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Research Article

An Investigation of Language Environment Analysis Measures for Spanish–English Bilingual Preschoolers From Migrant Low-Socioeconomic-Status Backgrounds

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Purpose: The current study was designed to (a) describe average hourly Language Environment Analysis (LENA) data for preschool-age Spanish–English bilinguals (SEBs) and typically developing monolingual peers and (b) compare LENA data with mean length of utterance in words (MLUw) and total number of words (TNW) calculated on a selected sample of consecutive excerpts of audio files (CEAFs).
Method: Investigators examined average hourly child vocalizations from daylong LENA samples for 42 SEBs and 39 monolingual English-speaking preschoolers. The relationship between average hourly child vocalizations, conversational turns, and adult words from the daylong samples and MLUw from a 50-utterance CEAF was examined and compared between groups.
Results: MLUw, TNW, average hourly child vocalizations, and conversational turns were lower for young SEBs than monolingual English-speaking peers. Average hourly child vocalizations were not strongly related to MLUw performance for monolingual or SEB participants (r = .29, r = .25, respectively). In a similar manner, average hourly conversational turns were not strongly related to MLUw for either group (r = .22, r = .21, respectively).
Conclusions: Young SEBs from socioeconomically disadvantaged backgrounds showed lower average performance on LENA measures, MLUw, and TNW than monolingual English-speaking peers. MLUw from monolinguals were also lower than typical expectations when derived from CEAFs. LENA technology may be a promising tool for communication sampling with SEBs; however, more research is needed to establish norms for interpreting MLUw and TNW from selected CEAF samples.

There is growing recognition of the need for innovative and promising practices for early assessment and progress monitoring of language development of young Spanish–English bilinguals (SEBs; August, Carlo, Dressler, & Snow, 2005; August & Shanahan, 2006; Kester & Peña, 2002). On the basis of the 2012 Census report (U.S. Census Bureau, 2012), growth in the Hispanic population represented 51% of the total growth in the U.S. population between 2000 and 2009. A portion of the growth represents immigrant families and children of first- or second-generation immigrants whose language of the home is Spanish. Spanish–English speakers of immigrant families are reported to be at risk for lower language scores compared with typical expectations for monolingual peers their age (Mancilla-Martinez & Lesaux, 2010). This heightened risk is intensified not only by later English experience and exposure but also because of the high prevalence of poverty among children of Mexican American immigrants (Reichman, Teitler, Garfinkel, & McLanahan, 2001). On the basis of data from interviews with 4,898 mothers in 16 randomly selected cities, three fourths of Mexican immigrant mothers had less than a high school education, 79% worked in labor or service jobs, and the income of 70% of respondents was below the poverty line (Reichman et al., 2001).

Previous research findings highlight risk for children from socioeconomically disadvantaged backgrounds to demonstrate slow rates of language development. Although there are many potential contributing factors, the increased risk for lower language scores in children from low-income backgrounds is thought to be partially attributable to parents' use of words and diversity of vocabulary in the environment (Dollaghan et al., 1999; Hart & Risley, 1995; Padilla, Dalton Radey, Hummer, & Kim, 2006). Hart and Risley (1995)

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reported that children of middle-class, well-educated parents have as many as two to three times the opportunities to converse with their parents as compared with children from low socioeconomic backgrounds. Given the relationship between income and quality of language environment, substantial risk and disadvantages have been recognized for children of Mexican immigrants from backgrounds that include low maternal education on average, high rates of poverty, and reduced access to supports and resources (Padilla et al., 2006).

The relationship between socioeconomic status (SES) and language development is particularly relevant when studying Spanish–English speakers from migrant backgrounds. *Migrant* is used to describe individuals employed by the agricultural industry who move regularly due to the location of seasonal employment. The need for early progress monitoring of Spanish-speaking children of migrant families is substantiated by a recent report of data on vocabulary growth trajectories of migrant Spanish–English speakers who continue to lag behind expectations for monolingual English-speaking peers (Jackson, Schatschneider, & Leacox, 2014). This finding was consistent with findings from earlier studies that included Spanish–English speakers with low maternal education levels and reported few books and shared reading experiences in the children's homes (Koskinen et al., 2000; Moss & Puma, 1995; Suárez-Orozco & Suárez-Orozco, 2001).

Given that young Spanish–English speakers from low SES backgrounds are at high risk for lower language scores, it is essential that educators and speech-language pathologists have assessment tools to monitor communication development and readily identify language learning disorders. Most of the evaluation tools used with young children result in static "snapshots" of performance on structured tasks or in comparison with average milestones but are not able to capture variability in a child's communication across contexts and activities or with varied communication partners (Crais, 1995). Although standardized tests offer appealing convenience, the use of standardized assessments alone often fails to yield meaningful, contextually relevant information about young Spanish–English speakers' language development (Kester & Peña, 2002; Restrepo & Silverman, 2001). Language sampling is a common informal assessment often used to address the shortcomings of standardized, norm-referenced assessments because it allows for the assessment of children's connected language within natural communicative contexts, such as conversational samples (Kemp & Klee, 1997).

Utility of Language Samples

Due to the well-documented pros and cons of formal and informal assessments, preferred practice for child language assessment typically involves a combination of both norm-referenced standard tests and informal assessment procedures (American Speech-Language-Hearing Association, 2004; Caesar & Kohler, 2009). Language sampling provides valuable insights into multiple aspects of children's language, including grammar, vocabulary, intelligibility, and pragmatic skills. For decades, language sampling has been among the most commonly used informal assessment procedure (Beck, 1995; Caesar & Kohler, 2009; Kemp & Klee, 1997; Wilson, Blackmon, Hall, & Elcholtz, 1991).

Language sampling may offer an advantage of additional cultural sensitivity and authenticity over formal, norm-referenced measures (Stockman, 1996). Natural communicative contexts may be particularly important to assess for children from culturally and linguistically diverse backgrounds. As one researcher noted, "capturing and interpreting the variety and complexity of inter-relationships among language skills within and across languages in bilingual children constitutes one of the main challenges in educational research nowadays" (Uccelli & Páez, 2007, p. 234). It is not surprising that a comprehensive analysis of a child's language sample has been recommended as an unbiased assessment, particularly as it allows for use of both languages in natural contexts (Gutiérrez-Clellen & Simon-Cereijido, 2007; Restrepo, 1998).

