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How does the family environment affect toddlerhood language and cognitive development? Evidence from peri-urban China

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ABSTRACT

Research suggests that elements of the family environment may have significant associations with cognitive and language development outcomes. Less is known, however, about the family environment in peri-urban China, where rates of cognitive and language delay in children aged 0-3 years are as high as 51% and 54%, respectively. Using data collected from 81 peri-urban households with toddlers aged 18-24 months in Southwestern China, this study examines the associations between stimulating parenting practices, the home language environment, and parental self-efficacy, with cognitive and language development. The results indicate that stimulating parenting practices was significantly associated with cognitive development, the home language environment was significantly associated with language development, and parental self-efficacy was significantly associated with cognitive development. The implications of such findings reveal several mechanisms for supporting healthy cognitive and language development among toddlers from peri-urban China.

Introduction

Decades of cross-disciplinary research have established the importance of early language and cognitive development in laying the foundation for lifelong development. The first three years of life, especially, is a critical developmental period (Demir-Lira et al., 2019; Black et al. 2017). Cognitive development between the ages of 0 and 3 years is predictive of complex skills development in later childhood, while early language development affects school-age language and cognitive outcomes, as well as long-term learning (Gilkerson & Richards, 2009; Attanasio, 2015). However, early adversities such as infectious disease, malnutrition, poverty, and limited access to high-quality healthcare and educational resources—which are all most prevalent in low- and middle-income countries (LMICs)—have been linked to higher rates of delayed development (Bai et al., 2019; McCoy et al., 2018). In fact, the rate of developmental delay in LMICs has been estimated to be as high as 43% among children under 5 years of age (Lu et al., 2016). China is an example of an LMIC where high rates of delay are concentrated in low-income settings. Rates of cognitive and language delay among children raised in low-socioeconomic status (SES), rural areas in China have been estimated to be between 45–54% and 46–61%, respectively (Emmers et al., 2021; Wang et al., 2019). Ultimately, low language and cognitive development in the first few years of life restricts children from reaching their full potential and may perpetuate the intergenerational transmission of poverty (Attanasio, 2015).

Family environment factors

The study of external factors that are associated with these developmental outcomes is crucial to identifying significant mechanisms that can possibly improve outcomes. For example, child-level factors (such as age, gender, and behaviors), have been linked to cognitive and language development outcomes in toddlers aged 22-42 months (Verhagen et al., 2022; Zhang et al., 2019). On the other hand, the family environment, which includes family-level factors like household income level or parenting practices, also affects language and cognitive development during toddlerhood (Berkes et al., 2019; Demir-Lira et al., 2019). According to Bronfenbrenner's theory on the ecology of families (Bronfenbrenner, 1979), the family environment forms a set of significant factors impacting

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early development outcomes. Bronfenbrenner developed a series of external models of family relationships, structures, and behaviors that have had an important impact on the way the family environment is understood. In this study, we focus on investigating if and how several elements of the family environment are associated with early cognitive and language development in a sample of 18- to 24-month-old toddlers from a low-income population in peri-urban Southwestern China. Based on previous research on early language and cognitive development and family environments in LMICs, including China, we chose to study the interactions between three components of the family environment—stimulating parenting practices (SPP), the home language environment, and parental self-efficacy (PSE)—and language and cognitive development outcomes.

Stimulating parenting practices

Research has identified SPP as a significant indicator of early cognitive and language development during the first three years of life (Britto et al., 2017). SPP include reading books, telling stories, and engaging in interactive play with children. In other words, SPP are enriching interactions for children that promote healthy cognitive and language development (Grantham-McGregor & Smith, 2016; Bradley et al., 2011). Using Family Care Indicators (FCI) to measure SPP, a study in Bangladesh found that the type of play, variety of play materials, and magazines and newspapers in the home were significantly associated with cognitive and language outcomes after controlling for parental educational attainment and SES (Hamadani et al., 2010). In Colombia, FCI was identified as a significant predictor of IQ and academic achievement through middle school, indicating that SPP have positive effects on cognitive and language outcomes (Rubio-Codina & Grantham-McGregor, 2020).

In China, several studies indicate that SPP is a significant factor of early cognitive and language development. A recent systematic review and meta-analysis on parental investment in rural China identified stimulating parenting as a factor of both early cognitive and language development (Emmers et al., 2021). Despite this finding, there remains a gap in the literature examining how SPP relate to the language and cognitive development of toddlers from peri-urban regions. To the best of our knowledge, only one study has examined parenting practices among peri-urban (migrant) communities in China; this study found positive associations between stimulating practices and developmental outcomes (Wang et al., 2019).

The home language environment

International research from low-, middle-, and high-income settings suggests that children who grow up in households with more adult speech and more diverse speech learn vocabulary faster, demonstrate increased processing speeds, and develop stronger language skills and higher levels of cognition (Gilkerson & Richards, 2009). The amount of adult speech (i.e., the number of words spoken by adults) a child is exposed to has been positively associated with their language skills and cognitive abilities (d'Apice & von Stumm, 2020; d'Apice et al., 2019; Hoff, 2003). Additionally, higher rates of adult-child conversations during infancy (6-14 months) have been shown to correlate with increased language and cognitive development in toddlerhood (Lopez et al., 2020; Ramírez et al., 2020). More responsive parent-child language interactions, such as asking toddlers open-ended and complex questions, encourages early cognitive and problem solving skills development and can lead to higher vocabulary and reasoning outcomes a year later (Rowe et al., 2017; Saracho, 2017). Finally, child vocalization, defined as the sounds and pre-speech noises made by children, has been studied for its ability to examine the home language environment's effects on prelinguistic vocal stages, expressive vocabulary development, and the overall development of language skills (Wang et al., 2020; Kent & Miolo, 2017).

Due to the challenging nature of recording the home language environment, naturalistic home observations of a child's exposure to adult speech are rare. However, technological advances have led to the development and wide usage of the Language Environment Analysis (LENA^{TM}) system (LENA Foundation, 2009), which is a small recording device and software system used to conduct unintrusive observation of the home language environment (Gilkerson & Richards, 2009). Using LENA, studies from Western and high-income settings have identified links between adult speech, adult-child interactions, and child vocalizations with child language and cognitive development (e.g., Romeo et al., 2018, 2021; Lopez et al., 2020; d'Apice et al., 2019; Uccelli et al., 2019; Gilkerson et al., 2018).

Although there exists a large body of research using the LENA system to study the home language environment, few studies in non-Western or LMIC settings have used LENA in practice (Ma et al., 2021; Ganek & Eriks-Brophy, 2018; Pae et al., 2016; Zhang et al., 2015). Moreover, only two LENA studies have been conducted in China, with only one conducted in a rural and low-income setting (Ma et al., 2021; Zhang

et al., 2015). In the first study, Zhang et al. (2015) explored the variations of LENA measures among urban families and their correlations with ECD; the researchers found that the quantity of adult-child conversations was positively correlated with language skills development scores (measured by Mac-Arthur Bates Communicative Developmental Inventory, MCDI) after three months of intervention. In the second study, Ma et al. (2021) investigated the home language environment of 38 families in rural Shaanxi Province and found significant variation in the quantities of adult words, adult-child conversations, and child vocalizations across sampled households. However, to the best of our knowledge, no studies using the LENA system have examined the home language environment in peri-urban China.

