

Family Environments and Early Development in Low-Income Nicaraguan Children

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Abstract

The associations between child and family characteristics and children's developmental status were examined in a sample of 95 impoverished Nicaraguan children, aged two months to five years. Particular attention was placed on the interaction of child and family characteristics on development, and understanding how different domains of development (such as language and motor) are differentially affected by child and family characteristics. Variance in developmental outcomes was explained by child characteristics (weight status and age), and family and home characteristics (number of children under age five in the home, household density, and reported food shortages), but language and fine motor development were more sensitive to these factors than social and gross motor development. Among older children, developmental delays were more pronounced, suggesting that the more complex competencies required of children in the preschool years may be difficult to attain in highly impoverished environments.

Keywords: Poverty; child development; home environment.

Ambientes de las Familias y Desarrollo de los Niños Empobrecidos en Nicaragua

Compendio

Las asociaciones entre las características de los niños y las familias con el estado de desarrollo de los niños se examinaron en una muestra de 95 niños nicaragüenses de bajos recursos económicos, de edades comprendidas entre los dos meses y los cinco años. Se prestó particular atención a la interacción de las características del niño y su familia con el desarrollo, y a entender como diferentes dominios del desarrollo (tales como el lenguaje y las actividades motoras) son afectadas de manera diferente por las características del niño y su familia. Las variaciones en los resultados del desarrollo fueron explicadas por características del niño (estado del peso y edad), y por características de la familia y el hogar (número de niños menores de cinco años en el hogar, densidad del hogar, e insuficiencias de alimentos reportadas), pero el desarrollo del lenguaje y de las actividades motoras finas fueron más sensibles a estos factores que el desarrollo social y las actividades motoras gruesas. En niños de mayor edad, los retrasos en el desarrollo fueron más pronunciados, sugiriendo que las competencias más complejas requeridas en los niños de edad preescolar pueden ser más difíciles de lograr en ambientes empobrecidos.

Palabras clave: Pobreza; desarrollo infantil; ambiente familiar.

Poverty and Development in Low-Income Nicaraguan Children

Despite the preponderance of evidence demonstrating that children living in poverty in the United States face substantial hurdles to healthy development (Brooks-Gunn & Duncan, 1997; Luthar, 1999), less research has addressed the developmental trajectories of children living in poverty in the developing world (Liddell, 1998). Presently there are 51 million children aged birth to four living in Latin American and Caribbean countries, and many of these children live in poverty. A majority of Latin American countries are defined by the World Bank as developing economies, or those with per capita income of less than \$3000 US per year (Bellamy, 2004; World Bank, 2005). Because of the unique threats faced by young children in the developing world, such as high rates of malnutrition

and low-quality housing (Bellamy, 2004), and because early development has important implications for lifelong learning, research is needed that addresses influences on early development among children living in poverty in developing countries. The present study examined the impact of child characteristics and family environments on the developmental status of young children living in a highly-impoverished environment in Nicaragua.

Research begun nearly 40 years ago in Mexico revealed the negative impact of malnutrition on the psychosocial development of young children, particularly cognitive development. The consequences of early nutrition last through adolescence for some children (Pollitt, Gorman, Engle, Martorell, & Rivera, 1993); specifically, inadequate intake of fats and protein has negative effects on cognitive development (Aboud & Alemu, 1995; Neumann, McDonald, Sigman, Bwibo, & Marquardt, 1991; Pollitt, 1998). Yet the influence of malnutrition on both early and later development depends on other features of the child's environment as well. A stimulating home environment ameliorates some of the negative effects of malnutrition, indicating that malnutrition most likely interacts with other features of the home environment to influence later

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development (Grantham-McGregor, Powell, Walker, & Himes, 1991; Sigman, 1995).

The complexity of the child's development within any ecological niche requires examination of multiple influences on early development simultaneously (Dasen & Super, 1988). In the context of impoverished nations, there is a wider range of potential harms on early development than in the industrialized world, such as higher prevalence of infectious disease and limited access to resources such as clean water and adequate housing (Bellamy, 2004). Examining children's development in high-poverty, developing world contexts underscores the need to consider many factors as potential influences on the development of young children (Werner, 1988). Indeed, children's development is perhaps best understood as the interaction of multiple forces, as described by Bronfenbrenner's ecological model (1979). Using this framework, children's adaptation can be conceptualized as resulting from child and family characteristics, and perhaps most importantly, the intersection between the two. Children's own characteristics and their surrounding family environments may interact with one another and lead to differential outcomes for groups of children, depending on ecological context. For example, young children's low weight status may be especially predictive of future difficulty in achieving developmental milestones when children are also living in understimulating home environments.

Moreover, for many children, negative influences on early development have concurrent, overlapping influences; for instance, children who suffer from malnutrition also may live in overcrowded homes with parents who have not been formally educated. While the unique roles of family context and children's characteristics on young children's development have not often been examined in existing literature, some research does suggest that both account for variance in children's developmental status. For example, among toddlers and school-age children in Kenya, both family characteristics and nourishment were significant predictors of cognitive development, with the most variance explained by a variety of family characteristics, in addition to nutritional status (Sigman, McDonald, Newman, & Bwibo, 1991; Sigman, Neumann, Jansen, & Bwibo, 1989). Johnston, Low, de Baessa and MacVean (1987) found that nutrition was related to variability in cognitive development among higher-income children, but not among the lowest income group, suggesting that for a portion of the most vulnerable children, there are environmental factors that exert considerable influence on cognitive development in interaction with nutritional status. A nine-country study found that feeding practices, a key correlate of malnutrition, have a stronger influence on weight gain in the lowest-income households than in higher income households,

further emphasizing the interactions between food intake and other characteristics of family environments (Ruel & Menon, 2002).