Index of Language Maturity

Naturalistic language sampling has been widely recognized as a measure of language growth and development for young, monolingual, English-speaking children (Brown, 1973; Caesar & Kohler, 2009; Kemp & Klee, 1997) and SEBs (Linares-Orama & Sanders, 1977; Mattes & Omark, 1984; Roseberry-McKibbin, 2007; Stockman, 1996). Mean length of utterance (MLU) is a gold standard for research and clinical use of English-based language sample analysis (Miller & Chapman, 1981; Nippold, Hesketh, Duthie, & Mansfield, 2005; Rice, Redmond, & Hoffman, 2006), as it has been found to be strongly related with age ($r = .88$), with children increasing an average of 1.2 morphemes per year of maturational development (Miller & Chapman, 1981). MLU is perhaps one of the most well-established indices of children's language maturity (Brown, 1973; McCarthy, 1954; Miller & Chapman, 1981) and the best indicators of language growth (Nippold et al., 2005) and a good predictor of children's syntactic development (Rice et al., 2006).

One challenge in using language samples collected from SEBs is determining the most appropriate method of analysis. Although guidelines for calculating MLU in morphemes were adapted for use with Spanish-speaking children to capture or give "credit" for the distinctive grammatical elements of Spanish that are not used in English (Gutiérrez-Clellen, Restrepo, Bedore, Peña, & Anderson, 2000), it is common for dual-language learners to incorporate both Spanish and English vocabulary within a single utterance, creating difficulty in determining which set of MLU calculation rules to follow. Furthermore, when the overall sample contains mixed use of Spanish and English across utterances, it is difficult to apply norms for the expected number of morphemes per utterance as the scale differs between the two languages. To help eliminate inconsistencies and obtain comparable counts across transcripts of SEBs, current best practice in language sample analysis (LSA) involving Spanish–English-speaking children is to

include MLU in words (MLUw-Spanish, MLUw-English, or combined) rather than MLU in morphemes (Gutiérrez-Clellen et al., 2000; Miller & Iglesias, 2010; Rojas & Iglesias, 2013).

Technology for Collecting Communication Samples

In recent years, a new device called the Language Environment Analysis (LENA) digital language processor (DLP) has provided another option for gathering naturalistic communication samples in everyday contexts. The LENA DLP may be used to capture and further describe children's communication in natural environments (Oller, 2010). The LENA DLP is a small device worn by young children during routine, everyday activities to capture a daylong sample up to 16 hr. The device contains speaker recognition software that segments speech versus nonspeech sounds (e.g., TV, radio, silence) and filters out any sound that is unlikely attributable to a person in the child's environment. In addition, because speaker recognition software generally works best in quiet settings with a single speaker, the LENA device considers overlapping speech (multiple speakers at a given moment) as background noise and eliminates these sounds as well as child nonspeech sounds (i.e., crying, laughing) from the audio content used for analyses. The remaining audio is then processed by the accompanying software, Advanced Data Extractor (ADEX), which provides an automated analysis of the sounds identified as adult (male or female) or child, differentiating between the key child and other children in the environment. These analyses provide information regarding child vocalization (CV), adult words (AWs), and conversational turns (CTs). A CV is considered an early communicative sound, babble, or words—a purposefully broad definition because the LENA system was designed to analyze the communication environment of infants and toddlers and provide estimated vocalization measures (Xu, Yapanel, & Gray, 2009). In contrast, the AW estimate indicates the number of words, rather than vocalizations, spoken by an adult when near the key child. When measures of AW and CV have been compared with measures calculated after human transcription and analysis of the same audio, the ADEX software typically provides more conservative estimates than what is heard and transcribed by a human, reporting an AW average anywhere from 2% to 27% lower than what is calculated through human transcription (Xu et al., 2009). To further explain potential differences between LENA estimates of rate of vocalization and calculations made on the basis of manual transcription, Xu et al. (2009) also explain that noisy environments with increased background noise or multiple people speaking at once result in more conservative estimates by the LENA system as ADEX excludes periods of overlapping speech from the audio to be analyzed.

The use of LENA technology has shown promise as a tool for capturing and studying linguistic diversity in the environments of young children (Oller, 2010). In a case study, the LENA system was used to record daylong recordings of a trilingual 2-year-old exposed to three languages. The case study incorporated the use of recordings, which ranged, on average, from 9 to 11 hr with automated analysis to examine vocal activities during natural routines and capture language input from linguistically diverse caregivers. Because the LENA automated analysis counts vocalizations as opposed to words, multiple languages being spoken within a single recording should presumably not cause difficulty for the ADEX software in determining child and adult vocalization counts. However, for the researcher interested in the specifics of the languages used, a more traditional method of analysis is required.

The use of average hourly rates of vocalizations as opposed to total values is common in studies using LENA technology due to differences in audio file lengths obtained from participants. Furthermore, because many young children take naps during daytime hours, large segments of silence are often observed in the data. The duration of silent napping time on the audio file is typically subtracted from the overall audio file duration to focus on parts of the child's day in which communication occurs. The average hourly measures may, therefore, be compared across children with varying durations of audio files.

The ease of automated processing and analyses using ADEX software with LENA recordings to produce quantifiable measures is a recognized strength to this burgeoning technology (Suskind et al., 2013); however, researchers also acknowledge potential limitations in the interpretation of the automated measures. It cannot be presumed that quantity of vocalizations correlates with quality of content. Further, it cannot be presumed that MLU derived from selected consecutive communication excerpts from the audio files (CEAFs) of preschool LENA samples recorded during daily activities would be similar to norm-referenced MLU derived from traditional language samples elicited through controlled contexts while intentionally gathering a sample.

Despite recent increased use of the LENA system with English-speaking monolinguals, little is known about average or expected rate of child vocalization for young SEBs, particularly from socioeconomically disadvantaged backgrounds. The relationship between quantity measures (e.g., CV), MLU, and total number of words (TNW) on selected consecutive utterance samples warrants further research. The rate of CVs and CTs (defined as alternating child–adult vocalizations) may be expected to be similar for young SEBs and English-speaking monolingual speakers; however, given that SEBs from migrant low-SES backgrounds have been reported to perform lower on standardized language measures, quantity of vocalizations as measured by LENA automated measures may be expected to be lower than that of English-speaking monolingual children from families reporting higher maternal education. In addition, cultural differences may be expected to affect the quantity or frequency of vocalizations across the day.

