OCONTROL factor is thoroughly discussed in the "Waiting Task" section.) Factors from the parental and child perspectives predicted the childrens' concurrent "academic" outcome: those rated as having better social behavior were moderately more likely to score highly in receptive language, verbal and nonverbal cognition, as well as visuomotor skill. These findings illustrate the close link between cognitive and affective development.

Future research on the structure of child social behavior should be intriguing. The role of method variance, versus meaningful rater "perspectives" could be explored. An evaluation of how different perspectives predict to later outcome would be interesting, as would a study of developmental changes in the relationship between viewpoints as the child grew older (especially in adolesence). It would also be useful to evaluate the usefulness of temperament as an approach to defining social behavior at other developmental levels (Lee & Bates, 1985).

Prediction of Childhood Social Outcome

Though developmental theory suggests substantial continuity in social development, the prediction of childhood social behavior has proven difficult (Lewis et al., 1984). In general, research taking an "attachment" theoretical approach has most often been successful in prediction (Arend, Gove & Sroufe, 1979, Erickson, Sroufe & Egeland, 1985), though not always (Bates, Maslin & Frankel, 1985). In the present study, neither temperament ratings nor microanalytic, observational measures of early child behavior predicted later child social outcome. This was true even though 48m child social behavior was measured, in part, during a mother-child interaction situation and through parental reports of temperament. In contrast, an early measure of security of attachment did predict later social outcome, primarily in one theoretically consistent situation. In addition, other early data significantly predicted social outcome in four-year-old preterms and fullterms.

In this data set, 12m security of attachment significantly predicted more optimal social behavior at 48m, from two perspectives: the child's view of his/her own social acceptance (KDACCEPT); and the observer perspective on child social behavior, derived from the "Waiting Task" (OCONTROL). Factors reflecting the parental view of child social behavior were not significantly related to earlier security of attachment. Quite surprisingly, neither were 48m Q-Sort measures of ego resiliency and ego control. This stands in direct contrast to the earlier findings of Matas et al. (1979). (There was also a relationship between security of attachment and longer 48m attention span. Note that the social outcome mean scores of the secure group were consistently higher than those of the insecure children. Interestingly, the secure group's mean academic scores were nearly always lower than were those of the insecure group.)

In the present study, then, security of attachment significantly predicted two views of 48m social skill, and produced a consistent pattern of higher social outcome mean scores among the secure children. Such consistent results, over the span of four years, were unlikely to results only from method variance, or by chance variation. In fact, there were three possible reasons that stronger relationships between security of attachment and 48m social (and perhaps academic) outcome were not obtained. First, recent findings suggest that attachment security may predict outome, over the long run, only in males (Lewis et al., 1984). Yet the present data were not analyzed separately by sex due to small sample size. Second, previous work showing the predictive value of the attachment measure has generally used children with stable attachments from age 12 to 18m. In this study, security of attachment was measured only once, and attachment stability could not be assessed, so all subjects were studied. Third, factors mediating relationships between attachment and later behavior, such as stress, were not considered in these analyses. Future work may resolve these issues.

Early data on the child's behavior, whether derived from ratings of temperament or observed in mother-infant interaction, was not consistent with 48m social behavior. Given these microanalytic data, then, child social development appeared discontinuous, in contrast to the continuity apparent from an attachment perspective.

Using multiple regression procedures, combinations of biological and environmental data could be used to significantly predict the five social behavior factors, and their overall sum (ALLSC). Equalized correlational data detailed, one-by-one, early variables explaining later social behavior. Data on early child social behavior played a predictive role, but in a complex fashion. In the regressions, for both preterms and fullterms, a combination of early information on mother age and biological status, as well as on the global and "proximal" environment, predicted later outcome. Significant $R2$'s ranging from .29 to .61 emerged from these regressions. For fullterms only, $R2$'s of .21 to .43 were generated by a different combination of early data (maternal age, biological status, and earlier child developmental outcome). Fullterm social outcome was more often predicted than that of the preterms. Note that in direct contrast to the attachment findings, parental views were more often predicted by these regressions than were the observer or child views of social skill (OCONTROL and KDACCEPT).

The complexities of prediction varied between preterms and fullterms, and between the different social outcome factors. Two examples will be given. First, since the prediction of behavior problems has been a focus of recent literature (Lewis et al., 1984; Erickson et al., 1985; Bates et al., 1985), the PBEHWELL factor will serve as an example. (PBEHWELL is defined as lack of child behavior problems.) Equalized correlational data revealed that lower stress (maternal and child), a better early home environment, more positive early child and maternal behavior, and better early developmental status were important (to at least a low moderate degree) to better PBEHWELL scores in both groups. However, child demographics (such as nonminority status, female sex and early health) were important only to better preterm BEHWELL scores. Important only to higher PBEHWELL ratings in fullterms were a better global environmental status, and a cluster of positive maternal attitudes. Note that the regression data highlighted the predictive power of earlier or concurrent global environmental status among the fullterms only.

Second, the child's view of his/her own acceptance (KDACCEPT) will serve as another example, as it is an aspect of social behavior not often studied. Equalized correlational data revealed rather different patterns of predictors in the preterm and fullterm groups. For fullterms, birth order, better early temperament and developmental status, childhood health, maternal age, and a few selected positive maternal attitudes and behavior were important to 48m KDACCEPT. There was an altogether different pattern for preterms. The following variables were important: early health and female gender; better early temperament and behavior (especially in the 12m picture book task); a wide variety of positive maternal attitudes, especially concurrent ones; and, most importantly, consistently good caregiving from 4m to concurrently. Note that regression data highlighted the importance of biological status and early maternal attitudes among the preterms. Among the fullterms, the role of childhood health was emphasized.

