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The Impact of Early Social Interactions on Later Language Development in Spanish–English Bilingual Infants

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This study tested the impact of child-directed language input on language development in Spanish–English bilingual infants (N = 25, 11- and 14-month-olds from the Seattle metropolitan area), across languages and independently for each language, controlling for socioeconomic status. Language input was characterized by social interaction variables, defined in terms of speech style ("parentese" vs. standard speech) and social context (one-on-one vs. group). Correlations between parentese one-on-one and productive vocabulary at 24 months (n = 18) were found across languages and in each language independently. Differences are highlighted between previously published monolingual samples, which used the same methods as the current study of bilingual infants. The results also suggest cultural effects on language input and language development in bilingual and bicultural infants.

According to the United States Census Bureau (2012), the Hispanic population is the largest minority living in the United States, and Spanish is the most common language used in households that report using a language other than English (i.e., 62%; United States Census Bureau, 2013). Understanding how children from bilingual households learn two languages has important implications for scientists, parents, educators, speech pathologists, and policymakers.

It is important, both theoretically and practically, to empirically examine the differences and similarities between monolingual and bilingual language development in order to understand the effects of dual language input on language development. For example, despite widespread belief that children learning two languages are at a disadvantage with regard to linguistic development (King & Fogle, 2006; Petitto, 2009; Petitto et al., 2001), research comparing monolingual and bilingual children indicates that vocabulary size is similar across groups when words in both languages in bilinguals are combined to assess total vocabulary size or TVS (e.g., Hoff et al., 2012; Holowka, Brosseau-Lapré, & Petitto, 2002; Marchman, Fernald, & Hurtado, 2009; Pearson, Fernández, & Oller, 1993; Petitto et al., 2001). Studies comparing monolingual and bilingual children can also reveal important group differences. For example, a recent study comparing 11-month-old monolingual and bilingual infants reveals interesting differences in brain activation between groups when listening to speech, particularly in prefrontal brain areas controlling attention, suggesting that bilingual language experience alters the brain very early in development (Ferjan Ramirez, Ramirez, Clarke, Taulu, & Kuhl, in press). However, much of the research investigating early language development has focused on toddlers and preschool aged children from monolingual and monocultural environments, and relatively little is known about the effects of language input to prelinguistic or bilingual/bicultural infants. It is therefore essential to investigate bilingual/bicultural infants' early language experience in longitudinal studies that examine language input and later language abilities in both the native languages of bilingual/bicultural children and compare the pattern of results to their monolingual/monocultural peers.

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In the current study, we evaluate relations between language input and language development in a group of Spanish–English bilingual infants using methods developed in a previous study of monolingual children (Ramírez-Esparza, García-Sierra, & Kuhl, 2014). Instead of relying on parental reports or short-recorded interactions, we use the LENA system (Language Environment Analysis Foundation, Boulder, Colorado) to assess everyday social interactions between adults and infants in natural settings over several consecutive days. We use a longitudinal approach, assessing social interactions when infants are 11 or 14 months old and measuring their vocabulary at 24 months of age. We evaluate language input and later vocabulary overall (i.e., without regard to the specific language), and independently for each of the languages (i.e., English and Spanish). We compare not only language milestone differences between monolinguals and bilinguals but also assess how parents from Latino bilingual cultural backgrounds are similar or different from their monolingual/monocultural peers.

This approach not only provides information that can address misconceptions about differences in monolingual and bilingual language development but can also investigate the effects of cultural background on speech to infants in their everyday lives. The current study will contribute to the small body literature that evaluates the languages and the cultural context of language input used by bilingual caregivers in natural settings and may advance our understanding of the sociocultural environments of bilingual children in the United States.

Language Input and Language Outcomes in Monolingual Children

There is a large body of research demonstrating that language experience in the home is fundamental for language learning in English monolingual children (e.g., Hart & Risley, 1995, 1999; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Ramírez-Esparza et al., 2014; Rowe, 2012; for a review, see Hoff, 2006). In a classic longitudinal study, Hart and Risley (1995, 1999) recorded 42 families for 1 hr, once a month, beginning at about 9 months of age and continuing for 2 and a half years as they interacted in a natural setting. Results indicated that the number of words produced by parents interacting with their children over time was related to the children's vocabulary. Their sample included a wide range of socioeconomic status (SES), and these investigators also found relations between SES and later language. However, they reported that language input measures were stronger predictors of later language than SES (Hart & Risley, 1995).

More recently, researchers have focused on relations between various characteristics of speech directed to toddlers and language development. Hoff (2003) recruited mothers and 2-year-old children from mid- and high socioeconomic backgrounds. Conversations were recorded twice, 10 weeks apart, in the participants' homes as the mothers dressed their children for the day, fed them breakfast, and played with toys (provided by the experimenter). Language input was evaluated in terms of the number of word tokens, mean length utterance, and number of word types produced. Child vocabulary was evaluated by the number of word types. The results showed that measures of maternal speech (i.e., number of word tokens, mean length of utterance, and number of word types) were related to children's vocabulary. Further analyses demonstrated that maternal speech accounted for most of the variance in children's vocabulary (i.e., 22%), whereas SES did not account for significant additional variance (i.e., 1%). Similar findings have been reported among monolingual Spanish-learning children (Hurtado, Marchman, & Fernald, 2008): Parental speech in Spanish at 18 months (assessed by number of word tokens, number of word types, and grammatical complexity) was unrelated to SES in a primarily low-SES sample and predicted Spanish vocabulary in toddlers at 24 months of age.

In another relevant study, Rowe (2012) recruited parent–child dyads with diverse SES. The parent and child were videotaped at home for 90 min while they engaged in their ordinary daily activities at 18, 30, and 42 months of age. The measures of parental speech were the total number of word tokens, the total number of different word types (or vocabulary diversity), and the total number of different rare words (or vocabulary sophistication) produced by parents during the 90-min interaction. In addition, occurrences of decontextualized language were coded. The Peabody Picture Vocabulary Test (PPVT), a measure of receptive vocabulary, was administered at 30, 42, and 54 months. The results showed that measures of parental speech were related to PPVT scores, even after controlling for SES. Furthermore, the specific measure of parental speech related to later vocabulary varied across time: Word tokens most important during the 2nd year of life, vocabulary diversity and sophistication during the 3rd year of life, and decontextualized language during the 4th year of life. Rowe (2012)

concluded that parents support language development by providing developmentally appropriate language input.

These studies demonstrate that a variety of measures of language input are related to child language development, and the impact of specific language input characteristics depends on the child's age and/or language ability. However, these studies focused on language input to toddlers who already produce words (i.e., about 18–24 months of age), and results may not generalize to prelinguistic infants. From their first months, infants show a strong listening preference for parentese speech (Fernald, 1985), defined as speech that is simplified at the grammatical and lexical levels with a unique acoustic and visual signature: Acoustically, it is characterized by higher pitch, slower tempo, and exaggerated intonation contours (Fernald, 1985; Grieser & Kuhl, 1988), and visually, parentese speech exaggerates articulatory gestures and social affect (Weikum et al., 2007). Many have hypothesized that parentese speech is beneficial to young language learners (Fernald, 1985; Fernald & Kuhl, 1987; Hirsh-Pasek et al., 1987; Karzon, 1985; Kemler Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989). Liu, Kuhl, and Tsao (2003) analyzed parentese speech directed to 6–8 and 10–12 months old infants in a laboratory setting. The results showed that the acoustic exaggeration in parentese speech is associated with the infants' ability to discriminate difficult computer-synthesized speech contrasts.

There is also evidence that social interaction plays a role in early language development. Kuhl, Tsao, and Liu (2003) found that 9-month-old infants show phonetic learning from live, but not prerecorded, exposure to a foreign language, suggesting a learning process that is enhanced by social interaction. Goldstein and Schwade (2008) demonstrated that when caregivers respond to babbling of 9.5-month-old infants with either fully resonant vowels or words, infants incorporated the phonological structure of caregivers' contingent utterances into their babbling and also extended their vocalizations to new phonetic forms. Ramírez-Esparza et al. (2014) also studied English monolingual prelinguistic infants, evaluating the effects of language input characterized by social interaction variables in natural settings on language development. Families with 11- or 14-month-old infants were audio recorded as they went about their lives, using a language environment analysis system (LENA Foundation, Boulder, Colorado). The researchers recorded approximately 32 hr across 4 days per family, coding and comparing parentese speech and standard speech in two social interaction contexts: speech directed to the infant while she or he is alone with the speaker (i.e., one-on-one social context), or speech directed to the infant while she or he is with a group of people (group social context). They found that only parentese speech in a 1:1 context was related to SES, and increased exposure to parentese speech in 1:1 context in infancy was associated with more frequent concurrent vocalizations and increased productive vocabulary at 24 months, controlling for SES. The other three social interaction variables evaluated (parentese speech in a group social context, standard speech in a 1:1 social context, and standard speech in a group social context) were neutral and unrelated to later word production.

Language Input and Language Outcomes in Simultaneous Bilingual Children

There has been increasing interest in language input to simultaneous bilingual toddlers in the home (De Houwer, 2007; García-Sierra et al., 2011; Hoff et al., 2012; Song, Tamis-LeMonda, Yoshikawa, Kahana-Kalman, & Wu, 2012). The methods and approaches employed are diverse, but in general recent studies demonstrate that (a) although simultaneous bilinguals are exposed to two languages in the home, one of these languages is dominant; and (b) the language input in each language is related to concurrent and later vocabulary.