Cultural Considerations

Cultural differences in communication norms may influence the frequency of vocalizations by children and

adults in communication samples. According to Teichman and Contreras-Grau (2006), communication styles vary across cultures; therefore, caregiver–child communication patterns may also be expected to differ between children from differing cultural linguistic backgrounds. Examples of culturally and linguistically diverse influences have been observed in young children's oral narratives, storytelling, and parent–child interactions (Fiestas & Peña, 2004), indicating that children's cultural background may affect the number of utterances, amount of description, sequence, and verb tense use. Differences in expected verbosity is another illustration of cultural influences on language (Gutiérrez-Clellen & Quinn, 1993), as some cultures value being concise or succinct, which would be expected to influence the TNW observed in a language sample. Moreover, theories of culture have been proposed in which groups are characterized as high- or low-context cultures (Hall, 1976). According to this theory, communicative interactions in a high-context culture rely more highly on nonverbal information than in a low-context culture in which communicative exchanges rely more heavily on the explicit use of language to convey a message.

Aims

In response to the growing population and the high risk for developmental language delays for SEBs from migrant low-SES backgrounds, additional studies are warranted to explore innovative and promising practices for early assessment and progress monitoring of communicative performance in young SEBs. LENA automated measures currently have not been extensively reported with young SEB children from migrant low-SES backgrounds. Therefore, to address the shortcomings in the literature, the current study addresses the following research questions: (a) What is the relationship among LENA automated measures (i.e., CV, AW, CT) and measures of transcribed excerpts (MLUw and TNW) derived from selected CEAF of daylong samples for bilingual and English-speaking monolingual children? (b) What is the average hourly rate of CVs and alternating child–adult CTs for young SEBs from migrant backgrounds and English-only-speaking peers? (c) Are there significant differences in average hourly LENA automated measures, TNW, and MLUw (as calculated on CEAFs) between English-speaking monolingual and SEB children of similar ages from migrant backgrounds?

Method

The investigators shared information about the study with parents of all preschool-age children enrolled in a summer program for children of migrant farm workers and four Head Start preschool classrooms providing school-year supports to SEBs in two rural, southeastern communities. In addition, investigators accumulated a database of LENA samples over a 2-year time period from monolingual English-speaking children attending day care and preschool programs in northwest Florida. Investigators contacted parents who provided signed informed consent to schedule a day of recording and complete a short case history (see Appendix A). Two participants were later excluded due to the short length of the recorded audio on the LENA system (a 1.5-hr sample and a 1.68-hr sample).

Participants

Participants included 81 children between 3 and 5 years of age. All participants were reported by their parents or teachers to be typically developing (i.e., no reported sensory impairments or disorders; no current enrollment in speech-language, physical, occupational therapies). Children were classified into two groups by their language use: SEB children and monolingual English speakers.

Spanish–English Speakers

Participants included 42 SEB children attending preschool programs who ranged in age from 36 to 65 months with an average age of 51 months (SD = 8.7). Children were classified as sequential language learners (i.e., the children began learning Spanish at home prior to their exposure to English in the classroom at age 3) on the basis of background questionnaires completed by families and informal interviews with the teachers. The group of SEBs was comprised of 18 boys (43%) and 24 girls (57%) who attended a Head Start program or a summer migrant education preschool program. Of the 42 families, 100% reported their child's ethnicity as Hispanic/Latin American. Parents of SEB participants worked for the local agricultural industry. Most parents reported their highest grade to be in high school or completing high school, one parent reported grade school to be the highest education, and one parent reported some community college training (see Table 1).

English-Speaking Monolinguals

LENA data were gathered for 39 monolingual English speakers attending preschool programs who ranged in age from 34 to 62 months, with an average age of 47 months (SD = 7.46). Demographic information was obtained through parent report on a questionnaire that was sent home with the LENA device (see Appendix A). Of the 36 responding parents, all parents classified their child as a monolingual English speaker (i.e., no language other than English was

Table 1. Child and family demographic information for mother's education.

	% for Spanish-English bilinguals (n = 42)	% for Monolingual English speakers (n = 39)
Education level	**24 girls, 18 boys**	**21 girls, 18 boys**
Elementary school	2.0	
Some high school	72.0	13.9
High school diploma	24.0	2.8
Some college	2.0	11.1
Associate's degree		50.0
Bachelor's degree		19.4
Graduate degree		2.8

spoken in the home). The group of English-speaking monolinguals comprised 18 boys (46%) and 21 girls (54%) who largely attended local or nearby child care or preschool programs. Although SEB participants were recruited from only two locations, some monolingual participants were recruited from the same classrooms as SEBs, with others recruited from different classrooms in nearby schools and cities. Some of the preschool programs did not offer free or reduced-price lunch, and some responded with "I don't know" because it was not offered in their preschool. The participants were classified as typical on the basis of responses to a developmental milestone question, the lack of medical history of excessive ear infections, and teacher and parent reports that there were no concerns and that the child did have an educational support plan for special services. The demographic questionnaire also provided race/ethnicity information: 84.2% of parents reported their child's ethnicity as White, 2.6% identified as Black, 10.5% self-identified as Hispanic/Latin American, and the remaining parents (2.6% of the sample) identified their child as being of Asian descent. Parents of English-speaking monolingual children worked in a variety of settings, and approximately 70% of parents had an associate's degree or higher (see Table 1).

Procedures

Participating children wore the LENA DLP, a small 2- to 3-in. recorder weighing 70 g, to gather a continuous daylong sample. Children were provided with a t-shirt containing a pocket on the chest to hold the DLP and ensure optimal positioning of the microphone in close proximity to the child's mouth. Investigators placed the LENA device on the child in the morning at his or her preschool center. Parents were instructed that children would wear the LENA DLP in their natural environments beginning in the morning during daily activities at preschool and would continue to wear the LENA DLP at home in the evening. Investigators provided parents with instructions that explained how to turn the LENA DLP off if desired as well as an envelope to return the t-shirt and DLP to the child's school the next school day.

The overall average length of recording (in hours: minutes) was 10:28 (range = 2:50–15:12). The LENA samples gathered for the SEBs averaged 11 hr and 9 min in length (range = 4:54–15:12). The samples from the monolingual group averaged 9 hr and 43 min (range = 2:50–14:30). Because these recordings varied in length, the average rate of vocalizations per hour was calculated (following the procedures of Suskind et al., 2013) rather than using the total numbers of CVs, AWs, or CTs from the entire recording. The samples were then exported to the accompanying ADEX for additional analysis.