In sum, existing evidence suggests that both a child's nutritional status and the family context surrounding the child influence both development, and it is likely that these characteristics interact with one another. Yet little research has examined developmental status using this method, particularly across a variety of developing world contexts. Although the studies reviewed earlier do provide some indication of the manner in which nutrition and family characteristics interact to predict cognitive development in Africa, there are still relatively few studies that examine the relations between variables in other developing societies, such as Latin America. The wide diversity in developing societies highlights the need to describe influences on children's development in many settings (Engle, Castle, & Menon, 1996; Liddell, 1998).

Moreover, there is a need to discover how family characteristics and food availability affect multiple arenas of development, such as language, motor, and social development. It is important to determine whether there are some areas of development that are more strongly affected by certain environmental conditions than others. For instance, food availability may have stronger effects on motor development than on other domains of development, due to the relation between caloric intake and motor activity, while household density may have a stronger influence on language development, due to frequency of interactions with adult speakers. Accordingly, this study examined multiple characteristics of young Nicaraguan children's environments as predictors of social, motor, and language development, as Nicaragua faces many of the problems similar to those of other developing countries, and thus offers an opportunity to examine influences on early child development among children living in poverty in the developing world.

Following upon previously reported research, it was hypothesized child-level characteristics, such as the child's age and weight-for-age, would have a strong effect on developmental status. Based on existing research outlining the role of the family in affecting the development of children in low-income, developing world contexts, it was also hypothesized that household and family characteristics, such as density of the home (taken as a proxy for socio-economic status and the number of people sharing resources within one home setting), food availability (taken as a proxy for the child's nutritional status) and the number of other children under age five (indicating the available resources for young children in the home and the extent of possible parental investment), would also influence developmental status. The goals of this study were as follows: 1) to use child-level and family-level characteristics as a predictors of development in

young children; 2) to examine the interactions between child and family characteristics as predictors of development; and 3) to examine the role of these factors on different domains of development, such as motor and language.

Method

Participants

Data were collected from 95 mothers and children living in a low-income neighborhood of Managua, Nicaragua. The neighborhood from which the sample was recruited was identified as low income by a local medical clinic that provided reduced-cost services to the neighborhood's inhabitants. There were no paved streets in the neighborhood. Some houses were made of cement blocks; others were constructed of tin or mud; 48.2% of the homes of families in the sample had one room and 6.2% of the homes had three rooms or more; 5.4% of the families reported that they were homeless. Most homes did not have running water or electricity. Fathers were

present in the majority of households (70.5%); extended family members were present in just over half of the households (50.9%). Ninety percent of mothers received less than a high school education. The average mother had given birth to three children, ranging from one child to 12 children; 10% of the sample had given birth to five children or more. Eighty-nine percent of children were breast-fed; on average mothers reported that children were breast-fed for ten months. The average age of children was two years, eight months, and 25% of the children were under one year, 15% were between one and two years, 15% were between two and three years, 18% were between three and four years, 14% were between four and five years, and 13% were between five and six years. Sample descriptives appear in Table 1.

Procedure

In collaboration with a local health clinic, families were approached at a main thoroughfare in the neighborhood. Besides these, eighteen children, or 16% of the sample, were screened when they came in to the health clinic from

Table 1
Sample Description (N=95)

Gender of children	
Male	<i>n</i> =47, 49.5%
Female	<i>n</i> =48, 50.5%
Mean age of child	2.37 (<i>SD</i> =1.70)
Underweight	<i>n</i> =38 (40%)
Maternal education level	
Illiterate	<i>n</i> =17, 17.9%
Primary	<i>n</i> =42, 44.3%
Secondary	<i>n</i> =35, 36.8%
Advanced	<i>n</i> =1, 1.1%
Mean parity	
0-3	<i>n</i> =69, 73.4%
4-5	<i>n</i> =15, 15.9%
more than 5	<i>n</i> =11, 10.7%
Mean density of household (persons per room)	4.60 (<i>SD</i> =4.03)
Mean number of children under five (not including child being assessed)	1.30 (<i>SD</i> =1.28)
Reported Food Shortage	
No food shortage	<i>n</i> =62 (55.5%)
Less than 7 days per month	<i>n</i> =7 (6.3%)
Between 7 and 14 days per month	<i>n</i> =18 (16.1%)
More than 14 days per month	<i>n</i> =25 (22.3%)
Total DDST Delays and Cautions (Higher scores indicate more delayed development on total and all subscales)	3.41 (<i>SD</i> =3.35)
Language subscale	1.83 (<i>SD</i> =2.19)
Fine motor subscale	0.74 (<i>SD</i> =1.01)
Gross motor subscale	0.48 (<i>SD</i> =0.67)
Social subscale	0.37 (<i>SD</i> =0.80)

the neighborhood. One-way ANOVAs indicated that these children did not differ from the other children in terms of the number of cautions and delays on the Denver Developmental Screening Test (dependent variable, described in the next section, Appendix A), or with regard to household density, so the two samples were combined for all analyses reported here. The maternal survey and the Denver Developmental Screening Test were administered at the same time; children were screened first and then mothers were asked to respond to the survey; children were weighed at the end of the assessment and were given a gift. The survey and the testing were conducted in Spanish, and one member of the neighborhood was available to provide additional explanation to both mothers and children about the project. The researcher administering the Denver Developmental Screening Test was a master's level public health worker.

Denver Developmental Screening Test. Many studies have used measures that were created and standardized in the United States, with some degree of adaptation for cultural norms and expectations (Aboud & Alemu, 1995; Johnston et al., 1987; Sigman et al., 1991); this study employs similar means for assessing early developmental status. Explaining the variance of children's performance on standardized tests using child and family characteristics within an ecological niche was of interest in the present study. Western assessments have been used to explain differences between children within one culture, rather than to compare them with children from other countries (e.g., Aboud & Alemu, 1995).

