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The Influence of Early Biological Risk and the Home Environment on Nine-Year Outcome of Very Low Birth Weight

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On a examiné les effets d'un risque médical tôt dans la vie et d'un milieu de vie à la naissance et à l'heure actuelle sur les résultats cognitifs et scolaires de 35 enfants âgés de neuf ans dont le poids à la naissance était extrêmement faible, et que l'on a suivis dans cette perspective. On n'a pas trouvé de relation évidente entre les mesures du risque médical tôt dans la vie et celles des résultats. La qualité du milieu de vie expliquait la moitié des variances au niveau des résultats. Cinq sujets ont montré à la longue une association constante avec les résultats positifs, ce sont la sensibilité des parents aux besoins des enfants (*parental responsivity*), le soutien des parents pour l'apprentissage, l'engagement des parents envers leur enfant, le fait d'être exposé à diverses situations et la présence d'une figure paternelle.

The contributions of early medical risk and the early and contemporary home environment on cognitive and academic outcomes of 35 nine-year-old survivors of very low birth weight (VLBW) who were followed prospectively were investigated. There were no significant relationships between the measures of early medical risk and outcome. The quality of the home environment accounted for half of the variance in outcome. Five themes that showed consistent associations over time with positive outcomes were: parental responsivity, parent support for learning, parent involvement with the child, exposure to a variety of experiences, and the presence of a father figure.

Children born prematurely with a very low birth weight (VLBW $\leq$ 1,500 grams) are assigned a high-risk developmental status because of their intrinsic vulnerability during infancy. This vulnerability has its origins in their immature physiological and biobehavioural systems and their exposure to medical complications. These children may be at continued risk during their school-age years because of subtle deficits in their information-processing abilities (Klein, 1988; Klein, Hack, Gallagher, &

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Fanaroff, 1985; Schraeder, Heverly, O'Brien, & McEvoy-Shields, 1992). Also, immature behaviour (Breslau, Klein, & Allen, 1988; Ross, Lipper, & Auld, 1990; Schraeder, Heverly, & Rappaport, 1990) may compromise their ability to perform well in the classroom.

It has been proposed that while all children require a supportive environment to develop optimally, high-risk children are especially sensitive to environment (Aylward, 1992). Nonsupportive environmental effects on vulnerable children have been referred to as "the continuum of caretaking casualty" (Sameroff & Chandler, 1975). A nonsupportive environment can amplify the risk status of vulnerable children. Conversely, from this perspective, vulnerable children reared in optimum environments can thrive and overcome their original and ongoing disadvantages.

While conceptually the environment is believed to influence outcomes of high-risk children, empirical work in the area has concentrated on describing the effects of structural measures of the environment – for example, social-risk indices such as socioeconomic status (SES), ethnic-minority status, mother with less than high school education, and single-parent family – on child development (Hack et al., 1992; Ross, Schechner, Frayer, & Auld, 1982; Vohr, Garcia-Coll, & Oh, 1989). The preponderance of studies examining social risk or SES on low-birth-weight developmental outcomes report that these social/structural variables explain little about developmental status during the first year of life. Structural variables become more strongly associated with developmental outcomes as the child matures and measures of development become based on language and problem-solving (Aylward, 1992). Structural variables may have value in screening programs for quickly identifying populations at risk, but by their nature they are epiphenomenal and as such do not have explanatory value. They are probably proxy measures of processes in the environment that influence development.

Despite the strong evidence that environmental factors are more important than biological risk factors in predicting or explaining developmental outcome after the first year of life of VLBW children, relatively few studies have described environmental processes essential to optimal outcome (Schraeder et al., 1990; Siegel, 1982). Knowledge about specific environmental processes, the time frame in which they are most critical, and the developmental processes they are most likely to affect is important to practitioners and to policy-makers, who have a stake in promoting children's optimal development (Aylward, 1992).