The "Waiting Task"

Developed for the present study from the perspective of attachment theory, the waiting task was designed to analyze the planning and coordination of joint activity between mother and child during early childhood. The waiting task centered around issues important to the mother-child relationship during the preschool period: for the child, the developmental issue was impulse control; for the mother, the flexible encouragement of child self-control. The degree to which the mother and child succeeded at these tasks was defined as "facilitation" of the waiting period. Maternal and child behavior during the waiting situation was characterized by the affect, the respective styles of "facilitation," as well as the degree of satisfaction and "facilitation" shown by the dyad as a whole.

The waiting task proved a valuable aid in the evaluation of 48m child social behavior. Coded live, in the home setting, interobserver reliability was excellent. There was considerable evidence of the task's validity. Observation of a preschool child, during the single context of a brief structured interaction, enabled an observer unfamiliar with the child to generate behavior ratings similar to those of the parent focusing on the child's self-control.

48m maternal and child behavior, as well as dyadic behavior and satisfaction, were consistent with a 12m rating of security of attachment, a striking finding. In addition, mothers with a positive approach to playing and reading with their children at 12m, both important early learning situations, were usually more positive in the 48m waiting task.

There were no preterm/fullterm differences in 48m waiting task behavior. Security of attachment predicted the waiting task actions (OCONTROL) of both groups. However, the transactions leading to child behavior during the waiting task did differ somewhat between groups. Important to 48m fullterm OCONTROL was 24m developmental status, as well as child and (especially) maternal behavior. Important to 48m preterm OCONTROL was child behavior, as well as a variety of maternal attitudes. For the premature children, OCONTROL relationships with earlier maternal behavior were very unclear. For example, contrary to expectations, less optimal 24m (lever task) actions were associated with better child (and maternal) performance during the 48m waiting task.

Behavior during the waiting task did differ between dyads of different social status: dyads from the lower social strata demonstrated less optimal affect and dyadic facilitation. Different social class subgroups varied in maternal facilitation style, consistent with the expectations of the literature on social class. Mothers with less education more often appeared authoritarian, encouraging dependence in their children by telling them what to do. Mothers with a middle level of education more frequently were "oversupportive," encouraging dependent child behavior by helping their children too much. Mothers with a higher educational level were more often rated as "facilitating," promoting their childrens' initiative and independent self-control.

The waiting task should be helpful in future research as a measure of the mother-child "partnership" during the preschool period, within the perspective of attachment theory. Perhaps the present "in vivo" coding system could be expanded, with a careful look at joint planning, if the situation is videotaped. But with the existing coding system, the waiting task may now be of utility as a brief, easily scored clinical tool focusing on an important developmental issue in the relationship of the parent and the preschool child.

Conclusions

The Mother-Infant Project (MIP) has examined and refined the general model of the preterm developmental process, presented earlier in this paper. From birth to age four, compared to their fullterm peers, the MIP preterms did indeed attain different developmental goals. Their developmental course differed from the fullterm norm, fulfilling some, though not all, of the predictions arising from a transactional developmental framework. The transactional approach proved to be quite valuable in building an understanding of preterm developmental process and outcome.

Developmental Outcome

Early on, this group of VLBW (and smaller LBW), relatively healthy preterms showed mental and motor difficulties, and the motor problems persisted through age two. However, their developmental status appeared only slightly less stable than that normally seen in early life. At age four, the focus of the present study, the preterm children were generally within normal limits, academically and socially, having "caught-up" in many areas. They were even as healthy during childhood as their fullterm peers. But the preterm group did not blend completely into the fullterm population, and the individual preterm child was still two to three times as likely to show specific or general developmental delay. As a whole, the premature children continued to show "academic" difficulties in nonverbal cognition and visuomotor skill. In the visuomotor area, at least, this appeared to be a delay, not a deficit, with performance below the normal range. Socially, at age four, the preterm group exhibited temperamental problems, fitting the definition of a rather mild attention deficit disorder. They also received less optimal parental ratings of social skill and, primarily among the male preterms, endorsed lower ratings of peer acceptance.

Biological Predictors

Male gender and smallness for gestational age were biological predictors of particular importance to these relatively healthy preterms, as they have been to sicker babies. Continuing illness, however, did not seem to be a problem for the preterm group as a whole, though a subgroup of children with serious physiological sequelae did show general academic and/or social delay.

These biological factors point to a possible neurological substrate underlying the academic and temperamental problems (perhaps more often in males and/or severely ill preterms). Arising either from preterm birth and/or the early hospital experience, this enduring neurological problem may prevent these children from responding adaptively to other developmental influences. Indeed, four years after preterm birth, these children may may indeed have difficulties processing information and responding normally. Given the portent of future school problems this portends, indepth neuropsychological testing and educational planning is called for, recognizing prematurity, and the other biological factors mentioned above, as potential risk factors.

Environmental Differences

The MIP preterms' early environment was clearly different, and apparently less optimal, than that of the fullterms. However, this situation changed after the first year of life. At age two (though perhaps not fully assessed) and again at four, careful global and "proximal" environmental measurement did not uncover many preterm/fullterm group differences. Certain attitudes and behaviors were more closely tied within the preterm group, but apparently only around age two. Indeed, the environmental context of the preterms was about as stable as that of the fullterms, except for differences in certain maternal attitudes.