Among the most common measures of general development in children under the age of five is the Denver Developmental Screening Test-II (Frankenburg, Dodds, Archer, Shapiro, & Bresnick, 1992), which has been used to assess the development of young children in many cultures, including children in Central and South America (Howard & De Salazar, 1984; Kaplan & Dove, 1987; Oberhelman, Guerrero, Fernandez, Silio, Mercado, Comiskey, Ihenacho, & Mera, 1998; Williams & Williams, 1987). The four subscales on the DDST-II (language, personal/social, fine motor, and gross motor) have been found to be sensitive tests of developmental delays among children in the United States (Glascoe, Byrne, Ashford, Johnson, Chang, & Strickland, 1992). The test is administered by asking children to perform age-appropriate (standardized on a North American Spanish-speaking sample) tasks such as copying a circle, identifying body parts on a doll, naming colors, and jumping. For pre-verbal children, items on the language scale include children's use of gestures and their mono and multi-syllabic utterances. The items on the scale are administered according to the child's age in months rather than by age group (such as infants, toddlers, and preschoolers). Some items are maternal report items, such as whether young

children use two-word sentences and whether children can dress themselves. Beginning with a group of items appropriate for the child's age, items are administered until children successfully complete at least three items, and testing continues until children fail at least three items.

To account for cultural differences that could skew the findings of the study, a team of local pediatricians was asked to provide guidance regarding the relevance of the items on the Denver Developmental Screening Test-II for Nicaraguan children. While the majority of items were deemed appropriate for Nicaraguan children, some items were adjusted to reflect cultural norms, and other items were deleted. Specifically, the social scale, which contains many items assessing older children's ability to dress and prepare food items, was significantly reduced due to the small number of items that were consistent with cultural expectations for children between the ages of three and six. A list of items that were altered or deleted appears in Appendix A.

Using standards developed by the Denver Developmental Screening Test for children in the United States, items were scored as "cautions" if children were not able to do a task that 75% of children of the same age in the standardization sample could complete, and items were scored as "delays" if they could not do a task that 90% of the children in the standardization sample could complete. The total number of delays and cautions was then summed to create a total score; higher scores indicated that the child had more difficulty completing items. Preliminary analyses indicated that 22% of the children had no delays or cautions; the average for the sample was 3.41 delays and/or cautions ($SD=3.35$), ranging from 0 to 12. On average, children's performance on the language subscale was poorer than performance on fine motor, gross motor, or social subscales. Means and standard deviations appear in Table 1.

Maternal Survey. In collaboration with local physicians, a survey was designed to inquire about child and family characteristics that were hypothesized to be related to developmental status. Mothers were asked to report on the child's health history, such as frequency and severity of illness. Mothers were also asked whether there was enough food to feed the family, and if not, how many days per month adequate food was not available; how many children the mother had given birth to; how many adults and children lived in the home; and how many rooms the home had. This information was used in later analyses to determine how environmental characteristics affected the child's development. Two items on the survey, number of rooms in the house and the number of inhabitants in the house, were used to create another variable, household density, which was used in the analyses reported below. This variable was created to provide a proxy for socioeconomic status, on the basis that families with higher

household density were lower in socio-economic status. Household density ranged from one person per room to 20 persons per room and was used as a continuous variable with no a priori judgments by the researcher as to what constituted high or low density. There were three families who were homeless who did not have values on household density and therefore were not included in multivariate analyses. The average household had 3.77 persons per room.

Weight Status. Each child's weight status was determined by comparing the child's actual weight to ideal weights for the child's age, as defined by the Nicaraguan Ministry of Health. Thirty-eight children were underweight according to this method. These children were significantly younger than the rest of the sample, $F(1,97)=10.29$, $p=.002$; 63.2% were female. Of the children who were underweight, ages of the children varied from two months to five and a half years. About 34% of underweight children were under one year of age.

Results

To address the aforementioned hypotheses, hierarchical regression models were created. Descriptive information on all variables used in regression analyses, including child age, weight status, household density, the number of children in the home under age five, and reported food shortage appear in Table 1. First, child-level characteristics (age and weight status) were entered; next, family characteristics (number of children under age five, household density, maternal education levels and reported food shortages) were entered; and last, the interactions between child and family-level characteristics were entered. The goals of the analyses were first to determine the amount of variance explained by characteristics of the child, by family characteristics, and finally, by their interactions; and second, to determine relations between

predictors and each subscale of the Denver Developmental Screening Test.

Bivariate analyses between the number of cautions and delays on the Denver Developmental Screening Test and characteristics of both the child and the environment revealed several strong relations. Results appear in Table 2. In particular, children with more delays and cautions were older, had more children in the home under age five, and their mothers reported more days each month when there was not enough food. Household density, weight status, maternal education, and gender were not related to number of delays and cautions in bivariate analyses. Correlations were also calculated for each subscale of the Denver Developmental Screening Test. The number of children under five, age, food shortages, and maternal education were significantly related to language development scores, and the number of children under five, maternal education, and age were related to fine motor scores. There were no significant bivariate associations between gross motor scores and social scores and the variables listed above, although weight status was marginally related to gross motor scores. The intercorrelations between subscales of the Denver Developmental Screening Test indicated that language and fine motor skills were more closely related than the other subscales, and that both were more strongly related to the total Denver Developmental Screening Test score than social or gross motor scores. There were also significant associations between predictor variables. Household density was positively associated with children's weight status ($r=.22$, $p<.05$) and with the number of children under age five ($r=.23$, $p<.05$). More frequent food shortages were positively associated with more children under the age of five living in the home ($r=.24$, $p<.01$).

