SPEECH ERRORS PRODUCED BY BILINGUAL SPANISH-ENGLISH SPEAKING CHILDREN AND MONOLINGUAL ENGLISH-SPEAKING CHILDREN WITH AND WITHOUT SPEECH SOUND DISORDER

by

Itzel Matamoros

A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science

Department of Speech, Language, and Hearing Sciences

West Lafayette, Indiana

August 2021

THE PURDUE UNIVERSITY GRADUATE SCHOOL
STATEMENT OF COMMITTEE APPROVAL

Dr. Françoise Brosseau-Lapré, Chair
Department of Speech, Language, and Hearing Sciences

Dr. Laurence B. Leonard
Department of Speech, Language, and Hearing Sciences

Dr. Chenell Loudermill
Department of Speech, Language, and Hearing Sciences

Approved by:
Dr. Preeti Sivasankar

In dedication to my family, who supports, encourages, and challenges me every day: mom, Xochitl, Jose Luis, Daysi, Matt. To my furry kids, Tato and Max.

ACKNOWLEDGMENTS

I would like to thank my advisor, Dr. Françoise Brosseau-Lapré, for her invaluable guidance and support throughout my graduate career, particularly in encouraging me to be creative in my critical thinking, guiding me through the research process amidst a global pandemic, and fostering my love for research.

I would also like to thank my advisory committee, Dr. Laurence B. Leonard and Dr. Chenell Loudermill for their time and constructive feedback throughout the development of this research project.

Finally, I would like to thank the children and parents of children who participated in this study, as well as the lab members of the Child Phonology Lab for their hard work. Thanks to Kathryn Bower for her time and commitment to the success of this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Purpose: Previous studies have shown that children with SSD speaking a language other than English produce different types of speech errors, although there is a paucity of information investigating these differences in speech sound production (e.g., Core & Scarpelli, 2015; Fabiano-Smith & Goldstein, 2010b; Fabiano-Smith & Hoffman, 2018). This study investigates the types of speech errors produced by bilingual Spanish-English and monolingual English-speaking children matched on age, receptive vocabulary, and articulation accuracy in single words.

Methods: Twelve bilingual English-Spanish speaking children, ages 4;0 to 6;11, were matched to twelve monolingual English-Speaking children. Participants completed standardized and non-standardized tests of speech and language, and performance between groups and assessment measures were compared. Consonant sound productions were categorized as correct, substitution errors, omission errors, or distortion errors.

Results: Bilingual Spanish-English children were significantly more likely than monolingual English children to produce omission errors, while monolingual English children were more likely to produce distortion errors. Both groups produced similar proportions of substitution errors. Bilingual children produced similar proportions of each error type in both of their languages.

Conclusion: SLPs should not rely on English normative data to diagnose SSDs in monolingual and bilingual Spanish-speaking children, as they demonstrate different errors patterns from monolingual English-speakers.

INTRODUCTION

Children with speech sound disorder (SSD) are less intelligible than other children of the same age despite presenting with normal hearing, adequate structure and function of the oral-motor mechanism, and an absence of other neurodevelopmental conditions (Gierut, 1988). SSD is the most common pediatric communication disorder on the caseload of speech-language pathologists practicing in schools (e.g., Eadie et al., 2015; Mullen & Schooling, 2010). According to the U.S. Census Bureau, between 2010 and 2019, the Latinx population in the U.S. increased from 16% to 18%, accounting for 52% of all U.S. population growth in the past decade. In 2017, Spanish-speaking children represented 75% of all school-age English language learners and, in 2007, represented 16.3-24.2% of K-12 school-based SLP caseloads (National Center for Education Statistics, 2020; Mullen & Schooling, 2010). The number of non-native English-speaking children in U.S. schools continues to rise and, despite the growing research on bilingual populations, there is a paucity of information on the phonological development of children who speak a language other than English. With only 8.0% of ASHA represented professionals self-identifying as bilingual service providers (ASHA, 2020), working clinicians may lack the necessary resources and information to accurately assess and treat bilingual children, including having limited information on phonological development and error patterns in this population. This study aims to bridge this gap through a comparison of speech sound errors between bilingual Spanish-English and monolingual English-speaking children.

Spanish and English Phonology

English and Spanish phonological systems have been compared in the literature (e.g., Goldstein, 1995; Brice et al., 2009; Gildersleeve-Neumann, et al., 2008). English's phonetic system is characterized by 24 consonants, 17 syllabic nuclei, 2 semivowels (glides), and approximately 14 vowels, while Spanish's phonetic system is more concise, including 19 consonants, 10 syllabic nuclei, 2 semivowels, and 5 vowels (Brice et al., 2009). Although many consonants are present in both languages (/b, p, d, t, g, k, m, n, l, tʃ, s, j, w/), differences exist at the segmental level, with consonants being uniquely present in either language (Gildersleeve-Neumann et al, 2008). Spanish consonant phonemes not present in English include /x, ɲ, ɾ, r/, whereas the English consonants /v, θ, ð, z, ʃ, ʒ, h, dʒ, ŋ, ɹ/ are typically not used for phonemic contrasts in Spanish (Gildersleeve-Neumann et al., 2008). Additionally, the two languages differ in the complexity of their vowel systems and the types of vowels, with only /i/ and /u/ being present in both languages. Spanish' vowel system consists of the five vowels /a, e, i, o, u/, while General American English includes vowels /ɪ, i, ɛ, e, æ, ə, ʌ, ɚ, ɝ, o, ɔ, u, ʊ, ɑ/.

Syllable Structure and Syllable Position. Differences in phonology between English and Spanish point to the need to describe error patterns in relation to syllable structure and syllable position in Spanish-English speaking children. Spanish, like French and Italian, is considered a syllable-timed language, while English is classified as a stress-timed language (see Brosseau-Lapré and Rvachew (2014) for French and Bortolini & Leonard (1996) for Italian). Words that are spelled similarly in both English and Spanish often have very different word shapes. The English word "temperature," for example, consists of 3 syllables in a strong-weak-strong stress pattern, with two of the syllables having a complex shape [ˈtɛm.pɹə.ˌʧɝ]. In Spanish, on the other hand, "temperatura" consists of 5 syllables in a strong-weak-weak-strong-weak stress pattern, and four of the five syllables are of the simple CV shape [ˌtɛm.pe.ra.ˈtu.ra]. In Spanish, most syllables are open and end in a vowel, whereas English has a higher rate of closed syllables (CVC). Though most words in Spanish end in a vowel, only /n, ɾ, s, l, d/ are permissible in the final position of a word (Brice et al., 2009). Research indicates that Spanish has a more limited segmental inventory than English, as well as less phonologically complex syllables, yet Spanish words are significantly longer in number of syllables (e.g., Gildersleeve-Neumann et al, 2008).