The purposes of this study were to describe the contributions of early and contemporary environmental-process variables and perinatal medical-risk status to development during the first nine years of life of VLBW children. Specific questions posed concern the influence on outcome of early biological risk; the contribution to outcome of the early and contemporary environment; and the specific early and contemporary environmental processes that influence outcome. The children were studied prospectively using a model predicated on the notion that development in children at early biological risk transcends any single variable such as birth weight or medical illness during the perinatal period and evolves from the dynamic relationship between the child and specific aspects of the environment (Aylward & Kenny, 1979).

Method

Study Design and Procedure

This report uses a descriptive correlational design to examine the effects of the environment and early medical risk on a cohort of children studied longitudinally. Environmental and developmental data described in this report were gathered during home visits when the children were six, 12, 24, and 36 months corrected gestational age, and four, five, and nine years chronological age. During each visit, rapport was established with the mother and informed consent was obtained. The project nurse obtained information concerning the environmental-process variables and a licensed psychologist administered the K-ABC, the VMI, and the PIAT-R. The K-ABC and the VMI were administered within one month of the child's ninth birthday and the PIAT-R was administered following the child's completion of the academic year, because the PIAT-R is sensitive to the cumulative effects of learning.

Data on the biological-risk variables (number of days on mechanical ventilation; length of stay in the intensive-care nursery; birth weight) were obtained, at the beginning of the study, from the original medical record. Intraventricular hemorrhage (IVH) status was determined by a board-certified neuroradiologist who rated the children's ultrasounds or brain scans for the presence of IVH using a well-recognized and validated clinical 0-to-4 rating scale (Papile, Burstein, Burstein, & Koffler, 1978). Of the 35 children, 20 had no evidence of IVH, four had grade 1, and seven had grade 2 hemorrhages. Four children did not undergo scanning. The mean number of days the children received mechanical ventilation was 6.43 (range 0 - 39; $SD = 9.64$). The mean length of stay was 51 days (range 11 - 93; $SD = 21.68$) and the mean birth weight was 1,214 grams (range 780 - 1,500; $SD = 192$).

Subjects

The subjects were 35 children and their primary caregivers who were recruited at the child's birth. The sample was obtained from census books at four nurseries for babies born between August 1982 and May 1983 at birth weights of 1,500 grams or less (Schraeder, 1986; Schraeder et al., 1990). Infants recruited into the study were appropriate for gestational age as assessed by the Dubowitz scale (Dubowitz, Dubowitz, & Goldberg, 1970), free from congenital anomalies, and discharged home from the nursery before six months of age. Of 64 potential subjects, two refused to participate, five children were inappropriate for gestational age or had a major congenital anomaly, and 16 could not be located, leaving 41 infants. The mean birth weight of the sample was 1,204 grams (*SD* = 197; range 780 - 1,500). One family was lost to the study in the second year. In a second family, the mother refused participation except for telephone interviews during the sixth year of the study. Four subjects were excluded from this analysis because they had severe developmental delay with neurological deficits and could not be assessed using the cognitive and academic measures selected for this study. See Table 1 for the characteristics of these children.

Data from the remaining 35 children were used in this analysis. Twenty children were girls and 15 were boys. Twenty were Caucasian and 15 were African American. Forty-one percent of the children were reared in households headed by single, unemployed mothers or by parents who were marginally employed in unskilled jobs.

Table 1 *VLBW Children Excluded from the Analysis Because of Severe Developmental Delay (N = 4)*

Subject	Gender	Race	Medical Diagnosis	Test results
#1	Male	White	Spastic quadriplegia; hydrocephally	Vineland < 20 (Profound deficit)
#2	Male	Black	Spastic quadriplegia; epilepsy	Vineland < 20 (Profound deficit)
#3	Male	Black	Blind with hydrocephally	Vineland < 20 (Profound deficit)
#4	Female	White	Microcephally with undifferentiated neurological dysfunction	Vineland = 53 (Moderate deficit)

Vineland = Vineland Social Adaptive Scale (Sparrow, Balla, & Cicchetti, 1984)

Instruments

Process Measures of the Environment

Home Observation for Measurement of the Environment (HOME – birth to three years) (Caldwell & Bradley, 1984) was used to assess aspects of the home environment at six to 24 months corrected gestational age. The 45-item scale assesses six areas: (a) emotional and verbal responsivity, (b) avoidance of restriction and punishment, (c) organization of the physical and temporal environment, (d) provision of appropriate play materials, (e) maternal involvement with the child, and (f) opportunities for variety in daily stimulation.