Place and Hoff (2011) completed a diary study assessing relative exposure to English and Spanish in 25-month-old children over a 7-day period. The authors reported that the percentage of 30-min blocks with English-only exposure was positively related to the children's English vocabulary and negatively correlated to Spanish vocabulary. The same pattern was found for Spanish: The percentage of 30-min blocks with Spanish-only exposure was positively related to the children's Spanish vocabulary and negatively correlated to English vocabulary. Song et al. (2012) reported similar findings with a sample of Mexican and Dominican bilingual toddlers in a longitudinal study. The authors videotaped interactions between mothers and children at both 14 and 24 months of age and measured language exposure by counting the number of utterances produced by the mothers. The results demonstrated that parents' usage of English was positively correlated with children's English vocabulary at both 14 and 24 months of age but negatively correlated with the children's Spanish vocabulary. These findings suggest that bilingual

children' linguistic accomplishments in each language are influenced by the number of utterances they hear in their two respective languages during parent–child interactions (Conboy & Thal, 2006; Hoff et al., 2012; Marchman et al., 2009; Song et al., 2012).

Song et al. (2012) also used measures of social context, surveying parents regarding the frequency of literacy activities with the child (e.g., singing songs, reading books, and telling stories) at 14 and again at 24 months of age, which likely involved parentese speech in a one-on-one setting. Results demonstrated that English literacy activities were positively correlated with children's English vocabulary at both 14 and 24 months of age but negatively correlated with the children's Spanish vocabulary. Likewise, Spanish literacy activities were positively correlated with children's Spanish vocabulary at both 14 and 24 months of age but negatively correlated with the children's English vocabulary. Similar findings were reported in an earlier study of 21- to 27-month-old Spanish–English simultaneous bilinguals in which literacy experience (frequency of book reading with parents) in each language was related to vocabulary in that language (Patterson, 2002).

Cultural Impacts

Although studies assessing the interaction of linguistic and cultural environments are scarce, evidence suggests that there are cultural linguistic differences between English monolingual and Latino bilingual children that may impact language development. For example, Western middle-class mothers tend to produce child-directed communication and alter prosodic features of their language when addressing their prelinguistic children, using parentese speech (Hoff, 2006; Lieven, 1994). In other cultures, such as the Mayan in Mexico, child-directed speech is less common: Prelinguistic children are not considered to be conversational partners but simply passive observers of the language around them (Shneidman & Goldin-Meadow, 2012). Furthermore, Mexicans and Latinos have been shown to be talkative and gregarious, engaging in frequent interactions with family and friends (Díaz-Loving & Draguns, 1999). In a study of social behaviors among Mexicans and Americans using a digital recorder to sample behavior in naturalistic settings, Mexicans spent more time socializing and talking to others in group interactions than Americans (Ramírez-Esparza, Mehl, Alvarez-Bermúdez, & Pennebaker, 2009). Accordingly, we might expect that Latino cultural values (engaging in more gregarious interactions) could impact language input to bilingual infants in their everyday lives.

General Aim, Goals, and Hypotheses

The study is motivated by a large body of research, noted above, demonstrating that language input to children is fundamental for language learning in English monolingual children (e.g., Hart & Risley, 1995, 1999; Hoff, 2003; Huttenlocher et al., 1991; Ramírez-Esparza et al., 2014; Rowe, 2012; for a review, see Hoff, 2006) and that SES is related to that language input (Hart & Risley, 1995, 1999; Hoff, 2003; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Ramírez-Esparza et al., 2014; Rowe, 2008). SES has also been associated with individual differences in language development (e.g., Arriaga, Fenson, Cronan, & Pethick, 1998; Fernald, Marchman, & Weisleder, 2013; Hart & Risley, 1995; Hoff, 2003). Whereas the mechanisms driving the relations among SES, language input, and language outcomes are necessarily complex because each factor can be assessed using multiple variables within and across studies, there is growing evidence that differences in the characteristics of language input mediate the relation between SES and language outcomes in children; that is, SES-related variation in language input results in SES-related variation in language outcomes (Hoff, 2003; Huttenlocher et al., 2010; Rowe, 2008; Rowe & Goldin-Meadow, 2009). In the current study, our goal is to utilize methodology we previously developed for the study of language input and language outcomes in monolingual infants (Ramírez-Esparza et al., 2014) in a sample of prelinguistic Spanish–English bilingual infants, controlling for SES, rather than to investigate the mediation effects of SES in a bilingual population.

The first goal of the present study is to investigate the relation between overall language input and language development (i.e., including both English and Spanish) in the bilingual sample, comparing results from the bilingual sample to our previously published monolingual results (Ramírez-Esparza et al., 2014). As in the monolingual study, we aim to study the relations between language development and child-directed speech characterized by four social interaction variables (i.e., parentese speech–1:1, parentese speech–group, standard speech–1:1, and standard speech–group), concurrent infant speech utterances, and later overall productive vocabulary (i.e., without regard to the specific language). We hypothesize a similar pattern

of results in the monolingual and bilingual samples: Specifically, (a) the occurrence of infant speech utterances and the total productive vocabulary in English and Spanish in the bilingual sample will be comparable to the occurrence of infant speech utterances and English productive vocabulary in our monolingual study (Ramírez-Esparza et al., 2014), allowing direct comparison across studies; (b) only the parentese speech–1:1 interaction variable will be related to SES; and (c) only parentese speech–1:1 interaction variable will be related to concurrent speech utterances and total productive vocabulary at 24 months, whereas other social interaction variables will be unrelated to language development, controlling for SES, as reported in the monolingual sample. Furthermore, we expect that the relative occurrence of 1:1 and group social interactions in the bilingual sample would be impacted by the cultural values and practices of this speech community.

The second goal is to evaluate the effects of the social interaction variables on language development within each of the infants' two languages. The associations between each of the four social interaction variables and later vocabulary are assessed independently in English and in Spanish. Concurrent speech utterances are excluded from the language-specific analyses because these utterances cannot be unambiguously categorized in terms of English versus Spanish. Based on previous work with bilingual children (e.g., Place & Hoff, 2011; Song et al., 2012), we expected a language-specific pattern of significant correlations consistent with the overall pattern of results: Specifically, (a) the amount of parentese speech–1:1 in English will be positively related to English productive vocabulary at 24 months and negatively related to Spanish productive vocabulary at 24 months, controlling for SES; and (b) the amount of parentese speech–1:1 in Spanish will be positively related to Spanish productive vocabulary at 24 months and negatively related to English productive vocabulary at 24 months, controlling for SES.

Approaches

We use the LENA system to record everyday social interactions between adults and infants in natural settings for 8 hr per day over several consecutive days, generating a large body of data from each participant. This approach is nonobtrusive (see Mehl & Holleran, 2007), and it captures natural everyday behaviors that are not available in shorter video-recorded interactions. For example, speech by a mother, father, or other adult can occur in different types of settings: while watching TV and speaking over the phone, while doing laundry and cleaning the house, in transit to another place, while visiting friends, or in the supermarket. Although this approach has been used with monolingual infants (i.e., Ramírez-Esparza et al., 2014; Weisleder & Fernald, 2013), it has not been employed with bilingual infants. We then employ the LENA software to locate segments distributed across the data set that are suitable for coding in terms of social interaction variables. This nonobtrusive observational approach allows documentation of English and/or Spanish usage by bilingual families in natural settings. This novel approach has important implications for understanding the interaction between language usage and cultural background. For example, bilingual families can overestimate or underestimate their usage of English or Spanish on self-reports due to cultural biases (e.g., Heine, Lehman, Peng, & Greenholtz, 2002 Heine & Renshaw, 2002; Ramírez-Esparza, Gosling, & Pennebaker, 2008). Our approach provides a snapshot of English and Spanish usage as people go about their lives over a 4-day period, allowing direct measurement of social interaction variables.

Method

Participants

The participants were 25 infants (11 girls, 14 boys) drawn from a research participant subject registry maintained by the University of Washington. Enrollment forms are mailed to families of all newborn infants in the Seattle metropolitan area based on birth records yielding a database of people who are interested in finding out more about participating in research studies. All families reported that both English and Spanish were spoken in the home and that at least one parent reported Spanish as their first language. Two age groups, 11 months (N = 14, age range = 11 months and 6 days–11 months and 15 days) and 14 months (N = 11, age range = 13 months and 27 days–14 months and 25 days), were recruited as part of a large-scale study at the Institute for Learning and Brain Sciences, Seattle, WA. Data were collected across a 3-year period, from 2008 through 2011.

All infants were delivered at full-term (37–43 weeks) with a normal birth weight (2.5–4.5 kg), and had no major birth or postnatal complications. SES was assessed using the Hollingshead index (Hollingshead, 2011), a widely used measure producing an overall SES score based on parental

education level and occupation (M = 44.34, SD = 16.03, range = 16–66). Twenty infants lived with both their mother and father; two infants lived with mother, father, and grandparents; one infant lived with mother, father, and an uncle; and two infants lived only with their mothers.

Social language interaction data and infants' speech utterances were coded for all participants based on the LENA recordings. Parental reports of later word production in English and in Spanish at 24 months (for all infants enrolled in the study regardless of age at enrollment) were obtained from 18 of the 25 families who participated in the study.

Families' Language and Cultural Characteristics

Twenty-two of the 25 participants responded to a language background questionnaire.