Cross-Linguistic Interaction

Bilingual children develop two separate linguistic systems that interact, though the extent of this interaction remains unknown (Paradis and Genesee, 1996; Core & Scarpelli, 2015; Gildersleeve-Neumann, 2008). Cross-linguistic effects have been examined by Paradis and Genesee (1996) in relation to language interdependence through transfer, acceleration, and deceleration (delay). Acceleration refers to earlier emergence of particular properties in bilingual children than in monolingual children. Deceleration (or delay, as described in Paradis and Genesee, 1996) refers to slowed acquisition of particular properties in bilingual children in comparison to monolingual speakers of a language. Existing research hypotheses support both acceleration and deceleration in bilingual children, suggesting back and forth language transfer, or interactions, between a child's two languages.

Spanish-English Bilingual Transfer. Paradis & Genesee's (1996) hypothesis of deceleration (slower phonological development) in bilingual children has been supported in recent research comparing Spanish-English bilingual and English monolingual syntax, morphology, and phonology (see Fabiano-Smith & Goldstein, 2010a). Specifically with regards to phonology, Gildersleeve-Neumann and colleagues (2008) compared speech sound development between 3- and 4- year-old monolingual English speaking children (E), Spanish-English speaking children with predominant exposure to English (PE), and simultaneous bilingual English-Spanish (ES) speaking children. Thirty-three children, with English, Mexican Spanish-English, and Mexican

Spanish home language environments were included in the study. The results indicated that, though children from both groups demonstrated similar phonetic inventories that fell within the normal range for English, bilingual children demonstrated higher error rates (particularly with syllable-level patterns), a lower intelligibility rating, and made more atypical errors than monolingual English-speaking children. These results support the hypothesis of a slower rate of phonological development (speech sound production) in bilingual children compared to monolingual children. Similarly, Fabiano-Smith & Goldstein (2010a) found significantly lower consonant accuracy, as well as greater difficulty with trill /r/, fricatives, and glides, in bilingual Spanish-English children when compared to monolingual Spanish-speaking peers aged 3-4 years. Bilingual participants did not demonstrate significant differences from monolingual English-speaking children; overall their consonant accuracy was slightly lower due to mild difficulties with stops and fricatives compared to their monolingual peers.

Some studies have also provided support for Paradis & Genesee's (1996) hypothesis of acceleration, or faster acquisition of certain speech sounds or syllable structures, in bilingual children. As described in Fabiano-Smith & Goldstein (2010a), prior comparisons between German-English and Spanish-English speaking children revealed faster acquisition of particular structural properties secondary to exposure to another language. For example, Fabiano-Smith & Goldstein describe a study where German exposure supported faster acquisition of coda consonants in Spanish word productions of Spanish-English bilinguals.

Though some research findings only indicate acceleration or deceleration, both forms can occur simultaneously. In a study comparing typologies of phonetic inventories in Spanish-English bilingual and monolingual 3-4-year-olds, Fabiano-Smith & Barlow (2010) found both acceleration and deceleration in the phonological skills of bilingual children. The investigators identified a unique type of simultaneous presentation of transfer, where the phonetic inventories of bilingual children were less accurate but equally complex as that of monolingual Spanish and monolingual English-speaking children. These results indicate that bilingual children can acquire a phonetic system in the same amount of time as a monolingual speaker, despite having to learn two separate inventories. In another study, Goldstein & Bunta (2011) compared phonological skills between monolingual Spanish-, monolingual English-, and bilingual Spanish-English speaking children, with ten 5-6-year-old children per group. Phonological analyses included whole-word measures (pMLU and Proximity), segmental and consonant feature accuracy measures (PVC and PCC-R), and occurrence of phonological processes (error patterns). Unlike Gildersleeve-Neumann et al. (2008), Goldstein & Bunta's results indicated greater phonological skills in bilingual children when compared to monolingual English-speaking children, providing support for positive transfer (i.e., acceleration) in bilingual children. On the other hand, this study's results also indicated a slower, but minimal, rate of phonological acquisition in Spanish-English bilingual children in comparison to monolingual Spanish speakers. Though specific language interactions in bilingual children's language systems have been explored in the literature, the extent and manner in which the two languages interact remains unclear.

Speech Errors in Bilingual Children

Speech sound errors include omissions (deletion of target sound/s), substitutions (replacement of a phoneme or group of phonemes for another), and distortions (slight misarticulation to target sound/s) errors. In their study comparing the speech errors in children with SSD to children with comorbid SSD and language impairment (LI), Macrae & Tyler (2014) coded error types as omissions or distortions, as well as typical or atypical. Twenty-eight children were matched based on age, speech sound errors, PCC, language abilities, MLU-morphemes, and on the PPVT-III, with 15 children in the comorbid SSD and LI group and 13 children in the SSD-only group. The study's results indicated no statistically significant differences between the two groups in number of errors, as well as types when comparing typical, atypical, and distortion errors. However, they found that children in the SSD+LI group produced significantly more omission errors than children in the SSD-only group. The investigators attributed this difference in omission errors to absent phonological representations for the target sounds, as proposed by Shriberg and colleagues (2005).

Previous studies have shown that children with a SSD speaking different languages produce different types of speech errors than monolingual English-speaking children with SSD. In a study by Brosseau-Lapré and Rvachew (2014), surface speech errors of French-speaking children with SSD and English-speaking children with SSD were compared. Production of singleton consonants and clusters on a single-word test of articulation in initial, medial, and final positions were coded as either correct, substitution, distortion, or syllable structure error (omissions and additions). Despite similar PCC values in conversation, the French-speaking children produced significantly more syllable structure errors than English-speaking children. In contrast, the English-speaking children produced significantly more substitution errors than the French-speaking children. One limitation of this study was that the list of words included in each language was not similar. Collecting production of very similar stimulus words in each language would allow to compare types of speech errors more systematically in each language while controlling for the complexity of the syllable shapes included in the target words.