The scale provides subscales and a total score. The scale was standardized on a study of 174 families that were heterogeneous in racial composition, educational achievement, and economic status. Internal consistency ranged from a low of .44 to an adequate .89 for the subscales and was .89 overall. Test-retest reliability from six to 12 months ranged from .29 to .62 for the subscales and was .62 overall. Construct validity was established by correlations with socioeconomic variables such as educational level and crowding in the home as well as correlations with mental-test scores (Caldwell & Bradley, 1984).

Interrater reliability for this study was established using procedures described in the HOME manual, and was .95. The mean HOME scores at six, 12, and 24 months were 32.8, 34.5, and 36.8, respectively. The means place the subjects in the 50th percentile when compared with the standardization population, with a range from the 10th to the 75th percentile.

Home Observation for Measurement of the Environment (HOME – preschool) (Caldwell & Bradley, 1984), an upward extension of the HOME – birth to three years, was used to assess the quality of the home when the children were three to five years. The 55-item scale assesses eight areas: (a) stimulation through toys, games, and reading materials; (b) language stimulation; (c) physical environment; (d) pride, affection, and warmth; (e) stimulation of academic behaviour; (f) modelling of social maturity; (g) variety of stimulation; and (h) physical punishment. Validity and reliability are well established (Caldwell & Bradley; Elardo & Bradley, 1981). For this sample, interrator reliability was .94 and internal consistency was .92. The mean HOME – Total score at 36 months was 41.1; at 48 months, 39.7; and at 60 months, 41.8.

Home Observation of Families of Elementary School Children (HOME – E), the upward extension of the infant and preschool HOME, was used to measure the quality of the home environment at nine years of age. The eight subscales measure (a) emotional and verbal responsivity, (b) encouragement of maturity, (c) emotional climate, (d) growth-fostering materials and experiences, (e) provision of active stimulation, (f) family participation in developmentally stimulating experiences, (g) paternal involvement, and (h) aspects of the physical environment. Validity and reliability are well established (Caldwell & Bradley, 1984).

Interrater reliability for this sample was .96 and the coefficient alphas ranged from a low of .40 for family participation in developmentally enhancing experiences to .77 for paternal involvement. Internal consistency for the entire scale was .89. The mean HOME – Total at nine years of age was 40.8.

Developmental Outcome Measures

Kaufman Assessment Battery for Children (K-ABC) measures cognition as expressed in mental-processing abilities and achievement. The test yields five major scores: sequential processing, simultaneous processing, mental-processing composite, achievement, and non-verbal.

The theoretical base for the K-ABC mental-processing scale rests on the assumption that two types of mental functioning exist: sequential functioning, which is characterized by temporal or serial order of stimuli when problems are being solved; and simultaneous processing, which requires a gestalt-like integration of stimuli to solve problems (Kaufman & Kaufman, 1983). The 10 subscales of the mental-processing section (three sequential and seven simultaneous) yield three scores – sequential, simultaneous, and mental-processing composite – thus permitting identification of processing strengths and weaknesses. The tests minimize the role of language skills and include items that transcend the influence of gender and social class (Kaufman & Kaufman).

The K-ABC was standardized on a sample of 2,000 children aged two to 12 years. The sample was stratified for gender, geographic region, parental education, racial-group membership, and community size. The test-retest reliabilities are in the .70s and .80s for the subscales and .80 to .90 for the global scales. The level of correlations with standardized achievement tests and intelligence tests provides concurrent and predictive validity (Kaufman & Kaufman, 1983). The mental-processing composite was used as an outcome measure of information-processing skills.