Parental self-efficacy

Another family environment factor, and the third factor included in this study, is PSE. Originating from Bandura's self-efficacy model, which defines self-efficacy as the sense of one's ability to produce and regulate events in one's life (Bandura, 1977, 1989), PSE is the belief in one's ability to perform competently and effectively as a parent (Teti & Gelfand, 1997). Whether a parent feels competent in their ability to care for their child can influence their ability to provide a supportive childrearing environment (Donovan et al., 1990). Research suggests that PSE supports healthy child development by promoting more engaging adult-child interactions (Gross et al., 1999). By supporting interactive parenting practices (Hess et al., 2004), PSE also promotes higher levels of parenting competence, which has been identified as a correlate of cognitive and language outcomes throughout early childhood (Jones & Prinz, 2005; Teti & Gelfand, 1997). However, the literature on the link between PSE and cognitive and language outcomes for toddlers remains mixed. Several studies have found direct positive associations between PSE and cognitive development (Weaver et al., 2008) and language development (Albarran & Reich, 2014; Coleman & Karraker, 2003) during toddlerhood (18-24 months), while others have found null associations between PSE and language development (Cunha et al., 2020; Dulay et al., 2018; Harty et al., 2007). In LMICs, a handful of studies have found no association between PSE and language development in children aged 3-5 years (Dulay et al., 2018; Harty et al., 2007), while other research has suggested that PSE has a statistically significant mediating role in the language development of younger children (Carneiro et al., 2019).

In the literature available on peri-urban populations in China, evidence suggests a positive and significant correlation between PSE and child cognitive development (Liu et al., 2020). In a sample of migrant and non-migrant families with children younger than 3 years from Shanghai, Liu et al. (2020) found that migrant caregivers had lower levels of PSE than non-migrant parents, and that PSE was a partially mediating factor of cognitive competence. Moreover, the same study found that PSE as a mediating factor of child cognition was significantly stronger among migrant households. To the best of our knowledge, this is the only study that explicitly examines PSE and cognitive development among children in this population; however, given that only cognitive competence was measured, and no children younger than 24 months were sampled, the lack of research investigating PSE and language development among toddlers in peri-urban China remains a large gap in the literature.

Cognitive and language development in peri-urban China

In the past four decades, China has experienced major economic growth (World Bank Country & Lending Groups Classification, 2021); as a result, significant inequalities between rural and urban China across income, education, and even early cognitive and language have emerged (Wang et al., 2019). In urban China, where levels of educational attainment, economic development, and human capital levels are generally higher than in rural areas, developmental delays are not particularly prevalent (Bai et al., 2019; Wang et al., 2018). The rate of delay in urban China among children under the age of 3 years ranges between 3 and 15% (Bai et al., 2019), which is considered a "healthy" rate of delay (Rozelle, 2016). In rural China—where more than half (55%) of China's population lives, including 140 million children aged 0-5 years—45% and 46% of children under the age of 5 years show signs of cognitive and language delay, respectively (Emmers et al., 2021; Liu & Ye, 2020). As the evidence demonstrates, children raised in rural China are at a greater risk of not achieving full potential over the course of life.

Although research on early development in China has highlighted disparities between rural and urban populations, significantly less research has focused on another rapidly growing demographic population: peri-urban residents. In the face of wide spread socio-economic inequality between rural and urban China,

many families have moved from rural to urban areas in search of economic opportunity. As a result, China's urbanization rate over the last 10 years has increased from 50% to 64%, with the population of rural-to-urban migrants reaching 236 million in 2019 (Liu & Ye, 2020). Due to the high cost of living in urban epicenters, many of these rural-to-urban migrants seek housing in more affordable peri-urban areas, also known as "villages-within-cities" (*chengzhongcun*) (Buckingham & Chan, 2018). Despite their urban surroundings, a majority of people living in peri-urban communities come from rural backgrounds and typically have levels of educational attainment and income similar to those in rural China (Heurlin, 2019; Tong et al., 2019). To be clear, for the purposes of this study, peri-urban China refers to rural populations living in urbanized physical spaces. Research has shown that children aged 6-30 months living in peri-urban China have higher rates of delay than both their urban and rural peers (Emmers et al., 2021; Wang et al., 2019). One study in Western China identified rates of cognitive delay to be as high as 51% among children living in resettlement migrant communities and rates of language delay as high as 54% (Wang et al., 2019). However, few studies have examined early cognitive and language development outcomes in peri-urban China. Moreover, to the best of our knowledge, there is currently no available data on the family environment and toddlerhood developmental outcomes in peri-urban China, leaving a critical gap in the literature that may be the key to understanding mechanisms of early cognitive and language development in peri-urban settings.

The present study

Preliminary evidence on the family environment in rural China shows that SPP, the home language environment, and PSE may play key roles in toddlerhood cognitive and language development. However, to date, no study has examined these three factors in relation to toddler (18-24 months) cognitive and language development among a solely peri-urban sample in China. Moreover, based on available evidence about child cognitive and language development in peri-urban China, children from peri-urban communities show signs of cognitive and language delay that are even higher than the already high rates of delay observed in rural China (Emmers et al., 2021; Wang et al., 2019). Given that child development in the earliest years of life has relatively large and wide-ranging effects on skills development and long-term life outcomes (Black et al., 2017), these rates of delay suggest that there may be certain aspects of early cognitive and language development in peri-urban China that require more attention.

This study extends the current body of research on child cognitive and language development in China by exploring evidence and theories regarding the family environment's possible contributions to early cognitive and language development among toddlers aged 18-24 months from peri-urban households in China. To guide this study, we present several research questions. First, what are the outcomes of early cognitive and language development in this sample of peri-urban toddlers? Second, how can we describe the family environment in terms of SPP, the home language environment, and PSE? Last, are there any significant associations between these elements of the family environment and toddlerhood cognitive and language development outcomes, and if so, what are those significant associations? To address this last research question, we present several hypotheses on the associations between the family environment and toddler developmental outcomes. Based on our literature review, we hypothesize that SPP will be significantly associated with cognitive and language development (Emmers et al., 2021; Wang et al., 2019); the home language environment will be significantly associated with language development (Ma et al., 2021; Zhang et al., 2015); and PSE will be significantly associated with cognitive and language development (Liu et al., 2020; Carneiro et al., 2019; Dulay et al., 2018; Harty et al., 2007).

Methods

Ethics statement

This study received ethical approval from the Stanford University Institutional Review Board (IRB) (Protocol ID 49552). All caregivers gave informed oral consent to our field survey team who were trained in the consent process. After our team provided participants with an overview of the research, participants were given time to ask questions. The participants understood that their recordings would be collected and listened to for the purposes of this study.

Study location

Data for this study were collected from households in a peri-urban district (District A) located in the eastern suburbs of a provincial capital (City A) in Southwestern China. Caregivers and children from

these households spoke Standard Mandarin and/or a provincial dialect of Mandarin. This provincial dialect comes from the Mandarin dialect and shares the same syllable structure as Standard Mandarin (Zhang, 2007), making it widely distinguishable and easily interpreted. District A is one of the most rapidly developing areas in City A: Its urbanization rate is 73%, with the majority of urbanization occurring since 2010 (City A Bureau of Statistics, 2020). Moreover, the district's average income has been rising. The average monthly income of a resident with urban *hukou,* or China's household registration system that classifies citizens as rural or urban residents and determines their social benefits accordingly (Li, 2010), was ¥3,830 ($593) in 2019, with a 9.1% increase from 2018. The average monthly income of a resident with rural *hukou* was ¥2,534 ($392) in 2019, with a 9.6% increase from 2018 (City A Bureau of Statistics, 2020).

Despite the rapid urbanization, an economic divide between rural and urban populations still exists in District A. The average per capita disposable income was ¥30,405 ($4,403) for rural residents in District A in 2019, while the average per capita income of urban residents in one of City A's central, and fully urbanized, districts was ¥49,193 ($7,613) (City A Bureau of Statistics, 2020). According to City A's Bureau of Statistics (2020), District A has 740,000 residents, of which approximately one third are legally classified as rural. Furthermore, District A is a second-tier district, meaning it has lower levels of economic development, political influence, and population size than first-tier districts and city, such as City A's five first-tier districts, which all have urbanization rates of 100% (City A Bureau of Statistics, 2020).