Few studies have investigated differences in speech errors produced by English-speaking children and by Spanish-speaking children. For instance, Goldstein et al. (2005) compared the patterns of speech errors between predominantly English-speaking, predominantly Spanish-speaking, and Spanish-English bilingual 5-year-old children with typical speech and language skills (TD). Investigators utilized a single-word assessment to gather information regarding the children's phonological skills. Results indicated that there was no statistically significant difference between the segmental accuracy, syllabic accuracy, or percentage of phonological processes between predominantly Spanish and Spanish-English bilingual children, as well as between predominantly English and Spanish-English bilingual children. Although there was no significant difference between groups, the authors found differences in sound class accuracy and accuracy for the early-, middle- and late-developing sounds across groups and individuals. In their later comparison of speech error patterns in 3-year-old English-speaking, Spanish-speaking, and bilingual English-Spanish speaking children, Fabiano-Smith & Goldstein (2010a; 2010b) found statistical differences in early-, middle- and late-developing speech sounds acquisition between monolingual Spanish-speaking children and bilingual children, as well as between monolingual English-speaking children and bilingual children. Spanish and English monolingual children outperformed bilingual children, suggesting a risk for misdiagnosing SSD among Spanish-English bilingual children. The studies by Goldstein and colleagues were a solid first step toward providing SLPs information to diagnose Spanish-speaking children with SSD more accurately. However, these studies focused on a few sound classes or substitutions, and described errors using the perspective of phonological processes.

Purpose and Hypothesis

The purpose of this study was to compare the types of speech errors produced by monolingual English-speaking children and bilingual Spanish-English speaking children with similar speech sound accuracy levels and language skills, when producing a similar list of single words. Based on what is currently known about Spanish and English phonological development, and on previous findings comparing syllable-timed languages such as French to English, I hypothesize that Spanish-English bilingual children will produce more omission errors and monolingual English-speaking children will produce more substitution errors. Additionally, I hypothesize that Spanish-English bilingual children will produce similar proportions of error types when comparing their productions of words in Spanish to their productions of words in English.

METHODS

Participants

Twenty-four children, ages 4;0 – 6;11, were included in the present study, which was approved by the Purdue University Institutional Review Board. Inclusion criteria for all participants included passing a pure tone audiometry screening at 20dB in each ear at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz and normal structure of the oral-peripheral mechanism. Exclusionary criteria included presence of other neurodevelopmental conditions such as global developmental delay or autism spectrum disorder. Children were categorized into four groups based on the results of an assessment conducted by a speech-language pathologist, with six children per group: 1) monolingual English-speaking children with TD, 2) monolingual English-speaking children with SSD, 3) bilingual Spanish-English speaking children with TD, and 4) bilingual Spanish-English speaking children with SSD. Bilingual children were matched with regards to age, receptive vocabulary, and PCC in single words to monolingual speakers of American English who completed a study investigating types of speech sound errors and phonological awareness abilities (Brosseau-Lapré & Roepke, 2019).

Monolingual Participants. Monolingual English-speaking children were recruited from the M.D. Steer Speech, Language and Swallowing Clinic, as well as schools and daycare centers in Tippecanoe County, Indiana. All monolingual children were speakers of Midwestern English and were tested in a quiet room for child speech research at Purdue University. Parents of all monolingual participants reported less than 5% exposure to a language other than English; none of these children were able to answer questions in Spanish or provide speech samples in Spanish.

Bilingual Participants. Bilingual English-Spanish participants were speakers of Mexican (n=8) and Argentinian (n=4) dialects of Spanish. The degree of bilingualism of these children was determined based on parent reports of language input across the child's environments (i.e., home, daycare, daily activities). Parents were asked to estimate the number of hours their child heard and spoke each language; to be included in the bilingual group, children needed at least 20% exposure in each language, as in Fabiano-Smith & Goldstein, 2010b and Pearson et al. (1997). All children included in the bilingual groups in the current study were exposed predominantly to Spanish at home and were able to provide speech samples in Spanish. Bilingual children were recruited through the Purdue Latino Cultural Center, as well as schools and daycare centers in Tippecanoe County, Indiana and Milwaukee County, Wisconsin. Five bilingual Spanish-English speaking children were tested in a quiet room at Purdue University whereas seven bilingual children were tested virtually at their home, utilizing a secure WebEx link, and with minimal environmental distractions (e.g., TV turned off, siblings in a different room, parent by their side).

As shown in Table 1, bilingual and monolingual children were considered a match if: (1) the age difference was 6 months or less, (2) the PCC-R in single words was no more than 3 percentage points, and (3) the difference in standard score on the receptive vocabulary measure was 10 points or less. One pair of participants is comprised of a bilingual girl with SSD and a monolingual boy with SSD; all other pairs of participants are matched on sex.

Table 1. Spanish- and English-speaking participants matched on age, PCC, and receptive vocabulary

Bilingual Spanish-English Speakers						*Monolingual English Speakers*					
Child ID	Group	Age	Sex	PCC	ROWPVT	Child ID	Group	Age	Sex	PCC	ROWPVT-4
2004	TD	78	F	98.30	103	1033	TD	74	F	96.79	112
2007	TD	50	M	91.71	85	1004	TD	52	M	90.41	95
2008	TD	52	M	91.84	97	1034	TD	48	M	90.54	103
2011	TD	78	F	96.79	108	1001	TD	76	F	93.83	118
2013	TD	50	F	90.96	117	1023	TD	48	F	90.31	112
2015	TD	75	M	96.91	125	1024	TD	78	M	97.95	121
2001	SSD	75	M	79.24	101	1014	SSD	78	M	79.87	101
2002	SSD	49	F	79.46	105	1019	SSD	49	F	76.98	106
2003	SSD	79	F	87.15	102	1028	SSD	82	M	90.8	108
2005	SSD	57	F	76.16	112	1025	SSD	52	F	78.52	106
2006	SSD	50	M	83.30	94	1038	SSD	53	M	80.95	103
2012	SSD	64	F	89.34	91	1013	SSD	68	F	88.97	101

Note: Age indicated in months; PCC is percent consonants correct in the CPAC-S for the bilingual children and the GFTA-2 for the monolingual children; ROWPVT-4 is the standard score.

Both groups of bilingual and monolingual participants had similar age ranges and mean ages (bilingual: *M* = 63.08, *SD* = 12.99; monolingual: *M* = 63.17, *SD* = 13.86), t(22) = -.015, *p* = .504. There were also no significant differences between the two groups of participants with regards to PCC-R in single words (bilingual: *M* = 88.43, *SD* = 7.46; monolingual: *M* = 87.99, *SD* = 7.16), *t*(22) = .146, *p* = .897 or with regards to receptive vocabulary (bilingual: *M* = 103.33, *SD* = 11.20; monolingual: *M* = 107.17, *SD* = 7.49), *t*(22) = .-.986, *p* = .297.

