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Research Article

Change the Things You Can: Modifiable Parent Characteristics Predict High-Quality Early Language Interaction Within Socioeconomic Status

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Purpose: Understanding variability sources in early language interaction is critical to identifying children whose development is at risk and designing interventions. Variability across socioeconomic status (SES) groups has been extensively explored. However, SES is a limited individual clinical indicator. For example, it is not generally directly modifiable. The purpose of this study was to examine if child language ability, input quantity and quality, and dyadic interaction were associated with modifiable caregiver characteristics—self-efficacy and developmental knowledge.
Method: We conducted secondary analyses using the baseline data (n = 41 dyads enrolled, n = 30 analyzed) from a longitudinal study. Mothers and children (1;0–2;3 [years; months]) in low-income households completed demographic questionnaires, self-efficacy and developmental knowledge measures, child language assessments, and interaction samples. We used linear regression models to examine the relationship between self-efficacy, developmental knowledge, and outcomes.
Results: Child receptive and expressive language scores were significantly associated with mothers' self-efficacy, knowledge, and Efficacy × Knowledge interaction. Specifically, maternal self-efficacy was positively associated with child language only in the context of high developmental knowledge. Neither self-efficacy nor developmental knowledge was significantly associated with the number of total or different words mothers produced. However, self-efficacy was significantly and positively associated with the rate of child-initiated conversational turns per minute, controlling for the number of child utterances. Mothers with higher self-efficacy responded more readily to their children than those with lower self-efficacy.
Conclusions: Child language ability and interaction quality vary based on modifiable parent characteristics. Modifiable individual characteristics should be considered in early language interaction within and across SES groups.

High-quality early interaction is a powerful context for child language development, with long-term implications across outcome domains (Adamson et al., 2020). Understanding sources of variability in early experiences is critical to identifying children whose language development is at risk. Furthermore, comprehensive exploration of individual strengths and challenges is critical to developing effective interventions. Many studies have examined differences in interaction quality based on child characteristics (e.g., developmental disorders; Adamson et al., 2019) or the shared family environment (e.g., socioeconomic status [SES]; Rowe, 2018). For example, low SES has been associated at the group level with poor early interaction quality and quantity as well as language and academic outcomes (Hoff, 2013; Huttenlocher et al., 2010).

Despite the group-level findings, SES is limited as an individual clinical indicator. Early language interaction

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quality and developmental outcomes vary within SES groups (Golinkoff et al., 2019; Hirsh-Pasek et al., 2015; Sperry et al., 2018). SES is also multidimensional and not modifiable—directly or at all—through existing early language interventions. Instead, some early language parent training programs use SES to identify participants but aim to modify knowledge and behavior (Luo et al., 2019; Suskind et al., 2016, 2017). Furthermore, developmental knowledge across domains (e.g., language, cognition, motor) is a mediator between SES and linguistic input complexity (Vernon-Feagans et al., 2008), a language input quantity–quality composite (Rowe, 2008), and child language and literacy outcomes (Rowe et al., 2016). SES remains an important consideration, especially for public policy and access to services. However, examining modifiable characteristics positively associated with interaction quality and child language ability within and across SES groups is a critical next step in effective risk identification and intervention.

This study addressed the need to identify modifiable, parent-level characteristics associated with differences in early interaction quality and child language ability. Specifically, we examined whether parent self-efficacy and developmental knowledge explained variability in child language, input quantity and quality, and dyadic interaction. An individual's general self-efficacy perceptions reflect the degree to which they believe they can effect change in their life, their circumstances, and others. Individuals with high self-efficacy are able to intentionally plan to effect change, respond in the moment to the consequences of their actions, and reflect on how to achieve a better future outcome (Bandura, 2001). Self-efficacy can vary across domains within an individual, but here, we were interested in perceptions related specifically to parents' roles in their children's learning and development. For example, a caregiver with high parenting self-efficacy would typically believe that they—and their actions—can positively effect change in their child's learning and development.

We selected self-efficacy and developmental knowledge because they are individually associated with parenting behaviors that support child development (Albanese et al., 2019; Rowe et al., 2016). Furthermore, developmental knowledge and self-efficacy might be modified during early language intervention (Feil et al., 2018; Luo et al., 2019; Mouton & Roskam, 2015; Suskind et al., 2016, 2017). However, despite promising preliminary data (Conrad et al., 1992; Hess et al., 2004), we know little about how beliefs and knowledge might work synergistically. This study contributes uniquely by concurrently examining self-efficacy and developmental knowledge within a low-SES sample.

Early Language Interaction and Language Development

Bioecological developmental theory provides a framework for understanding the role of individual differences in dyadic interaction and language development. Frequent, persistent, and dynamic interactions provide rich language-learning opportunities (Bronfenbrenner & Morris, 2007). Positive qualities of early language interaction include responsivity, reciprocity, diversity, and developmental appropriateness (Bibok et al., 2009; Bornstein et al., 2008; Hirsh-Pasek et al., 2015; Landry et al., 2001; Romeo et al., 2018; Weisberg et al., 2013). Differences in the frequency and nature of early interaction predict later language skills and academic performance (Hirsh-Pasek et al., 2015). Parent training as part of early language intervention, from a bioecological perspective (Bronfenbrenner & Morris, 2007), modifies the child's interactive environment to shape development. Parent training can be powerful, but individual outcomes vary (Heidlage et al., 2019; Roberts et al., 2019). Identifying modifiable characteristics associated with high-quality early interaction is critical to supporting language development.

Modifiable Characteristics

The bioecological model recognizes that factors within the parent, child, or shared environment can influence language interaction quality (Bronfenbrenner & Morris, 2007). Here, we focus on factors within the parent, because they are the primary agents of change in caregiver-implemented early language intervention. For example, parenting beliefs, knowledge, and practices can be modified during intervention—making them clinically meaningful.

Developmental Knowledge

Growing evidence suggests that parent-level characteristics support child development, early interaction quality, or parenting practices broadly. Rowe (2008) demonstrated that family SES indicators—parent education and income—were positively associated with the amount of child-directed speech during interaction. The amount of child-directed speech was also predictive of children's later vocabulary skills. More importantly, the relationship between SES and child-directed speech was mediated by parent developmental knowledge across domains (Rowe, 2008). In this study, we refer to parents' developmental knowledge as their understanding of typical developmental milestones and parenting expectations across domains (e.g., language, cognition, motor). For example, a parent with high developmental knowledge would be able to identify chronological age expectations for their child in different areas.