To characterize the content of the daylong LENA samples and provide detailed description of the bilingual recordings for replication, the total Spanish used across the daylong samples was calculated on the basis of systematic samplings of the first 1 min of speech for each 5-min segment across each child's entire recording. For 39 of the 42 SEBs, the LENA recording included both school and home settings (with more than 6 hr of recording). Of the three SEBs with recordings in only one setting, one of the children had recordings at home and two children had recordings at school only. Bilingual research assistants reviewed each 5-min audio segment and characterized the first 1 min of the child's speech as Spanish only, English only, or mixed use of Spanish and English. To derive the 1-min sample, the coding started when the child began to speak on the 5-min audio segment. A researcher-made index, estimated total Spanish, was then derived by taking the number of 5-min segments throughout the daylong sample containing Spanish and dividing by the total number of segments in the daylong recording. On the basis of the systematic review of the daylong recordings, 78% of the 5-min segments across the daylong LENA samples contained Spanish with 59% exclusively in Spanish, 19% contained both Spanish and English productions, 20% were exclusively in English, and 2% were undecipherable.

To ensure that the quality of audio files collected for the two groups did not affect group comparisons of interest, the investigators compared the percentage of noise (i.e., duration noise/duration of audio file = percentage noise) found on the audio samples of both groups using a t test. The mean percentage of noise found on the SEB children's audio files was 2.8% of the total audio file (SD = 3.3%), with a range of 0% to 16%. The mean percentage of noise found on the English-only-speaking children's audio files was 3% of the total audio file (SD = 4%), with a range of 0% to 25%. The average amount of noise found on the audio files of the two groups was not found to be statistically different, $t(79) = -0.26$, $p > .05$. Therefore, the quality of audio file was not thought to explain or cause any of the other possible differences found on the linguistic variables of interest.

CEAF Procedures

Investigators extracted 30-min audio segments from the LENA recordings for calculation of MLU and TNW on the basis of a selected communication sample composed of a CEAF for transcription and analysis. The investigators used the bar graphs generated by the LENA software to visually inspect 5-min segments during the daylong sample in which vocalizations occurred, beginning at 10:00 a.m., 4:00 p.m., 5:00 p.m., and 6:00 p.m. to find a 30-min segment of consecutive talk. Samples taken from the midafternoon times were avoided because of the increased chances of children or their peers taking naps. If a 30-min sample from the 10:00 a.m. segment was unavailable because of a noncommunicative context (e.g., watching a movie) or excessive background noise, a 30-min segment from late afternoon and early evening was exported. For SEBs with recordings in both home and school, the CEAF was from the setting with the higher CV rate on the basis of the bar graph.

For both SEB and English-speaking monolingual participant groups, seven trained research assistants majoring in speech-language pathology transcribed the sample. For

CEAFs involving SEBs, a fluent Spanish-speaking assistant transcribed the audio samples. Research assistants were instructed to transcribe 30 min of audio or 50 utterances, whichever criteria was achieved first; however, all participants achieved 50 utterances within the CEAFs. The sample size of 50 was utilized on the basis of previous research that established 50 utterances to be efficient and reliable for MLU calculations (Castby, 2011; Miller & Chapman, 1981) with strong split-half reliability (McCarthy, 1954), and there were no statistically significant differences in MLU when calculated across 50- and 100-utterance sample lengths (Castby, 2011; Rondal & DeFays, 1978). Utterances that contained unintelligible portions, that were exact imitations of a communication partner's utterance, or that were consecutive repetitions were not included in the analysis set of the transcript. Utterances were broken into communication units (c-units), which consist of a main clause and its dependent clauses. Utilizing the descriptions provided by Loban (1963) and Eisenberg and Guo (2013), c-units were determined by intonation and pauses and contained no more than one independent clause and any dependent phrasal and clausal components. Compound sentences were separated across utterance lines when a subject was present in both simple sentences.

To ensure accuracy of transcription and coding, a second listener listened to 10% of each audio file and checked the transcripts to calculate the percentage agreement of utterance segmentation (c-units) and morpheme counts (in words) between the second listener and each transcriber. Percentage agreement was calculated for both c-units and MLUw by identifying the total number of agreements divided by the number of disagreements plus disagreements to derive a percentage. The seven transcribers of monolingual audio files agreed with the second author an average of 96.89% of the time on utterance (c-unit) segmentation (range of 93.75% to 100% agreement across all transcribers). For SEBs, there was a 94% agreement in MLUw calculation between the bilingual transcriber and the third author. On the basis of previous literature, an overall agreement of at least 92% is expected in order to say that the transcribers were reliable and transcribing/coding in the same manner (Heilmann, 2006), and 94% is widely regarded as acceptable reliability (Miller & Chapman, 1981; Rice et al., 2006).

Analyses of CEAFs

Investigators used the Systematic Analysis of Language Transcripts (SALT; Miller & Iglesias, 2010) software to calculate TNW and MLUw for all participants. Because of the interchange of Spanish and English use within a single utterance, MLUw was calculated rather than MLU in morphemes (Gutiérrez-Clellen et al., 2000). Detailed descriptions of word count procedures are outlined in Appendix B.

To further describe the content of the samples to assess generalizability and to allow for replication, the transcripts were further described in terms of the percentage of words in Spanish and in English. The percentage of words in Spanish within the CAEFs was calculated by taking the number of Spanish words in the transcript divided by 50. Guidelines for assigning words to either Spanish or English were created and are included in Appendix B. A secondary investigator examined the accuracy of the coding to ensure that transcribers followed the guidelines. Any disagreements were discussed among transcribers until consensus was attained. Within the SEB group, 38 participants produced both English and Spanish words during their sample, three SEB participants used only Spanish words, and one participant used only English words. When considering all words produced by SEB participants in the CEAFs, roughly half of the words were spoken in Spanish (51.69%, SD = 38.35%). The average percentage of utterances (in c-units) entirely spoken in Spanish was slightly smaller but similar (47.67%, SD = 36.05%). Participants' use of both English and Spanish within the same utterance occurred, on average, 5.38% of the time (SD = 6.50%), with the remaining 46.95% of utterances entirely in English.