Sampling and surveying

We used a three-step protocol to choose the sample of peri-urban households. First, the research team obtained lists of all children who were within the target age range of 18-24 months (Zangl & Fernald, 2007) from two local hospitals in District A. We chose to sample toddlers (aged 18 to 24 months) due to the high rate of language development that occurs during this period. Most 12-month-old children are just beginning to speak and acquire new words at a slow pace (Fernald et al., 1998). At around 18 months of age, many children demonstrate a "vocabulary burst," shifting to a much faster rate of acquisition (Goldfield & Reznick, 1990), and by 18 months, they distinguish passages in which familiar functors are grammatically or ungrammatically positioned (Santelmann & Jusczyk, 1998). By age 24 months, children can typically produce 200 to 500 words (Fenson et al., 1994), and speed and accuracy in spoken word understanding increase dramatically over the second year of life (Fernald et al., 1998). Second, households were randomly screened by trained enumerators, who, via phone calls, confirmed whether each household met the eligibility criteria to be considered a peri-urban household. The eligibility criteria were based on whether households identified as rural migrants or *shidi* farmers, as defined by the Chinese government. To be considered a rural migrant, a.) the legal residence of either parent had to be a rural area outside of City A Municipality; and b.) one parent had to be living in the district for at least 6 months of the past year (*Children in China: An Atlas of Social Indicator*, 2018). To be considered a *shidi* farmer, a.) the legal residence of either parent had to be within the district; b.) all or part of the household's farmland must have been acquired by the government; and c.) any remaining land owned by the household must average to less than 200 square meters per adult (Hu, 2020). Third, from the peri-urban district, we enrolled a final sample of 109 eligible households who agreed to participate in the survey. Of these, 107 peri-urban households completed the interview data collection, and 81 households completed the LENA data collection. After conducting a balance test, we found no statistically significant differences between the demographic characteristics of the 81 households that consented to LENA data collection and the 26 households that refused the LENA data collection.

The data for the study were collected in the summer and fall of 2020. Our research team was extensively trained to follow a standardized data collection protocol and LENA recording process that lasted four days. On the first day, researchers conducted interviews at participating caregivers' homes or the local hospitals. After the survey—which included collection of early toddlerhood cognitive and language development measures, SPP, PSE, and toddler/household characteristics—researchers instructed caregivers how to use and charge the LENA recorders. During the second and third days, the households used the LENA recording devices to record two full days of household interactions between adults in the household and the toddler. Caregivers were instructed to charge the LENA recorders overnight between day 1 and day 2. On the fourth day, researchers conducted exit interviews regarding the caregivers' LENA use and retrieved LENA recorders.

Measures

Caregiver Reported Early Development Instrument

The Caregiver Reported Early Development Instrument (CREDI) was designed to serve as a population-level measure of ECD for children aged 0-3 years (Li et al., 2020; McCoy et al., 2018). The CREDI Long Form test produces both norm-referenced standardized scores (whose units can be interpreted as z-scores, but which are less appropriate for hypothesis testing) and raw scaled scores (whose units are not easily interpretable, but which are more appropriate for hypothesis testing). The CREDI Long Form produces an overall developmental score, as well as scores for each developmental domain: motor, cognitive, language, and social-emotional. For this study, we reported CREDI cognitive and CREDI language scores. Norm-referenced standardized scores were constructed by comparing the raw score in each domain to the average raw score in our CREDI reference population of a particular age. The accuracy, reliability, and validity of the CREDI have been proven in LMIC and high-income countries in both Western and non-Western settings, including China (Li et al., 2020; McCoy et al., 2018). The Cronbach alpha of CREDI for this sample is 0.713, meaning that it is a reliable measure to use.

FCI

This study used the FCI survey, developed by the United Nations (Frongillo et al., 2003), to measure SPP through caregivers' material and time investments. These indicators measure stimulation in the home environment by reporting the type and quantity of toys available to children, as well as caregiver-child play interactions. Caregivers were asked if they engaged with their child in the past three days by singing songs to their child, reading books to their child, telling stories to their child, spending time with their child in naming things, counting, or drawing, where 0 is *no* and 1 is *yes*. The reliability of the FCI survey to measure SPP has been proven in developing settings (Hamadani et al., 2010) and the survey has been adapted to the Chinese language and used in rural China in previous studies (Wang et al., 2022; Frongillo et al., 2003). FCI z-scores were used in our regression analysis. In our sample, the Cronbach alpha of FCI is 0.769, meaning that it is reliable.

LENA

To measure the home language environment, we used the LENA system, which is a recording device equipped with software to analyze the home language environment. Each child's caregiver was given a fully charged LENA recorder, a specialized LENA shirt, and a LENA charger. Following LENA validation protocols (Zhang et al., 2015), the recorder was placed in the chest pocket of the specialized shirt that the key child wore throughout the day. Caregivers were instructed to record two 16-hour days that were representative of the child's typical at-home experience, and to remove the LENA recorder and LENA-specialized shirt only when their children bathed or slept at night. In total, we collected two 16-hour recordings of "normal days" for each child. In peri-urban China, where childcare services are basically non-existent, a "normal day" consists of the primary caregivers, usually mothers and grandmothers, staying with the child in the household, with occasional visits to neighbors. We standardized the 16-hour recordings into 12-hour datasets by totaling participants' first usable 12-hour recordings to account for variation in recording start times across households, and to adjust for skewing commonly seen with count data. The LENA system produces three main measures of the home language environment: Adult Word Count (AWC) = number of adult words overheard by the child; Conversational Turns Count (CTC) = number of back-and-forth interactions between an adult and the child within 5 seconds; and Child Vocalization Count (CVC) = number of words or vocalizations made by the child. Logarithmically transformed AWC, CTC, and CVC were used in regression analysis.

LENA has been validated in different languages and linguistic contexts, including Chinese (Shanghai dialect, Shaanxi dialect, and Standard Mandarin), when compared with trained human transcribers (Ma et al., 2023; Busch et al., 2018; Ganek & Eriks-Brophy, 2018; Gilkerson et al., 2015, 2018; Canault et al., 2016; Pae et al., 2016). From China, results from Gilkerson et al. (2015) found that correlations across LENA and human annotations were strong for AWC ($r = 0.73$), but not for CTC ($r = 0.22$). A second validation of LENA for use in the Shaanxi Dialect and Standard Mandarin found that AWC, CTC, and CVC provided reasonably accurate estimates for the Shaanxi Dialect and Standard Mandarin languages when compared to human raters (Ma et al., 2023), following the same validation protocol as Gilkerson et al. (2015).

PSE

PSE was measured using a survey adapted from Cunha et al. (2013, 2020). Research has shown that PSE is correlated with child psychological functioning and adjustment, and that parents with higher self-

efficacy scores have higher levels of parenting competence and satisfaction (Jones & Prinz, 2005). The PSE survey was designed in Cunha et al. (2020) and based on items in the LENA Start enrollment form. While this survey has not been validated in other studies, Cunha et al. used an Item Response Theory Partial Credit Model (PCM) to process PSE scores to address the possibility of response bias/measurement error during surveying. The survey includes a total of four statements regarding self-efficacy in relation to parenting. Participating caregivers were instructed to read each statement and choose one response (1 through 5), with 1 representing *least sure* and 5 representing *very sure*. Scores for all four statements were aggregated to a total score out of 20 points. In the correlational analysis between PSE and the home language environment, following Cunha et al., the raw PSE scores were transformed into index scores using polychoric principal components analysis (PCA) (Kolenikov & Angeles, 2009). To provide the reliability of this survey item for this sample, the Cronbach alphas of PSE is 0.639, meaning that it is acceptable for use.