Each subscale (language, fine motor, gross motor and social) and total scores were regressed upon child and family characteristics. In the first step of the hierarchical

Table 2
Bivariate Relationships between Denver Developmental Screening Test Total Scores, Subscales and Family Variables (N=95)

	Gender (1) Boys Coded as 1	Age (2)	Children Under Five (3)	Food Shortage (4)	Weight Status (5)	Density (6)	Total DDST (7)	Language (8)	Social (9)	Fine Motor (10)	Gross Motor (11)
1. Gender		-.04	.07	.02	.21*	-.03	-.10	-.01	-.13	-.16	-.02
2. Age			.17+	.06	-.36***	-.04	.55***	.59***	.05	.34***	-.02
3. Children under Five				.28***	.18+	.20	.33***	.33***	.08	.25*	.07
4. Food Shortage					.16	.16	.22*	.24*	.09	.08	.04
5. Weight Status						.21*	.03	-.04	.06	.08	.21*
6. Density							.01	.06	-.03	-.03	-.08
7. Total DDST								.89***	.38***	.73***	.43***
8. Language									.14	.51***	.16
9. Social										.03	.19+
10. Finemotor											.25*

Note: + $p<.10$, * $p<.05$, ** $p<.01$, *** $p<.001$.

regression models, child-level characteristics, age and weight status, were entered. In the second step of the models, family-level characteristics were entered, including household density, the number of children under age five, and reported food scarcity. In the final step, the interactions of the significant child-level characteristics with family-level characteristics were entered (age by number of children under five, age by density, and age by food scarcity). Interactions were selected based on the interest in determining how child characteristics interacted with family characteristics. Consistent with conventions stating that interaction terms should not be included in a model unless a main effect is present (Holmbeck, 1997), interaction terms between weight and family characteristics were not included in the final step of the model because weight status was not a significant predictor of developmental outcomes for any of the regression models after controlling for family characteristics. Interaction terms were computed by centering variables and then multiplying variables by one another. R^2 -change was calculated for each step, in order to determine whether adding the next level of predictors significantly improved the ability of the model to account for the variance in total number of delays and cautions.

Because children of mothers with higher education level often perform better on cognitive assessments, all models were run controlling for maternal education levels. Although results from bivariate analyses indicated that maternal education was reliably related to children's outcomes, in multivariate analyses, maternal education was not a statistically significant predictor of outcome

variables, nor did the models account for more variance when maternal education levels were included. When reconciling these findings with the results of previous research which have demonstrated the importance of maternal education for children's development, it is important to note that there was little variance in education levels between mothers in this sample. As indicated in Table 1, the majority had received some education but only 10% had completed high school, thus precluding the statistical ability to capture the variance of child outcomes due to maternal education. Therefore, in order to increase the power of the statistical models, maternal education levels were not included in the regression models reported here.

Total delays and cautions. In the first step of the model, when attempting to predict the combined number of delays and cautions across all subscales, results indicated that both age and being underweight were reliable predictors of developmental status. Results for all steps of the model appear in Table 3. Older children received more delays and cautions; underweight children also had more delays and cautions. Age and weight status together accounted for 31% of the variance in scores across all subscales, $F(2, 92)=20.91, p<.05$.

In the second step of the model, when family characteristics were included in the model, weight status ceased to be a significant predictor of scores, but age remained a significant predictor; the number of children under age five in the home was also marginally related to total scores, with more children in the home being associated with more delays and cautions. Together child

Table 3
Summary of Hierarchical Regressions for Total Denver Developmental Screening Test Scores ($N = 94$)

Step One	<i>B</i>	<i>SEB</i>	β
Age	1.13	0.18	0.58***
Child weight status	1.52	0.61	0.22*
Step Two			
Age	1.02	0.18	0.53***
Child weight status	0.98	0.63	0.14
Food shortage	0.31	0.23	0.12
Household density	0.01	0.01	0.06
Number of children under five	0.45	0.24	0.17+
Step Three			
Age	1.10	0.17	0.57***
Child weight status	1.27	0.61	0.19*
Food shortage	0.41	0.22	0.16+
Household density	-0.03	0.02	-0.07
Number of children under five	0.47	0.23	0.18*
Age x food shortage	0.35	0.13	0.22*
Age x density	-0.02	0.01	-0.24*
Age x children under five	0.22	0.15	0.13

Notes: $R^2=.31$ for Step 1; $\Delta R^2=.06$ ($p<.10$). $R^2=.37$ for Step 2; $\Delta R^2=.09$ ($p>.05$). $R^2=.46$ for Step 3
+ $p<.10$; * $p<.05$; ** $p<.01$; *** $p<.001$

and family characteristics accounted for 37% of the variance, $F(5, 94)=10.33, p<.05$.

The final step, in which the interactions between child and family characteristics were included, did not account for a significant increase in variance over the previous models; however, two interaction terms reached significance. The final model accounted for 46% of the variance in total number of delays and cautions ($F(8, 94)=9.09, p<.05$). Age, weight status, and the number of children under age five were significant predictors after controlling for the interactions, and reported food shortages was marginally related to total scores. There were two significant interactions, between age and reported food shortage, and age and household density. The first interaction, between age and food shortage, revealed that for children in homes with more frequent food shortages, age predicted a greater number of developmental delays. As children grow older, food shortages are more strongly associated with developmental delays. The significant interaction between age and household density indicated that for children who live in low density homes (one standard deviation below the mean on household density), age is *more* associated with developmental delays. This finding suggests that high household density may serve as a protective factor for early childhood development as children grow older. A figure describing the interaction between age and food shortage appears in Figure 1, and a figure describing the interaction between age and household density appears in Figure 2.

Language. In the first step of the model, age and weight status were both significant predictors of language development. Older children and children who were

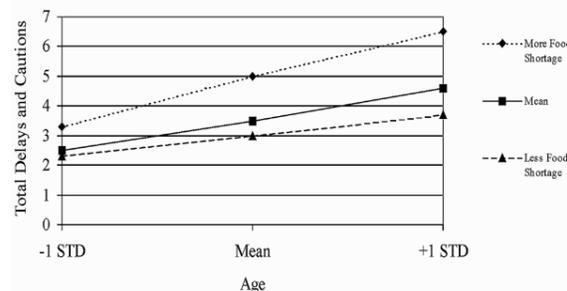


Figure 1. Relation of age and total scores, by food shortage

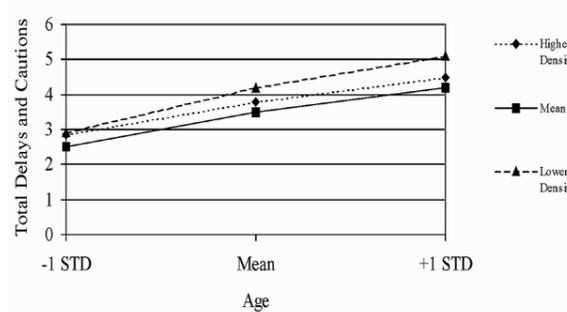


Figure 2. Relation of age and total scores, by household density

underweight had more delays and cautions on the language subscale. These two variables accounted for 39% of the variance in language scores, $F(2, 95)=29.57, p<.05$. Family characteristics also were significant predictors of language scores; when adding family characteristics, 47% of the variance was accounted for, a significant increase in