Biology X Environment Transactions

Overall, then, the preterm children, after the first year, moved in environments fairly similar to those of their fullterm peers. However, the preterms carried with them possible neurological problems and, importantly, a different interactional history. A word about prediction versus explanation is in order here. Only intervention studies can definitely establish causal factors. But prematurity is a natural experiment in biological and environmental change away from the norm. Thus, studies of prematurity can provide some explanation of causality, even though only correlational data are generated. The problem is to separate the various causal factors from among all those associated with preterm birth. The following discussion attempts an explanation of preterm outcome using correlational data, taking the transactional framework as a theoretical base, and fitting data from the present study into the overall data base on prematurity.

It appears that the child-environment transaction is not the same in families with preterm and fullterm children. Combinations of data, over time, as well as analysis of variance interaction effects, sketched the developmental process as an evolving network of developmental influences in the course of development leading to 48m preterm outcome. Traditional measures of biological and global environmental status, though important to preterm outcome earlier in life, were not really salient to outcome at age four. Measures of earlier developmental status did not add explanatory power, even given earlier outcome differences between preterms and fullterms. Only combining measures of biological status with measures of the "proximal" and global environment could explain selected aspects of preterm social outcome.

The preterm group did not experience a "double whammy," with the most severe problems appearing in children experiencing both lower social status and prematurity. Instead, there was evidence of a self-righting process within the preterm sample, in certain outcome areas strongly affected by the environment during normal development. Maternal behavior appeared to act as the self-righting mechanism in those areas, becoming a particularly important developmental influence for preterms. Apparently unaffected by persistent illness in the child, maternal behavior was nonetheless impacted by early biological status, probably immediate postnatal health. Caregiving behavior, especially when consistently poor, had a more powerful effect after age one, and had more of an impact on social than on academic outcome.

Positive maternal behavior seemed to act as a self-righting influence independent of socioeconomic status, at least for some areas of social outcome. (However, note that a greater number of consistently poor caregivers were of lower socioeconomic status.) The wider environmental context may affect preterms only indirectly, though age four, via the action of "proximal" environmental influences. In contrast, the fullterm child may respond directly to socioeconomic influences.

Given that caregiving is an important developmental influence in preterms, then early interactional difficulties between mothers and their children may well cause later problems. The role of early interactional problems, however, may not be straightforward, as expected within a transactional framework. The preterm's biological difficulties may indeed elicit a different caregiving reponse, though not necessarily more when they have persistent biological problems. The preterms' different interactional pattern may start as an appropriate adaptation, and may well be effective, given the lack of attachment differences between preterms and fullterms. But if this adaptation continues past the first year, it may appear inappropriate in sensitivity, lower in dyadic satisfaction and more negative in affect. Thus, it may make caregiving much less effective as a self-righting mechanism.

Clearly, numerous findings about the developmental course of preterm children fit a transactional framework. Enduring influences were more powerful. The child and the environment exerted a mutual influence, and self-righting seemed to be occurring. Developmental factors different from the fullterm norm emerged as important over time, and influences were not always direct. From one measurement framework, that of attachment theory, development appeared at least somewhat continuous, while from another perspective discontinuity was revealed.

Limitations and Directions for Future Research

But the developmental picture is even more complex than this.

Parenting is multiply determined (Belsky, 1984), and attitude-behavior relationships need further consideration. Future transational research may build upon the Mother-Infant Project, testing smaller, more specific models of the preterm developmental process. With a larger sample size, and programmatic research, these models could be carefully specified and studied with techniques such as path analysis. Information emerging from such work could be used to create, and cross validate, a set of predictive risk indices. Alternatively, very small groups of preterms could be studied intensively, carefully tracing their developmental history, and noting individual transactions and critical developmental events.

The data reported here have several limitations, which suggest future methodological considerations and research issues. Future work should consider the impact of the child's sex on the developmental process. A number of studies report sex differences in the course of development (Maccoby et al., 1984; Martin, 1981; Sigman & Parmalee, 1979). Indeed, male gender was found in this study to be of importance in predicting later outcome problems in preterms, though not as much in fullterms. In contrast, Cohen and Beckwith (1979) speculate that the risk status of preterms may actually attenuate sex differences, by eliciting less differentation in care. This controversy could not be addressed in the present study, as sample size prevented conducting preterm/fullterm transactional analyses separately by sex.

A careful examination of the MIP data on mother-child interaction suggested that preterm/fullterm group differences may not completely fade after the child's first year. The differences may emerge in the area of control, an issue important to development during the transition period. Unfortunately, control was not thoroughly assessed in the Mother-Infant Project. But there is scattered evidence showing very different patterns between preterms and fullterms surrounding this developmental issue.

First, for preterms only, noncompliance at age one (not two) predicted better nonverbal cognition and visuomotor skills at 48m (their "academic" areas of difficulty). In contrast, noncompliance predicted poorer academic outcome in fullterms. This suggests heterotypic continuity, in which specific behaviors may have a different meaning in two different populations. Second, knowing how the child behaved in the 12m picture-book task, a control situation, gave more information about 48m social behavior for the premature than for the fullterm group. Third, there were significantly more positive behavioral interactions between 24m-old preterms and mothers who perceived their families to have cohesive and expressive relationships without conflict, an emphasis on autonomy and, in particular, organization without undue control. This was not true of the fullterms. Fourth, only the mothers of preterms showed inconsistent control-related childrearing attitudes during the preschool years, yet these were highly associated with their child's 48m social outcome, even independent of social class.