Procedure and Materials

Parents of participating children completed a case history, where they provided information regarding their child's birth, medical and family history, developmental milestones, and past and current language exposure. Parents provided informed written consent prior to the first session and children gave verbal assent at the commencement of each session. Tasks for monolingual English-speaking participants were administered throughout two sessions, each lasting approximately 50-60 minutes. Tasks for the Spanish-dominant group were administered throughout three sessions of approximately 45-60 minutes each. Children's responses were recorded using a KMCL microphone and a Marantz PMD661 MKII broadcast recorder at a rate of 44.1 kHz.

The first two sessions took place in one language only (i.e., either English or Spanish), and were conducted by a native or near-native speaker of the child's primary language. Bilingual children completed a third session with a monolingual English-speaking research assistant, who spoke only in the child's second language to assess the child's receptive vocabulary, receptive language skills, and English speech production abilities.

Each child was administered the Oral Speech Mechanism Screening Examination, Third Edition (OSMSE-3; St. Louis & Ruscello, 2000) or the Oral Motor Screen subtest of the Diagnostic Evaluation of Articulation and Phonology (DEAP; Dodd et al., 2002) to ensure their oral structure was adequate for the production of speech and that no participant presented with a SSD secondary to structural defects such as cleft palate. The Kaufmann Brief Intelligence Test, Second Edition (KBIT-2; Kaufmann & Kaufmann, 2004) is a norm-referenced measure of verbal and nonverbal-intelligence. All participants were required to obtain a standard score of at least 80 on the nonverbal Matrices subtest of the KBIT-2 to be included in the current study.

The Conceptual Probes of Articulation Competence-Spanish (CPAC-S; Goldstein & Iglesias, 2006) is a norm-referenced test that assesses eight common phonological patterns and articulation accuracy for 19 Spanish consonants in a variety of word positions, and the Goldman-Fristoe Test of Articulation-2 (GFTA-2; Goldman & Fristoe, 2000) is a norm-referenced test that assesses articulation of English consonant sounds in a variety of word positions. Children were assigned to the TD and SSD groups based on the case history and results of the assessment measures administered by a speech-language pathologist. English-speaking children were classified in the SSD group if they obtained a standard score of or below 85 on the Sounds-in-

Words subtest of the GFTA-2 (indicative of at least one standard deviation point from the mean); produced non-developmental and/or atypical speech errors; and had a history of speech delay/SSD or had been referred for a speech evaluation. Spanish-dominant children who obtained a standard score below one standard deviation from the mean on the CPAC-S, produced non-developmental speech errors and who were receiving or had been referred for speech-language pathology services were also classified as presenting with SSD. All children classified as TD obtained a standard score of 90 or above on the single word test of articulation of their dominant language, produced only developmental speech sound errors, and had never received speech-language intervention or been referred for a speech-language assessment.

Children's receptive vocabulary was assessed using either the Receptive One Word Picture Vocabulary Test, Fourth Edition (ROWPVT-4; Martin & Bronwell, 2011) or the ROWPVT-4: Spanish-Bilingual (Martin, 2013). To note, the ROWPVT-4: Spanish Bilingual Edition was normed separately from the ROWPVT-4 and for use with bilingual individuals with varying levels of proficiency in Spanish and English. Either the ROWPTV-4 or the ROWPVT-4: Spanish-Bilingual Edition was administered per the appropriate instruction manual for all participants. A spontaneous, connected speech language sample was also obtained from all children, where each subject was allowed to speak in the language(s) he/she felt most comfortable in. Participants were prompted to either narrate an activity of personal interest or describe a picture.

Finally, all participants completed an experimental speech production task (see Appendix A), which elicits 60 single words that exist in both languages, and have either the same syllabic structure (such as doctor [’dɑktər]/[’dok.tor] and television [ˈteləˌvɪʒən]/[te.le.ˈβi.sjon]) or different syllable structures (such as temperature [ˈtɛm.pɹə.ˌʧɝ] and “temperatura” [ˌtɛm.pe.ra.ˈty.ra]). The 60 words vary in length between 1-5 syllables and in complexity of syllable shapes (CV and CVC to CCV, CVCC, and CVCCC). Spontaneous productions were elicited through carrier phrases and visual aids (i.e., pointing to pictures). Delayed imitation and immediate imitation were used as necessary to ensure production of all targeted words.

Data Analyses

Phonetic Transcription. All audio recordings were transcribed and scored independently by native Spanish- and English-speaking graduate students who are trained in narrow transcription of the International Phonetic Alphabet (IPA). Inter-rater reliability for the transcription of 25% of the recordings from the GFTA-2, CPAC-S and Single words experimental tasks, randomly selected from participants in the monolingual and in the bilingual groups, was calculated following the analyses. Mean percent inter-agreement reached 94.2% for the consonants produced by the monolingual speakers; 91.8% for the Spanish consonants produced by the bilingual children and 92.9% for the English consonants produced by the bilingual children.

Percentage of Consonants Correct-Revised. Percentage of Consonants Correct-Revised (PCC) values were derived from the productions of all target words in the CPAC-S for each bilingual participant and all target words in the GFTA-2 for the monolingual participants as per Shriberg & Kwiatkowski (1982) and Shriberg et al. (1997). Omissions and substitutions of target consonants, including voicing errors, were scored as incorrect; additions of a target consonant were also scored as incorrect, but distortion errors were coded as correct. Dialectal variants and allophones were also scored as correct, as were omissions of /h/ and substitutions of /n/ for /ŋ/ in unstressed syllables. For each single word sample per participant, the total number of correct consonants was divided by the total number of target consonants.

Error Type Coding. As in Macrae and Tyler (2014), each target consonant was categorized as a correct production or an omission, substitution, or distortion; however, errors were not further categorized as typical or atypical. We followed Brosseau-Lapré & Rvachew (2014), as there is no agreed-upon list of typical and atypical speech errors produced by French-speaking or by Spanish-speaking children. We coded all consonants from the experimental speech production task of Spanish single words for the bilingual participants, and all consonants from the English single words for both groups of participants. Omissions consisted of deletions of syllables or consonants from the target word (e.g., weak syllable deletion, *elephant* /ˈɛ**lə**fənt/ → [ˈɛfəntl]), and consonant cluster reduction, *train* /**tr**eɪn/ → [**t**eɪn]). Substitutions involved the production of another consonant without changing the syllable structure of the target word (e.g., stopping of fricatives, *coffee* /kɑ**f**i/ → [ˈkɑ**p**i] and gliding of liquids, *zebra* /ˈzib**ɹ**ə/ → [zib**w**ə]). Distortions did not modify the phonemic category of the target consonant and consisted mostly of lateral or dental productions of fricatives, such as /ˈ**z**ibɹə/ → [**z̪**ibɹə]. As in Rvachew et al. (2007), the substitution of interdental fricatives /θ/, /ð/ for the alveolar fricatives /s/, /z/ was also coded as a distortion.