Developmental Test of Visual-Motor Integration (VMI) measures the integration of visual perception and motor behaviour in children aged four through 17 years (Beery, 1989). This paper-and-pencil test essentially assesses the child's ability to copy increasingly complex shapes. It was used in this study to supplement the K-ABC mental-processing scales, because the K-ABC does not have a visual expressive processing component to assess children's fine motor abilities. The VMI was standardized on 5,824 children between the ages of two years and six months and 19 years who are representative of the U.S. population as recorded in the 1980 census. The median interrater reliability is .93 and the median test-retest reliability is .81; split-half reliability is .85. There is extensive evidence of concurrent validity with high correlations between chronological age and other tests of visual-motor ability. Predictive validity was established with school achievement (Beery).

Peabody Individual Achievement Test – Revised (PIAT-R) is an individually administered wide-range achievement test. It yields six scores: mathematics, reading recognition, reading comprehension, spelling, general information, and total. The total PIAT-R was used as a measure of academic achievement. The test was standardized on a sample of 1,563 students from geographic locations around the United States and from a wide range of socioeconomic and ethnic backgrounds. Content validity has been established and the PIAT-R has concurrent validity with the Peabody Picture Vocabulary Test. Test-retest reliability ranges from .88 to .98 for the entire test (Markwardt, 1989).

Results

Descriptive statistics and tabulations were run to examine the distribution of scores and to determine whether the data were normally distributed. Because there has been some evidence that high medical risk is associated with social class, Pearson product moment correlations were run between the medical-risk variables and SES in order to determine whether social class and medical risk were confounded in this sample of children (Aylward, 1992). The correlations were small (< .10) and there were no significant associations, indicating that medical risk and social class were independent of each other. Measures of association (Pearson product moment correlation) using two-tailed tests of significance were then obtained between the perinatal risk variables (length of stay in the intensive care nursery; number of days on mechanical ventilation; birth weight; intraventricular hemorrhage) and the outcome measures: information-processing skills; visual-motor integration; academic achievement. Correlation coefficients were squared to determine the variance accounted for by each association. Table 2 indicates that none of the measures between the perinatal-risk variables and the outcome measures was significant; the amount of variance accounted for by any of the outcome measures was less than 10%.

Table 2 *Relationship between Medical Risk and Developmental Measures at the End of Grade 3 (N =35)*

	Developmental Measures at End of Grade 3					
Medical Risk	**K-ABC (MPC)**		**VMI**		**PIAT-R**	
	r	Variance Explained	*r*	Variance Explained	*r*	Variance Explained
IVH	-.31	10%	-.17	03%	-.29	08%
LICN	.12	01%	.19	04%	.28	08%
NDMV	-.19	04%	-.07	0%	.07	0%
Birth Weight	.12	01%	.03	0%	-.21	04%

K-ABC (MPC) = Kaufman Assessment Battery for Children – Mental-Processing Composite
VMI = Beery Test of Visual-Motor Integration
PIAT-R = Peabody Individual Achievement Test – Revised
IVH = Intraventricular Hemorrhage
LICN = Length of Stay in Intensive-Care Nursery
NDMV = Number of Days on Mechanical Ventilation

When preschool and contemporary HOME-Total scores were correlated with the outcome measures, all of the associations between the environmental-process measures and information-processing skills and academic achievement were significant (Table 3). For associations between the home and information-processing skills, the contemporary HOME score accounted for half of the variance in the outcome measure, followed by HOME scores at 12 months (45%) and 24 months (46%). For associations between the HOME scores and academic achievement, HOME scores at 12 and 24 months accounted for over half of the variance, while the contemporary home accounted for one third of the variance. The relationship between the HOME scores and visual-motor integration was significant at only three points in time, 12 and 36 months and contemporary (Table 3).