The Mothers

One mother was born in Peru, one in Puerto Rico, one in El Salvador, two mothers were born in Venezuela, three in Colombia, seven in Mexico, and seven in the United States. Mothers had been living in the United States for an average of 16.20 years (SD = 9.68). Forty percent of the mothers preferred to use Spanish in daily life, 12% preferred English, and 36% preferred both languages. Only 19 mothers reported their preferred language when speaking to their infants: 36% of the mothers preferred Spanish, 28% preferred English, and 12% preferred both languages.

The Fathers

One father was born in Peru, one in El Salvador, one in Guatemala, one in Venezuela, one in Ecuador, two fathers in Colombia, two in Puerto Rico, six in the United States, and seven in Mexico. Fathers had been living in the United States for an average of 16.95 years (SD = 13.95). Fifty-two percent of the fathers preferred to use Spanish in daily life, 16% preferred English, and 20% preferred both languages. Only 19 fathers reported their preferred language when speaking to their infants: 40% of the fathers preferred Spanish, 28% preferred English, and 8% preferred both languages.

Social Interaction Variables and Language Activity Assessment

Social interaction and language activity was assessed using the same methods reported in our previous work for monolingual infants (Ramírez-Esparza et al., 2014) allowing cross-study comparisons.

Data Collection

Parents received two digital language processors (DLPs) and vests with a chest pocket designed to hold the DLP, allowing digital first-person perspective recordings of the infants' auditory environment at home and as they went about their daily lives. They were instructed to record 8 continuous hours each day for 4 consecutive days (including 2 weekdays and 2 weekend days), yielding approximately 32 hr of recorded audio data from each infant (M = 31.52, range = 21.85–32). Parents were also asked to complete a daily activity diary, noting the most relevant activities for each day.

Data Preparation

LENA software was used to analyze language input and to efficiently locate intervals with the language activity of interest (i.e., adult speech) in each participant's large data set of recorded audio for further analysis of language input (in terms of speech register and social context) and infant speech utterances. The audio data were transferred from the DLP to a computer and analyzed by LENA software employing advanced speech identification algorithms that automatically analyze audio files and produce reports of language activity. The LENA algorithms produced a total adult word count across all 4 days for each participant in the study. The algorithm is not able to further categorize the adult words counted and, therefore includes both speech that is directed to the child and speech that is overheard but not directed to the child, regardless of language. The accuracy of these values for the English language has been established in previous studies (Oller et al., 2010; Xu, Yapanel, & Gray, 2009). For the Spanish language, Weisleder and Fernald's (2013) research team transcribed 60-min samples from 10 participants of their study. Their analysis of these transcriptions showed a strong positive correlation (i.e., r = .80) between automated estimates and transcribed word counts.

The audio files were then further processed using the LENA Advanced Data Extractor Tool (ADEX) in order to efficiently identify short intervals with the language activity of interest (i.e., adult speech) for coding and eliminate intervals that did not qualify. This tool provides outputs for individual speech segments as short as a fraction of a second. We coded social interaction and language

activity based on 30-s intervals, a technique that has been reliably used for over a decade (e.g., Mehl, Pennebaker, Crow, Dabbs, & Price, 2001; Mehl, Vazire, Ramírez-Esparza, Slatcher, & Pennebaker, 2007; Ramírez-Esparza et al., 2009) and was employed in our previous study of monolingual infants (Ramírez-Esparza et al., 2014). The use of 30-s intervals has the advantage of being long enough to allow coding of social interactions while at the same time protecting participants' privacy by reducing context.

ADEX was used to segment each participant's large data set of recorded audio into 30-s intervals and to automatically calculate an adult word count for each interval. For example, an 8-hr recording yields approximately 960 intervals with adult word counts after the data are segmented into 30-s intervals. Intervals with zero adult words are removed and 40 intervals that are at least 3-min apart are selected from the remaining intervals across the entire day, chosen from those with the highest adult word counts. In essence, intervals are selected based on adult word count in order to ensure that there is language activity that will allow coding of social behaviors. Using this approach we avoid selecting intervals for coding when there is no social activity, only silence or noise (e.g., the infant was sleeping, the infant was not wearing the recorder). The mean adult word count across the coded 30-s intervals and across participants was 51.21 (SD = 22.60).

Ideally, the final data set would include a total of 160 intervals for each participant. However, some participants failed to record as instructed, and their recorded data yielded fewer than 160 intervals for coding. Consequently, an average of 156.96 (SD = 8.12) intervals per participant were coded, a total of 4,084 over the entire study. In addition, parents were instructed to read experimental materials to their children as part of the larger research project, which is beyond the scope of this study, and intervals including this experimental activity were excluded from analysis (M = 4.37 intervals, SD = 2.77). The remaining intervals then served as the full set of coded intervals for calculation of the relative time use estimates for each participant (M = 152.84, SD = 8.66).

Adapting the Social Environment Coding of Sound Inventory for Infants

The Social Environment Coding of Sound Inventory (SECSI) was designed to assess moment to moment naturalistic social behaviors, environments, and interactions in adult populations (e.g., Mehl, Gosling, & Pennebaker, 2006; Mehl et al., 2007; Ramírez-Esparza et al., 2009). We adapted the SECSI, creating an infant version that focused on the social and language environment (Ramírez-Esparza et al., 2014). The infant SECSI was designed to be a broad system and coded behaviors beyond the scope of the present study for use in future analyses, including 73 categories organized into six clusters: "speech partners," "speech style," "social context," "infant speech utterances," "activities," and "infant mood." A subset of categories within these clusters was selected to generate the social interaction variables analyzed in the current study: "speech partners"—mom speaks to infant, dad speaks to infant, other adult speaks to infant; "speech style"—parentese speech is used to address the infant, standard speech is used to address the infant; "social context"—infant is with one adult, infant is with two or more adults; and "infant speech utterances"—infant produces a speech utterance, infant does not produce a speech utterance (see Ramírez-Esparza et al., 2014, for more information).

Coding Selected Infant SECSI Categories

Three Spanish–English bilingual research assistants were trained to code the selected intervals for each participant (M = 152.84, SD = 8.66). Coders were provided with basic information about each selected interval (date, day of the week, time of day, and the time stamp of the audio recording). Coders were also provided with the participants' end of day diaries to supplement audio recordings. Transcribing software played the specific 30-s interval for coding based on the time stamp entered. The coders listened to each 30-s interval and coded each infant SECSI category associated with the interval. For example, in a given 30-s interval the coders would listen and enter "YES" if the behavior of interest occurred. The resulting matrix of YES and NOs indicated that a specific infant SECSI category occurred or did not occur in that interval. Infant SECSI categories are nonexhaustive and nonmutually exclusive, that is, several infant SECSI categories could be coded within a single interval (e.g., infant speech utterance, adult talking to physically present others, adult talking to infant, adult using parentese speech to address the infant, adult using standard speech to address the infant— all within a single 30-s interval). All coders were tested independently with a training file, which was used to evaluate intercoder reliability (for more details on training, see Ramírez-Esparza et al., 2014). The

12 categories used in the analysis produced an average intraclass correlation of .91—indicating effective training and reliable coding—based on a two-way random effects model (ICC [2, k]; Shrout & Fleiss, 1979). In addition to coding infant SECSI categories, research assistants noted the language(s) spoken by the adult(s) in each coded interval. Most intervals contained adult speech in only one language; however, adults used both languages (or code-switched) in about 10% of coded intervals.

Relative Time Use Estimates of Infant SECSI Categories

The coded data matrices containing YES and NO responses for each participant were aggregated to provide relative time use data by calculating the percentage of intervals coded for each category. For example, a relative time use estimate of 47.5% for the infant SECSI category "Mom speaks to infant" indicated that for a participant with 160 intervals, this category was coded YES in 76 of the 160 selected intervals (see Ramírez-Esparza et al., 2014). Relative time use estimates were calculated in three ways based on the language spoken by adults: Intervals independent of language spoken by adults yielded relative time use estimates across languages, intervals in which only English was spoken by adults yielded relative time use estimates for English, and intervals in which only Spanish was spoken by adults yielded relative time use estimates for Spanish. Those intervals in which adults used both languages or code-switched were included in the relative time use estimates across languages but were not included in the language-specific relative time use estimates.

Language Environment Assessment

To test our hypotheses, we examined four different social interaction variables based on the selected categories in the infant SECSI: (a) *parentese speech–1:1*—mother, father, or other adult spoke directly to the infant, parentese speech was used, and only one adult voice was recorded during the interval; (b) *parentese speech–group*—mother and/or father and/or other adult spoke directly to the infant, parentese speech was used, and two or more adult voices were recorded during the interval; (c) *standard speech–1:1*—mother, father, or other adult spoke directly to the infant, standard speech was used, and only one adult voice was recorded during the interval; (d) *standard speech–group*—mother and/or father and/or other adult spoke directly to the infant, standard speech was used, and two or more adult voices were recorded during the interval. The coded data were then converted into relative time use estimates across languages and within each language by calculating the percentage of valid intervals included in a specific category across the 4 days (e.g., percentage of intervals coded parentese speech–1:1, percentage of intervals coded standard speech–group). Relative time use estimates for the social interaction variables were neither mutually exclusive nor exhaustive and, therefore, will not add to 100%.