Demographic characteristics

Data on toddler and household demographic characteristics were collected from all participating households. For toddler characteristics, we collected data on each toddler's age (in months) and gender (described by indicator variables: 1 for boys and 0 for girls). In previous studies, significant differences in cognitive and language development outcomes were seen between toddlers of different ages (Gilkerson et al., 2018; Doyle et al., 2012), as well as between boys and girls (Bornstein, 2002).

We also collected data on household characteristics, which included the mother's age (in years), mother's educational attainment (1 if the mother had associate degree or above and 0 if not), mother's employment status (1 if both the mother had a job and 0 if not), father's educational attainment (1 if the father had associate degree or above and 0 if not), the number of adults in the household (in persons), the number of siblings in the household (in persons). Household characteristics related to SES, such as parents' ages, and levels of education, have been shown to be associated with child language and cognitive development (Ramírez et al., 2020; Bornstein, 2002), while household size has been studied as an influential factor in the home language environment and language development (Mayor et al., 2018).

Finally, to measure the value of household assets, we created a family asset index for all households using PCA based on whether the family owned or had access to running water, a toilet, a water heater, a washing machine, a computer, the Internet, a refrigerator, air conditioning, a motorcycle, and a car/truck (Kolenikov & Angeles, 2009).

Statistical analysis

To answer our first research question (what are the outcomes of early language and cognitive development in our sample), we perform descriptive analysis and calculate the probability density curves from norm-referenced standardized scores for CREDI cognitive and CREDI language. To answer the second research question (how to describe the family environment in terms of SPP, the home language environment, and PSE), we perform descriptive analysis to describe the prevalence of SPP, the home language environment, and PSE. To describe SPP, we produce the frequency and percentages for each FCI item. To describe the home language environment, we produce the mean and standard deviation (SD) of AWC, CTC, and CVC among all participating households. Last, to describe PSE, we produce the frequency and percent for each PSE survey item.

To answer the third research question (what are the significant associations between the family environment and toddlerhood developmental outcomes), we perform multivariate simple linear regression analysis to identify significant associations between SPP and CREDI (cognitive and language), measures of the home language environment (AWC, CTC, and CVC that were logarithmically transformed) and CREDI, and PSE and CREDI. We also perform multivariate multiple linear regression analyses to identify any significant associations between SPP and toddler cognitive and language development, the home language environment and toddler cognitive and language development, and PSE and toddler cognitive and language development. All analyses were conducted in STATA 16. P-values below 0.05 were considered statistically significant.

Results

Describing toddler and household characteristics

The descriptive statistics of our sample are displayed in Table 1. The mean age of toddlers in our sample was 21 months, and 57% of the toddlers were male. The average age of mothers in the sample was 29 years. Among mothers in the sample, 52% had

completed an associate degree or above, and 63% of mothers had a job at the time of the survey. For fathers, 52% had completed an associate degree or above. Examining household sizes, the average number of adults living in each household was three, and sampled toddlers, on average, had no siblings (SD = 1.01).

Describing SPP

Panel A of Table 2 presents data on the distribution of SPP among the sample. While 18.52% households did not have books in the household, 80.25% households reporting not having magazines or newspapers. In terms of sources of play materials, all sample children had toys bought from a store, and most toddlers played with household objects (92.59%). About one-fourth (25.93%) of the children did not have things from outside, and 48.15% of toddlers did not have home-made toys. The findings on the varieties of play materials show that almost all the toddlers in our sample had things that made music (100%) or were for moving around, such as balls or bats (98.77%). Approximately 9.88% of toddlers did not have picture books, and 13.58% of toddlers did not have things meant for stacking, constructing, or building. Another 13.58% of toddlers did not have toys for learning shapes and colors. Moreover, about 30% of toddlers had no play materials for drawing and writing, and 28.40% of toddlers did not have things for pretending. When asked about activities in the past three days, caregivers reported they rarely engaged with their toddler in interactive play activities, and on average each household did four different play activities (4.11 ± 1.63). More than two-fifths of households reported that in the last three days, they had not read books (40.74%), told stories to their toddler (48.15%), or spent time with their toddler in naming things, counting, or drawing (40.74%). Additionally, 34.57% of sample households reported that they did not sing songs to their toddler, and 13.58% reported that they did not play with their toddler using toys. Moreover, 11.11% of toddler had not been taken outside the home in the last three days.

Describing the home language environment

Panel B of Table 2 presents the distributions of LENA measures. The average AWC was 12,354 words (SD =5, 522), the average CTC was 482 (SD = 262), and the average CVC was 1,734 (SD = 749). Appendix Table 2 shows the summary statistics and quartile distribution (5th, 25th, 50th, 75th, 95th) for AWC, CTC, and CVC.

Describing PSE

Panel C of Table 2 presents the distributions of PSE survey responses. The results show that caregivers appeared relatively confident in their abilities to parent, with roughly half of caregivers believing that "I have the skills to be the best parent I can be" (50.62%) and "my toddler will do very well in school" (46.91%). About 60% of caregivers believed that "I know what my toddler should be able to do at each age as they grow" (56.79%) and "when my toddler is upset, I can easily calm him/her down" (59.26%). Moreover, 69.14% of caregivers felt relaxed most of the time when being with their toddler, and 76.54% reported that they spent a lot of time together. Almost three quarters (74.07%) of caregivers thought it was easy to talk with other parents about being a parent,

Table 1. Descriptive statistics of toddler and household characteristics (N = 81).

Variables	(1)
Toddler characteristics	
Age in months, Mean (SD)	21.10 (1.6)
Male (n, %)	46 (56.79)
Household characteristics	
Age of mother in years, Mean (SD)	29.11 (4.69)
Mother has completed an associate degree or above (n, %)	42 (51.85)
Mother has a job (n, %)	51 (62.96)
Father has completed associate degree or above (n, %)	42 (51.85)
Number of adults in the household, Mean (SD)	3.05 (1.01)
Number of siblings in the household, Mean (SD)	0.12 (0.33)
Asset index (PCA score)	0.00 (1.28)

Note: Toddler's age was coded by months; toddler's gender was described by indicator variables: 1 for boys and 0 for girls; the mother's age was coded by years; mother's educational attainment equal to 1 if the mother had associate degree or above and 0 if not; mother's employment status equal to 1 if both the mother had a job and 0 if not; father's educational attainment equal to 1 if the father had associate degree or above and 0 if not; the number of adults in the household and the number of siblings in the household were measured by persons; household assets was coded as a family asset index for all households using polychoric PCA based on whether the family owned or had access to running water, a toilet, a water heater, a washing machine, a computer, the Internet, a refrigerator, air conditioning, a motorcycle, and a car/truck.

Table 2. Frequency distributions of SPP, the home language environment, and PSE ($n = 81$).

