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Language Disparities Related to Maternal Education Emerge by Two Years in a Low-Income Sample

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Abstract

Objectives—Young children living in low-income households experience disparities in language development compared to their advantaged peers, with large differences in language skill by kindergarten entry. In this study, we sought to determine whether there were disparities in early language trajectories within a low-income sample of children from 9 – 36 months as a function of maternal education. We hypothesized that children with more highly educated mothers would show accelerated language trajectories compared to children with less educated mothers.

Methods—Using observational data collected from a longitudinal birth-cohort sample of 192 low-income mother-infant dyads in Ohio from 2014 to 2018, children's language skills were assessed at three time-points (ages 9–13 months, 20–24 months, and 32–36 months). Multi-level growth curve models were used to examine early language trajectories through three years of age as a function of maternal education.

Results—Multilevel growth curve models showed distinct language trajectories: young low-income children have significantly better language skills at 15 months if their mother had a college education compared to not, and this gap remained significant to almost *three* years of age.

Conclusion—Among young low-income children, disparities emerge in early language trajectories that differentiate children with less- versus more-educated mothers. Given that these disparities are apparent near the child's first birthday, it is necessary that pediatric care providers monitor children's early language trajectories and guide families to resources when lags are apparent.

Keywords

language; early childhood; developmental disparities; poverty; maternal education

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Introduction

In the United States, nearly one in two young children reside in a poor or near-poor household (Proctor, 2016). Established evidence have shown that residing in a low-income household significantly increases children's risks for numerous health and developmental adversities, such as asthma (Akinbami et al., 2016), obesity (Kaur et al., 2015), and behavior problems (Holtz et al., 2015). Accordingly, the American Academy of Pediatrics has taken a strong position on the need to eradicate childhood poverty, while also asserting that pediatric health practitioners should be well-informed of how poverty affects children's health and development (COUNCIL ON COMMUNITY PEDIATRICS, 2016).

One area of child health and development that is negatively affected by poverty is language acquisition (Noble, Engelhardt, et al., 2015; Noble, Houston, et al., 2015). Children reared in low-income households disproportionately experience lags in their development of language skills relative to advantaged peers (Hoff, 2013; Huttenlocher et al., 2002; Rowe, 2012), contributing to the 'word-gap' phenomenon of contemporary interest (Hindman et al., 2016). The word gap refers to the difference in vocabulary size between children from lower and upper socioeconomic status (SES) homes, which occurs in part to variability in vocabulary exposure in the home (Hart & Risley, 1995). Importantly, recent compelling evidence shows that poverty conditions affect structural and functional brain development, including cortical regions supporting language functions (Noble, Houston, et al., 2015), possibly due to ongoing exposure to early life toxic stress and impaired parent-child interactions. Experimental evidence shows that impoverished early-care environments negatively influence children's language trajectories (Fox et al., 2010).

Lags in language development among lower-SES children are a serious health concern, given the functional importance of language skills to daily-life activities, and the strong interrelations between language skill and reading comprehension, math achievement, and social-emotional competence (Justice et al., 2009). These early lags in language development must be identified and remediated to reduce the numerous educational and health disparities disproportionately borne by low-income children (Hoff, 2013). Pediatricians and other allied health professionals play a critical role in early identification of language delays and provision of early-intervention referrals (King et al., 2005) for children residing in low-income homes.

Recent work by Fernald and colleagues explored SES-disparities in children's early language trajectories at 18 and 24 months, distinguishing lower- and higher-SES households by maternal education (13.7 vs. 16.7 years of education, respectively; Fernald et al., 2013). Maternal education is often used as an index of SES that is distinct from household income (Braveman et al., 2001), as it serves as a proxy for the quality of adult-child interactions and caregiver investments in children (Huttenlocher et al., 2002; Walker et al., 1994), both of which are instrumental to children's early development (Sohr-Preston et al., 2013). Fernald and colleagues found that by 18 months, a significant disparity differentiated the language skills of lower- and higher-SES children, and this disparity grew over the forthcoming six months to more than a standard deviation in size ($d = 1.3$; Fernald et al., 2013). Using a nationally representative sample, Halle and colleagues provided evidence of SES-based

disparities even earlier, when children were only 9 months of age, on specific indices of language skill (e.g., naming objects Halle et al., 2009). While the mechanisms behind these disparities are unclear, such evidence suggests that SES-related factors such as maternal education dramatically shape children's very early language skills