Vernon-Feagans et al. (2008) used data from socioeconomically diverse participants in the Family Life Project to examine the relationship between parental demographics (e.g., education level), proximal characteristics (e.g., parent developmental knowledge), and language input to children. The relationship between high school educational level and linguistic input complexity during dyadic interaction was fully mediated by parental developmental knowledge and engagement. The complexity measure was a composite of the mean length of parent utterances and their use of bound morphemes. Importantly, developmental knowledge did not significantly mediate the relationship between education level and input quantity (i.e., a composite of time on

task and the number of different words; Vernon-Feagans et al., 2008).

A recent, large-scale analysis using the Early Childhood Longitudinal Study–Birth (National Center for Education Statistics, n.d.) cohort expanded upon this research by exploring differences across racial and ethnic groups (Rowe et al., 2016). Developmental knowledge in infancy was directly linked to child literacy and language skills at 4 years of age after controlling for other characteristics. Furthermore, parent developmental knowledge somewhat mediated the relationship of education with child language and literacy skills (Rowe et al., 2016). These studies measured developmental knowledge using items from the Knowledge of Infant Development Inventory (KIDI; MacPhee, 1981, 2002). The findings suggest that knowledge might be a better predictor of early interaction quality and child language development than parent education or income as proxies of SES.

Parenting Self-Efficacy

Self-efficacy perceptions have also been considered as a source of parent-level variability in child development literature. A recent systematic review examined how caregivers' self-efficacy perceptions impact their mental health, relationships with their children, and child development. Across studies, self-efficacy perceptions were mostly positively associated with parenting practices and child development outcomes (Albanese et al., 2019). Like developmental knowledge, parent self-efficacy either moderated or mediated the relationship between several developmental risk factors (e.g., low parental education or depression) and child outcomes (e.g., positive early learning environment and school readiness; Albanese et al., 2019; Jackson et al., 2009; Peacock-Chambers et al., 2017).

Self-efficacy is generally positively associated with parenting behaviors (e.g., responsiveness; DeSocio et al., 2003) that support child development with a few exceptions. For example, Grimes (2012) showed that, while parents with higher self-efficacy exhibited less hostility, they also tended to be more overprotective and likely to take agency away from their child. Similarly, in a preliminary parent training study, Alper et al. (2020) did not find significant associations between maternal self-efficacy and responsivity or use of language stimulation strategies. However, parents who had less favorable psychosocial perceptions (i.e., believed that control over their lives was more external than internal) were associated with greater training gains (Alper et al., 2020). Importantly, Alper et al. did not assess developmental knowledge, and the sample did not include a group of families in low-SES households.

Examining Characteristics Concurrently

Most of the research on self-efficacy and developmental knowledge in parent–child interaction has focused on separately examining these characteristics. However, preliminary evidence suggests that developmental knowledge might moderate the relationship between parenting self-efficacy beliefs and behaviors (Conrad et al., 1992; Hess et al., 2004).

Hess et al. (2004) observed a significant interaction between maternal knowledge and self-efficacy when predicting global interaction quality with infants (approximately 3.5 months). Specifically, self-efficacy was positively associated with interaction quality only when mothers also had high developmental knowledge. Mothers with high self-efficacy but low knowledge demonstrated the poorest interaction quality. Importantly, the authors did not report post hoc contrasts, so this pattern was determined based on visualization of predicted values (Hess et al., 2004).

Conrad et al. (1992) examined differences in mother–child (aged 12–35 months) global interaction quality across developmental knowledge and parenting confidence groups. Specifically, mothers were grouped into one of six categories based on developmental knowledge (low, middle, or high based on the KIDI; MacPhee, 1981) and parenting confidence (low or high based on the Toddler Care Questionnaire; Gross & Rocissano, 1988). Neither developmental knowledge nor self-efficacy was independently associated with interaction quality. However, there was a significant interaction such that dyads in which mothers had high confidence and knowledge exhibited greater interaction quality than those with high confidence but low knowledge. Importantly, Conrad et al. examined interaction quality broadly within a sample of participants with middle- to high-SES, who were almost exclusively White (98%). The present study expands on this research by examining specific indicators of language interaction quality within racially and ethnically diverse families in low-SES households.

Objectives

The purpose of this study was to examine if and how child language ability, input quantity and quality, and dyadic interaction quality vary based on parent self-efficacy and developmental knowledge. Specifically, we predicted that developmental knowledge would moderate the relationship between parent self-efficacy and our outcomes. Based on previous work (Conrad et al., 1992; Hess et al., 2004), we hypothesized that high developmental knowledge and self-efficacy are synergistic and most beneficial when they co-occur. This research will increase our understanding of the complex relationship between knowledge, beliefs, and practices. We asked three research questions: Do (a) child receptive and expressive language abilities, (b) parent number of total and different words per minute (i.e., input quantity and quality), and (c) number of adult- or child-initiated conversational turns (i.e., dyadic language interaction quality) vary based on parent self-efficacy and developmental knowledge? We predicted that developmental knowledge would significantly moderate the relationship between maternal self-efficacy and our outcome variables. Specifically, we expected that maternal self-efficacy would be positively associated with our outcomes only when accompanied by high developmental knowledge.

Method

The Temple University Institutional Review Board approved this research (#22638). Participants gave their informed consent before being enrolled in the study.

Study Design and Setting

This was a cross-sectional, observational design conducted as a secondary analysis using a subset of baseline data from a longitudinal study. Participants were residents of the Philadelphia metro area. This study was conducted in participants' homes or a community space as part of regular home-visiting services through a community organization. Data were collected from 2016 to 2018 (Luo et al., 2019).