Language Development Assessment

Language development was assessed concurrently and at 24 months of age. The concurrent measure was the relative time use estimate for infant speech utterances. Concurrent speech utterances were not evaluated for each language independently as these vocalizations cannot be unambiguously categorized into a particular language.

Productive vocabulary was assessed when participants were 24 months old. Productive vocabulary in English was measured using the MacArthur-Bates Communicative Development Inventory (CDI; Fenson et al., 2007), and productive vocabulary in Spanish was measured using the Spanish language adaptation, El Inventario de Desarrollo de Habilidades Comunicativas: Inventario II (Jackson-Maldonado et al., 2003). Specifically, parents reported the number of words produced based on the 680-word checklist section of the CDI in English and in Spanish when the children were 24 months old (n = 18).

Results

Initial Analyses

The initial steps in analysis were evaluation of age group differences at enrollment (i.e., 11 months vs. 14 months old) on the other experimental variables (SES, concurrent speech utterances, productive vocabulary at 24 months across languages and within languages, and social interaction variables derived from infant SECSI); and assessment of the characteristics of language input to infant participants.

Age Effects

Bilingual participants enrolled in the study showed no significant effects due to age at enrollment (i.e., 11 or 14 months) for social interaction

variables derived from the infant SECSI, language development variables (concurrent speech utterances, productive vocabulary at 24 months in English, in Spanish, and in English plus Spanish), or SES. Participants were collapsed across age at enrollment for the remaining analyses.

Characteristics of the Language Used in the Spanish–English Bilingual Households

In order to glimpse the language characteristics of the bilingual households, we provide descriptive analyses for both speech directed to the child and speech overheard by the child in English and in Spanish (see Table 1). Both mother and father are more likely to speak to their infant in Spanish than in English. This is consistent with the parental reports, which indicated that both mothers and fathers prefer to speak to their infants in Spanish instead of English (see Participants above). Paired *t* tests, however, revealed that the only significant difference across languages is more frequent use of English in overheard speech (i.e., when other adults spoke to other adults). Paired correlations demonstrated that the mothers and fathers who are more likely to use Spanish are less likely to use English, and vice versa. Table 1 also shows the low percentage of coded intervals in which parents and other adults used both English and Spanish (code-switched), indicating that the parents in this study were unlikely to code switch in any given moment; they used either English or Spanish.

The percent of coded intervals in which speech was directed to the infant across all speakers in English ($M = 19.83$, $SD = 18.01$) and in Spanish ($M = 30.29$, $SD = 21.12$) was not significantly different. Likewise the percent of coded intervals in which the infant overheard speech across all speakers in English ($M = 41.20$, $SD = 24.05$) and in Spanish ($M = 30.19$, $SD = 26.71$) was not significantly different. Finally, speech directed to the infant in English was negatively correlated with speech directed to the infant in Spanish ($r = -.80$, $p < .001$) and overheard speech in English was negatively correlated with overheard speech in Spanish ($r = -.70$, $p < .001$).

The data indicate that, as a group, participants are not likely to experience more input in one language than the other. However, parents who use more English use less Spanish and vice versa. Table 2 shows means and standard deviations for the four social interaction variables tested in this study. Bilingual families produced more intervals coded standard speech–1:1 in Spanish than standard speech–1:1 in English, and this difference approached significance ($t = -2.06$, $p = .051$, $df = 24$). Relative time use estimates of the other social interaction variables were not significantly different for English and Spanish. That is, the percentage of intervals in which bilingual families used

Table 1
Percentage of Coded Intervals During Which the Infant Was Exposed to English and Spanish Directly or Indirectly Across the 4 Days of Recording: t *Tests and Correlations, Controlling for Socioeconomic Status*

	Relative time use estimates, (% intervals)				
Infant SECSI items	Code-switching *M* (*SD*) *N* = 25	English *M* (*SD*) *N* = 25	Spanish *M* (*SD*) *N* = 25	*t* tests	*r*
Mom talking					
Mom talks to infant	5.00 (4.65)	11.22 (14.45)	20.89 (17.92)	−1.64	−0.66***
Mom talks to dad	0.70 (2.21)	8.51 (12.79)	8.99 (10.09)	−0.11	−0.52**
Mom talks to others	0.45 (0.64)	7.67 (7.48)	6.33 (9.45)	0.49	−0.27
Dad talking					
Dad talks to infant	1.29 (1.45)	3.40 (4.30)	7.21 (9.07)	−1.65	−0.42*
Dad talks to mom	0.49 (1.00)	7.64 (11.66)	8.78 (9.67)	−0.30	−0.53**
Dad talks to others	0.13 (0.26)	4.14 (5.89)	2.17 (3.24)	1.43	−0.06
Other adults talking					
Other adults talk to infant	1.44 (2.23)	7.09 (8.36)	5.04 (6.36)	0.83	−0.38
Other adults talk to parents	2.38 (3.70)	22.32 (18.84)	13.13 (15.63)	1.52	−0.53**
Others talk to others	1.02 (1.86)	9.45 (8.51)	3.52 (5.64)	2.62*	−0.24

Note. *t* tests assess differences across English and Spanish and *r* is the correlation between infant SECSI items in English and in Spanish, code-switching is not included. SECSI = Social Environment Coding of Sound Inventory. *$p < .05$. **$p < .01$. ***$p < .001$.

parentese speech–1:1, parentese speech–group, and standard speech–group did not differ for English and Spanish. However, correlations between the four social interaction variables in English and in Spanish are negative, and three of them significantly so, indicating that parents who use more English in a specific social interaction variable use less Spanish in the same variable and vice versa (Table 2).

Results for Goal 1: Comparison of the Monolingual and Bilingual Samples

Mean social interaction and language development variables. We compared mean social interaction and language development variables from the current study of bilingual infants (overall, across languages) and the corresponding variables collected in our previous study of monolinguals (Ramírez-Esparza et al., 2014; see Table 2, for *M*, *SD*, and *t* values). Monolingual and bilingual samples differed significantly in terms of the parentese speech–1:1 social interaction variable, with monolingual infants experiencing significantly more parentese speech–1:1 than bilinguals ($t = 3.3$, $p < .05$). There are no significant differences in the other three social interaction variables. The average TVS (words in English + words in Spanish) in bilingual children ($M = 393.67$, $SD = 237.79$) was not significantly different from that reported by Ramírez-Esparza et al. (2014) for the monolingual sample ($M = 376.56$, $SD = 19.89$, $t = -0.25$; Table 2). Vocabulary was converted to *z* scores for use in analysis, and all scores fall within ± 2.5 *SD* of the mean.

Correlations between SES, social interaction variables, and measures of later language development. We also evaluated correlations between SES, social interaction variables, and measures of later language development in the bilingual sample overall (Table 3). Results show that among social interaction variables, SES was significantly correlated only with percent intervals coded for parentese speech in a 1:1 social context ($r = .44$, $p < .05$, $N = 25$; Table 3), the same pattern observed in our sample of monolinguals (Ramírez-Esparza et al., 2014). In addition, SES was significantly correlated with productive vocabulary at 24 months for English plus Spanish (TVS; $r = .47$, $p = .05$, $N = 25$; Table 3), a relation not seen in our monolingual sample.

Intercorrelations among social interaction variables. Intercorrelations among social interaction variables, controlling for SES, were also evaluated (Table 4). As in the monolingual sample (see Ramírez-Esparza et al., 2014), we found significant negative correlations between standard speech–group and parentese speech–1:1 and a significant positive correlation between standard speech–group and parentese speech–group. Infants who experienced more standard speech in a group context also experienced less parentese speech in a 1:1 context ($r = -.45$, $p = .03$, $df = 22$) and more parentese speech in a group context ($r = .48$, $p = .02$, $df = 22$). In other words, in both monolingual and bilingual families with more frequent standard speech in a group context, more parentese speech occurs in a group context and less parentese speech in a 1:1 context. However, the bilingual sample also shows a significant positive correlation between standard speech–1:1 and parentese speech–1:1 ($r = .45$ $p = .03$, $df = 22$), indicating that bilingual families with more frequent parentese speech in a one-on-one context are also more likely to use standard speech in a one-on-one context.

Associations between language development and the four social interaction variables across languages. Finally, we evaluated the associations between language development and the four social interaction variables across languages: (a) parentese speech–1:1, (b) parentese speech–group, (c) standard speech–1:1, and (d) standard speech–group using partial correlations, controlling for SES. As we found in monolinguals, parentese speech–1:1 was associated with concurrent speech utterances ($r = .49$, $p < .01$, $df = 22$) and productive vocabulary in English plus Spanish at 24 months or TVS ($r = .49$, $p < .05$, $df = 15$; see Table 5 for partial correlations, see Figure 1 for scatter plots of the raw data). In addition, parentese speech–group was significantly associated with TVS at 24 months in bilinguals ($r = .52$, $p < .05$, $df = 15$; see Table 5 for partial correlations, see Figure 1 for scatter plots of the raw data), a relation not observed in the monolingual sample. Other social interaction variables were neutral and unrelated to concurrent speech utterances or later TVS.

Results for Goal 2: Testing Associations Between Social Interaction Variables and Language Development Within Each Language for the Bilingual Sample

Examination of productive vocabulary in English and in Spanish at 24 months revealed that these measures are not significantly correlated, controlling for SES ($r = .04$, $df = 15$).