In order to understand the degree of stability of the children's environment from infancy and preschool to the present, a correlation matrix at seven points in time was constructed using Pearson product moment (Table 4). The correlation coefficients for the relationships between the HOME-Total scores ranged from .58 (HOME at six months with HOME at 24 months) to .90 (HOME at 36 months with HOME at 48 months). The median association was $r = .76$. The environment appears to have had a high degree of stability, with children who enjoyed supportive homes as infants continuing to experience such support through the preschool years and at school age. Likewise, children in less supportive environments as infants continued to experience relative deprivation as preschoolers and at school age.

Table 3 *Relationship between Total HOME Score and Developmental Measures at the End of Grade 3 (N =35)*

	Deveopmental Measures at End of Grade 3					
HOME Total	**K-ABC (MPC)**		**VMI**		**PIAT-R**	
	r	Variance Explained	*r*	Variance Explained	*r*	Variance Explained
HOME 6 Months	.49**	24%	.20	04%	.57**	32%
HOME 12 Months	.67**	45%	.37*	14%	.76**	58%
HOME 24 Months	.68**	46%	.29	08%	.73**	53%
HOME 36 Months	.58**	34%	.37*	14%	.67**	45%
HOME 48 Months	.62**	38%	.21	04%	.67**	45%
HOME 5 Years	.60**	36%	.30	09%	.67**	45%
HOME 9 Years	.72**	51%	.47**	22%	.57**	32%

K-ABC (MPC) = Kaufman Assessment Battery for Children – Mental-Processing Composite
VMI = Beery Test of Visual-Motor Integration
PIAT-R = Peabody Individual Achievement Test – Revised
*< .05
**< .01

Table 4 *Stability for HOME – Total for Six, 12, 24, 36, 48, 60, and 108 Months (N =35)*

	HOME 6 Months	HOME 12 Months	HOME 24 Months	HOME 36 Months	HOME 48 Months	HOME 60 Months	HOME 108 Months
HOME 6 Months	.68*	.58*	.64*	.62*	.62*	.69	
HOME 12 Months		.85*	.87*	.82*	.87*	.79*	
HOME 24 Months			.78*	.81*	.79*	.60*	
HOME 36 Months				.90*	.81*	.72*	
HOME 48 Months					.76*	.71*	
HOME 60 Months						.63*	
HOME 108 Months						1.00	

*< .01

Table 5 *HOME Subscales Associated with Academic Achievement at Nine Years of Age (N = 35)*

HOME Subscales	r
6-Month HOME	
Parental Responsivity	.43**
Acceptance of Child's Behaviour	.29
Organization of Physical and Temporal Environment	.38*
Provision of Appropriate Play Materials	.42*
Parent Involvement with Child	.47**
Variety in Daily Stimulation	.39*
12-Month HOME	
Parental Responsivity	.59**
Acceptance of Child's Behaviour	.35*
Organization of Physical and Temporal Environment	.57**
Provision of Appropriate Play Materials	.47**
Parent Involvement with Child	.70**
Variety in Daily Stimulation	.54**
24-Month HOME	
Parental Responsivity	.65**
Acceptance of Child's Behaviour	.57*
Organization of Physical and Temporal Environment	.46**
Provision of Appropriate Play Materials	.50**
Parent Involvement with Child	.58**
Variety in Daily Stimulation	.51**
36-Month HOME	
Parental Responsivity	.40*
Acceptance of Child's Behaviour	.45**
Organization of Physical and Temporal Environment	.62**
Provision of Appropriate Play Materials	.52**
Parent Involvement with Child	.55**
Variety in Daily Stimulation	.49**
48-Month HOME	
Learning Stimulation	.64**
Language Stimulation	.56**
Physical Environment	.41*
Pride/Affection/Warmth	.25
Academic Stimulation	.38*
Modelling	.62**
Variety in Experience	.57**
Physical Punishment	.42*