Analyses

To answer our first research question, descriptive statistics were calculated using ADEX output to examine average hourly CVs, AWs, and CTs for participants. Correlational analyses were also conducted to examine relationships between LENA and SALT measures, examining the relationship between average hourly CVs, CTs, AWs, MLUw, and TNW during the sample. To explore the second research question examining significant differences between SEBs and English-speaking monolingual participants, independent-samples t tests were used to compare differences in LENA and SALT measures between the two groups. Levene's statistic was also analyzed to test the assumption of equal variances within groups on each measure of interest. This statistic was nonsignificant for all variables. Because of the multiple comparisons made between the two groups, a Bonferroni correction was applied ($\alpha = .05/6 = .008$) to adjust the probability and control for a type I error.

Results

Relationship Among Measures Derived From LENA and SALT

To answer our first research question, partial correlations were conducted controlling for children's age to determine the relationship among LENA measures and MLUw and TNW (see Table 2). Partial correlations were calculated for bilingual and English-speaking monolingual participants separately to observe possible differences in relationships between the groups. For both groups, the measure of MLUw (derived from SALT) was not significantly related to any of the three LENA measures of interest (i.e., average hourly CV, AW, and CT). A different pattern emerged, however, within the observed relationships among LENA measures. For bilingual participants, all LENA measures were strongly and significantly related to each other after controlling for age (r range = .61–.86). In

Table 2. Partial correlations for Spanish–English and monolingual English participants.

Measure	Spanish-English bilinguals				Monolingual English			
	1	2	3	4	1	2	3	4
1. Average hourly CVs	—				—			
2. Average hourly CTs	0.86**	—			0.81**	—		
3. Average hourly AWs	0.61**	0.81**	—		0.40*	0.71**	—	
4. MLUw	0.29	0.22	0.16	—	0.25	0.21	0.15	—

Note. Partial correlations control for child age. CV = child vocalization; CT = conversational turn; AW = adult word; MLUw = mean length of utterance in words.

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

a similar manner, English-speaking monolingual children's average hourly CV was significantly related to AW ($r = .40$) as well as to their average hourly CT ($r = .81$).

Group Comparisons

To address the second research question, the average hourly rate of CVs and CTs were examined and are described for all participants by group of participants in Table 3. The means suggested that Spanish-speaking students produced fewer average hourly CVs and CTs than their English-speaking monolingual peers. To address the third research aim, to determine whether these mean group differences were statistically significant, independent-samples t tests were conducted and revealed significant differences between groups on measures of average hourly CV, $t(79) = -5.63$, $p < .008$, $d = 1.25$; and rates of CT, $t(79) = -5.03$, $p < .008$, $d = 1.11$. Both of these group differences were representative of a very large effect, with English-speaking monolingual students demonstrating higher average hourly CVs and CTs. Further, the AWs were also compared between groups. The independent-samples t test again revealed that, within our sample, adults produced more words per hour during interactions with English-speaking monolinguals, on average, than those interacting with the SEBs, $t(79) = -3.38$, $p < .008$, $d = 0.75$.

In addition, an analysis of transcribed CEAF data from SALT revealed that, although English-speaking monolingual participants produced a higher TNW in the 50-utterance sample and more words per utterance (MLUw) than was found in the CEAFs of their bilingual peers, the group differences in TNW, $t(79) = -2.68$, $p > .008$; and MLUw, $t(79) = -2.68$, $p > .008$; were not statistically significant after controlling for type I error. The mean difference in TNW between groups was 25.48, with SEBs producing 159.08 words on average ($SD = 45.90$) and monolingual English speakers producing an average of 184.56 words ($SD = 39.10$). Compared with the large effect sizes observed for variables calculated using LENA data, indices of practical significance for SALT measures reveal moderate effects ($d = 0.60$ for both TNW and MLUw), despite the statistically nonsignificant findings after controlling for type I error.

Discussion

The finding that SEBs in this sample showed lower average hourly CVs overall, compared with English-speaking monolingual peers, is not surprising, given previous literature suggesting children from migrant low-SES backgrounds hear fewer words throughout the day than children from higher SES backgrounds (Hart & Risley, 1995). The two groups in this study differed in primary language, maternal education level, amount of adult talk, and migrant status, making it difficult to isolate the extent to which each factor accounted for the group differences in average hourly CVs and CTs.

Although the cause of the lower average hourly CVs and CTs cannot be determined from the current descriptive

Table 3. Means and standard deviations for participants' LENA and SALT performances.

Measure	Spanish-English bilinguals			Monolingual English		
	M	*SD*	Min–Max	*M*	*SD*	Min–Max
Average hourly CVs	126.92	86.11	20.24–328.26	249.50**	109.33	73.16–506.65
Average hourly AWs	784.64	433.97	160.88–2,064.58	1,103.80**	414.89	360.23–2215.88
Average hourly CTs	23.64	19.79	3.31–93.91	50.16**	27.32	11.25–125.74
TNW	159.08	45.95	61.00–264.00	184.56*	39.10	105.00–262.00
MLUw	3.18	0.92	1.22–5.28	3.69*	0.78	2.10–5.24

Note. Asterisks represent significant group mean differences. Min = minimum; Max = maximum; CV = child vocalization; AW = adult word; CT = conversational turn; TNW = total number of words; MLUw = mean length of utterance in words.

*$p < .001$. **$p < .01$.

study, previous literature would support SES as a stronger contributor to lower outcomes. The lower overall MLUw, TNW, CV, and CT averages for this group of children from migrant low-SES linguistic minority backgrounds appears to be consistent with the lower outcomes reported in previous studies that included SEBs from low-SES backgrounds (Crosnoe, 2007; Koskinen et al., 2000; Moss & Puma, 1995; Suárez-Orozco & Suárez-Orozco, 2001). A recognized limitation in the current study, however, is that it cannot be determined whether the results are generalizable to children of families from low-SES backgrounds in general or only those of migrant low-SES backgrounds.

Culture may also be considered as a contributor to the lower frequency of vocalizations by the SEB group. In the present study, the SEB participants presented with lower average hourly CVs, AWs, and CTs across the day and lower TNW and MLUw as calculated on CEAFs from a daylong sample. Although the influence of culture was not directly analyzed in this study, differences in outputs between the monolingual English-speaking participants and the SEBs may be partially attributable to cultural differences. Lower rates of CVs, CTs, and AWs may be related to diverse expectations for frequency in vocalizations. According to high- or low-context theory (Hall, 1976), in a high-context culture, a large degree of information tends to be transmitted nonverbally, whereas individuals in largely low-context cultures tend to communicate more directly using vocalizations explicitly to convey a message. Although only a theory, caregivers and children from Latin-American backgrounds may have reflected a high-context culture, and such cultural differences may partially explain lower vocalizations on LENA and MLU measures. Although the extent to which culture influences average hourly CVs and MLUw in the present study is unknown, the lower rate of AWs in the CEAFs of children from Latin-American backgrounds would support an influence of high- or low-context differences between cultures. The fact that average hourly AW was greater for the monolinguals than the SEBs may relate to cultural differences and, furthermore, may have been an important influencing factor in the lower MLUs, TNW, and average hourly CVs obtained in the SEB sample.