Participants

At baseline, 39 caregivers and 41 children (1;0–2;3 [years;months]) in low-income households, who were receiving home-visiting services through a community-based organization, were enrolled (Luo et al., 2019). Eleven dyads were excluded due to missing self-efficacy or knowledge data (n = 6), exposure to a language other than English and Spanish (n = 2), twin status (i.e., one of each twin pairs was randomly excluded from analyses; n = 2), or the primary caregiver not being the main interaction partner during filming (n = 1). This left 30 dyads with complete self-efficacy and developmental knowledge data, who were included in this study (see Figure 1 for participant flow). All participants had to be able to receive services in English, but some also spoke Spanish.

Measures

Demographics

We collected demographic information including child age and sex, mother age, education, marital status, employment, place of birth, education, household income, race and ethnicity, and language spoken to the child using a questionnaire. Age was measured continuously in months or years for children and parents. All other demographic variables were described categorically (see Table 1).

Self-Efficacy

We measured maternal self-efficacy using the Self-Efficacy for Parenting Tasks Index–Toddler Scale—"Teaching" and "Play" subscales (Coleman & Karraker, 2003). Our sample's Cronbach's alpha across the subscales was .81, 95% confidence interval (CI) [.72, .91]—similar to the originally reported alphas of .73 for teaching and .92 for play (Coleman & Karraker, 2003). Mothers rated their agreement with 16 items on a 6-point Likert scale from *strongly disagree* to *strongly agree*. Scores range from 16 to 96; higher scores represent greater self-efficacy. These included positively phrased and flipped statements such as "I believe my toddler learns a great deal from my efforts to show him/her things" and "I find it hard to loosen up and just play with my child" (Coleman & Karraker, 2003, p. 145). This scale has been used in parenting research with families in low-income households and children under 5 years old (Peacock-Chambers et al., 2017).

Developmental Knowledge

We measured caregiver's developmental knowledge by using a 58-item adaptation (Center for Prevention Research and Development, 2016) of the KIDI (MacPhee, 1981). The KIDI assesses parent knowledge of motor, behavioral, language, social, and cognitive development. The first 40 items prompt parents to report if they agree, disagree, or are unsure about each statement. We coded uncertainty as incorrect for scoring purposes, which is consistent with the "total score" option presented in the original manual (MacPhee, 1981). For items 40 and beyond, parents were asked to decide if a statement was true and, if not, whether it applied to an older or younger child. We selected this version because it was used as part of a large-scale home-visiting program evaluation and the items chosen were relevant specifically to infants and toddlers (Center for

Figure 1. Participant flow.

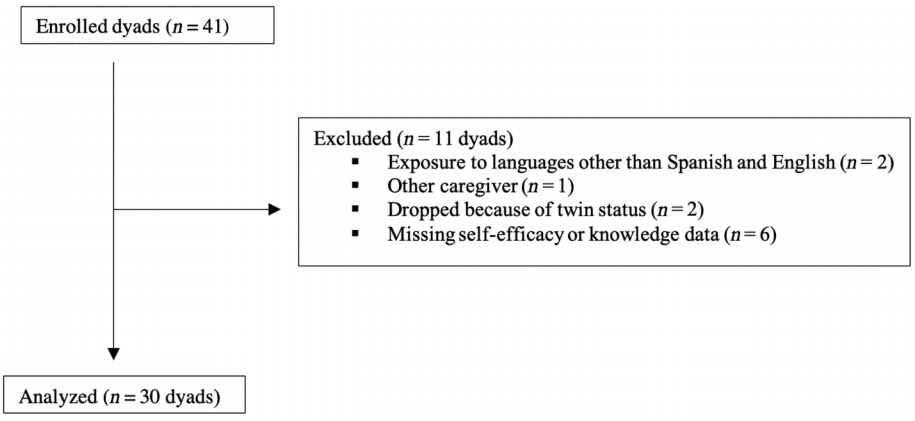


Table 1. Participant demographics.

Variable	*M (SD)* or % (*n* = 30)
Child age (months)	19.2 (4.09)
Male child (%)	50
Mother age (years)	30 (10.04)
Mother self-efficacy[a]	81.9 (10.48)
Mother developmental knowledge[b]	25.6 (3.88)
Mother married (%)	27
Mother employed (%)	23
Mother foreign born (%)	33
Mother education	
≤ High school	53
Annual household income	
Less than $25,000	63
$25,000–$50,000	27
Unknown/did not answer	10
Race and ethnicity	
African American	47
Non-White Hispanic	43
White	3.3
White Hispanic	3.3
Other	3.3
Language mother to child	
English/mostly English	60
Spanish/mostly Spanish	27
English and Spanish	13

Note. Means and standard deviations are presented for child and mother ages; percentages are given for categorical demographic variables.

[a]Coleman and Karraker (2003). [b]Center for Prevention Research and Development (2016); MacPhee (1981).

Prevention Research and Development, 2016). Items can be categorized into four broad categories: norms and milestones (general, cognition, emotions, perception, experience, and physical), principles (language, social, experience, perception, and three individual difference items), parenting, and health/safety (MacPhee, 1981). Studies that report one internal consistency across the full scale yield widely ranging Cronbach's alpha values (e.g., .50–.82; Center for Prevention Research and Development, 2016; MacPhee, 1981). This could be due to the scale capturing knowledge across developmental categories, since Cronbach's alpha assumes unidimensionality (McNeish, 2018).

Our full-scale (i.e., all 58 items together) alpha was low, .42, consistent with a violation of unidimensionality. Specifically, when we examined within category, we found that the health/safety and physical milestones items had the most negative impact on internal consistency. Once we dropped these two subsets, we systematically identified some additional items (three individual differences, three principles, one perceptual norm, one perceptual milestone), which when removed substantially improved consistency using the psych package in R (Revelle, 2020). This package allowed us to see the alpha projection if each item were dropped. Our final item set had acceptable internal consistency (Cronbach's $\alpha = .69$, 95% CI [.54, .89] across a subset of 35 items). Importantly, we retained all parenting items, language and cognitive principles and milestones, as well as social and emotional milestones. These domains are conceptually consistent with our research questions and theoretical framework. Possible scores in this study ranged from 0 to 35, with higher scores indicative of better developmental knowledge. Scores on other versions of the KIDI (MacPhee, 1981, 2002) have been positively associated with child language outcomes across racially, ethnically, culturally, and socioeconomically diverse participants (Bornstein et al., 2010; Huang et al., 2005; Rowe, 2008).