*< .05
**< .01

(continued on page 89)

Table 5 *continued*

HOME Subscales	9-year Academic Achievement
5-Year HOME	
Learning Stimulation	.69**
Language Stimulation	.50**
Physical Environment	.38*
Pride/Affection/Warmth	.21
Academic Stimulation	.52**
Modelling	.45**
Variety in Experience	.53**
Physical Punishment	.11
9-Year HOME	
Responsivity	.42*
Encouragement of Maturity	.34*
Emotional Climate	.14
Growth-Fostering Materials	.57**
Active Stimulation	.36*
Family Participation	.55**
Paternal Involvement	.44**
Physical Environment	.32

Academic Achievement = Total Standard Score for Grade of Peabody Individual Achievement Test - Revised
*< .05
**< .01

In order to understand the distinct characteristics of the environment that support optimal outcome, measures of association (Pearson product monment) between the individual HOME subscales at six, 12, 24, and 36 months and four, five, and nine years and academic achievement at the end of Grade 3 were examined. As expected, there were many significant associations. In addition, individual items in the subscales at each age were examined in order to identify common themes in situations where the name of the subscale changed because the expression of developmental support appropriately changed as the child matured. Table 5 shows the subscale and PIAT-R correlations. The subscales in bold-faced type represent scales contributing to consistent themes. To be identified as a consistent theme, subscales reflecting similar constructs had to be significantly associated with the outcome variable at all data points: six, 12, 24, and 36 months and four, five, and nine years. In Table 5, the subscales in bold-faced type demonstrate five consistent themes. The first is *parent responsivity*, as expressed verbally (Subscale 1 on the Infancy HOME and the School-Age HOME, and Subscales 1 and 2 on the 48-month and 60-month HOME). The second theme is *parent support for learning*, as expressed in the play scales (Subscale 4 on the Infant HOME), the academic stimulation scales (Subscale 5 on the 48-month and 60-month HOME), and the growth-fostering material scale (Subscale 4 on the School-Age HOME). The third theme is *parent involvement with the child*, expressed in Subscale 5 of the Infancy Scale, Subscale 7 of the School-Age HOME, and Subscale 6 (Modelling) in the 48-month and 60-month Scales. The fourth theme is *exposure to a variety of experiences* expressed in Subscales 6 and 7 of the Birth-to-60-months HOME and the family participation scale (Subscale 6) of the School-Age HOME. Lastly, all the scales (from birth to 60 months and 108 months) that contained items relevant to the *active presence of a father figure* in the household had significant relationships with academic achievement at the end of Grade 3.

Discussion

The lack of measurable impact of the perinatal-risk variables parallels the findings from earlier work with this cohort of children during the preschool years (Schraeder, 1986, 1987; Schraeder et al., 1990; Schraeder, Rappaport, & Courtwright, 1987). While many investigators, including this team, have found that VLBW children as a group are at a relative disadvantage when competing in the classroom (Hack et al., 1992; Lagerstrom, Bremme, Eneroth, & Janson, 1991; Schraeder, Heverly, O'Brien, & Goodman, in press), the etiology of their learning problems cannot be accounted for by specific early medical or biological risk factors. The mechanism for the impact of the biological fact of VLBW on school performance has yet to be explained.

The findings concerning the impact of environmental process variables are congruent with a number of studies that have found that environmental risk indicators or environmental structural measures such as SES have greater influence on academic achievement and cognitive development than birth-weight status (Hack et al., 1992; Ross et al., 1982; Vohr et al., 1989). In this study, the quality of the home environment at several points in time accounted for more than half of the variance in both cognitive processing skills and school achievement.

One area in which the quality of the home environment had a more ambiguous role in outcome is visual-motor integration. There were significant associations with outcome at only three points, 12 and 36 months and contemporary. It may be that some aspects of visual-motor performance are influenced by environmental factors – for instance, parents providing children with crayons and paper for drawing, or parents and children playing games that stress careful attention to geometric properties of objects – while other aspects of visual-motor integration are more likely to be innate, relatively immutable abilities, dependent on a maturational timetable.