Panel A. SPP (FCI)	Frequency (percent)
Household books	
None	15 (18.52)
1–2	4 (4.94)
3–5	12 (14.81)
>= 6	50 (61.73)
Magazine or newspapers in household	
None	65 (80.25)
1–2	7 (8.64)
3–5	5 (6.17)
>= 6	4 (4.94)
Sources of play materials	
Home-made toys	42 (51.85)
Household objects	75 (92.59)
Things from outside	60 (74.07)
Toys bought from store	81 (100.00)
Mean score ± SD (Standard Deviation)	3.19 ± 0.87
Varieties of play materials	
Things which make/play music	81 (100.00)
Things for drawing/writing	57 (70.37)
Picture books for children (not schoolbooks)	73 (90.12)
Things meant for stacking, con structing, building (blocks)	70 (86.42)
Things for moving around (balls, bats, etc.)	80 (98.77)
Toys for learning shapes and colors	70 (86.42)
Things for pretending (dolls, tea-set, etc.)	58 (71.60)
Mean score ± SD (Standard Deviation)	6.04 ± 1.07
Play activities	
Read books or look at picture-books with child	48 (59.26)
Tell stories to child	42 (51.85)
Sing songs with child	53 (65.43)
Take child outside home place	72 (88.89)
Play with the child with toys	70 (86.42)
Spend time with child in naming things, counting, drawing	48 (59.26)
Mean score ± SD (Standard Deviation)	4.11 ± 1.63
Panel B. The home language environment (LENA outcomes)	**Mean (SD)**
Adult word count (AWC)	12,354 (5,522)
Conversational turn count (CTC)	482 (262)
Child vocalization count (CVC)	1,734 (749)
Panel C. PSE	**Frequency (percent)**
I have the skills to be the best parent I can be	41 (50.62)
My child will do very well in school	38 (46.91)
I know what my child should be able to do at each age as they grow.	46 (56.79)
When my child is upset, I can easily calm him/her down	48 (59.26)
I am relaxed most of the time when I'm with my baby.	56 (69.14)
My family spends a lot of time together	62 (76.54)
It's easy for me to talk with other parents about being a parent	60 (74.07)
It's easy for me to ask other parents for help or advice if I need to	64 (79.01)

Note: Stimulating parenting practices (SPP, measured by Family Care Indicators, or FCI), the home language environment (measured by Adult Word Count or AWC, Conversational Turn Count or CTC, and Child Vocalization Count or CVC), and parental self-efficacy (PSE) are factors of early child development (ECD). FCI measure the prevalence of parental investment. AWC, CTC, and CVC are measures of the home language environment. PSE measures a parent's belief in their ability to perform the parenting role competently and is measured on a Likert-type scale of four statements pertaining to self-efficacy where parents choose one (out of five) alternative that ranges from *least sure* to *very sure*.

and 79.01% believed it was easy to ask other parents for help or advice.

Associations between SPP and language and cognitive development outcomes

Table 3, Row 1 presents the multivariate simple linear regression analysis results between SPP and language and cognitive development outcomes. Appendix Figures 1 and 2 present the distributions of toddler cognitive and language development outcomes of the sample, measured by CREDI. As summarized in Table 3, FCI z-scores were significantly and positively associated with higher CREDI cognitive scores ($p < 0.01$), but not with CREDI language scores. Specifically, a higher FCI z-score (by 1 SD) corresponded to higher CREDI language scores by 0.26 SD.

Table 4 reports the results of multivariate multiple linear regressions between FCI and CREDI cognitive and language scores, while controlling toddler and household variables. Table 4 shows that the

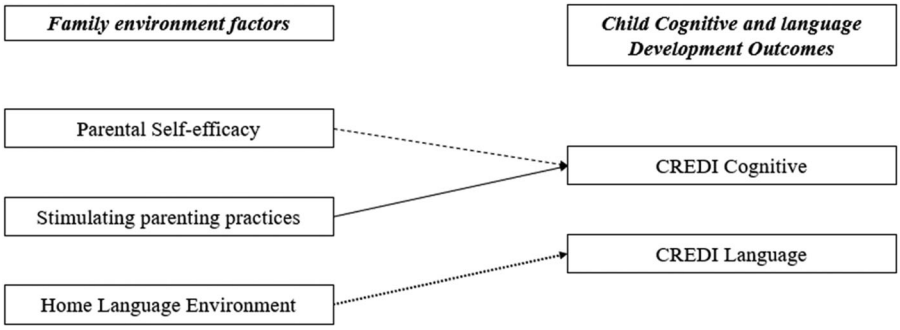

Figure 1. Structural equation model showing multivariate multiple linear regression analysis: associations between family environment factors and toddler cognitive and language development.
Stimulating parenting practices (measured by Family Care Indicators, or FCI), the home language environment (measured by Adult Word Count or AWC, Conversational Turn Count or CTC, and Child Vocalization Count or CVC), and parental self-efficacy (PSE) are factors of early child development (ECD). FCI measure the prevalence of parental investment. AWC, CTC, and CVC are measures of the home language environment. PSE measures a parent's belief in their ability to perform the parenting role competently and is measured on a Likert-type scale of four statements pertaining to self-efficacy where parents choose one (out of five) alternative that ranges from least sure to very sure. ECD outcomes are measured by the Caregiver Reported Early Development Instrument (CREDI), which produces scores of cognitive development and language development.

Table 3. Multivariate simple linear regression analysis: associations between family environment factors and CREDI cognitive and language scores.

Variables		CREDI cognitive (1)	CREDI language (2)
(1)	FCI z-score	0.26**	0.24
		(0.10)	(0.13)
(2)	lnAWC	0.08	0.69*
		(0.22)	(0.28)
(3)	lnCTC	0.24	0.79**
		(0.20)	(0.24)
(4)	lnCVC	0.30	0.82**
		(0.25)	(0.31)
(5)	PSE PCA score	0.17**	0.13
		(0.06)	(0.09)

Note: Standard errors in parentheses. Stimulating parenting practices (SPP, measured by Family Care Indicators, or FCI), the home language environment (measured by Adult Word Count or AWC, Conversational Turn Count or CTC, and Child Vocalization Count or CVC), and parental self-efficacy (PSE) are factors of early child development (ECD). FCI measure the prevalence of parental investment. AWC, CTC, and CVC are measures of the home language environment. PSE measures a parent's belief in their ability to perform the parenting role competently and is measured on a Likert-type scale of four statements pertaining to self-efficacy where parents choose one (out of five) alternative that ranges from *least sure* to *very sure*. Early childhood development outcomes are measured by the Caregiver Reported Early Development Instrument (CREDI), which produces scores of cognitive development and language development. 1% increase of home language environment outcomes (AWC, CTC, and CVC) is associated with beta/100 SD change in outcome variable. $^{**}p < 0.01$, $^{*}p < 0.05$.

association between FCI and CREDI cognitive remained statistically significant and positive after controlling for toddler and household characteristics ($p < 0.05$). Specifically, higher FCI z-scores by 1 SD corresponded to higher CREDI language scores by 0.23 SD, after controlling for toddler and household characteristics. However, FCI was no longer significantly associated with CREDI cognitive scores when controlling for LENA outcomes and PSE (Appendix Table 1).

Table 4. Multivariate multiple linear regression analysis: associations between SPP and CREDI cognitive and language scores, controlling toddler and household characteristics.

Variables		CREDI cognitive (1)	CREDI language (2)
(1)	FCI z-score	0.23*	0.08
		(0.11)	(0.13)
(2)	Controls	Yes	Yes
(3)	Observations	81	81
(4)	R-squared	0.22	0.32

Note: Family Care Indicators (FCI) measures the prevalence of stimulating parenting practices (SPP). Early childhood development (ECD) outcomes are measured by the Caregiver Reported Early Development Instrument (CREDI), which produces scores of cognitive development and language development. 1% increase of home language environment outcomes (AWC, CTC, and CVC) is associated with beta/100 SD change in outcome variable. $^{**}p < 0.01$, $^{*}p < 0.05$.

Associations between the home language environment and language and cognitive development outcomes

Table 3 also presents the multivariate simple linear regression analysis results between the home language environment and language and cognitive development outcomes. Specifically, the results of Table 3 report associations of AWC, CTC, and CVC to CREDI cognitive and CREDI language scores. As shown in Table 3, toddlers with higher AWC, CTC, and CVC had higher CREDI language scores ($p < 0.05$, $p < 0.01$, and $p < 0.01$ respectively). Higher AWC, CTC, or CVC by 1% corresponded to higher CREDI language scores by 0.0069 SD, 0.0079 SD, or 0.0082 SD respectively.