Child Language

We assessed child receptive and expressive language with the Preschool Language Scales–Fifth Edition (PLS-5), English and Spanish versions (Zimmerman et al., 2011, 2012). The PLS-5 is a standardized, norm-referenced, direct assessment for children from birth through 7;11. We selected the PLS-5 because it had good psychometric properties (Muldoon et al., 2019), was age appropriate, and was designed for children who spoke English or English and Spanish. The PLS-5 evaluates preverbal language (e.g., attention and gestures), interaction and play-based skills (e.g., pretend play and social cues), integrative language (e.g., analogies and theory of mind), and early literacy skills (e.g., shapes naming and book handling). Children who only spoke English were assessed with the English version of the PLS-5 and compared to monolingual norms (Zimmerman et al., 2011). Those who spoke Spanish and English were evaluated with the bilingual version of the PLS-5 and compared to bilingual norms (Zimmerman et al., 2012). We used the Auditory Comprehension and Expressive Communication standard scores to quantify child receptive and expressive language.

Input Quantity and Interaction Quality

Parents and children completed a modified version of the three boxes task (Hirsh-Pasek et al., 2015), which we used to assess input quantity and interaction quality. Dyads were asked to share a book, play imaginatively, and clean up, each for 5 min. Books with minimal words were used to address concerns about varying parent literacy levels. The imaginative play context involved pretend food and a kitchen set.

Number of total and different words. The parent–child interaction tasks were transcribed using Codes for Human Analysis of Transcripts conventions and analyzed using Computerized Language Analysis (CLAN; MacWhinney, 2000). Transcribers were blind to independent variables (i.e., self-efficacy perceptions and developmental knowledge scores) and some were English-Spanish bilingual. Most transcript times were trimmed to reflect 4 min per task; three out of the 81 task segments were less than 4 min.

Eleven of 27 mothers (41% of the total video sample) used English and Spanish. Transcribers identified the primary and secondary (if applicable) language for each transcript with markers and assigned corresponding precodes in CLAN. We then extracted the number of different and total words produced by the mother directed at the

child across languages using the CLAN "MOR" libraries (MacWhinney, 2000).

Conversational turns. We calculated the number of conversational turns using Mangold Interact software (Mangold, 2017). Interact allows for frame-by-frame analysis using individualized coding schemes and automated contingency calculation. Using the prepared transcripts, we assigned codes to the mother and child verbal behaviors. This included mother verbal behaviors coded as *responsive* (e.g., models, repetitions), *constructive directive* (e.g., questions), and *acknowledgment* (e.g., fillers). We excluded mother verbal behaviors coded as *unrelated* or *behavioral directive* (e.g., commands to regulate behavior). We included all child verbal behaviors, except those which were *unrelated* (e.g., directed at a sibling) or *unintelligible* (i.e., an unintelligible production that was not a clear attempt to label, comment, or respond to a mother's directive). Using the contingency function, we identified conversational turns—adult-to-child or child-to-adult—based on a 5-s window from the offset of the initiating behavior (Romeo et al., 2018). We analyzed the number of adult- and child-initiated conversational turns per minute, controlling for the number of utterances produced by the partner. This allowed us to specifically examine adult and child responsivity while controlling for the partner's contribution. For instance, when analyzing child-to-adult (aka child-initiated) turns, we controlled for the number of child utterances such that variability in the outcome measure reflected differences in mothers' rates of response.

Variables

The dependent variables were children's receptive and expressive language standard scores, the number of total and different words mothers produced per minute, and the number of adult- and child-initiated conversational turns per minute. The independent variables of interest were the continuous parent self-efficacy perceptions and developmental knowledge scores. We tested the Self-Efficacy × Developmental Knowledge interaction to examine moderation.

Bias

The data collectors were blind to the tested hypotheses. Furthermore, transcribers and coders were blind to participants' self-efficacy and developmental knowledge scores.

Sample Size

This was a secondary analysis of the baseline data from a longitudinal study (Luo et al., 2019). Thus, the sample size was determined for the initial study. The process by which we identified all applicable baseline participants for this analysis is described in Figure 1.

Reliability

Participant videos that included English and Spanish were transcribed by bilingual researchers blind to parents' self-efficacy and developmental knowledge scores, child language, and demographic data. Transcripts were made prior to interaction coding; therefore, reliability is reported separately for each step. Percent agreement was used to assess transcription reliability; intraclass correlation coefficient (ICC) was used for coding reliability. ICC estimates and their 95% CIs were calculated using the irr package (Gamer et al., 2012) in R, based on a single-measures, absolute-agreement, two-way mixed-effects model (McGraw & Wong, 1996).

Transcription

Each video set—including the book sharing, play, and cleanup tasks—was transcribed using Codes for Human Analysis of Transcripts conventions (MacWhinney, 2000) in ELAN (Wittenburg et al., 2006). Reliability was assessed by a secondary transcriber, who watched the interaction video and noted any discrepancies (e.g., time, content, or speaker) with the primary transcript. Discrepancies were compiled by dyad and video type.

There were 27 total participant dyad video sets. Seven dyads were randomly selected for reliability checks (21 transcripts, 26% of total participant video sets). Twenty-nine percent of the reliability transcripts had English and Spanish; the rest had only English. Intertranscriber agreement was 96.6% across tasks (120 disagreements in 3,579 utterances)—95.9% book sharing, 96.5% play, and 97.7% cleanup. This is a high level of accuracy and consistent with other similar research (e.g., Alper et al., 2020).

Interaction Coding

Participant videos were assigned to trained research assistants for coding. Six dyads (18 files, 22% of participants with complete interaction videos) were randomly selected for reliability coding. Of the sets identified for reliability, four (67%) used English and Spanish. Coding was independently completed from a clean transcript by research assistants competent in both languages. Conversational turn counts were calculated using the same contingency procedure in Interact (Mangold, 2017). Coding reliability was computed for the number of conversational turns for each dyad, within each context—book sharing, play, and cleanup.