The results of the present study suggest some considerations for intervention. Parents of preterms may benefit from a clear understanding of their child's potential for later developmental problems, data provided in this study. It may be wise to draw their attention to the need to analyze how their child best learns and processes information, especially at the time when the preterm enters a preschool environment. In fact, continuous developmental screening may be an excellent idea (Bennett, 1984). The families participating in the MIP study found the periodic testing informative and reassuring.

Those working with the families of preterms may benefit from an awareness of the particular importance of caregiving to the child's eventual outcome. They should be aware that: (1) caregiving must be provided within an optimal range of receptivity; (2) an appropriate caregiver adaptation to a preterm infant must be modified as the child grows and develops; and (3) in a deprived socioeconomic environment, positive maternal behavior may actually buffer some aspects of a child's 48m social outcome. This information could prove important to those counseling families responding to the stress of a premature birth. Future research should provide even more information for intervention with the growing number of surviving preterm children and their families.

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Appendix A - Table 1

Abbreviations, Definitions and Descriptive Biological and Environmental Variables

Variable	Definition	Descriptive Statistics			
Biological Status:					
GROUP	1=Preterms according to study definition 2=Fullterm controls	---			
BIOSUM1	1m biological status summary score: sum of z-scores of gestational age, birthweight, post-natal health score, and reversed number of days in hospital.		M	SD	low - high
		Preterm	-1.27	2.34	-6.73-3.28
		Fullterm	6.66	.795	4.64-8.01
		Internal consistency: standardized α = .953 (N=103)			
BIOSUM48	48m biological status summary score: sum of z-scores of gestational age, birthweight, reversed number of days in hospital and reversed severity rating of childhood health problems	Preterm	-1.43	2.32	-7.74-2.09
		Fullterm	5.17	.791	3.02-6.62
		Internal consistency: standardized α = .835 (N=83)			
PNHEALTH	Postnatal health score: a weighted combination of the absence of possible postnatal health problems.	Preterm	72.63	18.78	50-160
		Fullterm	150.91	21.55	87-160
		Internal consistency: standardized α = .835 (N=83)			

Appendix A - Table 1 (continued)

Variable	Definition		Descriptive Statistics		
			M	SD	low - high
KIDHEALTH	Childhood health score from 1-1/2 4 years: 1=severe problems 2=moderate problems 3=mild problems	Preterm Fullterm	2.29 2.67	.84 .64	1-3 1-3
			Internal consistency: standardized α = .835 (N=83)		
Environmental Status:					
MOMED1	Mother's years of education at 1m visit	Preterm Fullterm	12.50 12.57	1.72 2.00	9-17 9-18
MOMED48	Mother's years of education at 48m visit	Preterm Fullterm	13.00 13.24	1.94 2.21	10-18 9-19
FHHEAD48	48m Four-Factor Family Hollingshead Score: a weighted combination of maternal and paternal education and occupation	Preterm Fullterm	38.32 32.22	12.55 13.40	14-66 12-66
			(both group means were in Class III)		
WTCHANGE48[a]	Weighted total of household change (loss and entrance events) occurring during the four years of the child's life	Preterm Fullterm	2.87 3.71	2.78 2.81	0-10 0-12

Note. This information comes from a "frequencies" printout.

[a]A higher score on this variable is less optimal.

Appendix A - Table 2

Abbreviations, Definitions and Descriptive Statistics for 48-Month Child Outcome Variables[a]

Variable	Definition		Descriptive Statistics Using MOMED48	Descriptive Statistics Using FHHEAD48
Academic Outcome:				
PPVT	Receptive Language (PPVT IQ score)	Preterm	102.47	100.64
		Fullterm	105.06	106.56
INFO	Verbal cognition (WPPSI Information subtest score)	Preterm	11.37	11.11
		Fullterm	11.71	11.96
BD	Nonverbal cognition (WPPSI Block Design subtest score)	Preterm	10.70	10.55
		Fullterm	12.41	12.57
VMIAQ	Visuomotor actual age quotient (Beery VMI score calculated according to actual age)	Preterm	90.23	88.54
		Fullterm	97.43	99.08
VMICQ	Visuomotor corrected age quotient (Beery VMI score calculated according to corrected age)	Preterm	94.14	92.25
		Fullterm	97.26	99.04
Summary Social Outcome:				
ALLSC	Summary Social Outcome Scores (See Table 9.)	Preterm	-1.84	-3.35
		Fullterm	1.79	2.90
PSOCSKILL		Preterm	-1.09	-1.60
		Fullterm	.85	1.30
PCONTROL		Preterm	-.72	-.81
		Fullterm	.52	.66

Appendix A - Table 2

Abbreviations, Definitions and Descriptive Statistics for 48-Month Child Outcome Variables[a]