Social interaction variables and productive vocabulary in English. Productive vocabulary in English at 24 months was significantly associated with parentese speech–1:1 in English ($r = .69$, $p < .01$, $df = 15$) and standard speech–1:1 in English

Table 2
Means, Standard Deviations, t *Values, and* r *Values for Social Interaction Variables and Language Development Variables: Monolinguals and Bilinguals*

	Monolinguals (N = 26)		Bilinguals (N = 25)			Bilinguals (N = 25)					
	English		Across languages		t value	English		Spanish		t value	
	M	SD	M	SD	(indep.)	M	SD	M	SD	(paired)	r
Social interaction variables											
Parentese Speech–1:1	41.12%	19.62%	24.71%	15.62%	3.30*	7.19%	10.74%	12.8%	12.10%	−1.47	−0.39
Parentese Speech–Group	19.21%	8.16%	20.27%	6.80%	−0.50	8.39%	6.89%	9.77%	8.85%	−0.47	−0.71***
Standard Speech–1:1	.92%	5.12%	11.36%	7.18%	−1.97	3.04%	3.48%	6.51%	6.04%	−2.06^{+}	−0.53**
Standard Speech–Group	19.36%	8.60%	23.68%	7.24%	−1.93	9.46%	8.20%	12.43%	10.01%	−0.87	−0.76***
Language development											
Concurrent speech utterances	65.41%	14.33%	62.01%	11.91%	0.92	NA	NA	NA	NA	NA	NA
Productive vocabulary at 24 months	376.56	19.89	393.67	237.79	−0.25	236.39	175.69	157.28	134.51	−1.65	0.16

Note. Monolingual data from Ramírez-Esparza et al. (2014). Productive vocabulary at 24 months for the monolinguals is English only (n = 23), productive vocabulary at 24 months for the bilinguals is TVS or English productive vocabulary plus Spanish productive vocabulary (n = 18). t value (indep.) corresponds to mean differences between monolinguals and bilinguals; t value (paired) corresponds to mean differences across languages for the bilinguals. r is the correlation between social interaction variables of input in English and Spanish, or between language development variables in English and in Spanish. NA = not applicable. $^{+}p = .051$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

(r = .64, $p < .01$, df = 15; see Table 6 for partial correlations, see Figure 2 for scatter plots of the raw data). Other social interaction variables in English and all social interaction variables in Spanish were neutral or unrelated to later English word production.

Social interaction variables and productive vocabulary in Spanish. Productive vocabulary in Spanish at 24 months was significantly associated with parentese speech–1:1 in Spanish (r = .57, $p < .01$, df = 15) and parentese speech–group in Spanish (r = .64, $p < .01$, df = 15; see Table 6 for partial correlations, see Figure 2 for scatter plots of the raw data). Other social interaction variables in Spanish and all social interaction variables in English were neutral or unrelated to later Spanish word production.

Discussion

The general aim of the current investigation was to utilize methodology we previously developed for the study of speech development in monolingual infants (Ramírez-Esparza et al., 2014) in a sample of prelinguistic Spanish–English bilingual infants, evaluating language input and language outcomes overall, and for each native language independently, focusing on speech register (i.e., parentese speech vs. standard speech) and social interaction context (one-on-one or group). Our results are consistent with previous work relating parentese speech (e.g., Liu et al., 2003; in monolingual infants), one-on-one interactions (e.g., Goldstein & Schwade, 2008; with monolingual infants; Song et al., 2012; with bilingual toddlers), and social interaction variables (Ramírez-Esparza et al., 2014, in monolingual infants) to language development.

Social Interactions and Language Development in Monolinguals and Bilinguals

We hypothesized a similar pattern of results in the previously published monolingual and current bilingual samples: specifically, (a) the occurrence of infant speech utterances and the total productive vocabulary in English and Spanish in the bilingual sample will be comparable to the occurrence of

Table 3
Correlations Between Socioeconomic Status and Social Interaction Variables, and Measures of Later Language Development

Target variables	Correlations with covariate Hollingshead (SES)
Social interaction variables	
Across languages	
Parentese Speech–1:1	.44*
Parentese Speech–Group	.19
Standard Speech–1:1	.09
Standard Speech–Group	−.21
In English	
Parentese Speech–1:1–English	.24
Parentese Speech–Group–English	.32
Standard Speech–1:1–English	.18
Standard Speech–Group–English	.28
In Spanish	
Parentese Speech–1:1–Spanish	.30
Parentese Speech–Group–Spanish	−.07
Standard Speech–1:1–Spanish	−.01
Standard Speech–Group–Spanish	−.35
Language development	
Concurrent speech utterances	.30
Productive vocabulary at 24 months in English plus Spanish (TVS)	.47*
Productive vocabulary at 24 months in English	.35
Productive vocabulary at 24 months in Spanish	.36

Note. SES = socioeconomic status. *$p \leq .05$.

Table 4
Correlations Among Social Interaction Variables Measures Across Languages, Controlling for Socioeconomic Status

Across languages	Parentese Speech–1:1 $N = 25$	Parentese Speech–Group $N = 25$	Standard Speech–1:1 $N = 25$	Standard Speech–Group $N = 25$
Parentese Speech–1:1	1			
Parentese Speech–Group	−0.01	1		
Standard Speech–1:1	0.45*	−.35	1	
Standard Speech–Group	−0.45*	.48*	−.07	1

*$p < .05$. ***$p < .001$.

infant speech utterances and English productive vocabulary in our monolingual study (Ramírez-Esparza et al., 2014), allowing direct comparison

Table 5
Correlations Between Social Interaction Variables and Language Development, Controlling for Socioeconomic Status

	Speech development	
Social interaction variables	Concurrent speech utterances $N = 25$	TVS at 24 months $n = 18$
Parentese Speech–1:1	.49**	.49*
Parentese Speech–Group	.15	.53*
Standard Speech–1:1	.08	.08
Standard Speech–Group	−.34	−.14

Note. TVS = Productive Vocabulary in English + Productive Vocabulary in Spanish. *$p < .05$. **$p < .01$

across studies; (b) only the parentese speech–1:1 social interaction variable will be related SES; and (c) only parentese speech–1:1 will be related to concurrent speech utterances and total productive vocabulary at 24 months, whereas other social interaction variables will be unrelated to language development, controlling for SES, as reported in the monolingual sample. Our hypotheses were largely confirmed: Bilingual infants in the current study exhibit a pattern of results that is generally consistent with that of monolinguals (Ramírez-Esparza et al., 2014), but there were also interesting differences between language groups.

As hypothesized, monolingual and bilingual samples did not differ significantly in terms of infant speech utterances or overall productive vocabulary. In addition, and consistent with monolinguals, only the parentese speech–1:1 social interaction variable was related to SES in the bilingual sample. Interestingly, both samples showed the same significant relation between SES and parentese speech–1:1, even though it was the only social interaction variable that differed significantly across language groups, that is, the relative time use estimates for parentese speech–1:1 were significantly higher in our previous sample of monolinguals than the current study sample of bilinguals (see Table 2). SES may account for this language group difference because significant correlations were positive for each group, and SES was significantly higher in monolinguals than bilinguals (i.e., Hollingshead indices of 54.7 and 44.34, respectively).

Differences in cultural conversational values may also account for and/or contribute to differences in relative time use estimates for parentese speech–1:1 across language groups. Western middle-class mothers tend to produce child-directed communication and alter prosodic features of their

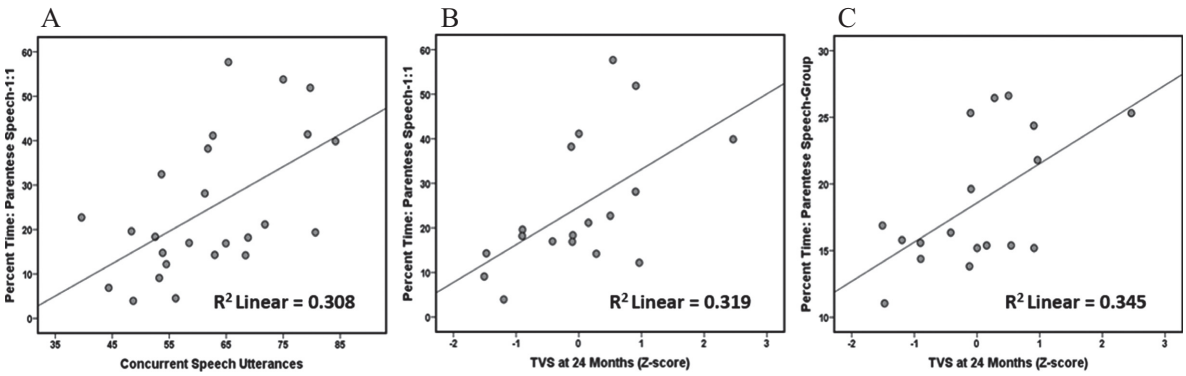

Figure 1. Scatter plots of the correlations between (A) parentese speech–1:1 and concurrent speech utterances, (B) parentese speech–1:1 and total vocabulary size at 24 months (English + Spanish), (C) parentese speech–group and total vocabulary size at 24 months (English + Spanish), reported in Table 5.
Note. TVS at 24 months was converted to *z* scores. Participants fall within ± 2.5 *SD* of the mean.