Resulting ICCs were good for cleanup (ICC = .71) and excellent for book sharing (ICC = .91) and play (ICC = .89; Cicchetti, 1994). However, the 95% CIs of the ICC estimates were large, spanning poor to excellent reliability for cleanup (95% CI [.04, .95]) and fair to excellent reliability for book sharing (95% CI [.48, .99]) and play (95% CI [.49, .98]). Further investigation of intersubject agreement revealed relatively poor agreement in cleanup compared to reading and play, so the former was excluded from subsequent analyses. When reading and play conversational turns were summed, the resulting ICC was excellent (ICC = .89, 95% CI [.39, .98]). The ICC estimate based on total conversational turns in reading and play still carries a large CI, but this is expected with small samples.

Statistical Methods

All outcome variables met normality assumptions based on Shapiro–Wilk (Shapiro & Wilk, 1965) tests. We conducted the main statistical analyses using the lm (R Core Team, 2020), lm.beta (Behrendt, 2014), and stats (R Core Team, 2020) functions in RStudio (RStudio Team, 2016). We tested our hypotheses using linear multiple regression models, adjusting for demographic covariates. We report standardized and unstandardized coefficient values—interpreting effect sizes throughout per the Ferguson (2009) guidelines. For models in which there was a significant interaction, we conducted Johnson–Neyman (J-N; Bauer & Curran, 2005; Johnson & Fay, 1950) comparisons using the sim_slopes function (Long, 2019) in RStudio. Additionally, we adjusted for multiple testing by using the p.adjust function in R (R Core Team, 2020), with the false discovery rate method with $\alpha = .05$. We used pairwise deletion for missing data. Graphs were constructed using sjplot (Lüdecke, 2020).

Results

Participants

Descriptive Data

Participant demographic data are presented in Table 1. We examined the relationships between demographic characteristics and outcome variables to identify covariates we needed to control for in the models. Demographic variables were controlled for in the analyses when they contributed significantly to the models. We tried adjusting for child language abilities in the input and interaction quality models, which yielded the same key findings. We therefore dropped these variables from the final models.

Main Results

Model output—including standardized and unstandardized regression coefficients, CIs, *p* values, and model-level statistics—is provided in Table 2.

Child Language

Receptive. The average receptive standard score was 86.50 ($SD = 14.47$). Self-efficacy ($B = -4.45$, $p = .031$, $p_{adj} = .034$), developmental knowledge ($B = -12.43$, $p = .034$, $p_{adj} = .034$), and the Efficacy × Knowledge interaction ($B = 0.17$, $p = .024$, $p_{adj} = .034$) were significantly associated with children's receptive language standard scores after controlling for child age, child, sex, and mothers' education, $F(6, 23) = 3.58$, $p = .012$, adj-$R^2 = .35$. A plot of the Efficacy × Knowledge interaction is presented in Figure 2. The J-N interval indicated that the slope of the self-efficacy variable was significant when developmental knowledge scores were outside the range [16.18, 28.72]. When maternal developmental knowledge scores were above 28.72 (+0.80 *SD* from the sample mean), self-efficacy was significantly and positively associated with child receptive language scores. Conversely, when maternal developmental knowledge scores were below 16.18 (−2.42 *SD* from the sample mean), self-efficacy was significantly and negatively associated with child receptive language scores. The standardized regression coefficients for self-efficacy ($\beta = -3.23$), developmental knowledge ($\beta = -3.34$), and their interaction ($\beta = 5.31$) represent large effect sizes (Ferguson, 2009).

Expressive. The average expressive standard score was 90.20 ($SD = 18.84$). Self-efficacy ($B = -4.77$, $p = .022$, $p_{adj} = .022$), developmental knowledge ($B = -15.87$, $p = .009$, $p_{adj} = .014$), and the Efficacy × Knowledge interaction ($B = 0.21$, $p = .008$, $p_{adj} = .014$) were significantly associated with children's expressive language standard scores after controlling for child age, $F(4, 25) = 9.55$, $p < .001$, adj-$R^2 = .54$. A plot of the Efficacy × Knowledge interaction is provided in Figure 3. The J-N interval revealed that the slope of the self-efficacy variable was significant for developmental knowledge scores outside the range [11.53, 25.06]. When maternal developmental knowledge scores were above 25.06 (−0.14 *SD* from the sample mean), self-efficacy was significantly and positively associated with child expressive language scores. Conversely, when maternal developmental knowledge scores were below 11.53 (−3.62 *SD* from the sample mean), self-efficacy was significantly and negatively associated with child expressive language scores. Importantly, the observed range of scores on the knowledge measure was [14, 32], so the lower bound of the J-N interval represents a predicted value. The standardized regression coefficients for self-efficacy ($\beta = -2.65$), developmental knowledge ($\beta = -3.27$), and their interaction ($\beta = 4.99$) represent large effects (Ferguson, 2009).

Maternal Input Quantity and Diversity

Mothers produced 59.19 ($SD = 22.29$) total and 22.67 ($SD = 6.00$) different words per minute on average. Neither maternal self-efficacy, developmental knowledge, nor the interaction term was significantly associated with the number of total, $F(3, 23) = 0.65$, $p = .590$, or different, $F(3, 23) = 0.99$, $p = .414$, words mothers produced per minute.

Mother–Child Interaction Quality

On average, there were 2.41 ($SD = 1.86$) adult-initiated and 3.68 ($SD = 2.06$) child-initiated conversational turns per minute. Only self-efficacy (i.e., not developmental knowledge) was significantly and positively associated with ($B = 0.06$, $p = .013$) the rate at which mothers responded to their children's utterances responses, controlling for ethnicity and the number of child utterances, $F(3, 22) = 25.66$, $p < .001$, adj-$R^2 = .75$. Thus, mothers with higher self-efficacy more readily responded to their children than those with lower self-efficacy after accounting for differences in the number of child utterances. The standardized regression coefficient for maternal self-efficacy ($\beta = 0.32$) represents a small effect size (Ferguson, 2009). Self-efficacy was not significantly associated with the rate at which children responded to parents' productions (i.e., the adult-initiated conversational

Table 2. Regression models for child language, input quantity, and input/interaction quality.