Variable	Definition	Descriptive Statistics		
			MOMED48	FHHEAD48
PBEHWELL		Preterm	-.43	-.80
		Fullterm	.33	.64
OCONTROL		Preterm	-.11	-.27
		Fullterm	.08	.19
KDACCEPT		Preterm	6.00	5.98
		Fullterm	6.32	6.37
Component Social Outcome:				
ACTIVITY[b]	Selected component social outcome scores - see Table 6.	Preterm	1.26	1.37
		Fullterm	.80	.73
ADAPTABILITY		Preterm	3.83	3.90
		Fullterm	4.11	4.02
ATTENTION		Preterm	4.67	4.21
		Fullterm	6.24	6.58
RHYTHMICITY		Preterm	6.11	5.92
		Fullterm	5.58	5.71
REACTIVITY[b]		Preterm	3.25	3.33
		Fullterm	2.54	4.43
MOMACCEPT		Preterm	3.10	3.13
		Fullterm	3.22	3.20
PEERACCEPT		Preterm	2.83	2.85
		Fullterm	3.16	3.17
EGORESILIENCE		Preterm	.45	.43
		Fullterm	.52	.54
EGOCONTROL		Preterm	7.06	6.95
		Fullterm	7.06	7.20

Appendix A - Table 2 (continued)

Abbreviations, Definitions and Descriptive Statistics for 48-Month Child Outcome Variables[a]

Variable	Definition	Descriptive Statistics		
			MOMED48	FHHEAD48
EXTERNAL[b]		Preterm	54.72	55.95
		Fullterm	53.42	52.16
INTERNAL[b]		Preterm	54.87	56.50
		Fullterm	52.53	51.01
Other Outcome:				
PHYSICALCOMP	child's view of his/her own physical competence	Preterm	2.99	3.02
		Fullterm	3.13	3.12
COGCOMP	child's view of his/her own cognitive competence	Preterm	3.14	3.11
		Fullterm	3.19	3.21

[a]The mean scores were taken from ANCOVA analyses using both MOMED48 and FHHEAD48 as indicators of environmental status. The ranges were taken from a "frequencies" printout.

[b]For these outcome variables, a higher score is less optimal.

Appendix A - Table 3

Abbreviations, Definitions and Descriptive Statistics for 48-Month Maternal Attitude Variables

Variable	Definition	Descriptive Statistics	MOMED48	FHHEAD48
SATISPARENT (transformed)	Satisfaction with the parental role	Preterm	2.57	2.49
		Fullterm	2.57	2.63
SATISKID	Satisfaction with the child	Preterm	6.73	6.67
		Fullterm	6.86	6.92
ATTSAT (transformed)	Perceived intimate social support	Preterm	1.45	1.39
		Fullterm	1.45	1.50
COMSAT (transformed)	Perceived community social support	Preterm	1.96	1.59
		Fullterm	1.91	1.61
FRDSAT (transformed)	Perceived friendship support	Preterm	1.68	1.64
		Fullterm	1.74	1.74
FAMSAT	Perceived family social support	Preterm	3.14	3.10
		Fullterm	3.28	3.28
TOTSAT (transformed)	Perceived total social support	Preterm	2.15	2.11
		Fullterm	2.24	2.26
STRESS[b]	Perceived amount of negative life stress	Preterm	2.19	2.13
		Fullterm	2.90	2.92
LIFESAT	General life satisfaction	Preterm	1.65	1.63
		Fullterm	1.66	1.66
FAMCOHESION	Perceived family cohesion	Preterm	8.83	8.78
		Fullterm	9.28	9.29
FAMADAPTABILITY	Perceived family adaptability	Preterm	10.85	10.80
		Fullterm	10.60	10.63
RESTRICT[b]	Childrearing attitudes: restrictiveness	Preterm	62.20	63.54
		Fullterm	62.67	61.15

Appendix A - Table 3 (continued)

Abbreviations, Definitions and Descriptive Statistics for 48-Month Maternal Attitude Variables

Variable	Definition	Descriptive Statistics		
			MOMED48	FHHEAD48
NURTURE	Childrearing attitudes: nurturance	Preterm	94.28	93.45
		Fullterm	93.80	94.37

[a]The mean scores were taken from ANCOVA analyses using both MOMED48 and FHHEAD48 as indicators of environmental status. The ranges were taken from a "frequencies" printout.

[b]For these outcome variables, a higher score is less optimal.

Appendix A - Table 4

Abbreviations, Definitions and Descriptive Statistics for 48-Month Mother-Child Interaction Variables[a]

Variable	Definition	Descriptive Statistics		
			MOMED48	FHHEAD48
WTKIDAFFECT[b]		Preterm	3.60	3.53
		Fullterm	3.58	3.62
WTMOMAFFECT[c]	Maternal and child behavior ratings during the "waiting task" (see Table 6 for definitions)	Preterm	3.89	3.79
		Fullterm	3.84	3.90
WTDYADSTYLE		Preterm	3.66	3.56
		Fullterm	3.81	3.86
WTDYADSATIS		Preterm	3.74	3.60
		Fullterm	3.58	3.67
WTKIDSTYLE[b]			(See Table 6 for relevant descriptive statistics.)	
WTMOMSTYLE				
WTAUTHOR	Authoritarian style			
WTOVERSP	Oversupportive style			
WTIGNORE	Ignoring style			
WTUNPRED	Unpredictable style			
WTFACIL	Facilitating style			
CARE1F	Consistency of caregiving in free play during the child's first year		(See Table 37 for relevant descriptive statistics.)	

Appendix A - Table 4 (continued)

Abbreviations, Definitions and Descriptive Statistics for 48-Month Mother-Child Interaction Variables[a]

Variable	Definition	Descriptive Statistics
CARE14S	Consistency of caregiving in structured play from ages 1 to 4	(See Table 37 for relevant descriptive statistics.)