The aim of the study was to determine whether there were disparities in early language trajectories within a low-income sample of children from 9 – 36 months as a function of maternal education. We used maternal education as our primary measure of SES, given that it is a robust proxy for SES-related health inequities (Généreux et al., 2008) and offers unique variance to children's development compared to other measures of SES, such as neighborhood income (Luo et al., 2006). We surmised that even within a low-income sample, children with more highly educated mothers would show accelerated language growth trajectories compared to children with less educated mothers, and that such disparities would be present prior to children's second birthday, per the Fernald results referenced previously (Fernald et al., 2013). If such effects are documented, results coalesce with recent work showing that linguistic disparities reflecting variability in maternal education emerge very early in life (Fernald et al., 2013), warranting a rapid response by pediatric health-care providers to monitor the developing language skills of young children from low-SES homes.

Methods

Data and Participants

Data were from the Kids in Columbus Study (KICS), a five-year birth-cohort study of children born into poor and low-income families (Justice et al., 2019). Study procedures were approved by the Institutional Review Board of the university affiliated with this study. The present work used data collected during the first three years of the project from 322 mother-child dyads recruited from five Women, Infants, and Children (WIC) clinics across a large, urban city. Eligible women: (a) were either pregnant or had an infant younger than 3 months of age, (b) planned on being in the county for the entirety of the study (five years), (c) were at least 18 years of age, (d) had conversational English skills, and (e) had a child that was not premature or diagnosed with any severe problems. All eligible women were invited to participate and the ones who registered must give their informed consent prior to their inclusion in the study. Any details that might disclose the identity of the participants were omitted in the stage of data processing. The research was conducted in accordance with prevailing ethical principles and reviewed by an Institutional Review Board.

The present study focused on a subsample of 192 children who had at least one language assessment during the three years of participation (Table 1). In this subsample, 55% were girls; 43% were African American, 38% were white, 8% were multi-racial, and 8% were Hispanic. At enrollment, participating mothers averaged 27 years old (range = 18~43), 57% were unemployed, and most families (84%) reported an annual household income of less than \$30,000. Forty percent of the women had a high school diploma or equivalent as the highest level of education, 34% had some college education, and 12% were college graduates. In terms of primary home language, 84% of the households spoke English only,

8% spoke another language (e.g., Spanish, Somali, etc.), and 8% were bilingual or multilingual (spoke English and another language at home).

Measures

KICS data were collected during home visits organized as a series of time-points (TPs) corresponding to children's ages, with approximately six-month intervals between TPs. The current study used demographic data from parent questionnaires collected at TP1 (recruitment), and direct assessments of children's language skills collected at TP 3 (child aged 9 to 13 months), TP 5 (child aged 20 to 25 months) and TP 7 (child aged 32 to 36 months). Descriptives and available sample size for relevant measures are provided in Table 1 (for demographics information) and Table 2 (for language assessments).

Child language skills—Children's language skills at 1, 2, and 3 years were measured using the Receptive Communication subtest of *Bayley Scales of Infant and Toddler Development – Third Edition* (Bayley, 2005). The subtest contains 49 items that assesses the pre-verbal behavior, vocabulary development, morphological development, and verbal comprehension of children aged 0 to 3.5 years, with a raw score ranging from 0 to 49. While items measuring children's pre-verbal behaviors were not language-specific, other items assess the child's development in the English-language specifically, such as use of certain words or morphemes. As a standardized assessment of core language competencies, scaled scores are normed to a mean of 10 and a standard deviation (*SD*) of 3. In the current study, we used both the raw scores and scaled scores of Bayley Receptive Communication test to investigate potential disparities of early language development within the low-SES sample due to non-normative ranges for children of low-SES.