Model	*B*	95% CI for *B*	*SE B*	β	*p*	*F*	Adjusted R^2
Receptive Language[a]					.012	3.58	.35
Intercept	439.58	[130.66, 748.50]	149.33		.007		
Child age (months)	–1.77	[–2.93, –0.61]	.56	–.50	.004		
Child sex (female)	8.39	[–1.64, 18.42]	4.85	.29	.097		
Mother education	–9.86	[–20.27, .55]	5.03	–.35	.062		
Developmental knowledge	–12.43	[–23.83, –1.04]	5.51	–3.34	.034		
Self-efficacy	–4.45	[–8.46, –.45]	1.94	–3.23	.031		
Efficacy × Knowledge	.17	[.03, .32]	.07	5.31	.024		
Expressive Language[a]					< .001	9.55	.54
Intercept	476.28	[164.28, 788.29]	151.49		.004		
Child age (months)	–1.80	[–3.01, –.60]	.59	–.39	.005		
Developmental knowledge	–15.87	[–27.48, –4.26]	5.64	–3.27	.009		
Self-efficacy	–4.77	[–8.81, –.73]	1.96	–2.65	.022		
Efficacy × Knowledge	.21	[.06, .36]	.07	4.99	.008		
Mother total words per minute					.590	.65	N/A
Intercept	201.54	[–372.69, 775.78]	277.59		.475		
Developmental knowledge	–6.68	[–27.94, 14.58]	10.28	–1.22	.522		
Self-efficacy	–2.01	[–9.48, 5.45]	3.61	–.97	.582		
Efficacy × Knowledge	.09	[–.18, .37]	.13	1.92	.497		
Mother different words per minute					.414	.99	N/A
Intercept	2.62	[–149.00, 154.25]	73.30		.972		
Developmental knowledge	.30	[–5.32, 5.91]	2.71	.20	.914		
Self-efficacy	.17	[–1.80, 2.14]	.95	.31	.858		
Efficacy × Knowledge	–.0008	[–.07, .07]	.04	–.06	.982		
Child-led conversational turns per minute					< .001	25.66	.75
Intercept	–4.34	[–8.46, –.22]	1.99		.040		
Hispanic/Latinx	1.20	[.21, 2.19]	.48	.30	.020		
Child utterances	.46	[.33, .58]	.06	.82	< .001		
Self-efficacy	.06	[.01, .11]	.02	.32	.013		

[a]Preschool Language Scales–Fifth Edition (Zimmerman et al., 2011, 2012).

turn rate) after adjusting for the number of maternal utterances per minute, $F(2, 23) = 0.68$, $p = .518$.

Discussion

Overview

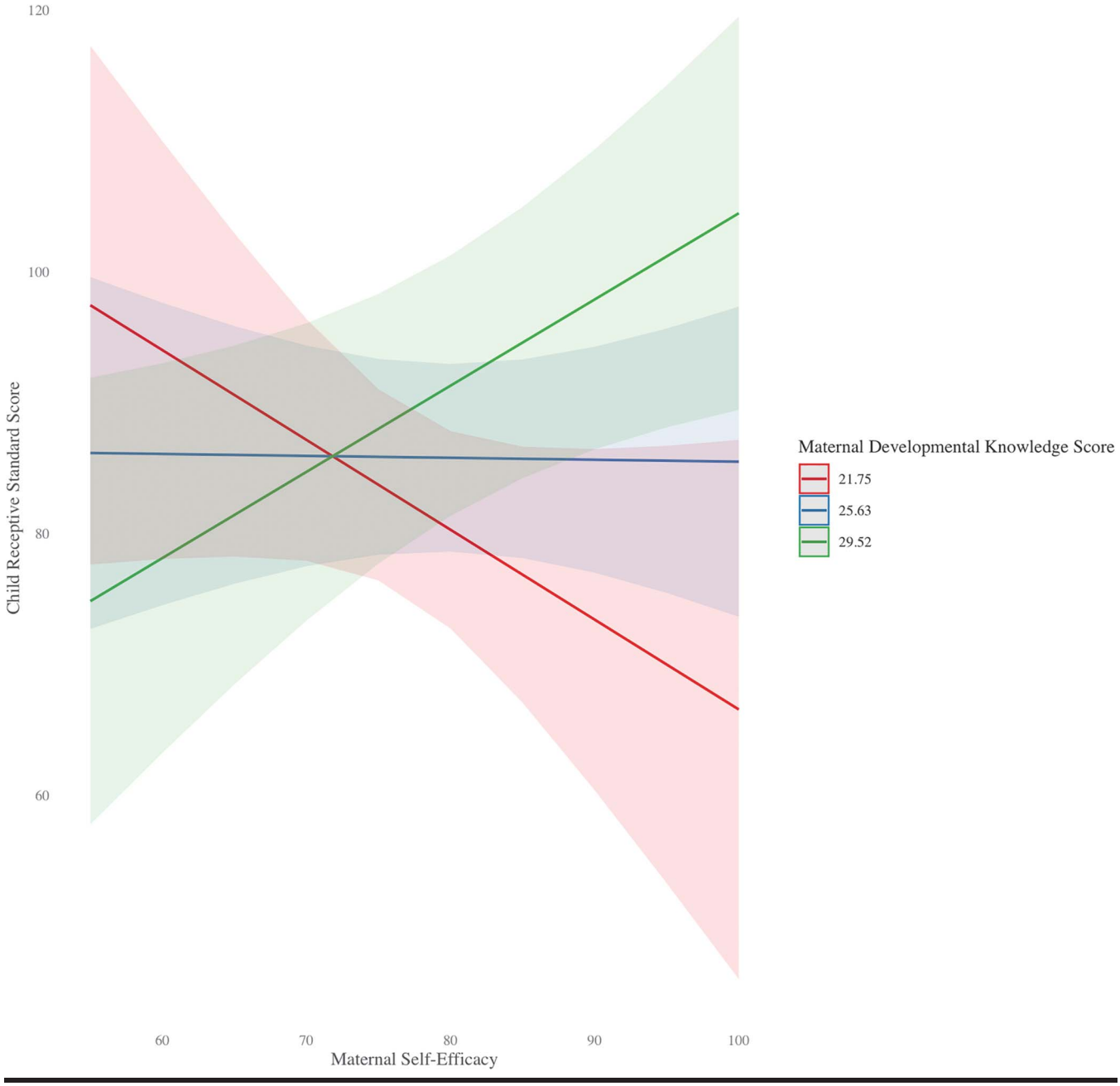
Identifying modifiable parent characteristics associated with early language interaction quality is critical to improving children's long-term outcomes. Characteristics such as SES have been studied extensively (Hoff, 2013; Huttenlocher et al., 2010) and are helpful to inform group-level public health practices. However, SES is a multidimensional construct, there are large intragroup differences (Golinkoff et al., 2019; Hirsh-Pasek et al., 2015; Sperry et al., 2018), and it is not directly modifiable in most early language interventions. These limitations have motivated research on modifiable characteristics that are clinically meaningful at the individual level (e.g., Albanese et al., 2019).