Three models of environmental action have been used to explain the way in which processes in the environment influence child development (Bradley, Caldwell, & Rock, 1988). In Model I, derived from paradigms that place primacy on the mother-infant relationship such as attachment and psychoanalytic theory, early relationships with significant others influence future development by serving as the building block for basic trust in the environment. High levels of maternal responsivity and parental attention to, and the availability of, responsive objects provide an opportunity for mastery, which motivates the child for future learning. Model II downplays the effects of the early environment and holds that children's experiences contemporary with the measure of outcome play a large role in the mastery of the outcome measure. Model III postulates the importance of constancy and stability across time. Stable environments buffer children from stress and changes in parental fortunes. In this model, it is not only important that the child be provided with a constant, responsive mother figure early in life, but the parent must engage in activities that are supportive at each developmental stage. Environmental effects are cumulative.

The Bradley et al. (1988) longitudinal study of 42 normal-birth-weight children found support for all three models, with the contemporary measure of the quality of the home environment having the strongest correlation with academic-achievement tests. In this study the home contemporary measure had the highest correlation with cognitive processing skills, but earlier measures of the home environment, particularly those at 12 and 24 months, had higher correlations than the contemporary home with overall academic achievement. This pattern of associations can be explained by another theory of environmental action, which suggests that different developmental outcomes (cognitive processing skills, academic achievement, and visual-motor integration) can be explained by different models of environmental action. Cognitive processing skills might be more sensitive to the effects of the child's home than to school achievement. School achievement may reflect a combination of causative factors such as motivation, work habits, and the quality of the child's school.

Considering the high levels of stability noted in HOME-Total scores for this study, and the variations in degree of correlation over time in both of the outcome measures, support can be mustered for all of the models. However, given what is known about the ongoing dynamic interplay between children and their environments, developmental status probably reflects the history of this interplay and a consistent cumulative effect (Bradley et al., 1994).

The themes identified by this study – parental responsivity, parental support for learning, parental involvement with the child, and exposure to a variety of experiences – manifested themselves at all stages of development and had moderate to large correlations with academic achievement at the end of the Grade 3. While the themes provide an overall framework for program development, it must be borne in mind that families have their own strengths and weaknesses and any intervention needs to be individually tailored. It may be that some families need help developing responsive interactions, or do well with responsive interactions in infancy but are unable to cope with the busyness and inquisitiveness of the toddler and preschooler and require assistance recognizing these characteristics as positive and important to future learning. Other families may need assistance finding economic and social supports, for they may have the knowledge to provide responsive parenting but be overwhelmed by stress and lack the energy to parent optimally. Some parents may not be able to support their child's learning because they cannot read or do simple figures themselves and may be unable, or may be too ashamed of their situation, to provide the child with appropriate academic supports. Seeking supports for improving parents' own academic skills and helping them to find alternative ways of supporting their children's learning may be the most appropriate intervention in such cases. Other families may need help understanding the importance of exposing children to a variety of experiences. Many of the families in this study lived in or near a city rich in museums and cultural activities but did not expose their children to these attractions because of their social isolation and fear of crime. This situation is not confined to subjects in low SES homes, but is also characteristic of many families who live in middle-class suburbs. Yet variety of experience, expressed by taking the preschooler to the dry cleaner or the grocery store, or by taking the eight-year-old to the "dinosaur" museum, has strong associations with academic achievement.

It is clear from this study that VLBW is not just a problem of medical risk. Interventions aimed at decreasing the academic and social hazards of low-birth-weight children longitudinally should take place in the community and in the home. Analysis of HOME data over nine years suggests what some of these interventions could encompass. While we have little information about the effectiveness of interventions for families of VLBW children and the characteristics of families who would benefit from the interventions (Bradley et al., 1994), this study is a small step in delineating what those interventions might be.

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