Table 4
Summary of Hierarchical Regression Analysis for Language Scores ($N = 95$)

Step One	B	SEB	β
Age	0.83	0.11	.65***
Child weight status	0.81	0.38	.18*
Step Two			
Age	0.76	0.11	.60***
Child weight status	0.43	0.38	.1
Food shortage	0.26	0.14	.15+
Household density	0.01	0.01	.12
Number of children under five	0.26	0.15	.15+
Step Three			
Age	0.81	0.10	0.64***
Child weight status	0.60	0.36	0.14
Food shortage	0.33	0.13	0.19*
Household density	-0.02	0.01	-0.02
Number of children under five	0.27	0.14	0.16+
Age x food shortage	0.21	0.08	0.20*
Age x density	-0.02	0.00	-0.26**
Age x children under five	0.14	0.09	0.12

Notes: $R^2=.39$ for Step 1; $\Delta R^2=.07$ ($p<.05$). $R^2=.46$ for Step 2; $\Delta R^2=.09$ ($p<.05$). $R^2=.55$ for Step 3
+ $p<.10$; * $p<.05$; ** $p<.01$; *** $p<.001$

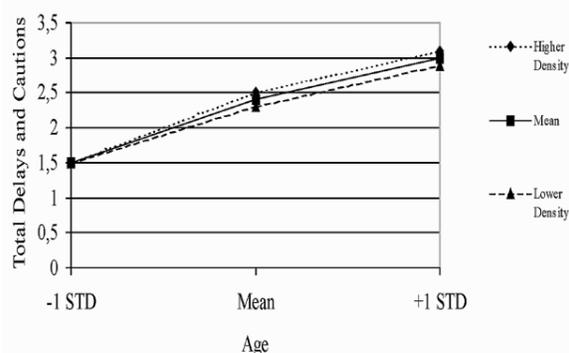


Figure 3. Relation of age and language scores, by density of household

variance over the first step of the model, $F(5, 95)=15.34$, $p<.05$. Specifically, age was a significant predictor, and food shortage and the number of children under age five were marginally related to language scores.

When adding the interactions (age by food shortage, age by household density, age by the number of children under five), the model accounted for 55% of the variance of language scores, $F(8,95) = 13.24$, $p<.05$. Age and reported food shortages were both significant and negative predictors of language scores, and the number of children under age five was marginally and negatively related to language scores. Further, the interactions between age and food shortage, and age and household density, were both significant, displaying the same interaction pattern described in relation to total scores (see Figure 1). Results appear in Table 4. The interaction between age and

household density in relation to language scores appears in Figure 3. Specifically, children in low density homes showed more language delays than children in either homes at the mean of density or higher density homes, and low household density was more strongly associated with language delays for older children.

Fine motor. This model also accounted for a significant, but smaller, proportion of variance of fine motor scores. In the first step of the model, age and weight status predicted 14% of the variance; age was significantly related to fine motor scores while weight status was not, $F(2,95)=7.46$, $p<.05$. Adding family characteristics increased the variance accounted for to 17%, $F(5, 95)=3.61$, $p<.05$; again, age was a significant predictor, and the number of children under age five was a marginal predictor. In the third step of the model, when interactions were added, the model accounted for 23% of the variance, $F(8,95)=3.19$, $p<.05$; age was significantly related to fine motor scores, and the number of children under age five approached significance, as did the interaction between age and food shortage. In both the second and third steps, the R^2 -change statistic indicated that adding additional variables did not reliably increase the model's ability to account for variance. Results appear in Table 5.

Personal/Social and Gross Motor. The regression model failed to predict a reliable proportion of variance in either personal/social (for the final model, $F(8, 95) = 0.29$; *NS*) or gross motor scores (for the final model, $F(8, 94) = 0.70$; *NS*). Results appear in Tables 6 and 7. While weight status was reliably related to gross motor scores when

Table 5
Summary of Hierarchical Regression Analysis for Fine Motor Scores ($N=95$)

Step One	β	SEB	β
Age	0.25	0.06	0.39***
Child weight status	0.29	0.22	0.13
Step Two			
Age	0.22	0.07	0.34**
Child weight status	0.18	0.24	0.08
Food shortage	-0.03	0.09	-0.00
Household density	-0.01	0.01	-0.02
Number of children under five	0.16	0.09	0.18+
Step Three			
Age	0.23	0.07	0.37**
Child weight status	0.28	0.24	0.13
Food shortage	0.01	0.09	0.02
Household density	-0.06	0.01	-0.10
Number of children under five	0.17	0.09	0.20+
Age x food shortage	0.09	0.05	0.18+
Age x density	-0.03	0.00	0.14
Age x children under five	0.08	0.06	0.14

Notes: $R^2=.14$ for Step 1; $\Delta R^2=.03$ ($p>.05$). $R^2=.17$ for Step 2; $\Delta R^2=.09$ ($p<.10$). $R^2=.23$ for Step 3
+ $p<.10$; * $p<.05$; ** $p<.01$; *** $p<.001$

Table 6
Summary of Hierarchical Regressions for Social Scores (N=95)

Step One	B	SEB	β
Age	0.04	0.05	0.09
Child weight status	0.16	0.18	0.10
Step Two			
Age	0.03	0.05	0.07
Child weight status	0.13	0.19	0.07
Food shortage	0.03	0.07	0.05
Household density	0.01	0.01	-0.03
Number of children under five	0.03	0.07	0.05
Step Three			
Age	0.04	0.06	0.09
Child weight status	0.14	0.19	0.09
Food shortage	0.02	0.07	0.05
Household density	0.00	0.02	-0.07
Number of children under five	0.02	0.07	0.05
Age x food shortage	0.02	0.04	0.05
Age x density	0.03	0.05	-0.02
Age x children under five	0.01	0.00	0.07

Note: $R^2=.31$ for Step 1; $\Delta R^2=.06$ ($p<.10$). $R^2=.37$ for Step 2; $\Delta R^2=.09$ ($p>.05$). $R^2=.46$ for Step 3.