[a]The mean scores were taken from ANCOVA analyses using both MOMED48 AND FHHEAD48 as indicators of environmental status. They differ slightly from the values listed in Table 6, which were taken from the "frequencies" printout, since they have maternal age covaried. The ranges were taken from a "frequencies" printout.

[b]WTKIDAFFECT and WTKIDSTYLE are the component variables of OCONTROL (which is listed in Appendix A - Table 2.)

[c]WTMOMAFFECT and MOMBEH48-S are the same variable: maternal affect during the 48m structured play segment (the "Waiting Task").

Appendix A - Table 5

Abbreviations and Definitions for Other Variables Analyzed in the 48-Month Follow-up Study

Variable	Definition
Demographics/Home Environment:	
KIDAGE48	Child age at 48m data collection
ETHNICITY	Race (white versus nonwhite)
BIRTHORDER	Birth order (firstborn versus laterborn
SEX	Male versus female
ENVORGANIZ8	Environmental organization in the home at 8m
PLAYMATERIAL8	Play materials available in the home at 8m
STIMVARIETY8	Variety of stimulation in the home at 8m
Earlier Child Outcome:	
MDI12	12m mental development (Bayley MDI Score)
PDI12	12m physical development (Bayley PDI score)
MDI24	24m mental development (Bayley MDI Score)
PDI24	24m physical development (Bayley PDI score)
PPVT24	24m receptive language (PPVT raw score)

Appendix A - Table 5 (continued)

Variable	Definition
Earlier Child Behavior:	
INTENSITY1	1m temperament: intensity
MOOD1 MOOD8	Either 1 or 8m temperament: mood
DISTRACTIBILITY1 DISTRACTIBILITY8	Either 1 or 8m temperament: distractibility
KIDBEH4	4m child interaction quality rating (combined free and structured play)
KIDBEH8	8m child interaction quality rating (combined free and structured play)
KIDBEH12-F	12m child interaction quality in free play
KIDBEH12-S	12m child interaction quality in structured play
NONCOMPLIANCE12	12m child percent of noncompliance
DISTRESS12	12m child distress during separation
KIDBEH24-S	24m child interaction quality in structured play
Earlier Maternal Attitudes:	
SATISKID1 SATISKID8 SATISKID18	Either 1, 8 or 18m satisfaction with the child
SATISPARENT1 SATISPARENT8 SATISPARENT18	Either 1, 8 or 18m satisfaction with the parental role
MOMFEEL1	1m maternal feelings about the child

Appendix A - Table 5 (continued)

Variable	Definition
COMSAT1 MCOMSAT8 COMSAT18	Either 1, 8 (modified) or 18m satisfaction with community support
FRDSAT1 FRDSAT18	Either 1 or 18m satisfaction with friendship support
ATTSAT1 ATTSAT8 ATTSAT18	Either 1, 8 or 18m satisfaction with intimate support
AGGCONTROL18	18m childrearing opinions about appropriate control of aggression
RECIPROCITY18	18m childrearing opinions about encouragement of reciprocity
EMOTACCEPT18	18m childrearing opinions about acceptance of emotional complexity
RELATIONSHIPS24	24m perception of family relationships
GROWTHORIEN24	24m perception of family growth orientation
SYSTEMMAIN24	24m perception of family system maintenance (organization and control)
STRESS8 STRESS18	Either 1 or 18m perceived negative life stress

Earlier and Concurrent Mother-Child Interaction:

COGFOSTER4	Cognitive fostering by the mother at 4m
EMOTFOSTER4	Emotional fostering by the mother at 4m
EMOTRESP8	Emotional responsivity of the mother at 8m

Appendix A - Table 5 (continued)

Variable	Definition
ATTACH12	12m attachment classification
MOMBEH4	4m maternal interaction quality rating (combined free and structured play)
MOMBEH8	8m maternal interaction quality rating (combined free and structured play)
MOMBEH12-F	12m maternal interaction quality rating in free play
MOMBEH12-S	12m maternal interaction quality rating in structured play
MOMBEH24-F	24m maternal interaction quality rating in free play
MOMBEH24-S	24m maternal interaction quality rating in structured play
MOMBEH48-S[a]	48m maternal affect in structured play

[a]WTMOMAFFECT and MOMBEH48-S are the same variable: maternal affect during the 48m structured play segment ("the Waiting Task").

Appendix B: Factor Analytic (FA) Extraction Used to Examine the Structure of Child Social Behavior

The factor structure emerging from the principal components analysis (PCA) was compared to a factor analytic solution (FA). FA techniques eliminate error and unique variance and examine only the variance common to the component variables. Table B-1 contains results of these analyses, and can be compared to the PCA findings shown in Table 8.

With two exceptions, a loading of .40 was used as the cutoff point for inclusion of variables in factor interpretation, as in the PCA procedure. The FA solution was confined to six factors, a priori. In general, the FA findings confirmed the results of the PCA. Four of the FA factors were interpretable (accounting for 88% of the shared variance), and were similar to four of the PCA factors. The first factor (PSOCSKILL) accounted for 54% of the explained variance in the FA solution, and constituted the strongest factor in both the PCA and FA. The PCA factor labelled PCONTROL (the parent's view of the child's self control) did not completely emerge from the FA procedure, demonstrating its instability.