This study expanded this line of research on the role of modifiable individual differences in early language interaction. Specifically, we examined if and how child language ability, parent language input, and interaction quality varied based on parenting efficacy perceptions and developmental knowledge. Our data showed large variability within an all low-SES sample. Some of this variability was explained by differences in parenting efficacy perceptions and developmental knowledge. Furthermore, these data suggest that there may be more precise risk indicators for low input quantity and interaction quality than SES.

Specifically, we observed that maternal self-efficacy, developmental knowledge, and the Efficacy × Knowledge interaction were significantly associated with variability in child receptive and expressive language abilities. Controlling for covariates, the relationship between maternal self-efficacy and child language was only positive in the context of approximately average (expressive) or above average (receptive and expressive) developmental knowledge. Furthermore, self-efficacy was significantly and negatively associated with child language scores when maternal developmental knowledge was well below average (−2.42 and −3.62 *SD* for receptive and expressive). These were large effect sizes (Ferguson, 2009). Only self-efficacy—not developmental knowledge—was significantly and positively associated with the child-initiated conversational turn rate with a small effect size (Ferguson, 2009). After controlling for maternal ethnicity and number of child utterances, mothers with higher parenting self-efficacy responded more frequently to their children's utterances than those with lower self-efficacy. Neither self-efficacy nor developmental knowledge was significantly associated with the number of different or total words mothers used per minute during the dyadic interactions.

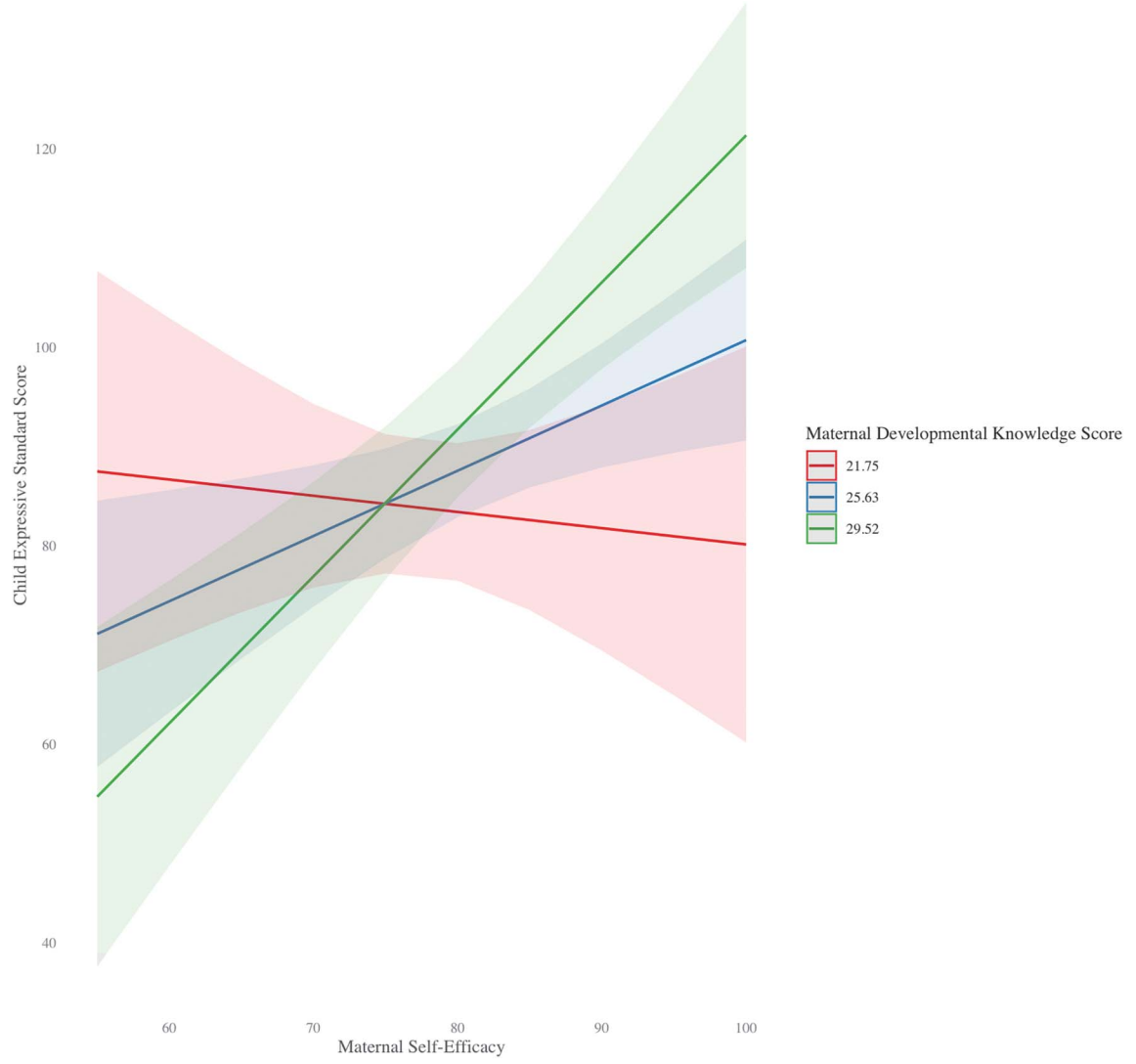
The significant Self-Efficacy × Developmental Knowledge interaction we observed related to child language is