Table 7
Summary of Hierarchical Regressions for Gross Motor Scores (N = 94)

Step One	B	SEB	β
Age	0.01	0.04	0.02
Child weight status	0.27	0.15	0.18+
Step Two			
Age	0.01	0.05	0.02
Child weight status	0.27	0.16	0.20+
Food shortage	0.01	0.06	0.00
Household density	0.01	0.00	-0.03
Number of children under five	0.01	0.06	0.02
Step Three			
Age	0.01	0.05	0.03
Child weight status	0.29	0.16	0.21+
Food shortage	0.02	0.06	0.02
Household density	-0.01	0.01	-0.11
Number of children under five	0.01	0.06	0.02
Age x food shortage	0.01	0.04	0.08
Age x density	-0.01	0.00	-0.16
Age x children under five	0.01	0.04	0.05

Note: $R^2=.01$ for Step 1; $\Delta R^2=.01$ (NS). $R^2=.02$ for Step 2; $\Delta R^2=.01$ (NS). $R^2=.03$ for Step 3; + $p<.10$.

tested in bivariate analyses, this effect ceased to be significant when controlling for other family and child characteristics and their interactions, although a marginal effect remained indicating that children who were underweight had higher numbers of gross motor delays.

In sum, results indicated that children's age, their weight status, and the number of children under five in the household were all reliable predictors of children's developmental status. In addition, age was more strongly

associated with delays and cautions for children whose mothers reported more food shortage, and was less strongly associated with delays and cautions for children who lived in high-density households. Similar patterns were noted for children's total, language and fine motor scores. Conversely, children's social skill and gross motor scores were not reliably related to either child or family characteristics.

Discussion

This study explored the child and family characteristics that influence the early development of children living in a low-income neighborhood in the developing world. In addition, whether child characteristics, defined here as age and weight status, impact development differently according to family context, defined by household density, food availability, and the number of children under five, was also investigated. The findings were in keeping with an ecological model as proposed by Bronfenbrenner (1979), in which various aspects of the child's personal and family ecologies have differential effects on development and interact with one another. Findings indicate that children's early developmental status is both dependent on the quality of the home environment and the child's age, and also that the effects of family context on development depend on the age of the child. Findings clearly indicate that the effects of the family environment vary according to children's ages: what is beneficial for preschool-aged children is not necessarily beneficial for infants and toddlers. These findings add to existing literature by demonstrating that family context and child characteristics interact differently as children develop, which is a new insight into the dynamics of development among very low income children.

Preschool-aged children in this sample experienced greater developmental delays than babies and toddlers, but only in language and fine motor development, and not in personal/social or gross motor development. Age was consistently and strongly associated with delays in language, fine motor, and total scores. As children grow older, children both seek out and naturally encounter more complex cognitive tasks, and their increasing cognitive complexity is especially pronounced in relation to their growing reliance on language and representational thought (Piaget & Inhelder, 1969). It is possible that the family environments typical in this low-income neighborhood support the acquisition of the less complex developmental competencies required of younger children, but do not provide enough stimulation and support for the development of more complex skills. For instance, children may be able to learn a first word in even the most challenging circumstances, but may need additional support to define words or tell a story along the timelines typical for children in the developed world.

Although the present study is not longitudinal, findings may be consistent with existing work demonstrating that children in impoverished environments in Jamaica experience a decline in developmental quotient between the ages of one and two (Grantham-McGregor et al., 1991), and also are consistent with research from the United States demonstrating that young children living in poverty tend to experience declines in cognitive development relative to middle-income children as they grow older (Ayoub et al.,

2005). There are also implications for interventions that emerge from the results reported here. Programs designed to ensure the healthy development of young, low-income children in developing countries may be able to promote children's well-being by focusing on children's acquisition of more complex cognitive skills, particularly as children enter the preschool years and prepare for school. Few studies have examined age as a predictor of developmental status among very young children in the developing world, and more research is needed to identify the dynamics associated with children's difficulties gaining competencies as they move through the preschool years. Consistent with previous research, children's weight status was also associated with greater developmental delays, but not as consistently or as substantially as the age of the child. The failure to find significant effects of weight status on children's scores on the subscales of the DDST may be due to the relatively imprecise measurement of weight status used in the present study, but also suggest that future research should attempt to identify whether underweight children experience greater developmental delays in some domains over others.

While child age was a consistent predictor of development, family and environmental characteristics also reliably predicted developmental status. Consistent with research conducted in the United States demonstrating that early development is strongly affected by the home environment (Bradley, Corwyn, Burchinal, Pipes McAdoo, & Garcia Coll, 2001), children in Nicaragua seem to be strongly affected by the home environment as well. The most consistent finding was that the number of children under age five in the home is associated with delayed development in total and language scores. Young children in the Nicaraguan homes in this sample may compete for limited resources with other young children in the home, leading to negative effects on development when there are numerous children in the home under age five. Of note is that the deleterious effects on development associated with the number of children under age five are distinct from household density; according to the findings of this study, as children grow older, density may actually *enhance* a child's ability to learn language, especially among older children. It appears, then, that the presence of numerous young children in the home exert a negative influence on development while having many adults in the home may promote development, perhaps by promoting children's exposure to complex language or by increasing the amount of adult attention received by each child.