Maternal education as proxy for SES—At recruitment, participating women completed the family background questionnaires (FBQ), in which they were asked to select their highest level of completed education out of the nine options provided (0 = eighth grade or less, 8 = doctorate). Given the traits of the study sample we combined maternal education into three categories: no high school diploma (14% of the sample), high school diploma (40% of the sample), and some college or above (46% of the sample).

Demographics

Demographics information for the participating families was obtained from FBQ and parent interviews. Participating women provided basic information about themselves, their children, and their household, including the primary languages spoken at home. Demographic variables were summarized to describe the study sample, and primary home language was used as a control variable in all statistical models.

Statistical Analysis and Missing Data

We first examined descriptive statistics for children's language scores across the three time-points of assessments. We then conducted multivariate regression analyses to examine the association between children's language skills and maternal education. To examine the development of language over time as a function of maternal education, we used multilevel growth models (Raudenbush & Bryk, 2002), with scores nested within children. By treating

longitudinal data as time-specific observations nested within participants, multilevel growth models can accommodate for unequal spacing among time-points but also missing data due to attrition. Finally, we estimated children's language trajectories from 9 to 36 months based on two categories of maternal education (college education vs. none) using multiple-group analyses and tested for differences in the intercept, linear slope, and quadratic slope (i.e., the slowing or acceleration of growth) of the trajectories. Children's home language was used as a control variable in all statistical models given its potential confounding effect on children's language development.

The initial sample size at recruitment was 322. While concerted efforts have been made to retain participation, attrition rate was high after three years (17% per follow-up time point on average) with the study sample, which featured some of the prominent risk factors (e.g., young age, low income levels, low educational levels, minority status) associated with longitudinal attrition (Gustavson et al., 2012; e.g., Young et al., 2006). After removing cases with missing data on all language assessments, the analytical sample contained 192 children. Comparison between the removed cases and the analytical sample revealed no significant differences in children's demographics (e.g., age, gender, ethnicity, family income), although women in the analytical sample tended to report higher levels of education than women in the excluded sample ($p = .002$). To utilize all data available, within the analytical sample we employed full information maximum likelihood (Arbuckle et al., 1996) in all models to treat missing data in individual variables.

Result

Initial Descriptive Analysis

We first examined language skills across the three time-points of assessments (9~13 months, 20~25 months, and 32~36 months) based on the analytical sample ($N = 192$; available sample size differs at each time-point). Overall, our sample scored significantly lower than the population mean (10) in language skill at all three time-points ($p < .001$). The raw scores increased by approximately 10 points per year, and variation among the scores increased substantially from 9~13 months to 20~25 months (Table 2; Figure 1). Given participants attrition in latter time-points, we also examined language scores of a small subsample of children who completed all three assessments ($n = 68$) to cross-validate this trend of development. Similar descriptive statistics were observed in this subsample of children at each time-point.

Since 8% of the sample came from non-English-speaking households, we further compared children's language scores based on home language. No significant differences were found at the first two time-points, although by 32~36 months children from non-English speaking households scored significantly lower than children from multilingual homes ($p = .03$). See Appendix, Table 4 for details.

Emergence of Disparities in Early Language Skill

To evaluate whether and to what extent early language development within this low-income sample may reflect variability in maternal education, we used multilevel models with

maternal education represented as dummy-coded predictors at level-2. Specifically, we represented maternal education using three categories: no high school diploma (NO HS; 14%), completed high school (HS; 40%), and some college or college completion (COL; 46%). After controlling for home language, significant differences in children's language scores were found between COL and NO HS (raw score: $b = 2.02$, $p = .05$, Cohen's $d = 0.38$; scaled score: $b = 0.63$, $p = .10$, $d = 0.33$), and between COL and HS (raw score: $b = 1.59$, $p = .06$, $d = 0.26$; scaled score: $b = 0.73$, $p = .03$, $d = 0.33$). No differences were observed between NO HS and HS.