Statistical Analyses. Mann-Whitney U tests were performed to compare the percent occurrence of omissions and substitutions in the English productions of the bilingual and the monolingual participants. To compare the percent occurrence of omissions and substitutions in the Spanish and in the English productions of the bilingual children, the Wilcoxon test was used. Nonparametric tests were used to control for the small sample size in each group of participants and unequal variances that could result in Type II error.

RESULTS

Speech Errors Produced in English

The mean percentages of each type of speech errors (omissions, substitutions, and distortions) and correct consonants produced in the English words by all the participants are shown in Table 2. Most bilingual Spanish-English speakers produced more omission errors compared to substitution errors; 3/12 bilingual participants produced more substitutions than omissions. Participant 2013 has typical speech and produced very few substitutions and omission errors whereas participant 2015, also with TD, produced many substitutions, almost exclusively gliding of the liquids /ɹ, l/. The third bilingual speaker who produced more substitutions than omissions is participant 2012, who presents with SSD and also frequently substituted /ɹ, l/ → [w], /k, g/ → [t, d], and substituted fricatives by another fricative or a stop. In the group of monolingual English speakers, 11/12 participants produced more substitution errors than omission errors. The one participant who showed the reverse pattern (1034) is a child aged 4;0 with TD who reduced many consonant clusters and codas inside the word (such as “panda” /pæ**n**də/).

Table 2. Percentage of occurrence of speech errors and correct consonants in the English single words

Child ID	Age	Group	Substitution	Omission	Distortion	Correct
2004	78	TD Bilingual	1.32	1.76	0	96.92
2007	50	TD Bilingual	13.45	20.18	0	65.92
2008	52	TD Bilingual	11.01	12.33	0.45	76.21
2011	78	TD Bilingual	3.08	5.29	0	91.19
2013	50	TD Bilingual	4.50	4.05	0.90	89.64
2015	75	TD Bilingual	10.57	3.52	2.20	83.70
2001	75	SSD Bilingual	9.69	10.13	1.76	76.65
2002	49	SSD Bilingual	13.21	14.98	0.88	70.04
2003	79	SSD Bilingual	1.32	7.49	0	91.19
2005	57	SSD Bilingual	15.41	25.55	1.32	57.72
2006	50	SSD Bilingual	16.81	25.45	0	57.73
2012	64	SSD Bilingual	13.66	11.45	0	72.25
1033	74	TD Monolingual	6.17	3.52	5.73	84.58
1004	52	TD Monolingual	8.92	6.70	6.70	77.68
1034	48	TD Monolingual	7.92	10.57	2.20	79.30
1001	76	TD Monolingual	3.97	2.64	0	93.39
1023	48	TD Monolingual	11.89	3.52	3.52	81.06
1024	78	TD Monolingual	4.95	0.90	0.45	93.69
1014	78	SSD Monolingual	18.94	6.17	2.20	72.69
1019	49	SSD Monolingual	29.51	11.01	4.85	54.63
1028	82	SSD Monolingual	8.81	3.52	7.05	79.29
1025	52	SSD Monolingual	12.33	10.13	11.01	65.64
1038	53	SSD Monolingual	24.67	10.57	5.73	59.03
1013	68	SSD Monolingual	16.74	11.01	3.96	68.28

Table 3 shows the average occurrence of each of the error types for the bilingual and the monolingual participants.

Table 3. Average productions of error types and correct consonants for the bilingual Spanish-English and the monolingual English-speaking groups of participants

	Bilingual children			*Monolingual children*		
Production	*M*	*SD*	*Range*	*M*	*SD*	*Range*
Substitution	9.50	5.55	1.32-16.81	12.90	8.05	3.97-29.51
Omission	11.85	8.25	1.76-25.55	6.69	3.81	0.90-11.01
Distortion	0.63	0.78	0-2.20	4.45	3.09	0-11.01
Correct	77.43	13.28	57.72-96.92	75.77	12.29	54.63-96.92

To compare the proportion of speech errors used by the bilingual participants compared to the monolingual participants, I calculated the use of each type of error when producing a target consonant inaccurately (i.e., I divided the total number of each type of error by the total number of errored consonants). The distribution of the frequency of use of each speech error for the bilingual participants is shown in Figure 1a, and these are shown for the monolingual participants in Figure 1b. When producing speech errors, the bilingual Spanish-English children were significantly more likely than the monolingual English-speaking children to produce omissions, $U = 15.00$, $z = -3.291$, $p < 0.001$, $r = -.67$. The bilingual children were significantly less likely to produce distortion errors when making a consonant error, $U = 17.00$, $z = -3.215$, $p = 0.001$, $r = -.66$. There was no significant difference between the two groups of participants with regards to their likeliness to substitute a consonant when producing a target consonant in error, $U = 42.00$, $z = -1.733$, $p = 0.089$, $r = -.35$.

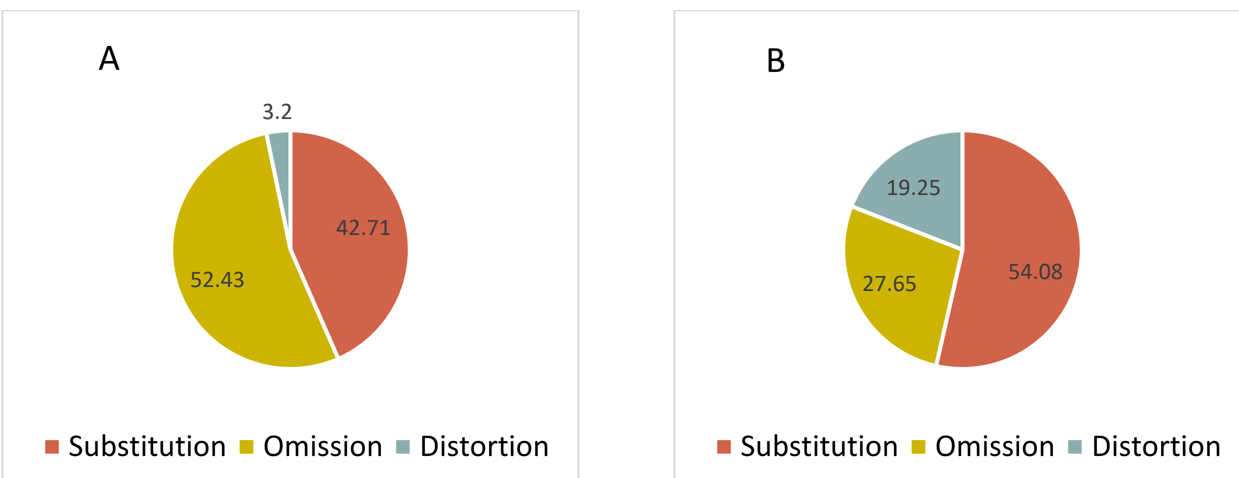

Figure 1. Distribution of frequency of speech error types in monolingual English (1A) and bilingual Spanish-English (1B) speaking children