Yet in addition to demonstrating that both age and characteristics of the home environment are related to children's development, the findings of this sample also reveal that the relation between family environment and early developmental outcomes vary according to the child's age. The effects of the home environment on development

are not consistent across infants, toddlers, and preschool children. Densely populated homes seem to be beneficial only for language development among older children, who are rapidly acquiring language skills. Older children living in homes with high levels of density had better language development than those living in homes with low household density. Children in dense homes may be spoken to more frequently by adults or may hear more different words over the course of an average day, two factors linked to language development in the United States (Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991).

For children living in homes with high levels of reported food shortages, age was more positively associated with increased delays in total scores, language, and fine motor. While there was an association between age and delayed development among children with lower levels of food shortages, the relation was less pronounced. It appears, then, that children will experience greater developmental delays associated with age when they are living in homes with extensive food shortages. The effect of reported food scarcity does not seem to be entirely attributable to present weight status, and instead may reflect deprivation that has occurred over many years, the developmental effects of which are more apparent as children move into the preschool years. Food scarcity may be especially important for children's language development. Little work to date has focused specifically on language development among developing world children, but the findings reported here are somewhat analogous to findings reported in industrialized countries; research in the United States shows that children in low-income families experience delayed language acquisition compared to children of higher-income families (Smith, Brooks-Gunn, & Klebanov, 1997). However, intentionally exposing children to language interactions with adults could promote development even in the context of food shortage.

The inability of child characteristics and family environments to predict a substantial portion of variance of gross motor and social subscales also represents an important finding, namely that they may affect certain domains of development more than others. The lower number of delays and cautions on these subscales suggests that the Nicaraguan children in this sample may reach developmental milestones in these areas on the same timeline as children in the industrialized world. Personal/social and gross motor development may rely on developmental mechanisms that are not so strongly impeded by the environmental conditions typical for children in this sample. Also notable is that the findings reported here regarding gross motor skills are consistent with the findings of Johnston et al. (1987), who found that Jamaican children scored lower on cognitive performance tasks than on motor development tasks. Specification of the developmental domains that are differentially affected

by highly impoverished environments fine-tunes present understanding of how poverty in developing countries does *and* does not affect early development.

While the results of this study provide insight into the dynamics of child development among impoverished children in Nicaragua, there are several limitations. First, this study relied on a measure of developmental status that was North American in origin. While the children in this sample are expected to gain similar competencies as children in North America, there may be features of early development that were not accurately gauged in this study. In particular, the work of Vygotsky (1933/1978) and more recently, Rogoff (1990) suggest that children's cognitive development is most accurately viewed as being reflective of the surrounding ecology and culture. According to this formulation, reliance on a North American measure could obscure the developmental competencies that these Nicaraguan children demonstrate, because the measure used may have failed to assess competencies that parents in low-income, developing world societies value and actively develop within their children. However, it is also important to note that almost all children living in low-income, developing world communities are expected to attend school and master formal cognitive competencies. Because of this, it may be useful to assess their skills using measures designed for use primarily within a diverse North American population. Second, using a binary variable to measure children's weight-for-age instead of a continuous scale may have obscured the relations between weight-for-age and developmental outcomes. While weight status did have some effect on measures of developmental status, the effect was smaller than has been seen in other studies, and the measure used here may account for that difference. It is also possible, however, that a more complete description of the home environment would account for some of the effects on child development previously attributed to weight status. Third, as noted in the results section, there was little variability in maternal education in this sample, which may have precluded the ability to describe the importance of maternal education for young children's cognitive development. Substantial research has demonstrated that maternal education is an important predictor of children's cognition, and findings from this study should not be taken as an indication that maternal education is not important. Rather, it appears that within this sample, maternal education was not related to child outcomes because so few mothers had attended more than a few years of secondary schooling.

The present study strongly suggests that future research on young children living in poverty in the developing world should adopt a wide focus. Understanding how characteristics of children and their home environments affect development, both singly and in interaction with each other, may provide valuable insights about the nature of

early development. Dasen and Super (1988), for example, maintain that an understanding of the role of ecology in development requires the simultaneous description of many aspects of children's environments, and the findings of this study support that assertion. For example, rather than viewing nutritional status as being independently predictive of children's developmental status, it may be more accurate to view the effects of nutritional status as having an independent effect and also as dependent on the characteristics of the child's ecological niche. Again, these effects are consistent with those reported by Sigman et al. (1989, 1991) and Johnston et al. (1987), and further demonstrate that children's cognitive status results from a combination of nutritional and environmental factors (Sigman, 1995). Moreover, nutritional and environmental factors are intertwined. In this sample, children who were underweight and experienced food shortages were also more likely to live in high density homes with many children under five, highlighting the complexity of children's nutritional and environmental conditions.

These conditions may be especially important for language development. Early language development is an essential building block for future literacy (Walker, Greenwood, Hart, & Carta, 1994). Accordingly, increasing insight into how language is affected by environmental conditions within the context of highly impoverished, developing world societies could potentially help promote optimal development among millions of children worldwide who are at risk of lifelong poverty. Further, taken as a whole, findings from this study highlight the need to design intervention programs that attempt to improve developmental outcomes by focusing efforts on enhancing home environments simultaneously with attempts to improve child nutrition.