To further investigate the juncture at which these SES-related disparities emerge, we used maternal education as a dichotomized variable (COL vs. NO COL) in multivariate regression models to predict language scores at each time-point (controlling for home language). After adjustment for multiple comparisons, COL and NO COL were significantly different at 20~25 months (raw score: $b = 2.26$, $p = .01$, $d = 0.44$; scaled score: $b = 1.30$, $p = .01$, $d = 0.29$), and sizeable differences ($d > 0.2$, the threshold for small effect) were observed at 32~36 months (raw score: $b = 1.84$, $p = .11$, $d = 0.44$; scaled score: $b = 0.62$, $p = .18$, $d = 0.25$). Furthermore, in comparing the changes in children's language scores across time-points (see Figure 2), disparities in language growth between COL and NO COL were especially salient from age 1 and age 2 ($b = 2.42$, $p = .018$, $d = 0.44$), whereas the growth rate from age 2 to age 3 was not significantly different. Overall, these results suggested that disparities in children's language trajectories as a function of maternal education emerge by 20~25 months and persist through 32~36 months (see Figure 3).

Differential Language Trajectories as a Function of Maternal Education

In our final analyses, we estimated multiple-group, multilevel growth-curve models based on two categories of maternal education (i.e., COL vs. NO COL) to test whether there were differences in the intercept, linear growth rate, or quadratic growth rate of children's language trajectories. Results (Table 3, Model 1) suggested that intercepts at 9 months were not significantly different between COL and NO COL (Wald $\chi^2 = 2.89$, $df = 1$, $p = .089$), but there were significant differences in both linear (Wald $\chi^2 = 7.74$, $df = 1$, $p = .005$) and quadratic growth rates (Wald $\chi^2 = 5.09$, $df = 1$, $p = .024$). Furthermore, the quadratic parameter was non-significant for the NO COL trajectory. Constraining the intercepts to be the same between groups and fixing the NO COL quadratic term as zero, the final parameter estimates of the growth trajectories for COL and NO COL are shown in Table 3, Model 2. On average, children with more-educated mothers grew at a higher rate (1.06 points per month) in language skill than children with less-educated mothers (0.81 points per month), with growth rates slowing over time. Additional tests based on the growth model suggested that the language gap between COL and NO COL became significant at 15 months ($p = .026$) and remained so at 31 months ($p = .038$).

Discussion

Young children's language trajectories are negatively affected by poverty, with children in lower-income homes commonly performing more than one standard deviation below their advantaged peers on standardized measures of language by kindergarten entry (Cabell et al.,

2011). Evidence suggests that the conditions of poverty may affect the architecture of the developing brain (Fox et al., 2010) through early exposure to chronic stress (Johnson et al., 2013) and impaired parent-child interactions (Vernon-Feagans et al., 2012). As argued by the American Academy of Pediatrics (COUNCIL ON COMMUNITY PEDIATRICS, 2016), there is great need for research on the social determinants of health among young children residing in poverty, characteristic of the present study.

Using a longitudinal, birth-cohort sample of low-income mother-infant dyads, we sought to determine whether there were disparities in early language trajectories within a low-income sample of children from 9 – 36 months as a function of maternal education. Corroborating past literature, our findings indicate that young children whose mothers had at least some college education had significantly better language skills compared to children whose mothers never attended college. Our work also found that language disparities emerge even before two years of age in a sample of children in low-income homes with less- versus more-educated mothers. That is, children with more-educated mothers have an early and persistent advantage in language growth over children with lower-educated mothers, with a language gap that becomes significant at 15 months and remains significant almost 1.5 years later.