The small, nonsignificant correlations observed between LENA measures (CV, CT) and MLUw for both Spanish and English speakers was an interesting unexpected finding. MLUw from monolinguals were, overall, lower than those expected on the basis of published norms on traditional LSA procedures. Although the reason for this finding cannot be conclusively determined in the current study, it is possible that MLUw derived from CEAFs of daylong recordings may not be expected to result in equivalent MLUw to those derived from traditional language sample procedures. Given the overall low MLUws in both groups of children (compared with norms that are based on traditional LSA for children of comparative ages), it is possible that the sampling conditions using CEAFs are substantially different than what we may have obtained from the same children in an adult-elicited language sample with communicative temptations or samples in which adults use expectant pauses or other techniques to elicit CTs. This unexpected finding of rather low MLUw in both groups supports the need for more research comparing MLUw of a traditional language sample within the same day as a daylong LENA sample to compare the similarities and differences further. Traditional LSA elicitation and collection practices may be necessary for obtaining MLUs comparable to published norms.

The lack of relationship between LENA measures and MLUw does not preclude the use of LENA in assessment procedures for young SEBs for observing Spanish and English use across the day, which may be useful in observing the child's communication across varied contexts and communication partners; however, the current results suggest the automated data should be interpreted cautiously given the lack of a strong relationship between LENA measures and MLUw and TNW calculated on CEAFs of 50 utterances from a selected communication sample. The current study may have had poor representation of the children's use of both languages since the CEAF was taken from one context only, recognizing that home and school contexts may result in different average hourly CV (Jackson & Callender, 2014) and noting that comprehensive samples from both of a child's languages is considered best practice (Gutiérrez-Clellen & Simon-Cereijido, 2007). In future research, it would be beneficial to compare LENA data to LSAs of traditionally elicited language samples within controlled contexts in both home and school settings.

Implications

The significantly lower overall average hourly CV and CT observed in SEBs from migrant low-SES backgrounds substantiates the importance of progress monitoring and the need for heightened resources and supports to prevent a word gap in children from socioeconomically disadvantaged backgrounds. Implications of the current study should be interpreted cautiously, given that the current study did not include a comparison of SES-matched groups and the daylong recordings varied in length, context, and communication partners. Regardless of the comparative limitations in the current design, low resources and higher incidence of poverty among families from Spanish-speaking immigrant backgrounds have been well documented in other studies (Padilla et al., 2006). The lower performance highlighted in the current sample warrants innovative approaches to minimize gaps in early language development.

Considering desirable traits of evaluation and assessment tools for young children, the daylong recording allows for sampling communication across naturalistic contexts with varied communication partners who may have different linguistic backgrounds. The ability to obtain quantifiable measures (e.g., CV, CT) using automated processing and analyses is a recognized strength of the LENA technology (Suskind et al., 2013); however, researchers have also highlighted cautions in interpretation that warrant additional investigation.

Although LENA facilitates sampling vocalizations across naturalistic contexts, naturalistic sampling provided less control of the quantity and type of communicative opportunities that occur during the sample. The rate of CVs and CTs may be affected by the number of opportunities in the environment. As a result, it cannot be determined from the LENA automated analyses alone whether a low average number of CVs or CTs results from low developmental language levels, limited stimuli, or fewer communicative temptations in the environment. It is also impossible to calculate how representative the sample was of the typical number of opportunities and exchanges in their environments. Given the lack of predictable quantity of communicative opportunities in any given day, additional research is needed to examine the internal consistency or test–retest stability of naturalistic daylong samples using LENA.

Although the LENA automated measures may contribute additive information about the children's vocalizations across the day, the limitations noted in the study support the need to weigh the LENA data in combination with other microanalyses. Automated analyses may be limited in terms of finer discriminations of linguistic content and communicative function. A high CV count may indicate a high number of novel verbalizations or frequent repetition of a small set of verbalizations, making access to the audio samples for microanalysis imperative to obtain information about the use of Spanish and English across the sample as well as structural analysis of the semantic and morphosyntactic development.

Future Directions

Future studies are needed to further explore the use of automated measures to capture multilinguistic communication for assessment and research purposes and explore the relationship to LSA measures from samples gathered through traditional procedures. It will be interesting to continue to gather longitudinal data on migrant SEBs to establish a normative database over time. A normative database would enhance the utility of the average hourly LENA automated measures for screening and early identification. Additional research is needed to compare bilingual and English-speaking monolingual groups matched in SES backgrounds and maternal education levels.

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References

American Speech-Language-Hearing Association. (2004). *2003 omnibus survey results*. Rockville, MD: Author.

August, D., Carlo, M., Dressler, C., & Snow, C. (2005). The critical role of vocabulary development for English language learners. *Learning Disabilities Research & Practice, 20,* 50–57. doi:10.1111/j.1540-5826.2005.00120.x

August, D., & Shanahan, T. (Eds.). (2006). Executive summary and methodology. In *Developing literacy in second language learners: Report of the National Literacy Panel* (pp. 1–8). Mahwah, NJ: Erlbaum.

Beck, A. R. (1995). Language assessment methods for three age groups of children. *Journal of Communication Development, 17,* 51–56. doi:10.1177/152574019501700206

Brown, R. (1973). *A first language: The early stages*. Cambridge, MA: Harvard University Press.