References

- Aboud, F. E., & Alemu, T. (1995). Nutrition, maternal responsiveness and mental development of Ethiopian children. *Social Science and Medicine*, 41(5), 725-732.
- Ayoub, C., O'Connor, E., Rappolt-Schlichtmann, G., Raikes, H., & Chazan-Cohen, R. (2005). *Losing ground early: Vulnerability and resilience in low-income children's cognitive performance*. Unpublished manuscript. University of Nebraska, Lincoln, USA.
- Bellamy, C. (2004). *The state of the world's children 2005: Childhood under threat*. New York: Unicef.
- Bradley, R., Corwyn, R., Burchinal, M., Pipes McAdoo, H., & Garcia Coll, C. (2001). The home environments of children in the United States Part II: Relations with behavioral development through age thirteen. *Child Development*, 72(6), 1868-1886.
- Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press.
- Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *Future of Children*, 7(2), 55-71.
- Dasen, P. R., & Super, C. M. (1988). The usefulness of a cross-cultural approach to studies of malnutrition and psychological development. In P. R. Dasen, J. W. Berry, & N. Sartorius (Eds.), *Cross-cultural research and methodology: Vol. 10. Health and cross-cultural psychology* (pp. 112-138). London: Sage.
- Engle, P. L., Castle, S., & Menon, P. (1996). Child development: Vulnerability and resilience. *Social Science and Medicine*, 43(5), 621-635.
- Frankenburg, W. K., Dodds, J., Archer, P., Shapiro, H., & Besnick, B. (1992). The Denver II: A major revision and restandardization of the Denver Developmental Screening Test. *Pediatrics*, 89(1), 91-97.
- Glascow, F. P., Bryne, K. E., Ashford, L. G., Johnson, K. L., Chang, B., & Strickland, B. (1992). Accuracy of the Denver-II in developmental screening. *Pediatrics*, 89, 1221-1225.
- Grantham-McGregor, S. M., Powell, C. A., Walker, S. P., & Himes, J. H. (1991). Nutritional supplementation, psychosocial stimulation, and mental development of stunted children: The Jamaican study. *Lancet*, 338, 1-5.
- Holmbeck, G. (1997). Toward terminological, conceptual, and statistical clarity in the study of mediators and moderators: Examples from the child-clinical and pediatric psychology literatures. *Journal of Consulting and Clinical Psychology*, 65, 599-610.
- Howard, D. P., & De Salazar, M. N. (1984). Language and cultural differences in the administration of the Denver Developmental Screening Test. *Child Study Journal*, 14, 1-9.
- Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology*, 27(2), 236-248.
- Johnston, F. E., Low, S. M., de Baessa, Y., & MacVean, R. B. (1987). Interaction of nutritional and socioeconomic status as determinants of cognitive development in disadvantaged urban Guatemalan children. *American Journal of Physical Anthropology*, 73, 501-508.
- Kaplan, H., & Dove, H. (1987). Infant development among the Ache of eastern Paraguay. *Developmental Psychology*, 23(2), 190-198.
- Liddell, C. (1998). Conceptualising "childhood" in developing countries. *Psychology and Developing Societies*, 10(1), 35-53.
- Luthar, S. (1999). *Poverty and children's adjustment*. Los Angeles: Sage.
- Neumann, C., McDonald, M. A., Sigman, M., Bwibo, N., & Marquardt, M. (1991). Relationships between morbidity and development in mildly to moderately malnourished Kenyan toddlers. *Pediatrics*, 88(5), 934-942.
- Oberhelman, R. A., Guerrero, E. S., Fernandez, M. L., Silio, M., Mercado, D., Comiskey, N., Ihenacho, G., & Mera, R. (1998). Correlations between intestinal parasitosis, physical growth, and psychomotor development among infants and children from rural Nicaragua. *American Journal of Tropical Medicine and Hygiene*, 58(4), 470-475.
- Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York: Basic Books.
- Pollitt, E. (1998). *Statement on the link between malnutrition and cognitive development in children*. Medford: Center on Hunger, Poverty and Nutrition Policy.
- Pollitt, E., Gorman, K., Engle, P., Martorell, R., & Rivera, J. (1993). Early supplemental feeding and cognition. *Monographs for the Society for Research in Child Development*, 58 (7, Serial No. 235).
- Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. New York: Oxford University Press.
- Ruel, M. T., & Menon, P. (2002). Child feeding practices are associated with child nutritional status in Latin America: Innovative uses of the demographic and health surveys. *Journal of Nutrition*, 132, 1180-1187.
- Sigman, M. (1995). Nutrition and child development: More food for thought. *Current Directions in Psychological Science*, 4, 52-55.

- Sigman, M., McDonald, M. A., Neumann, C., & Bwibo, N. (1991). Prediction of cognitive competence in Kenyan children from toddler nutrition, family characteristics and abilities. *Journal of Child Psychology and Psychiatry*, 32(2), 307-320.
- Sigman, M., Neumann, C., Jansen, A., Bwibo, N. (1989). Cognitive abilities of Kenyan children in relation to nutrition, family characteristics and education. *Child Development*, 60, 1463-1474.
- Smith, J., Brooks-Gunn, J., & Klebanov, P. (1997). Consequences of living in poverty for young children's cognitive and verbal skills and early school achievement. In G. Duncan, & J. Brooks-Gunn (Eds.), *Consequences of growing up poor* (pp. 132-189). New York: Russell Sage.
- Vygotsky, L. (1978). *Mind in society: The development of higher mental processes*. Cambridge: Harvard University Press. (Original work published 1933).
- Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development*, 65, 606-621.
- Werner, E. (1988). A cross-cultural perspective on infancy: Research and social issues. *Journal of Cross-Cultural Psychology*, 19(1), 96-113.
- Williams, P. D., & Williams, A. R. (1987). Denver Developmental Screening Test norms: A cross-cultural comparison. *Journal of Pediatric Psychology*, 12, 39-59.
- World Bank (2005). *Facts and figures from World Development Indicators, 2005*. Available: http://www.worldbank.org/data/databytopic/reg_wdi.pdf. Retrieved: June 28, 2005.

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Appendix A

Items Modified or Deleted from the Denver Developmental Screening Test – Revised

Personal/Social Subscale

- Child dresses without help – Deleted
- Child plays board games or card games – Deleted
- Child prepares cereal – Deleted

Fine Motor

No modifications or deletions

Language

Knows 3 adjectives – modified because one of the adjectives requires that children know that when you are cold, you put on a coat; children in tropical climates do not have coats and rarely, if ever, are cold.

Gross Motor

No modifications or deletions