Communalities from the FA extraction were generally high, indicating that the variables were fairly well-defined by this factor solution. However, relatively low communality values, and thus higher unique variance, were seen for the CBCL Social Competence Scale, and for three of the DOTS scales. The DOTS Rhythmicity scale measured such a unique aspect of social behavior that it did not load on any of the a unique aspect of social behavior that it did not load on any of the four factors interpretable from the FA. The remaining DOTS scales loaded less highly in the FA than in the PCA solution. This suggested that the DOTS scales be analyzed separately, as well as within the summary PCONTROL social outcome factor.

Appendix B - Table 1

Factor Loadings, Communalities (h^2), Percent of Variance and Descriptive Labels for Factor Analysis (FA) Extraction with Varimax Rotation on 48-Month Child Social Outcome Scores

48m Social Outcome Variables	F_1	F_2	F_3	F_4	F_5	h^2
CBCL Internalizing	.35	.81	.00	.21	.07	.83
CBCL Externalizing	.32	.69[a]	.04	.15	.52	.88
CBCL Social Competence	.54	.14	-.04	-.02	.11	.32
WT Child Style	-.01	.14	.85	.12	.11	.77
WT Child Affect	.18	.02	.78	.07	.08	.66
HRI Gutsy	.83	.09	.04	.11	.23	.77
HRI Rules	.74[a]	.06	.21	.06	.42	.79
HRI Peer Sociability	.90	.04	.08	.10	.03	.83
HRI Frustration Tolerance	.85	.28	.20	.07	-.04	.87
HRI Good Student	.75	.21	.12	.10	.01	.78
DOTS Activity Level	-.01	.42	.11	-.09	-.03	.20
DOTS Attention Span	.26	.19	.09	.04	.26[c]	.71
DOTS Adaptability	.43[a]	.09	.06	.26	-.41	.44
DOTS Rhythmicity	.25	.31	-.01	-.04	.13	.24
DOTS Reactivity	.35	.30	.10	-.06	.39	.39
Ego Control (arithmetic transformation)	.20	.06	.30	.08	.61	.58
Ego Resilience	.67	.52[b]	-.03	.15	-.01	.78
PCS Peer Acceptance	.02	.10	.11	.80	.01	.66
PCS Mom Acceptance	.15	-.08	.07	.79	.00	.66
% of variance	53.9	13.1	11.5	9.7	6.2	
Label	PSOCSKILL	PBEHWELL	OCONTROL	KDACCEPT	factor similar to PCONTROL but without ATTENTION span	

[a]These scores are part of two factors.

[b]Ego resiliency score is not included in PBEHWELL, even though it loads above the cutoff point, since it is used as a unique marker of ego resilience in PSOCSKILL.

[c]ATTENTION span does not load highly enough in FA to generate an identical factor to the PCA-generated PCONTROL.

Appendix C: Group Differences in 48m Child Developmental Outcome: Simple ANCOVAs

The prematurity literature has generally examined the impact of biological status on child outcome while controlling for environmental status, using "simple" ANCOVAs. The present study, in contrast, used factorial ANCOVAs, examining both biological and environmental effects. To check whether the two methods generated similar main effects for prematurity, a comparison set of "simple" ANCOVAs were conducted, examining the main effect of biological status (preterm vs fullterm birth) across socioeconomic categories. Environmental status was measured by 48m maternal educational level (MOMED48).

With current maternal education (MOMED48) and age statistically removed, prematurity showed significant main effects on 48m developmental outcome. As expected, the preterm children scored lower on tests of nonverbal cognition and visuomotor abilities, when compared to fullterms of the same chronological age (BD: F (3,76) = 7.40, p = .008; and the VMI actual age quotient (VMIAQ: F (3,74) = 4.28, p = .042). With a correction for prematurity, however, preterms did not differ from fullterms on visuomotor skill (VMICQ: F (3,74)= 1.01, p = .318).

As expected, the preterm group showed a trend toward a less positive view of their acceptance by others (KDACCEPT: F (3,73) = 2.92, p = .091). However, there were more males in the preterm sample, making this difference a possible confound by child sex. Parents of preterms did not characterize their children as less self controlled, as hypothesized, although the preterm-fullterm difference approached statistical significance (PCONTROL: $F = 2.684$ (3,76), $p = .105$). There were no other differences on indices of child social skill.

These findings were quite similar to the main effects for prematurity emerging from factorial ANCOVAs and reported in the present study.

Appendix D

Complete List of Measures Used in the Mother-Infant Project

DATA COLLECTION PERIOD AND LOCATION OF DATA COLLECTION	GLOBAL ENVIRONMENTAL INFORMATION	QUALITY OF HOME ENVIRONMENT	MATERNAL ATTITUDES	MOTHER-CHILD INTERACTION	CHILD BIOLOGICAL INFORMATION	CHILD DEVELOPMENTAL INFORMATION
1 MONTH (HOME)	-Maternal Age -Maternal Education -Maternal Occupation -Paternal Education -Paternal Occupation -Family Structure (single parent vs. two-parent family) -Presence of Income Supplement (This data is partially summarized in various environmental status scores.)	--	-LES-M (negative life stress) -SSQ (social support: satisfaction with community support (COMSAT); satisfaction w/ friendship support (FRDSAT); satisfaction with intimate support (ATTSAT)) -GLS (general life satisfaction) -SWPS (satisfaction (with parenting: satisfaction with parental role (SATISPARENT) and satisfaction with child (SATISKID))	--	-Birthweight -Gestational Age -Presence of IRDS -Presence of SGA -Ethnicity -Sex -No. of Days in Hospital -Postnatal Health Score (This data is partially summarized in several biological status scores.)	SOCIAL -SOSTEK (infant temperament) LANGUAGE -REEL (receptive α expressive scores)