Table 6
Within Language Analyses: Correlations Between Social Interaction Variables and Speech Development, Controlling for Socioeconomic Status

	Productive vocabulary at 24 months	
Social interaction variables	English *n* = 18	Spanish *n* = 18
English		
Parentese Speech–1:1	.69**	−.31
Parentese Speech–Group	.40	−.32
Standard Speech–1:1	.64**	−.35
Standard Speech–Group	.19	−.40
Spanish		
Parentese Speech–1:1	−.12	.57*
Parentese Speech–Group	−.30	.59*
Standard Speech–1:1	−.17	.09
Standard Speech–Group	−.42	.38

*$p < .05$. **$p < .01$.

language when addressing their prelinguistic children, using parentese speech (Hoff, 2006; Lieven, 1994). Although the culturally specific conversational values of Latinos have not been studied in terms of child-directed and parentese speech, they may differ from Western middle-class mothers. Examination of the pattern of intercorrelations among social interaction variables in the two samples provides some support for this interpretation. Both monolingual and bilingual groups exhibited significant negative correlations between standard speech–group and parentese speech–1:1, and a significant positive correlation between standard speech–group and parentese speech–group. However, the correlation between parentese speech–1:1 and standard speech–1:1 was significant only in the bilingual sample. This significant positive correlation indicated that bilingual families who produced more parentese speech in a one-on-one social context were also more likely to produce more standard speech in a one-on-one context. It is possible that, compared to the monolinguals, bilinguals are not consistent in the speech register they use with their infants in a one-on-one social context, tending to use both parentese and standard speech. However, both interpretations are speculative, and further research is needed to investigate the possible contributions of SES and/or cultural conversational values to differences in occurrence of parentese speech–1:1 reported here.

Finally, we hypothesized that only parentese speech–1:1 would be related to concurrent speech utterances and total productive vocabulary at 24 months, whereas other social interaction variables would be unrelated to language development in bilinguals, controlling for SES, as reported in the monolingual sample. We found that parentese speech–1:1 was associated with concurrent speech utterances and TVS at 24 months in the current study of bilingual infants. Both monolingual and bilingual prelinguistic infants benefit from the acoustic properties of parentese speech (e.g., Fernald, 1985; Fernald & Kuhl, 1987; Hirsh-Pasek et al., 1987; Karzon, 1985; Kemler Nelson et al., 1989) and one-on-one social context, perhaps due to increased opportunities for contingent social interaction between adult and child, as suggested by the work of Goldstein and Schwade (2008).

However, we also found that parentese speech–group was also positively related to TVS at 24 months in bilinguals but not in monolinguals.

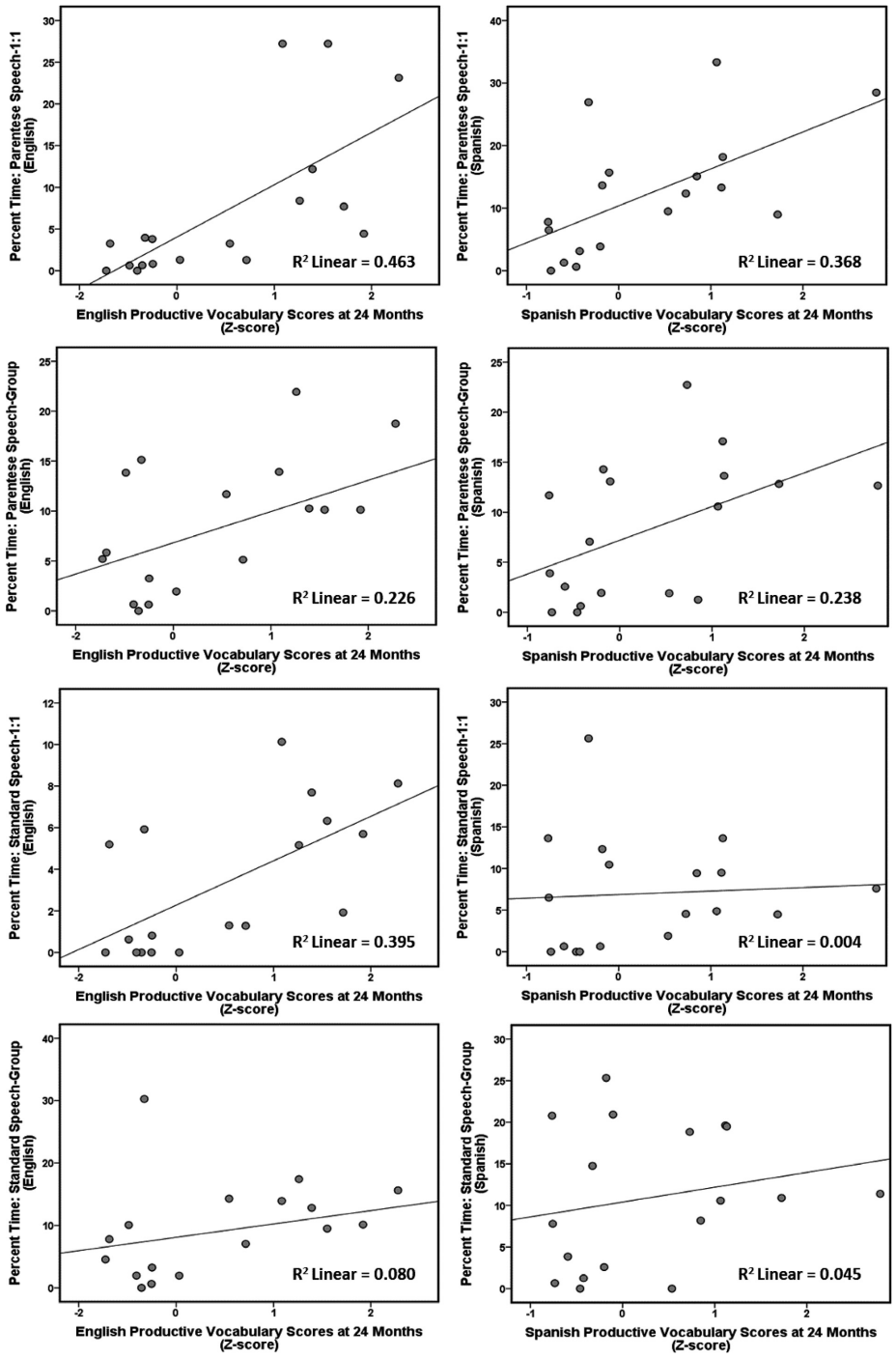

Figure 2. (A) Scatter plots of the correlations between English productive vocabulary at 24 months and English parentese speech–1:1, English parentese speech–group, English standard speech–1:1, English standard speech–group (from Table 6). (B) Scatter plots of the correlations between Spanish productive vocabulary at 24 months and Spanish parentese speech–1:1, Spanish parentese speech–group, Spanish standard speech–1:1, Spanish standard speech–group (from Table 6).
Note. Spanish and English productive vocabulary scores at 24 months were converted to *z* scores. Participants fall within ± 2.5 *SD* of the mean.

This difference may be related to specific cultural characteristics of the samples. For example, Latinos spend more time engaged in group interactions, whereas European Americans spend more time alone (Ramírez-Esparza et al., 2009). Therefore, it is possible that the Latino bilingual infants in the current study are more likely to be exposed to polyadic situations and multiparty conversations due to their cultural background (Lieven, 1994). This increased exposure to multiple conversations may reduce parentese speech–1:1 interactions and permit parentese speech–group to play a more important role in language development in this population. Further research will be required to advance our understanding of the effects of culture on the interplay between language input and language development.

Social Interactions and Language Development Within Bilinguals

In this investigation, the four social interaction variables were related to language development independently for each language (i.e., English and Spanish). We hypothesized (a) the amount of parentese speech–1:1 in English would be positively related to English productive vocabulary at 24 months and negatively related to Spanish productive vocabulary at 24 months, controlling for SES; and (b) the amount of parentese speech–1:1 in Spanish would be positively related to Spanish productive vocabulary at 24 months and negatively related to English productive vocabulary at 24 months, controlling for SES.

The results show that language input in a given language is related to productive vocabulary at 24 months in that language but unrelated to productive vocabulary in the other language. As hypothesized, parentese speech–1:1 in English was positively related to later vocabulary in English, however, the hypothesized negative relation between parentese speech–1:1 in English and later vocabulary in Spanish was not observed. Instead, parentese speech–1:1 in English was unrelated to later vocabulary in Spanish. Similarly, parentese speech–1:1 in Spanish was positively related to later vocabulary in Spanish but unrelated to later vocabulary in English. These findings are consistent with, but not identical to, previous work in bilingual toddlers, which showed significant relations between child language and language input in terms of either percentage of 30-min blocks of exposure to a single language (Place & Hoff, 2011) or number of maternal utterance and literacy activities (Song et al., 2012). In these studies, English language input was positively related to the toddlers' English vocabulary and negatively correlated to Spanish vocabulary, and Spanish language input was positively related to toddlers' Spanish vocabulary and negatively correlated to English vocabulary. The current study demonstrates that engaging prelinguistic infants as conversational partners employing parentese speech in a 1:1 social context in a specific language has important implications for learning in that language in bilinguals. However, we do not observe the significant effects for the other native language as has been reported in toddlers. Instead, significant relations between parentese speech–1:1 and later productive vocabulary are restricted to the positive relations within language, whereas the negative trends across language do not reach significance.