Speech Errors Produced in Each Language by the Bilingual Children

The total number of each type of error, produced by each bilingual participant, was divided by the total number of errored consonants. Table 4 presents the proportions of each type of speech error produced by each bilingual participant in English, and in Spanish. There were no significant differences in the proportion of substitution errors produced by the bilingual children in Spanish (M = 40.84) and English (M = 42.71), z = -.628, p = .530, r = -.13. Similarly, there were no significant differences in the proportions of omissions produced by the Spanish-English children in Spanish (M = 58.16) and English (M = 52.43), z = -1.098, p = .272, r = -.22. Finally, there was no significant difference in the proportions of distortions in Spanish (M = 1.00) and English (M = 3.20), z = -1.260, p = .208, r = -.26, in the single words produced by the bilingual children in each language.

Table 4. Proportions of speech errors produced by the bilingual children in English and in Spanish

			English Consonants			*Spanish Consonants*		
Child	Age	Group	Substitution	Omission	Distortion	Substitution	Omission	Distortion
2004	78	TD	42.86	57.14	0	41.46	58.54	0
2007	50	TD	39.47	59.21	0	59.26	40.74	0
2008	52	TD	45.45	52.73	1.82	35.71	64.29	0
2011	78	TD	35.00	55.00	0	50.00	50.00	0
2013	50	TD	43.48	39.13	8.70	31.25	68.75	0
2015	75	TD	70.30	16.21	13.51	25.00	75.00	0
2001	75	SSD	44.90	46.94	8.16	43.18	56.82	0
2002	49	SSD	45.45	51.52	3.03	43.86	52.63	3.51
2003	79	SSD	15.00	85.00	0	41.18	52.94	5.88
2005	57	SSD	36.46	60.42	3.13	36.59	63.41	0
2006	50	SSD	39.79	60.21	0	36.84	60.53	2.63
2012	64	SSD	54.39	45.61	0	45.71	54.29	0

DISCUSSION

Twelve monolingual English-speaking children and twelve Spanish-English bilingual children were matched on age, PCC-R in single words, and receptive vocabulary. The first goal of this study was to compare the proportions of omission and substitution errors produced by bilingual Spanish-speaking children to the proportions of errors produced by their monolingual peers. The results supported my hypothesis, as monolingual English-speaking participants produced more substitution errors compared to omission and distortion errors, whereas Spanish-English bilingual children produced more omission errors compared to substitution and distortion errors. There were differences for omission and distortion errors, with bilingual children more likely to produce omission errors and less likely to produce distortion errors when compared to monolingual English-speaking peers. This finding supports previous research who had found that children speakers of French, a syllable-timed language like Spanish, are more likely than monolingual English-speaking children to omit consonants in clusters and codas within the word (Brosseau-Lapré and Rvachew, 2014). In the current study, there was no statistical difference between the groups in the percent occurrence of substitution errors in English single word productions. However, the likelihood of monolingual children to produce more or less substitution errors as compared to bilingual speakers was affected by the high number of distortion errors in the monolingual English-speaking group.

In addition to deletion of consonants in clusters and in word-internal codas, bilingual participants often deleted initial consonants, an error pattern that is considered atypical in English. Since initial sounds are intended to be more simplistic and prominent (in comparison to medial and final sounds), it is expected that children acquire them first and with ease, yet cross-linguistic research has exhibited support for initial consonant deletion in children with speech sound disorder who speak Spanish, or French (Fabiano-Smith & Cuzner, 2018; Rvachew et al., 2013). Fabiano-Smith & Cuzner (2018), in particular, examined initial consonant deletion in thirteen monolingual English-Speaking and bilingual Spanish-English speaking preschoolers with SSD. Results of this study demonstrated initial consonant deletion at an average of 1.6% for monolingual English-speaking participants and an average of 5.7% in bilingual children. Similarly, monolingual speakers in this study produced a smaller proportion of omission errors than bilingual speakers on average (6.69% for monolingual English, 11.85% for bilingual). These findings indicate a need for a more detailed analysis of initial consonant deletion in bilingual speakers, including an examination on whether this yields particular patterns with sound classes, such as those described in Fabiano-Smith & Cuzner (2018).

The second goal of the study was to compare the types of speech errors produced by bilingual Spanish-speaking children in each of their languages. The results also supported my hypothesis, as the bilingual children produced similar proportions of substitution, omission, and distortion errors in both their Spanish and English single word productions. To my knowledge, no other study has compared the productions of a list of similar words in Spanish and English in bilingual children. In general, the Spanish-speaking children produced less total number of errors in Spanish compared to English. Almost all of the participants were more dominant in Spanish compared to English, so this result was expected. Although the bilingual children produced more errors in English, the proportions of the types of errors (substitutions, omissions, distortions) were not statistically different across their two languages. In other words, the bilingual Spanish-English children tended to produce more omission errors in English (as they did in Spanish), and less substitution errors.

Limitations and Future Directions

The current study had several limitations that should be taken into consideration when interpreting the results. It is well-known in research that large group studies yield more accurate and most generalizable results. This study was limited in that only a small number of participants was included. Additionally, not all bilingual Spanish-English speaking children were of the same dialectal background, which could affect the interpretation of the data. Because we did not collect data from a monolingual Spanish control group, a direct comparison of Spanish phonological skills between bilingual and monolingual Spanish-speaking children was not possible. As noted above, differences in syllable structure between English and Spanish point to the need to compare error patterns according to syllable structure and syllable position within a word. Since an analysis of syllable position, the shape of a syllable, and word length on the likelihood of omitting or substitution consonants was not included, conclusions on syllable error patterns cannot be made. In future research, I aim to include a larger group of English- and Spanish-English speakers, as well as monolingual Spanish speakers using a larger cross-sectional design with children ages 4;0-7;0. Additionally, a systematic data collection for consonants in varied syllable shapes with a larger group of participants will be included. Analyses will include the impacts of syllable position, syllable shape, and word length on the likelihood of omitting or substituting a consonant phoneme.