Table 5 reports the results of multivariate multiple linear regressions between the home language environment and CREDI, while controlling toddler and household variables. In Table 5, we see that when controlling toddler and household characteristics,

Table 5. Multivariate multiple linear regression analysis: associations between home language environment measures and CREDI cognitive and language scores, controlling toddler and household characteristics.

		Panel A: CREDI cognitive		
		(1)	(2)	(3)
(1)	lnAWC	−0.13		
		(0.23)		
(2)	lnCTC		0.04	
			(0.23)	
(3)	lnCVC			0.15
				(0.28)
(4)	Controls	Yes	Yes	Yes
(5)	Observations	81	81	81
(6)	R-squared	0.18	0.17	0.17
		Panel B: CREDI language		
		(1)	(2)	**(3)**
(1)	lnAWC	0.51		
		(0.27)		
(2)	lnCTC		0.53*	
			(0.26)	
(3)	lnCVC			0.47
				(0.33)
(4)	Controls	Yes	Yes	Yes
(5)	Observations	81	81	81
(6)	R-squared	0.35	0.35	0.33

Note: Standard errors in parentheses. LENA measures (Adult Word Count or AWC, Conversational Turn Count or CTC, and Child Vocalization Count or CVC) are measures of the home language environment. Early childhood development (ECD) outcomes are measured by the Caregiver Reported Early Development Instrument (CREDI), which produces scores of cognitive development and language development. 1% increase of home language environment outcomes (AWC, CTC, and CVC) is associated with beta/100 SD change in outcome variable. $^{**}p < 0.01$, $^{*}p < 0.05$.

CTC was the only significant and positive association with CREDI language scores ($p < 0.05$). Specifically, higher CTC (by 1%) was significantly associated with higher CREDI language scores by 0.0053 SD. CTC was also significantly and positively associated with CREDI language scores ($p < 0.05$) after controlling for FCI and PSE (Appendix Table 1). Higher CTC (by 1%) was significantly associated with higher CREDI language scores by 0.0054 SD after controlling for FCI and PSE.

Associations between PSE and language and cognitive development outcomes

Table 3 additionally presents the multivariate simple linear regression analysis results between PSE and language and cognitive development outcomes. Specifically, the results of Table 3 report associations of PSE measures to CREDI cognitive and CREDI language scores. Summarized in Table 3, PSE was significantly associated with CREDI cognitive scores ($p < 0.01$), but not with CREDI language scores. Specifically, a higher PSE score by 1 SD was significantly associated with higher CREDI cognitive scores by 0.17 SD.

Table 6. Multivariate multiple linear regression analysis: associations between parental self-efficacy (PSE) and CREDI cognitive and language scores, controlling toddler and household characteristics.

Variables		CREDI cognitive (1)	CREDI language (2)
(1)	PSE PCA score	0.17*	0.13
		(0.07)	(0.08)
(2)	Controls	Yes	Yes
(3)	Observations	81	81
	R-squared	0.24	0.34

Note: Standard errors in parentheses. PSE measures a parent's belief in their ability to perform the parenting role competently and is measured on a Likert-type scale of four statements pertaining to self-efficacy where parents choose one (out of five) alternative that ranges from least sure to very sure. Early childhood development (ECD) outcomes are measured by the Caregiver Reported Early Development Instrument (CREDI), which produces scores of cognitive development and language development. $^{**}p < 0.01$, $^{*}p < 0.05$.

Table 6 reports the results of multivariate multiple linear regressions between PSE and CREDI, while controlling toddler and household variables. Table 6 shows that the association between PSE and CREDI cognitive remained statistically significant after controlling for toddler and household covariates ($p < 0.05$), and the association remained statistically significant after controlling for FCI and LENA outcomes ($p < 0.05$, see Appendix Table 1). Specifically, higher PSE scores (by 1 SD) were significantly associated with higher CREDI cognitive scores by 0.17 SD and 0.16 SD, respectively, after controlling for toddler and household covariates, and after controlling for FCI and LENA outcomes. To display these relations visually, we summarize the significant correlations between family environment factors and cognitive and language development in a structural equation model (Figure 1).

Discussion

In this paper, we presented the first ever findings on contributions of family environment factors (SPP, the home language environment, and PSE) to early language and cognitive development outcomes among 81 toddlers aged 18–24 months from peri-urban households in Southwestern China. The results demonstrated that caregivers had moderate levels of SPP and moderately high levels of PSE. In addition, the toddlers on average heard 12,354 adult words, had 482 conversations with adults, and made 1,734 vocalizations in a 12-hour period. To better understand the effects of these factors on early language and cognitive development outcomes, we tested three hypotheses with multivariate multiple linear regression analyses. First, we found that the SPP was significantly and

positively associated with cognitive development, but not language development. Second, the home language environment was a significant and positive factor of language development, but not of cognitive development. And finally, PSE was significantly and positively associated with cognitive development, but not with language development.

Family environment factors: peri-urban China and international comparisons

Overall, our results demonstrated that peri-urban caregivers had moderate levels of SPP, suggesting that they invest more like caregivers from urban China than caregivers from rural China. On average, more than half of the peri-urban caregivers read books and told stories to their children on a regular basis; even more caregivers frequently sang to their children. According to the literature, 50% of caregivers from urban areas in the same province as our sample read books to their child every day, with 64% reading books to their child at least once every two days (Guo, 2016). Comparatively, a recent systematic review (Emmers et al., 2021) found that, on average, 23% of rural families across Western China read with their children on a regular basis and 25% told stories to their children. Frequent engagement in singing was somewhat higher, at 45%.

In developing settings, low levels of SPP are common (Nonoyama-Tarumi & Ota, 2011; Walker et al., 2007). For example, a study in rural Malawi found that households with children under 2 years scored relatively low on FCI measures, including toy availability and parent-child interaction, before the implementation of a parenting training program (Gladstone et al., 2018). Similarly, in a study conducted among households with children under 2 years in peri-urban Peru, Rothstein et al., (2021) found low levels of SPP, particularly in the domains of reading and storytelling with the child. Up to 60% of parents in the same study reported that they read to their children less than once a month or not at all—even less often than the parents in our sample. In the specific context of China, the low prevalence of SPP observed in rural areas may be seen as a reflection of the economic inequality that demarcates rural and urban areas, as financial stress, time constraints, knowledge constraints, and mental health problems associated with such inequality may limit rural caregivers in their parental investments (Emmers et al., 2021). Despite many of the caregivers in our study coming from rural backgrounds (either as rural migrants who moved from rural regions to peri-urban communities, or as *shidi* farmers who lived rural lifestyles before the urbanization of their home environments), they appeared to invest in their children in ways similar to their urban peers. A previous study confirms this difference in parental investment between rural and peri-urban caregivers: Wang et al. (2019) reported that migrant caregivers outperformed rural caregivers in how much time they spent reading books, telling stories, and singing to children. We hypothesize that the nominally increased access to caretaking resources (such as stores) in peri-urban spaces allow peri-urban caregivers to engage in more SPP than rural caregivers; however, more in-depth research is needed to fully understand what underlies this trend.

In contrast to the moderate levels of SPP among caregivers from peri-urban China, measures of the home language environment were relatively low, though there was large variation across all measures. When we compared our findings to those from rural or peri-urban settings in other countries, we saw variation in home language environments across countries. Compared to a study conducted in peri-urban households in South Africa, the CTC (458) of infants aged 21-28 months was similar to our samples (CTC = 482) (Dowdall, 2019). However, another study conducted among low-SES families in rural Senegal reported higher CTC (654) when extrapolated from hourly data into a 12-hour comparable total (Weber et al., 2017). In peri-urban Vietnam, when extrapolated from 5-minute data into a 12-hour comparable total, the CTC (360) of toddlers aged 22–47 months was lower than that of our sample (Ganek & Eriks-Brophy, 2018).