Caesar, L. G., & Kohler, P. D. (2009). Tools clinicians use: A survey of language assessment procedures used by school-based speech-language pathologists. *Communication Disorders Quarterly, 30,* 226–236. doi:10.1177/1525740108326334

Castby, M. W. (2011). The relationship of sample size and mean length of utterance in children with developmental language impairment. *Child Language Teaching & Therapy, 27,* 286–293. doi:10.1177/0265659010394387

Crais, E. R. (1995). Expanding the repertoire of tools and techniques for assessing the communication skills of infants and toddlers. *American Journal of Speech-Language Pathology, 4,* 47–59. doi:10.1044/1058-0360.0403.47

Crosnoe, R. (2007). Early child care and the school readiness of children from Mexican immigrant families. *International Migration Review, 41,* 152–181. doi:10.1111/j.1747-7379.2007.00060.x

Dollaghan, C. A., Campbell, T. F., Paradise, J. L., Feldman, H. M., Janosky, J. E., Pitcairn, D. N., & Kurs-Lasky, M. (1999). Maternal education and measures of early speech and language. *Journal of Speech, Language, and Hearing Research, 42,* 1432–1443. doi:10.1044/jslhr.4206.1432

Eisenberg, S. L., Guo, L.-Y. (2013). Differentiating children with and without language impairment based on grammaticality. *Language, Speech, and Hearing Services in Schools, 44,* 20–31. doi:10.1044/0161-1461(2012/11-0089)

Fiestas, C. E., & Peña, E. D. (2004). Narrative discourse in bilingual children: Language and task effects. *Language, Speech, and Hearing Services in Schools, 35,* 155–168. doi:10.1044/0161-1461(2004/016)

Gutiérrez-Clellen, V. F., & Quinn, R. (1993). Addressing narratives of children from diverse cultural linguistic groups. *Language, Speech, and Hearing Services in Schools, 24,* 2–9.

Gutiérrez-Clellen, V. F., Restrepo, M. A., Bedore, L., Peña, E., & Anderson, R. (2000). Language sample analysis in Spanish-speaking children: Methodological considerations. *Language, Speech, and Hearing Services in Schools, 31,* 88–98. doi:10.1044/0161-1461.3101.88

Gutiérrez-Clellen, V. F., & Simon-Cereijido, G. (2007). The discriminant accuracy of a grammatical measure with Latino English-speaking children. *Journal of Speech, Language, and Hearing Research, 50,* 968–981. doi:10.1044/1092-4388(2007/068)

Hall, E. T. (1976). *Beyond culture*. New York, NY: Doubleday.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experiences of young American children*. Baltimore, MD: Brookes.

Heilmann, J. J. (2006). *Narrative language: A multi-level perspective*. Unpublished doctoral dissertation. University of Wisconsin, Madison.

Jackson, C. W., & Callender, M. F. (2014). Environmental considerations: Home and school comparison of Spanish-English speakers' vocalizations. *Topics in Early Childhood Special Education, 34,* 165–174. doi:10.1177/0271121414536623

Jackson, C. W., Schatschneider, C., & Leacox, L. (2014). Longitudinal analysis of receptive vocabulary growth in young Spanish English-speaking children from migrant families. *Language, Speech, and Hearing Services in Schools, 45,* 40–51. doi:10.1044/2013_LSHSS-12-0104

Kemp, K., & Klee, T. (1997). Clinical language sampling practices: Results of a survey of speech-language pathologists in the United States. *Child Language Teaching and Therapy, 13,* 161–176. doi:10.1177/026565909701300204

Kester, E. S., & Peña, E. (2002). *Limitations of current language testing practices for bilinguals*. College Park, MD: Eric Clearinghouse on Assessment and Evaluation. Retrieved from http://www.ericdigests.org/2003-3/testing.htm

Koskinen, P., Blum, I. H., Bisson, S. A., Phillips, S. M., Creamer, T. S., & Baker, T. K. (2000). Book access, shared reading, and audio models: The effects of supporting the literacy learning of linguistically diverse students in school and at home. *Journal of Educational Psychology, 92,* 23–36. doi:10.1037/0022-0663.92.1.23

Linares-Orama, N., & Sanders, L. J. (1977). Evaluation of syntax in three-year-old Spanish-speaking Puerto Rican children. *Journal of Speech and Hearing Research, 20,* 350–357. doi:10.1044/jshr.2002.350

Loban, W. D. (1963). *The language of elementary school children* [Research Report No. 1]. Urbana, IL: National Council of Teachers of English.

Mancilla-Martinez, J., & Lesaux, N. K. (2010). Predictors of reading comprehension for struggling readers: The case of Spanish-speaking language minority learners. *Journal of Educational Psychology, 102,* 701–711. doi:10.1037/a0019135

Mattes, L. J., & Omark, D. R. (1984). *Speech and language assessment for the bilingual handicapped*. San Diego, CA: College-Hill Press.

McCarthy, D. (1954). Language development in children. In L. Carmichael (Ed.), *Manual of child psychology* (2nd ed., pp. 492–630). New York, NY: Wiley.

Miller, J. F., & Chapman, R. S. (1981). The relation between age and mean length of utterance in morphemes. *Journal of Speech and Hearing Research, 24,* 154–161. doi:10.1044/jshr.2402.154

Miller, J. F., & Iglesias, A. (2010). *Systematic analysis of language transcripts* (instructional version) [Computer software]. Middleton, WI: SALT Software.

Moss, M., & Puma, M. (1995). *Prospects: The congressionally mandated study of educational opportunity and growth: Language minority and limited English proficient students*. Washington, DC: U.S. Department of Education. Retrieved from http://www.ncela.us/files/rcd/BE020434/Prospects_The_Congressionally_Mandated.pdf

Nippold, M. A., Hesketh, L. J., Duthie, J. K., & Mansfield, T. C. (2005). Conversational versus expository discourse: A study of syntactic development in children, adolescents, and adults. *Journal of Speech, Language, and Hearing Research, 48,* 1048–1064. doi:10.1044/1092-4388(2005/073)

Oller, D. K. (2010). All-day recordings to investigate vocabulary development: A case study of a trilingual toddler. *Communication Disorders Quarterly, 31,* 213–222. doi:10.1177/1525740109358628

Padilla, Y. C., Dalton Radey, M., Hummer, R. A., & Kim, E. (2006). The living conditions of U.S.-born children of Mexican immigrants in unmarried families. *Hispanic Journal of Behavioral Sciences, 28,* 331–349. doi:10.1177/0739986306290367

Reichman, N. E., Teitler, J. O., Garfinkel, I., & McLanahan, S. (2001). The Fragile Families and Child Wellbeing Study: Sample and design. *Children and Youth Services Review, 23,* 303–326. doi:10.1016/S0190-7409(01)00141-4

Restrepo, M. A. (1998). Identifiers of predominantly Spanish-speaking children with language impairment. *Journal of Speech, Language, and Hearing Research, 41,* 1398–1411. doi:10.1044/jslhr.4106.1398