Clinical Implications

The main findings from this study demonstrates that speech-language pathologists should be cautious when utilizing normative data to diagnose Spanish-English bilingual children, as Spanish-English bilingual children with an SSD produce significantly more omission errors than monolingual English-speaking children with SSD. Per Fabiano-Smith & Hoffman (2017), traditional standardized measures of phonological ability appear to have good specificity and sensitivity for Spanish-English bilingual children at age five years. However, research indicates that bilingual children reach a phonological ceiling at age five, when their speech accuracy is equivalent to that of monolingual English-speaking children in single words (Goldstein et al., 2005). This points to a need for SLPs to pay particular attention to error patterns in children younger and older than five years, and to take into consideration a child's linguistic background in order to prevent a misdiagnosis. Per Brosseau-Lapré and Rvachew (2014), an alternative and evidence-based analysis of a child's phonological system at all levels of the phonological hierarchy (e.g., syllable, word, phrase structural levels, and relationships among the levels) can be done utilizing multi-linear phonology (Bernhardt & Stemberger, 1998). During a thorough assessment of a bilingual child's phonological skills, SLPs should test a child in both of their languages, utilizing a variety of standardized and non-standardized measures, including: measures of speech sound accuracy, a percentage of occurrence of error types, inventory size and complexity, measures of intelligibility, and parent/family member interview. The development of normed assessment tools to mirror English phonological characteristics of Spanish- bilingual children would provide more accurate measures of typically developing versus disordered speech sound production in these children.

Conclusion

Bilingual Spanish-English speaking children and monolingual English-speaking children produce different types of speech sound errors. Results from this study indicate that bilingual children will produce more omission errors, while monolingual children will produce more substitution errors. A comparison of bilingual children's two languages indicated that bilingual children produce a similar proportion of errors (substations, omissions, distortions) across their two languages. Both of these conclusions provide support for both my hypotheses and existing research. Though these findings provide additional guidance into accurate diagnoses of SSDs in bilingual children, additional research is needed.

APPENDIX A. EXPERIMENTAL WORDS

Word Structure	Gloss	IPA	Word Structure	Glos	IPA
CCVC	train	/tɹeɪn/	CV.CV.CV	banana	/bəˈnænə/
CCVCC	plates	/pleɪts/	CV.CV.CV	gorilla	/gəˈɹɪlə/
CV.CV	baby	/ˈbeɪbi/	CV.CV.CV	koala	/kəˈwɑlə/
CV.CV	coffee	/ˈkɑfi/	CV.CV.VC	cereal	/ˈsiɹiəl/
CV.CV	sofa	/ˈsoʊfə/	CV.CV.CVC	vacation	/veɪˈkeɪʃən/
CV.VC	lion	/ˈlaɪən/	CV.CV.CVC	telephone	/ˈtɛləfoʊn/
CV.CVC	guitar	/ gəˈtɑr/	CV.CV.CVC	tomatoes	/təˈmeɪɾoʊz/
CV.CVC	tiger	/ˈtaɪgɚ/	CV.CV.CVC	bicycle	/ˈbaɪsɪkəl/
CV.CVC	photos	/ˈfoʊɾoʊz/	CVC.CV.CV	kangaroo	/keŋgəˈɹu/
CV.CVC	lemon	/ˈlɛmən/	CV.CCV.CV	mosquito	/məˈskiɾoʊ/
CV.CVC	giraffe	/ʤəˈɹæf/	CV.CVC.CV	galaxy	/ˈgæləksi/
CV.CVC	melon	/ˈmɛlən/	CCV.CV.CV	spaghetti	/spəˈgɛɾi/
CVC.CV	pizza	/ˈpi͡tsa/	V.CV.CVCC	animals	/ˈænəməlz/
CVC.CV	panda	/ˈpændə/	V.CV.CVCC	elephant	/ˈɛləfənt/
CVC.CV	taxi	/ˈtæksi/	CV.CV.CCVC	telescope	/ˈtɛləskoʊp/
CVC.CV	mango	/ˈmeɪŋgoʊ/	CVC.CV.CVC	hospital	/ˈhɑspɪɾəl/
CV.CCV	zebra	/ˈzibɹə/	CCV.CV.CVC	tricycle	/ˈtɹaɪsɪkəl/
VC.CVC	actor	/ˈæktɚ/	CCV.CV.CVC	crocodile	/ˈkɹɑkədaɪl/
CVC.CVC	dolphin	/ˈdɑlfɪn/	VC.CCV.CVC	astronaut	/ˈæstɹənɑt/
CVC.CVC	garden	/ˈgɑɹdən/	CVC.CVC.VCC	restaurant	/ˈɹɛstɚɑnt/
CVC.CVC	doctor	/ˈdɑktɚ/	CCV.CV.CCVC	stethoscope	/ˈstɛθəskoʊp/
CV.CVCC	yogurt	/ˈjoʊgɚt/	VC.CCV.CVCCC	ambulance	/ˈæmbjəlɛn͡ts/
VC.CVCC	artist	/ˈɑɹdɪst/	CV.CV.CV.CV	ballerina	/bæləˈɹinə/
CVC.CVCC	dentist	/ˈdɛntɪst/	CV.CV.CV.CVC	television	/ˈtɛləvɪʒən/
CCVC.CVC	trumpet	/ˈtɹʌmpət/	CVC.CV.CV.CV	harmonica	/hɑɹˈmɑnɪkə/
CCVC.CVC	tractor	/ˈtɹæktɚ/	CV.CV.CVC.CVC	helicopter	/ˈhɛləkɑptɚ/
CV.V.CV	piano	/piˈænoʊ/	CVC.CV.CV.CVC	thermometer	/θɚˈmɑməɾɚ/
CV.CV.V	radio	/ˈɹeɪdioʊ/	CV.CV.CV.CV.CVC	hippopotamus	/hɪpəˈpɑɾəməs/
CV.CV.CV	camera	/ˈkæməɹə/	CV.CVC.CV.CV.VC	veterinarian	/vɛtɚ(ɹə)ˈnɛɹiən/
CV.CV.CV	family	/ˈfæməli/	CV.CCV.CVC.V.CVC	refrigerator	/ɹəˈfɹɪdʒɚeɪɾɚ/

REFERENCES

American Speech-Language-Hearing Association (2020). Demographic Profile of ASHA Members Providing Bilingual Services, Year-End 2020. Available from www.asha.org

Bernhardt, B. H., & Stemberger, J. P. (1998). Handbook of Phonological Development: From the Perspective of Constraint-Based Nonlinear Phonology. San Diego, CA: Academic Press.