Comparing our results to past studies from China, we found that measures of the home language environment in peri-urban households were lower than those previously observed in rural and urban households in China. Toddlers in our peri-urban sample, on average, heard 1,074 fewer adult words, had 77 fewer adult-child interactions, and made 406 fewer vocalizations than a previously studied sample of toddlers in rural Shaanxi, who were the same age as toddlers in our study (Ma et al., 2021). One possible explanation for this disparity is that caregivers in peri-urban China may face unique challenges not encountered in rural China, including a lack of permanent housing, separation from family members, mental health issues, or limited access to health care, which may be associated with how much adult-speech they use with their toddlers and how many interactions they have (Zhan, 2011; Chen et al., 2016). In addition,

the households in our study reported lower home language environment measures than a previously studied sample of households in urban Shanghai (Zhang et al., 2015). There are three likely reasons for this disparity. First, in our sample, 52% of mothers and fathers had completed an associate degree or above, whereas 100% of parents in the Shanghai sample had completed a college degree or above. Second, in 2020, the urbanization rate of Shanghai's permanent population reached 89% (Shanghai Bureau of Statistics, 2020), greater than the 79% urbanization rate of the sampled province in our study (City A Bureau of Statistics, 2021). Third, per capita disposable income of rural households was ¥26,432 ($3,830) (City A Bureau of Statistics, 2021), only three-quarters that of Shanghai (¥34,911, or $5,060) (Shanghai Bureau of Statistics, 2021). Perhaps because of these household advantages, the urban children in Zhang et al. (2015) outperformed the toddlers from peri-urban China in our study, hearing 8,745 more adult words and having 269 more conversations with adults despite being younger than their peri-urban counterparts. As AWC, CTC, and CVC were lower in peri-urban China than in rural and urban China, more attention should be placed on researching the home language environment in peri-urban settings and designing targeted interventions for these vulnerable communities.

While limited research into PSE has been conducted in developing contexts, several previous studies have similarly shown relatively high levels of PSE among these populations. For instance, Dulay et al. (2018) found that low- and middle-income mothers in the Philippines had an average score of 5.24 on a 6-point PSE scale, indicating high confidence in their own parenting abilities. Meanwhile, in peri-urban Haiti, She et al., (2022) found that a majority (52.4%) of sampled parents reported relatively high PSE. In China, only one such study has examined the prevalence of PSE among peri-urban migrants (Liu et al., 2020), to the best of our knowledge. Most studies on PSE in China have instead been conducted among urban samples. Although we cannot directly compare our PSE results to these studies due to the use of different instruments, studies in urban China have confirmed high levels of PSE among Chinese caregivers. Gao et al. (2014) examined levels of PSE among pregnant women in Guangzhou, and identified higher levels of PSE there than in Hong Kong (Ngai & Chan, 2012). Although these studies confirm a high level of confidence in Chinese caregivers' abilities to parent, urban China and peri-urban China are characterized by differences in SES, political influence, and development; thus, comparing to urban caregivers may not be the best way to analyze such results (Li, 2010). Comparing migrant and non-migrant caregivers in the same urban city, however, Liu et al. (2020) showed that migrant caregivers had lower levels of PSE than non-migrant caregivers. One possible reason for this division may be that migrant caregivers are of lower SES than their fully urbanized peers, and are therefore at a greater risk of suffering from economic and emotional distress, which may lead to them feeling less efficacious in their abilities to act as a financially-supportive caregivers (Zhang et al., 2017). However, little attention has been devoted to studying PSE in the context of peri-urban populations in China. We believe more research is needed to better understand the prevalence of PSE.

Hypothesis testing: is the family environment associated with ECD in peri-urban China?

Given the distributions of family environment factors in this peri-urban sample, we asked in this study whether SPP, the home language environment, and PSE were associated with early language and cognitive development outcomes of toddlers aged 18-24 months from peri-urban households in China. Using both multivariate simple and multiple regression analyses, we tested three hypotheses. Our first hypothesis proposed that SPP was associated with cognitive and language development. However, our findings revealed that SPP was significantly associated with toddler cognitive development but not with language development. This finding deviates from the main international and Chinese literature (Emmers et al., 2021; Luo et al., 2019; Wang et al., 2019; Yue et al., 2019)—but why?

Looking at how caregivers demonstrated SPP, we found that higher proportions of parenting investment were in sources and varieties of play materials than in the type of play activities. More caregivers invested through giving their toddlers toys than through playing interactively with them. On one hand, as caregivers provided more adequate materials for toddlers to play with, they produced more opportunities for stimulating interaction, which positively affects cognitive development (Emmers et al., 2021; Hamadani et al., 2010; Wang et al., 2022; Wang et al., 2019). Thus, play materials may more strongly be associated with cognitive development, while interactive activities between toddlers and caregivers (i.e., reading books, singing songs) may more strongly stimulate early

language development (Emmers et al., 2021). On the other hand, the quality of interactive parental investments by peri-urban caregivers (i.e., during playtime or reading time) may be too low to be significantly associated with language development. The international literature suggests that high quality linguistic interactions (i.e., using diverse adult speech and having more adult-child conversations) are significantly correlated to language development (Romeo et al., 2021; d'Apice & von Stumm, 2020; d'Apice et al., 2019). Therefore, perhaps in peri-urban households, there was a lack of higher quality adult-child interactions which may account for the null effect of SPP on language development.

Our second hypothesis posited that the home language environment would be associated with cognitive and language development outcomes. Though international literature has identified links between the home language environment and cognitive development, our results suggested that the home language environment was a significant factor of only language development for toddlers in peri-urban communities. The number of conversations between adults and a toddler was positively and significantly associated with language development, which is consistent with previous research (Gilkerson et al., 2018). With this finding, it was not surprising that toddlers in our sample had high rates of vocalizations, which was another significant factor of their language skills development. However, contradicting other literature (Lopez et al., 2020; Ramírez et al., 2020; Gilkerson et al., 2018), we found that the home language environment was not a strong predictor of early cognitive development. As previous studies suggested that responsive parenting practices, such as asking children more open-ended, complex questions, encouraged cognitive skills development (Saracho, 2017), we believe that the quality, rather than the quantity, of adult-child conversations may matter more for early cognitive development—at least in this peri-urban sample. While the quantity of adult-child conversations was significantly associated with language development, perhaps the quality of the interactions was not high enough to have a significant association with cognitive development. Thus, the amount of conversations had in the home language environment may serve as an important mechanism for language development, yet not cognitive development, in peri-urban households.

The third and final hypothesis we tested was to determine if PSE was associated with cognitive and language outcomes among toddlers in peri-urban China. Part of our hypothesis was proven true: PSE was significantly and positively associated with cognitive development but not language development, which is consistent with Coleman and Karraker (2003) and Liu et al. (2020). In the literature, PSE has been tested as a mediating mechanism between parenting practices and children's cognitive development (Coleman & Karraker, 2003). From our literature review, the only previous study conducted among migrant communities in China found that children (younger than 3 years) whose caregivers had higher PSE reported higher levels of cognitive competence and that PSE acted as a mediating factor of parent-child interactions (Liu et al., 2020). Analyzing these findings with our results, caregivers with a stronger sense of self-efficacy may have been able to parent better and provide more interactive and enriching behaviors that supported their toddler's cognitive development.