The lack of significant effects for language input in one language and language outcomes in both languages may be due to differences between the structure of the coded variables across studies. Previous studies do not report the relation between measures of language input in English and Spanish; however, because each of the language input measures employed by these studies (i.e., percentage of 30 min blocks with single language exposure, number of maternal utterances, and literacy activities) was assigned to one of the two languages, it is likely that measures in English and Spanish are significantly and negatively correlated. In the current study, language input was coded in terms of four social interaction variables in each of the two languages, which permits multiple patterns of cross-language relations, and inspection of those relations reveal an interesting pattern of results. Although cross-language relations were negative for all of the four social interaction variables, the correlation failed to reach significance only for parentese speech–1:1 (see Table 2). Another possibility is that the effects of language input in terms of social interaction in infancy are not as language specific as the measures of parental speech evaluated later in development in previous work. Future work will be required to evaluate the effects of social interaction variables in older children.

Unlike the monolingual study, other social interaction variables were also significantly related to productive vocabulary, and they differed with language. Specifically, standard speech–1:1 in English was positively related to productive vocabulary in English at 24 months and parentese speech–group in Spanish was positively related to productive vocabulary in Spanish at 24 months. This pattern of

unexpected findings could be the result of an interplay between the cultural makeup of the family and the language they are most likely to use. For example, it is possible that families who tend to use more English also tend to have more one-on-one interactions with their children because fewer individuals are living in or visiting the household. In contrast, those families who tend to use more Spanish may use more parentese speech in a group context because more individuals are living in or visiting the household.

There is evidence that cultural effects on language and learning may be very subtle. The interaction of language usage and the characteristics of maternal speech in Latino bilingual families were recently investigated by Tamis-LeMonda et al. (2014). The authors report that language usage by Latino mothers interacting with their 2-year-old children during a book-sharing activity predicts later cognitive skills at age 5, even after controlling for the children's language growth. However, maternal usage of unique words in English during a book-sharing activity predicted different types of cognitive skills (e.g., quantitative reasoning, applied problem tests), whereas the usage of unique words in Spanish did not predict cognitive ability. The authors suggested that the results are due to differences in cultural values in English-speaking and Spanish-speaking mothers. For example, Latino English-speaking mothers may be more focused on literacy and math concepts than Latino Spanish-speaking mothers (see also Tamis-LeMmonda, Sze, Ng, Kahana-Kalman, & Yoshikawa, 2013). Research in the area of cultural effects on language and learning is just beginning and will undoubtedly make important contributions to the understanding of relations between language input and language development in bilingual and multilingual children.

Conclusion

Our results are consistent with recently published studies demonstrating that toddlers exposed to two languages develop each of their languages as a function of relative exposure (Hoff et al., 2012; Place & Hoff, 2011; Song et al., 2012) as well as the now well-established literature that reports that monolingual language development is linked to the characteristics of language input children receive in their everyday lives (e.g., Hart & Risley, 1995, 1999; Hurtado et al., 2008; Huttenlocher et al., 1991; Ramírez-Esparza et al., 2014; Rowe, 2012; for a review, see Hoff, 2006). Furthermore, our findings support theoretical arguments that experience and social interaction are necessary for language acquisition (Bruner, 1983; Vygotsky, 1962). The current study is unique in evaluating language input to prelinguistic bilingual infants in terms of speech register and social context, and demonstrates that bilingual infants (a) are similar to monolingual infants in that they benefit from interactions in parentese that occur in a one-on-one setting and (b) differ from monolingual infants in that they also benefit from other social interactions in ways that suggest that their cultural background and the opportunities to learn two languages contribute to a more intricate language learning path. Finally, we demonstrate that language input in the form of social interaction variables affects language development independent of SES.

Limitations and Future Directions

Our approach codes only a small fraction of a full day of recording, and intervals were chosen based on highest adult word count in order to maximize intervals with language interactions. This approach does not allow us to capture infant speech utterances in the absence of adult language activity, and future investigations would benefit from other sampling approaches. For example, it would be of theoretical interest to evaluate infant speech utterances during interactions with adults and in isolation.

Another limitation of this study is that the sample size is small and bilingual families were not selected to be representative of the entire population of Spanish–English bilingual infants in the United States. This limits interpretation of the data. As the current study controls for SES, relations between social interaction variables and language outcomes may be underestimated. A larger sample chosen to represent the entire population would permit more sophisticated analyses that could tease apart the contributions of SES and social interaction variables on language outcomes in bilingual children—evaluating SES as a mediator in the relation between parentese speech–1:1 and language development in bilingual children, as has been demonstrated in monolingual populations (Huttenlocher et al., 2010; Rowe & Goldin-Meadow, 2009). Larger samples of bilinguals similar to that recruited by Song et al. (2012) would also permit comparison of specific cultural groups and enable discussion of differences in language development as a function of cultural background. The answer to these questions will have important implications, not only for parents but also for educators, policymakers, and scientists across disciplines.

To date, most research on bilingual children has focused on English language development compared to monolingual peers. Only a few recently published studies have attempted to understand how children develop their two languages and the role that the environment plays on productive vocabulary. In general, studies found that (a) language milestones in bilinguals are comparable to monolinguals when vocabularies from both languages are considered and (b) the relative amount of exposure to the two native languages *and* the characteristics of speech—as we demonstrate in the current study—are closely related to the size of a bilingual child's vocabulary later in life. However, the potential role of other environmental and cultural factors on learning two languages is an area ripe for further investigation. As the world becomes increasingly multicultural and multilingual, the study of bilingual language learning is both crucial and fascinating.

References

Arriaga, R. I., Fenson, L., Cronan, T., & Pethick, S. J. (1998). Scores on the MacArthur Communicative Development Inventory of children from low- and middle-incomes families. *Applied Psycholinguistics*, *19*, 209–223. doi:10.1017/S0142716400010043

Bruner, J. (1983). *Child's talk: Learning to use language*. New York, NY: W. W. Norton. doi:10.1177/026565908500100113

Conboy, B. T., & Thal, D. J. (2006). Ties between the lexicon and grammar: Cross-sectional and longitudinal studies of bilingual toddlers. *Child Development*, *77*, 712–735. doi:10.1111/j.1467-8624.2006.00899.x

De Houwer, A. (2007). Parental language input patterns and children's bilingual use. *Applied Psycholinguistics*, *28*, 411–424. doi:10.1017/S0142716407070221

Díaz-Loving, R., & Draguns, J. G. (1999). Culture, meaning, and personality in Mexico and in the United States. In Y.-T. Lee, C. R. McCauley, & J. G. Draguns (Eds.), *Personality and person perception across cultures* (pp. 103–126). Mahwah, NJ: Erlbaum.

Fenson, L., Marchman, V. A., Thal, D., Dale, P. S., Reznick, J. S., & Bates, E. (2007). *MacArthur-Bates communicative development inventories: User's guide and technical manual* (2nd ed.). Baltimore, MD: P.H. Brookes. doi:10.1037/t11538-000

Ferjan Ramirez, N., Ramirez, R. R., Clarke, M., Taulu, S., & Kuhl, P. K. (in press). Speech discrimination in 11-month-old bilingual and monolingual infants: A magnetoencephalography study. *Developmental Science*. Advance online publication. doi:10.1111/desc.12427

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development*, *8*, 181–195. doi:10.1016/S0163-6386(85)80005-9

Fernald, A., & Kuhl, P. K. (1987). Acoustic determinants of infant preference for motherese speech. *Infant Behavior and Development*, *10*, 279–293. doi:10.1016/0163-6383(87)90017-8

Fernald, A., Marchman, V. A., & Weisleder, A. (2013). SES differences in language processing skill and vocabulary are evident at 18 months. *Developmental Science*, *16*, 234–238. doi:10.1111/desc.12019

García-Sierra, A., Rivera-Gaxiola, M., Percaccio, C. R., Conboy, B. T., Romo, H., Klarman, L., & Kuhl, P. K. (2011). Bilingual language learning: An ERP study relating early brain responses to speech, language input, and later word production. *Journal of Phonetics*, *39*, 546–557. doi:10.1016/j.wocn.2011.07.002

Goldstein, M. H., & Schwade, J. A. (2008). Social feedback to infants' babbling facilitates rapid phonological learning. *Psychological Science*, *19*, 515–523. doi:10.1111/j.1467-9280.2008.02117.x

Grieser, D. L., & Kuhl, P. K. (1988). Maternal speech to infants in a tonal language: Support for universal prosodic features in motherese. *Developmental Psychology*, *24*, 14–20. doi:10.1037/0012-1649.24.1.14

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: P.H. Brookes. doi:10.1093/jpepsy/24.1.85

Hart, B., & Risley, T. R. (1999). *The social world of children learning to talk*. Baltimore, MD: P.H. Brookes. doi:10.1177/027112149901900407

Heine, S. H., Lehman, D. R., Peng, K., & Greenholtz, J. (2002). What's wrong with cross-cultural comparisons of subjective Likert scales? The reference-group effect. *Journal of Personality and Social Psychology*, *82*, 903–918. doi:10.1037/0022-3514.82.6.903

Heine, S. H., & Renshaw, K. (2002). Interjudge agreement, self-enhancement, and liking: Cross-cultural divergences. *Personality and Social Psychology Bulletin*, *28*, 578–587. doi:10.1177/0146167202288002

Hirsh-Pasek, K., Kemler Nelson, D. G., Jusczyk, P. W., Cassidy, K. W., Druss, B., & Kennedy, L. (1987). Clauses are perceptual units for young infants. *Cognition*, *26*, 269–286. doi:10.1016/s0010-0227(87)80002-1

Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development*, *74*, 1368–1878. doi:10.1111/1467-8624.00612

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review*, *26*, 55–88. doi:10.1016/j.dr.2005.11.002

Hoff, E., Core, C., Place, S., Rumiche, R., Señor, M., & Parra, M. (2012). Dual language exposure and early bilingual development. *Journal of Child Language*, *39*, 1–27. doi:10.1017/s0305000910000759

Hollingshead, A. B. (2011). Four factor index of social status. *Yale Journal of Sociology*, *8*, 21–52.