Restrepo, M. A., & Silverman, S. W. (2001). Validity of the Spanish Preschool Language Scale-3 for use with bilingual children. *American Journal of Speech-Language Pathology, 10,* 382–393. doi:10.1044/1058-0360(2001/032)

Rice, M. L., Redmond, S. M., & Hoffman, L. (2006). Mean length of utterance in children with specific language impairment and in younger control children shows concurrent validity and stable and parallel growth trajectories. *Journal of Speech, Language, and Hearing Research, 49,* 793–808. doi:10.1044/1092-4388(2006/056)

Rojas, R., & Iglesias, A. (2013). The language growth of Spanish-speaking English language learners. *Child Development, 84,* 630–646. doi:10.1111/j.1467-8624.2012.01871.x

Rondal, J. A., & DeFays, D. (1978). Reliability of mean length of utterances as a function of sample size in early language development. *The Journal of Genetic Psychology, 133,* 305–306. doi:10.1080/00221325.1978.10533390

Roseberry-McKibbin, C. (2007). *Language disorder in children: A multicultural and case perspective*. Boston, MA: Allyn & Bacon.

Stockman, I. J. (1996). The promises and pitfalls of language sample analysis as an assessment tool for linguistic minority children. *Language, Speech, and Hearing Services in Schools, 27,* 355–366. doi:10.1044/0161-1461.2704.355

Suárez-Orozco, C., & Suárez-Orozco, M. M. (2001). *Children of immigration*. Cambridge, MA: Harvard University Press.

Suskind, D., Leffel, K. R., Hernandez, M. W., Sapolich, S. G., Suskind, E., Kirkham, E., & Meehan, P. (2013). An exploratory study of quantitative linguistic feedback: Effect of LENA feedback on adult language production. *Communication Disorders Quarterly, 34,* 199–209. doi:10.1177/1525740112473146

Teichman, J., & Contreras-Grau, J. (2006). Acculturation and teaching styles among young mainland Puerto Rican mothers. *Hispanic Journal of Behavioral Sciences, 28,* 84–101. doi:10.1177/0739986305284092

Uccelli, P., & Páez, M. M. (2007). Narrative and vocabulary development of bilingual children from kindergarten to first grade: Developmental changes and associations among English and Spanish skill. *Language, Speech, and Hearing Services in Schools, 38,* 225–236. doi:10.1044/0161-1461(2007/024)

U.S. Census Bureau. (2012). *Social, economic, and housing statistics division: Poverty*. Retrieved from http://www.census.gov

Wilson, K. S., Blackmon, R. C., Hall, R. E., & Elcholtz, G. E. (1991). Methods of language assessment: A survey of California public school clinicians. *Language, Speech, and Hearing Services in Schools, 22,* 236–241. doi:10.1044/0161-1461.2204.236

Xu, D., Yapanel, U., & Gray, S. (2009). *Reliability of the LENA Language Environment Analysis System in young children's natural home environment* [Technical Report]. Boulder, CO: The LENA Foundation. Retrieved from http://www.lenafoundation.org/wp-content/uploads/2014/10/LTR-05-2_Reliability.pdf

Appendix A

Parent Questionnaire

Child's name (first and last) _____
Child's date of birth: _____
Child's gender: *Male Female* Child's race/ethnicity: _____
Your relationship to the child (e.g., mother, father): _____
In order to include your child in our study, we are asking all participants to answer a few questions to help us learn more about your child.

1) Has your child been exposed to any languages other than English in your home? Or at school/day care? (Circle your response) YES NO
If so, what other languages are spoken? _____
Is your child fluent in the other language(s)?_____
Which language is your child most comfortable speaking?_____
If Spanish, at what age did your child begin learning Spanish?_____
At what age did your child begin learning English?_____
Please estimate the percentage of time your child speaks English:_____
Please estimate the percentage of time your child speaks Spanish:_____

2) Does your child attend day care or preschool? YES NO
a. If yes, is this for the full day, or part of the day? _____

3) Does your child live with other siblings? YES NO
a. If so, what are their ages? _____

4) Has your child ever been diagnosed with a disability/had an individualized family service plan (IFSP) or individualized education program (IEP)? YES NO
a. If so, what was his/her diagnosis? _____

5) Approximately how many ear infections would you estimate your child has experienced?
_____

6) How old was your child when he/she produced their first words? (in months) _____

7) Circle the highest level of education you and your spouse (if applicable) have completed:

You	**Spouse**
High school	High school
Some college, no degree	Some college, no degree
Associate's degree	Associate's degree
Bachelor's degree	Bachelor's degree
Master's degree	Master's degree
Doctoral	Doctoral

8) What kind of work do you do? _____
a. If applicable, what kind of work does your partner/spouse do? _____

9) What is the zip code where you live? _____

10) What ethnicity would you consider yourself? (*CIRCLE CHOICE(S)*)
African American
Caucasian
Hispanic
Asian American
Other
What ethnicity is your spouse? _____

11) Is your child eligible for the free or reduced lunch program? YES NO I don't know

Appendix B

Guidelines Used for Describing Content and Spanish or English

1. Within utterance congruency: If the word was language neutral, such as *no*, a proper noun, or a borrowed word (e.g., *patio*, *Chihuahua*), count as the language used in the rest of the sentence. For example, the phrase "I have two Chihuahuas" was counted as an English-only c-unit, and the phrase "Tengo dos Chihuahuas" was counted a Spanish-only c-unit.
2. Consecutive utterance congruency: If the language-neutral word occurs alone in an utterance, such as "No no no," the proceeding utterance was used to determine whether the word is likely to be Spanish or English.
3. Pronominal clitics: Pronomimal clitics (e.g., dámelo = da + me + lo) or lexicalized words were thought to represent multiple lexical units in oral speech (i.e., equivalent in meaning to "me lo das" or "give it to me") and therefore counted as separate words in computing MLUw (Miller & Iglesias, 2010).
4. Dysfluencies: False starts and part-word repetitions were not counted as additional words. For example, "wha-what do you want" would count as four English words.
5. Misarticulations: Investigators disregarded an articulation error if it did not affect overall intelligibility of the word. Unintelligible segments (e.g., whole words or phrases) were excluded from analyses.
6. Direct repetitions of the immediate previous utterance were excluded from the MLUw calculation; however, if the child added new linguistic information or expanded upon the prior utterance, the utterance was included.
7. Utterances containing rote recitation of songs or counting were excluded from the transcript.