Figure 2. Efficacy × Knowledge interaction and child receptive language standard scores. Preschool Language Scales–Fifth Edition Auditory Comprehension standard scores (Zimmerman et al., 2011, 2012). Developmental knowledge levels shown are the sample mean and ± 1 *SD*. 95% confidence intervals are presented for each level of developmental knowledge.



consistent with previous research (Conrad et al., 1992; Hess et al., 2004) and our initial predictions. As anticipated, maternal self-efficacy was significantly and positively associated with children's language abilities only when mothers also had developmental knowledge at (expressive) or above the mean (expressive and receptive). Importantly, this interaction could also be interpreted symmetrically such that high developmental knowledge is only a significant predictor in the presence of high self-efficacy. However, we focused on the interpretation of developmental knowledge as the moderator because the thresholds are more readily interpretable. Furthermore, this approach allows for easier comparison of our findings with previous work. In contrast to previous work, only self-efficacy—not developmental knowledge—was significantly associated with interaction quality in the form of maternal responses

Figure 3. Efficacy × Knowledge interaction and child expressive language standard scores. Preschool Language Scales–Fifth Edition Expressive Communication standard scores (Zimmerman et al., 2011, 2012). Developmental knowledge levels shown are the sample mean and ± 1 *SD*. 95% confidence intervals are presented for each level of developmental knowledge.



to child utterances (Conrad et al., 1992; Hess et al., 2004).

The demographics of our sample (e.g., all families in low-SES households) and outcomes (e.g., specific elements of interaction quality) of our study also differed from similar prior research (Conrad et al., 1992; Hess et al., 2004). Thus, additional research is needed to explore profiles of parent self-efficacy and developmental knowledge within a demographically diverse cohort across a variety of outcomes. Importantly, we observed large variability within participants from very low SES households, with a relatively small sample size, and after robust adjustments for multiple testing. However, our small sample size could also have contributed to some of the nonsignificant findings. We discuss the findings related to each outcome.

Child Language

Controlling for demographic characteristics, mothers' self-efficacy beliefs, developmental knowledge, and the Efficacy × Knowledge interaction were significantly associated with receptive and expressive child language. The models explained 35% (receptive) and 54% (expressive) of the variance in children's language. The interaction plots and J-N intervals (see Figures 2 and 3) revealed that maternal self-efficacy perceptions were positively associated with children's language scores only when mothers also had strong developmental knowledge. In the presence of low developmental knowledge, maternal self-efficacy was negatively associated with child language scores. The lowest predicted language scores are for children whose mothers have mixed high-low or low-high efficacy and knowledge scores.

We did not make causal assumptions, nor are we drawing causal inferences in this study. Rather, we were interested in examining differences to generate future hypotheses to test experimentally. Particularly regarding child language, it is important to consider the possibility of bidirectional influence between child language and maternal characteristics (e.g., the transactional model; Sameroff, 2010). For instance, a mother might have lower perceived self-efficacy if her child struggles to learn language in the presence of adequate input. However, we would be less likely to expect developmental knowledge to be influenced by child language status. For example, mothers with high developmental knowledge might have low self-efficacy if their child struggles to learn language (i.e., the mother knows what to expect developmentally but does not feel able to effect change in her child's language). The potential bidirectionality of the relationship and the large interaction effects merit further study.

Quantity and Quality

Self-efficacy and developmental knowledge were not significantly associated with the number of different or total words mothers produced per minute. The limited power could explain some nonsignificant differences. However, our finding is also consistent with that of Vernon-Feagans et al. (2008), who observed that developmental knowledge mediated the relationship between maternal education and input complexity but not the quantity composite. Examining the nature and quantity of input remains important for characterizing nuanced parent–child interaction. However, growing evidence suggests that measures of interaction quality might be more powerful predictors of language outcomes (Hirsh-Pasek et al., 2015). Conversational turns have been connected via behavioral and neural data to language development (Romeo et al., 2018).

We did not extrapolate across time, but there is potential for sizable cumulative differences in the number of conversational turns over time. Thus, it is important to consider modifiable characteristics—such as developmental knowledge and parenting perceptions—when examining interaction quality variability. These findings have clinical implications for understanding how parent characteristics can influence interaction quality and child language development. This was an observational study, but our data demonstrated that parents' self-efficacy beliefs and developmental knowledge are not always in alignment. Future research and clinical practice can consider how to support parents' beliefs in their ability to effect change while also increasing knowledge of developmental expectations. We do not discount SES as a group-level factor to consider in public policy decisions. Rather, the current findings support the need to identify proximal, modifiable factors to shape individual clinical decision making.

Limitations

This exploratory investigation involved secondary analyses of baseline data from a longitudinal study. There were several limitations, including the relatively small sample size, which limited power and could explain nonsignificant findings. The observational, cross-sectional data limited our ability to infer directionality, especially for child language. Furthermore, there could be nonobvious or nonmeasured contributors that might explain our findings. Following previous literature (e.g., Romeo et al., 2018), we identified conversational turns as a pair of responsive, temporally contingent behaviors. We excluded nonresponsive behaviors, but some temporally proximal utterances might be topically unrelated. Future prospective, experimental research can help test causal assumptions. Experimental manipulations are needed if modifying efficacy and knowledge affects interaction quality and child language. We characterized children's language exposure (i.e., English, Spanish, or both), and participants had to be able to receive services in English, but heterogeneity could have influenced our findings.

Conclusions

Understanding sources of variability in early interaction quality and child language ability is critical to improving long-term outcomes. Low SES is a group-level risk factor but is minimally useful as an individual clinical indicator. To identify meaningful, individual parent characteristics, this study examined differences in child language ability and interaction quality based on maternal self-efficacy and developmental knowledge within a low-SES sample. We found a significant Efficacy × Knowledge interaction in modeling children's receptive and expressive language scores. Maternal self-efficacy was positively associated with child language scores only when accompanied by robust developmental knowledge. Maternal self-efficacy was significantly and positively associated with the frequency with which mothers responded to their children's utterance (i.e., child-initiated conversational turn rate). These data can inform identification of families who might need services, intervention design, and future research.

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