Appendix D (continued)

DATA COLLECTION PERIOD AND LOCATION OF DATA COLLECTION	GLOBAL ENVIRONMENTAL INFORMATION	QUALITY OF HOME ENVIRONMENT	MATERNAL ATTITUDES	MOTHER-CHILD INTERACTION	CHILD BIOLOGICAL INFORMATION	CHILD DEVELOPMENTAL INFORMATION
4 MONTHS (LABORATORY)	--	--	--	Quality of Mother-Child Interaction in Free Play and Structured Play (measured as the sum of ratings of affect (- +), gratification (lo- hi) and sensitivity/responsivity (lo- hi) for both mother and child)	--	GENERAL DEVELOPMENTAL -Bayley MDI and PDI
8 MONTHS (LABORATORY)	--	Modification of HOME inventory (total stimulation in home: 1 score)	-LES-M (stress) -SSQ (support: COMSAT, ATTSAT) -GLS (life satisfaction: 1 score) -SWPS (satisfaction with parenting: 2 scores)	Quality of Mother-Child Interaction in Free Play and Structured Play (measured with interaction quality quality ratings as above)	--	SOCIAL -CAREY (infant temperament) LANGUAGE -REEL (receptive α expressive scores)
12 MONTHS (LABORATORY)	--	--	--	Quality of Mother-Child Interaction in Free Play and Structured Play: latter involves picture book reading; games; and separation-reunion	--	GENERAL DEVELOPMENTAL -Bayley MDI and PDI LANGUAGE Expressive Measures: -Bout Analysis

Appendix D (continued)

DATA COLLECTION PERIOD AND LOCATION OF DATA COLLECTION	GLOBAL ENVIRONMENTAL INFORMATION	QUALITY OF HOME ENVIRONMENT	MATERNAL ATTITUDES	MOTHER-CHILD INTERACTION	CHILD BIOLOGICAL INFORMATION	CHILD DEVELOPMENTAL INFORMATION
12 MONTHS (LABORATORY) (continued)				sequences (measured with interaction quality ratings as above in free play and reading; also measured with "game scores" during games; also with "distress" and "attachment category" scores in separation-reunion sequence)		-MLU (mean length of utterance -No. of Proto imperatives and Proto declaratives -PICCS (Parent-Infant Communication Coding System)
18/24 MONTHS (MAILING/ LABORATORY)	Demographics (same as 1m information: collected at 18m)	--	-LES-M (negative life stress) -SSQ (support: all 3 scores) -GLS (general life satisfaction: 1 score) -SWPS (satisfaction with parenting: 2 scores) -MAS (child-rearing attitudes: 3 scores) -FES (perceptions of the family environment: 3 scores) (Note: all except FES collected at 18m)	Quality of Mother-Child Interaction in Free Play and and Structured Play: latter was "lever task" situation done at 24m (measured with interaction quality ratings in free and structured play; also measured with ratings of maternal "supportive presence" and "quality of assistance" in lever task situation)	--	<u>GENERAL DEVELOPMENTAL</u> -Bayley MDI and PDI (24m) <u>LANGUAGE</u> Receptive measure: -PPVT (24m) Expressive measures: -No. of words (18m) -SICD (24m) -Bout Analysis (24m) -PICCS (24m)

Appendix D (continued)

DATA COLLECTION PERIOD AND LOCATION OF DATA COLLECTION	GLOBAL ENVIRONMENTAL INFORMATION	QUALITY OF HOME ENVIRONMENT	MATERNAL ATTITUDES	MOTHER-CHILD INTERACTION	CHILD BIOLOGICAL INFORMATION	CHILD DEVELOPMENTAL INFORMATION
48 MONTHS (HOME)	-Demographics (same as 1m information) -Weighted Total of Household Change Over Past 4 Years	--	-LES-M (stress) -SSQ (support: 3 scores) -GLS (general life satisfaction: 1 score) -SWPS (satisfaction with parenting: SATISPARENT and and modified SATISKID) -M-CRPR (child-rearing attitudes: scores of restrictiveness and nurturance) -FACES-II (perceptions of family style: perceived family cohesion and perceived family adaptability	Quality of Mother-Child Interaction in Structured Play: "Waiting Task" situation (measured with ratings of mother, child and dyadic style of interaction; dyadic satisfaction; as well as mother and child affect)	Child Health Since Age 1-1/2	<u>SOCIAL</u> -DOTS temperament: 5 scores) -Q-SET ("process" measure: 2 scores -CBCL ("product" measure: 3 scores -HRI (coping skills: 5 scores) -PCS (child's view: 4 scores) (This data is summarized in 5 aggregate social behavior factors, which also include child affect and style in the waiting task.

Appendix D (continued)

DATA COLLECTION PERIOD AND LOCATION OF DATA COLLECTION	GLOBAL ENVIRONMENTAL INFORMATION	QUALITY OF HOME ENVIRONMENT	MATERNAL ATTITUDES	MOTHER-CHILD INTERACTION	CHILD BIOLOGICAL INFORMATION	CHILD DEVELOPMENTAL INFORMATION
48 MONTHS (HOME) (continued)						LANGUAGE -PPVT (receptive vocabulary) COGNITION -BD (Block Design: performance cognition) -INFO (Information: verbal cognition) ACHIEVEMENT -VMI (visual-motor integration)

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