These findings corroborate other work showing that SES-related language disparities emerge early and persist but is particularly unique in showing disparities in early language trajectories in an exclusively low-income sample. Overall, children in this study performed below national norms in language skills at each time-point. Moreover, for a subset of children the language growth lagged behind during the toddler years, contributing to a serious skill discrepancy by age two. These findings make clear the need for intentional language development programming in the infancy/toddler years for low-income children, in particular those children whose mothers have more limited education backgrounds. This need makes the role of the pediatric health professionals especially important. Given that pediatric health practitioners have access to young children and their caregivers at very young ages, they are crucial partners in helping caregivers address their children's early developmental needs. An important and necessary role of the pediatric health provider is being attentive to the early language trajectories exhibited by young children in low-income homes. Pediatric providers can monitor early language trajectories and identify when children's language skills are lagging with ongoing use of psychometrically sound language screening tools developed for infants and toddlers, such as the MacArthur Communicative Development Inventory (Fenson et al., 2007).

The current study had several strengths but also limitations that warrant note. First, families in this study were recruited from WIC centers, and thus may be biased in the representation of lower-income families with young children. Further studies are needed to examine whether the results are generalizable to other low-income families who are not utilizing such public services. Second, our study was able to examine language disparities from 9 months to 36 months as a function of maternal education, but we cannot know if these gaps remain after three years of age. Based on prior literature, it is likely these gaps will remain but it is also possible that preschool experiences can narrow the gaps by maternal education. Third, a small subset of our sample spoke languages other than English in the home, yet this study

measured children's language growth in English-only. Understanding linguistic trajectories for children in their home language is an important goal for future research on this topic. Finally, we also note our measurement of children's language takes an overall broad focus on language growth without more nuanced attention to granular aspects of language, such as temporal processing of speech or gestural development. It is necessary to understand more precisely those aspects of language that are disrupted by SES-related disparities.

This study is the first of which we are aware to document significant discrepancies in the early language trajectories of low-income children as a function of maternal education. Among low-income children, higher levels of maternal education differentiated early language trajectories from lower levels of maternal education. These findings have important implications. First, early language disparities can emerge early and persist. Pediatric care providers can play a critical role in identifying children whose language trajectories are lagging at very early ages and referring caregivers to evidence-based community resources for intervention. Although there is a dearth of effective screening tools for early, reliable identification of language delays (US Preventive Services Task Force, 2006), we would argue that any child who is not producing at least 50 different spoken words by their second birthday be referred to a speech-language pathologist (SLP) for a more complete evaluation (Zubrick et al., 2007). Second, for children whose skills are lagging, provision of early intervention by SLPs can accelerate early language trajectories, often via parent-implemented interventions (Roberts & Kaiser, 2011). Meta-analytic findings show positive effects of parent-implemented language interventions on the magnitude of nearly one-half of a standard deviation on children's language abilities (Roberts & Kaiser, 2011). As an exemplar of such work, Landry and colleagues used intensive home visiting with mothers of very young children (6 to 13 months of age) to teach responsive parenting behaviors that are associated with early language growth in children (Landry et al., 2006). Positive effects on important parenting behaviors, such as contingently responding to their infant, was observed across the range of SES for these mothers, and improvements in parenting behaviors yielded positive effects for children's language growth. Targeting these types of programs to low-income caregivers whose children are showing early lags in language growth may provide an important buffer to the negative effects of early delays in language development.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Significance

What is already known on this subject?

Children reared in low-income households disproportionately experience lags in their development of language skills relative to advantaged peers. Evidence suggests that language skill differences related to maternal education emerge by 18 months of age.

What this study adds?

Early language disparities associated with maternal education emerge even earlier than 18 months and persist at least until three years of age even within an exclusively low-income sample.