Holowka, S., Brosseau-Lapré, F., & Petitto, L. A. (2002). Semantic and conceptual knowledge underlying bilingual babies' first signs and words. *Language Learning*, *52*, 205–262. doi:10.1111/0023-8333.00184

Hurtado, N., Marchman, V. A., & Fernald, A. (2008). Does input influence uptake? Links between maternal talk, processing speed and vocabulary size in Spanish-learning children. *Developmental Science*, *11*, 31–39. doi:10.1111/j.1467-7687.2008.00768.x

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology*, *27*, 236–248. doi:10.1037/0012-1649.27.2.236

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. V. (2010). Sources of variability in children's language growth. *Cognitive Psychology*, *61*, 343–365. doi:10.1016/j.cogpsych.2010.08.002

Jackson-Maldonado, D., Thal, D. J., Marchman, V. A., Newton, T., Fenson, L., & Conboy, B. (2003). *MacArthur Inventarios del Desarrollo de Habilidades Comunicativas: User's guide and technical manual*. Baltimore, MD: Brookes.

Karzon, R. G. (1985). Discrimination of polysyllabic sequences by one- to four-month-old infants. *Journal of Experimental Child Psychology*, *39*, 326–342. doi:10.1016/0022-0965(85)90044-x

Kemler Nelson, D. G., Hirsh-Pasek, K., Jusczyk, P. W., & Cassidy, K. W. (1989). How the prosodic cues in motherese might assist language learning. *Journal of Child Language*, *16*, 55–68. doi:10.1017/s030500090001343x

King, K., & Fogle, L. (2006). Bilingual parenting as good parenting: Parents' perspectives on family language policy for additive bilingualism. *International Journal of Bilingual Education and Bilingualism*, *9*, 695–712. doi:10.2167/beb362.0

Kuhl, P. K., Tsao, F.-M., & Liu, H.-M. (2003). Foreign-language experience in infancy: Effects of short-term exposure and social interaction on phonetic learning. *Proceedings of the National Academy of Sciences of the United States of America*, *100*, 9096–9101. doi:10.1073/pnas.1532872100

Lieven, E. V. M. (1994). Crosslinguistic and cross cultural aspects of language addressed to children. In C. Gallaway & B. J. Richards (Eds.), *Input and interaction in language acquisition* (pp. 74–106). Cambridge, UK: Cambridge University Press. doi:10.1017/cbo9780511620690.005

Liu, H.-M., Kuhl, P. K., & Tsao, F.-M. (2003). An association between mothers' speech clarity and infants' speech discrimination skills. *Developmental Science*, *6*, F1–F10. doi:10.1111/1467-7687.00275

Marchman, V. A., Fernald, A., & Hurtado, N. (2009). How vocabulary size in two languages relates do efficiency in spoken word recognition by young Spanish–English bilinguals. *Journal of Child Language*, *37*, 817–840. doi:10.1017/s0305000909990055

Mehl, M. R., Gosling, S. D., & Pennebaker, J. W. (2006). Personality in its natural habitat: Manifestations and implicit folk theories of personality in daily life. *Journal of Personality and Social Psychology*, *90*, 862–877. doi:10.1037/0022-3514.90.5.862

Mehl, M. R., & Holleran, S. E. (2007). An empirical analysis of the obtrusiveness of and participants' compliance with the electronically activated recorder (EAR). *European Journal of Psychological Assessment*, *23*, 248–257. doi:10.1027/1015-5759.23.4.248

Mehl, M. R., Pennebaker, J. W., Crow, M. D., Dabbs, J., & Price, J. H. (2001). The electronically activated recorder (EAR): A device for sampling naturalistic daily activities and conversations. *Behavior Research Methods, Instruments, and Computers*, *33*, 517–523. doi:10.3758/bf03195410

Mehl, M. R., Vazire, S., Ramírez-Esparza, N., Slatcher, R. B., & Pennebaker, J. W. (2007). Are women really more talkative than men? *Science*, *317*, 82. doi:10.1126/science.1139940

Oller, D. K., Niyogi, P., Gray, S., Richards, J. A., Gilkerson, J., Xu, D., . . . Warren, S. F. (2010). Automated vocal analysis of naturalistic recording from children with autism, language delay and typical development. *Proceedings of the National Academy of Sciences of the United States of America*, *107*, 13354–13359. doi:10.1073/pnas.1003882107

Patterson, J. L. (2002). Relationships of expressive vocabulary to frequency of reading and television experience among bilingual toddlers. *Applied Psycholinguistics*, *23*, 493–508. doi:10.1017/s0142716402004010

Pearson, B. Z., Fernández, M. C., & Oller, D. K. (1993). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. *Language Learning*, *43*, 93–120. doi:10.1111/j.1467-1770.1993.tb00174.x

Petitto, L. S. (2009). New discoveries from the bilingual brain and mind across the life span: Implications for education. *Mind Brain and Education*, *3*, 185–197. doi:10.1111/j.1751-228x.2009.01069.x

Petitto, L. A., Katerelos, M., Levy, B. G., Gauna, K., Tetreault, K., & Ferraro, V. (2001). Bilingual signed and spoken language acquisition from birth: Implications for the mechanism underlying early bilingual language acquisition. *Journal of Child Language*, *28*, 453–496. doi:10.1017/s0305000901004718

Place, S., & Hoff, E. (2011). Properties of dual language exposure that influence two-year olds' bilingual proficiency. *Child Development*, *82*, 1834–1849. doi:10.1111/j.1467-8624.2011.01660.x

Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2014). Look who's talking: Speech style and social context in language input to infants are linked to concurrent and future speech development. *Developmental Science*, *17*, 880–891. doi:10.1111/desc.12172

Ramírez-Esparza, N., Gosling, S. D., & Pennebaker, J. W. (2008). Paradox lost: Unraveling the puzzle of Simpatía. *Journal of Cross-Cultural Psychology*, *39*, 703–715. doi:10.1177/0022022108323786

Ramírez-Esparza, N., Mehl, M. R., Alvarez-Bermúdez, J., & Pennebaker, J. W. (2009). Are Mexicans more or less sociable than Americans? Insights from a naturalistic observation study. *Journal of Research in Personality*, *43*, 1–7. doi:10.1016/j.jrp.2008.09.002

Rowe, M. L. (2008). Child-directed speech: Relation to socioeconomic status, knowledge of child development and child vocabulary skill. *Journal of Child Language*, *35*, 185–205. doi:10.1017/s0305000907008343

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, *83*, 1762–1774. doi:10.1111/j.1467-8624.2012.01805.x

Rowe, M. L., & Goldin-Meadow, S. (2009). Differences in early gesture explain SES disparities in child vocabulary size at school entry. *Science*, *323*, 951–953. doi:10.1126/science.1167025

Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: How important is directed speech? *Developmental Science*, *15*, 659–673. doi:10.1111/j.1467-7686.2012.01168.x

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing reliability. *Psychological Bulletin*, *86*, 420–428. doi:10.1037/0033-2909.86.2.420

Song, L., Tamis-LeMonda, S., Yoshikawa, H., Kahana-Kalman, R., & Wu, I. (2012). Language experiences and vocabulary development in Dominican and Mexican infants across the first 2 years. *Developmental Psychology*, *48*, 1106–1123. doi:10.1037/a0026401

Tamis-LeMmonda, C. S., Sze, I., Ng, F., Kahana-Kalman, R. K., & Yoshikawa, H. (2013). Maternal teaching during play with 4-year olds: Variation by ethnicity and family resources. *Merrill Palmer Quarterly*, *59*, 361–398. doi:10.1353/mpq.2013.0016

Tamis-LeMonda, C. S., Song, L., Luo, R., Kuchirko, Y., Kahana-Kalman, R., Yoshikawa, H., & Raufman, J. (2014). Children's vocabulary growth in English and Spanish across early development and associations with school readiness skills. *Developmental Neuropsychology*, *39*, 69–87. doi:10.1080/87565641.2013.827198

United States Census Bureau. (2012). *U.S. Census Bureau projections show a slower growing, older, more diverse nation a half century from now*. Retrieved from https://www.census.gov/newsroom/releases/archives/population/cb12-243.html

United States Census Bureau. (2013). *Language use in the United States: 2011*. Retrieved from http://www.census.gov/prod/2013pubs/acs-22.pdf

Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press. doi:10.1037/11193-000

Weikum, W. M., Vouloumanos, A., Navarra, J., Soto-Faraco, S., Sebastian-Galles, N., & Werker, J. F. (2007). Visual language discrimination in infancy. *Science*, *316*, 1159. doi:10.1126/science.1137686

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*, 2143–2152. doi:10.1177/0956797613488145

Xu, D., Yapanel, U., & Gray, S. (2009). *Reliability of the LENA language environment analysis system in young children's natural home environments*. Retrieved from http://www.lenafoundation.org/wp-content/uploads/2014/10/LTR-05-2_Reliability.pdf