Limitations

We acknowledge several limitations of this study. First, we acknowledge that the logistical complexity of naturalistic home language environment observation limits the duration of LENA recordings in this study. Compared to other studies that record LENA measurements on a weekly or bi-weekly schedule (Zhang et al., 2015), we recorded two days of LENA recordings for each sample household. The shorter recording duration could lead to imprecise measurements if the recordings did not reflect typical days. However, we made sure to confirm with each household that the recordings were representative of normal life, asking households to redo their recordings if there was anything irregular about the day. The second limitation is that the child development outcome measurement used in this study (CREDI) is self-reported data, reported by the primary caregiver of each child in the sample. The CREDI was designed to serve as a population-level measure of early childhood development for children from birth to the age of three years (Lopez et al., 2020; d'Apice et al., 2019; Saracho, 2017). Despite being proven as accurate, reliable, and valid in LMICs and in both Western and non-Western settings, including China (Li et al., 2020; McCoy et al., 2018), the nature of this data collection still opens itself to reporter bias. A third limitation is that our results are correlational in nature and must be interpreted cautiously. Although we identify statistically significant associations between the family environment and early developmental outcomes, these

findings are not causal and should not be overinterpreted.

Conclusions

This study presents findings on the significant factors of early child cognitive and language development among children aged 18-24 months from peri-urban households in China, and highlights several mechanisms for improving ECD outcomes in peri-urban communities. Moreover, this study presents one of the largest datasets on the included family environment factors and ECD outcomes for toddlers living in peri-urban China, marking its important contribution to the literature. Our results suggest that child cognitive development may be improved by targeting elements of the family environment, such as SPP and PSE, while child language development might be improved through improvements in the home language environment, specifically in adult-child linguistic interactions. Since 2000, China's peri-urban population, including migrants and other groups affected by urbanization, has almost doubled from 121 million to 236 million (Liu & Ye, 2020). Given the growing population and high rates of cognitive and language delays in children under 3 years of age in these communities (Wang et al., 2019), future ECD policy should focus on strengthening how caregivers invest in interactive parenting and the home language environment, as well as delegate attention for improving caregivers' levels of PSE. The rates of developmental delay in both peri-urban and rural communities stands as a unique challenge for the growth and productivity of China's economy, especially as China's demographic landscape changes with continued urbanization. Therefore, a key to China's continued economic growth rests in the healthy ECD of its future rural and peri-urban generations.

Moreover, this study makes several important contributions to the literature on early toddlerhood language and cognitive development in peri-urban China. First and most importantly, this is one of the first studies to explore evidence and theories on how SPP, the home language environment, and PSE are associated with early language and cognitive development among toddlers aged 18-24 months from peri-urban households in China. Peri-urban China is an understudied population observed to have high levels of developmental delay (Wang et al., 2019). Furthermore, as the rate of urbanization continues rising in China and more families settle in peri-urban spaces, there will be a greater need for understanding what threatens and promotes healthy early language and cognitive development among these populations. Second, this study draws on a large sample size for an observational study of the naturalistic home language environment in peri-urban China. Given the challenges of unobtrusively recording the home language environment, studies that use LENA and other recording technologies are typically limited to small samples. For example, the only existing LENA studies in rural China recorded the home language environments of 38 households (Ma et al., 2021). With a sample of 81 peri-urban households, this study makes a substantial contribution to the existing body of LENA research in China.

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Appendix

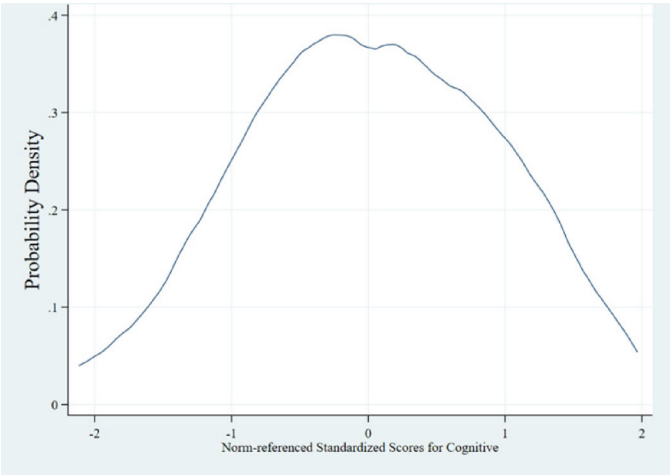

Figure A1. Descriptive statistics of CREDI cognitive scores.

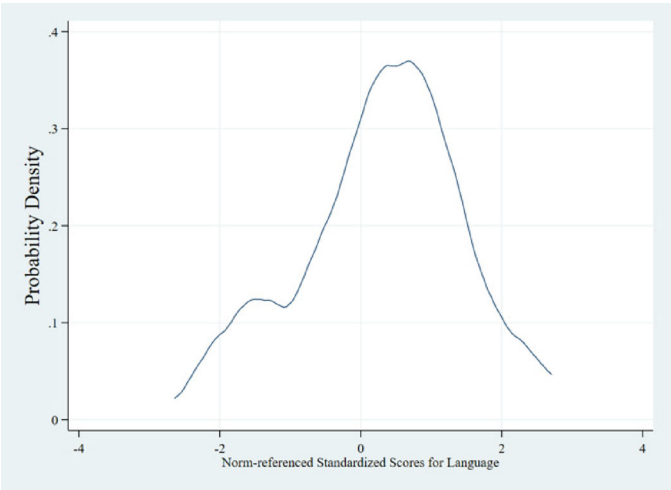

Figure A2. Descriptive statistics of CREDI language scores.

Table A1. Multivariate multiple linear regression analysis: associations between family environment factors and child cognitive and language outcomes, controlling FCI, and toddler and household characteristics.

		Panel A: CREDI cognitive		
		(1)	(2)	(3)
(1)	FCI z-score	0.21	0.20	0.20
		(0.11)	(0.11)	(0.11)
(2)	lnAWC	−0.14		
		(0.22)		
(3)	lnCTC		0.02	
			(0.21)	
(4)	lnCVC			0.20
				(0.27)
(5)	PSE PCA score	0.16*	0.16*	0.17*
		(0.07)	(0.07)	(0.07)
(6)	Controls	Yes	Yes	Yes
(7)	Observations	81	81	81
(8)	R-squared	0.28	0.28	0.28
		Panel B: CREDI language		
		(1)	(2)	(3)
(1)	FCI z-score	0.06	0.04	0.05
		(0.13)	(0.13)	(0.13)
(2)	lnAWC	0.51		
		(0.27)		
(3)	lnCTC		0.54*	
			(0.26)	
(4)	lnCVC			0.53
				(0.33)
(5)	PSE PCA score	0.13	0.13	0.14
		(0.08)	(0.08)	(0.08)
(6)	Controls	Yes	Yes	Yes
(7)	Observations	81	81	81
(8)	R-squared	0.37	0.38	0.36

Note: Standard errors in parentheses. Stimulating parenting practices (measured by FCI), the home language environment (measured by adult word count or AWC, conversational turn count or CTC, and child vocalization count or CVC), and parental self-efficacy (PSE) are factors of early child development (ECD). FCI measure the prevalence of parental investment. AWC, CTC, and CVC are measures of the home language environment. PSE measures a parent's belief in their ability to perform the parenting role competently and is measured on a Likert-type scale of four statements pertaining to self-efficacy where parents choose one (out of five) alternative that ranges from *least sure* to *very sure*. ECD outcomes are measured by the Caregiver Reported Early Development Instrument (CREDI), which produces scores of cognitive development and language development. 1% increase of home language environment outcomes (AWC, CTC, and CVC) is associated with beta/100 SD change in outcome variable. $^{**}p < 0.01$, $^{*}p < 0.05$.

Table A2. LENA summary statistics and percentiles.

LENA measures/ percentile	Mean (SD) (1)	5th (2)	25th (3)	50th (4)	75th (5)	95th (6)
AWC	12354 (5522)	4907	8173	11915	15265	22964
CTC	482 (262)	184	291	405	649	891
CVC	1734 (749)	908	1256	1545	2088	3320

Note: AWC = adult word count; CTC = conversational turn count; CVC = child vocalization count; SD = standard deviation.