Figure 1:
Distribution of Bayley receptive language raw scores by child age

Figure 2:
Changes in Bayley receptive language raw scores during year 2 and year 3 by maternal education

Figure 3:
Means of Bayley receptive language raw scores at TP 1 (9~13 months), TP 2 (20~25 months) and TP 3 (32~36) months, by maternal education

Table 1

Descriptive statistics of the analytical sample (N = 192)

Variable	N	TP	Mean or % ²	SD	Range
Child characteristics					
Sex: Female	192	1	54.5%		
Ethnicity: non-White/Hispanic	190	1	62.1%		
Age in months (Age 1)	169	3	11.18	0.93	8.5~13.3
Age in months (Age 2)	147	5	22.69	1.37	19.8~25.4
Age in months (Age 3)	107	7	33.65	1.03	32.1~36.2
Maternal characteristics					
Highest education:	189	1			
High school/GED			40.2%		
Some college			34.4%		
College or above			11.7%		
Unemployed	187	1	56.7%		
Age (years)	192	1	26.54	5.27	18~43
Household characteristics					
Annual income:	178	1			
\$0~\$10,000			46.1%		
\$10,001~\$30,000			38.2%		
Primary language spoken at home:	192	1			
English only			84.4%		
Other language only (Spanish, Somali, etc.)			7.8%		
English and other language(s)			7.8%		

Note. TP = Time-point of data collection; TP 1 = recruitment, TP 2 = 2~13 months, TP 3 = 9~13 months, TP 5 = 20~25 months, TP 7 = 32~36 months.

² Means are reported for continuous variables and percentages for categorical variables

Table 2

Descriptive statistics of Bayley III receptive language scores for the analytical sample

Variable	N	Mean	SD	Range
Raw score				
TP 3	158	11.46	1.90	7~18
TP 5	142	21.49	5.25	11~35
TP 7	103	30.75	6.34	11~42
Scaled score				
TP 3	158	7.54	2.43	3~15
TP 5	142	8.32	3.00	2~17
TP 7	103	9.03	2.51	2~15

Note. Bayley III = Bayley Scales of Infant and Toddler Development – Third Edition.

SD. Standard deviation; TP 3: 9~13 months; TP 5: 20~25 months; TP 7: 32~36 months.

Table 3

Growth curve analyses of receptive language development from 9 to 36 months: multiple-group, multilevel regression model

	<u>Mother did not attend college (NCOL)</u>			<u>Mother attended college (COL)</u>			<u>Group difference (Wald test)</u>		
	<i>b</i>	S.E.	<i>p</i>	<i>b</i>	S.E.	<i>p</i>	χ^2	<i>df</i>	<i>p</i>
Model 1: Different intercepts									
Intercept	10.11	0.40	<.001	9.13	0.41	<.001	2.89	1	0.089
Age (in months) linear	0.67	0.11	<.001	1.10	0.11	<.001	7.74	1	0.005
Age quadratic	0.01	0.00	0.207	−0.01	0.00	0.054	5.09	1	0.024
Level-1 variance	14.95	1.49	<.001	14.95	1.49	<.001	/	/	/
Level-2 variance	4.41	0.77	<.001	4.41	0.77	<.001	/	/	/
Model fit	$\chi^2 = 1.04$, $df = 2$, $p = 0.594$; RMSEA = 0.000; CFI = 1.000; SRMR within = 0.004, SRMR between = 0.002.								
Model 2: Same intercepts									
Intercept	9.45	0.26	<.001	9.45	0.26	<.001	/	/	/
Age (in months) linear	0.81	0.04	<.001	1.06	0.09	<.001	7.31	1	0.007
Age quadratic	0.00	/	/	−0.01	0.00	0.068	/	/	/
Level-1 variance	15.08	1.47	<.001	15.08	1.47	<.001	/	/	/
Level-2 variance	4.33	0.77	<.001	4.33	0.77	<.001	/	/	/
Model fit	$\chi^2 = 3.43$, $df = 4$, $p = 0.489$; RMSEA = 0.000; CFI = 1.000; SRMR within = 0.004, SRMR between = 0.007.								

Note. In both Model 1 and Model 2, the variable age was re-centered so that the intercept reflects the mean language scores at 9 months of age. Both models controlled for children's home language status (not listed in the table). Level-1 and level-2 variances were constrained to be the same across the two groups since the between-group differences were not significant. In Model 2, the quadratic parameter was fixed to be zero.

b = unstandardized coefficient estimate; S.E. = standard error; / = not applicable.