Bortolini, U. & Leonard, L.B. (1996). Phonology and Grammatical Morphology in Specific Language Impairment: Accounting for Individual Variation in English and Italian. *Applied Psycholinguistics*, 17, 85-104.

Brice, A.E., Carson, C.K., & O'Brien, J.D. (2009). Spanish-English Articulation and Phonology of 4- and 5- Year-Old Preschool Children: An Initial Investigation. *Communication Disorders Quarterly*, 1-12.

Brosseau-Lapré, F., & Roepke, E. (2019). Speech errors and phonological awareness in four and five years old English-speaking children with and without speech sound disorder. *Journal of Speech, Language, and Hearing Research*, 62, 3276-3289. https://doi.org/10.1044/2019_JSLHR-S-17-0461

Brosseau-Lapré, F., & Rvachew, S. (2014). Cross-linguistic comparison of speech errors produced by English- and French-speaking preschool-age children with developmental phonological disorders. *International Journal of Speech-Language Pathology*, *16*(2), 98-108. https://doi.org/10.3109/17549507.2013.794863

Core, C., & Scarpelli, C. (2015). Phonological development in young bilinguals: clinical implications. *Seminars in Speech and Language, 36*(2), 100-108.

Dodd, B., Hua, Z., Crosbie, S., Holm, A., & Ozanne, A. (2002). *Diagnostic Evaluation of Articulation and Phonology.* Pearson Assessments.

Eadie, P., Morgan, A., Ukoumunne, O. C., Ttofari Eecen, K., Wake, M., & Reilly, S. (2015). Speech sound disorder at 4 years: Prevalence, comorbidities, and predictors in a community cohort of children. *Developmental Medicine and Child Neurology, 57*, 578-584. https://doi.org/10.1111/dmcn.12635

Fabiano-Smith & Barlow (2010). Interaction in Bilingual Phonological Acquisition: Evidence from Phonetic Inventories. *International Journal of Bilingual Education and Bilingualism*, 13(1), 81-97.

Fabiano-Smith, L. & Cuzner, S.L. (2018). Initial Consonant Deletion in Bilingual Spanish-English-Speaking Children with Speech Sound Disorders. *Clinical Linguistics & Phonetics*, 32:4, 392-410. DOI: 10.1080/02699206.2017.1367037

Fabiano-Smith, L., & Goldstein, B.A. (2010a). Phonological acquisition in bilingual Spanish-English speaking children. *Journal of Speech, Language, and Hearing Research, 53*, 160-178.

Fabiano-Smith, L., & Goldstein, B.A. (2010b). Early-, middle-, and late-developing sounds in monolingual and bilingual children: an exploratory investigation. *American Journal of Speech-Language Pathology*, *19*, 66-77.

Fabiano-Smith, L., & Hoffman, K. (2018). Diagnostic accuracy of traditional measures of phonological ability for bilingual preschoolers and kindergarteners. *Language, Speech, and Hearing Services in Schools, 49*, 121-134.

Gierut, J. A. (1998). Treatment efficacy: Functional phonological disorders in children. *Journal of Speech, Language, and Hearing Research, 41*, 85–100. https://doi.org/10.1044/jslhr.4101.s85

Gildersleeve-Neumann, C.E., Kester, E.S., Davis, B.L., & Peña, E.D. (2008). English speech sound development in preschool-aged children from bilingual English-Spanish environments. *Language, Speech, and Hearing Services in Schools, 39,* 314-328.

Goldman, R., & Fristoe, M. (2000). *Goldman–Fristoe Test of Articulation, Second Edition*. Circle Pines, MN: AGS.

Goldstein, B. (1995). Spanish Phonological Development. In H. Kayser (Ed.), *Bilingual Speech-Language Pathology,* pg.17-39. San Diego, CA: Singular.

Goldstein, B.A. & Bunta, F. (2011). Positive and Negative Transfer in the Phonological Systems of Bilingual Speakers. *International Journal of Bilingualism*, 16(4), 388-401.

Goldstein, B.A., Fabiano, L., & Washington, P.S. (2005). Phonological skills in predominantly English-speaking, predominantly Spanish-speaking, and Spanish-English bilingual children. *Language, Speech, and Hearing Services in Schools, 36*, 201-218.

Goldstein, B., & Iglesias, A. (2006). *Contextual Probes of Articulation Competence-Spanish.* Pro-Ed.

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Brief Intelligence Test, Second Edition.* Circle Pines, MN: American Guidance Services.

Macrae, T. & Tyler, A.A. (2014). Speech Abilities in Preschool Children with Speech Sound Disorder with and Without Co-Occurring Language Impairment. *Language, Speech, and Hearing Services in Schools,* 45, 302-313.

Martin, N., & Brownell, R. (2011). *Receptive One Word Picture Vocabulary Test, Fourth Edition*. Austin, TX: PRO-ED.

Martin (2013). *Receptive One Word Picture Vocabulary Test, Spanish-Bilingual Edition.* Pearson Assessments.

Mullen, R., & Schooling, T. (2010). The national outcomes measurement system for pediatric speech-language pathology. *Language, Speech, and Hearing Services in Schools*, *41*, 44-60. https://doi.org/10.1044/0161-1461(2009/08-0051

National Center for Education Statistics. Fast Facts: English Language Learners. Retrieved from https://nces.ed.gov/fastfacts/display.asp?id=96

Paradis, J. & Genesee, F. (1996). Syntactic Acquisition in Bilingual Children. *Studies in Second Language Acquisition*, 18, 1-25.

Pearson, B. Z., Fernández, S. C., Lewedeg, V., & Oller, D. K. (1997). The relation of input factors to lexical learning by bilingual infants. *Applied Psycholinguistics*, 18(01), 41–58.

Rvachew, S., Marquis, A., Brosseau-Lapré, F., Paul, M., Royle, P., & Gonnerman, L. M. (2013). Speech Articulation Performance of Francophone Children in the Early School Years: Norming of the Test de Dépistage Francophone de Phonologie. *Clinical linguistics & Phonetics,* 27(12), 950–968.

Rvachew, S., Chiang, P., & Evans, N. (2007). Characteristics of speech errors produced by children with and without delayed phonological awareness skills. *Language, Speech, and Hearing Services in Schools, 38*, 60-71. https://doi.org/10.1044/0161-1461(2007/006)

Shriberg, L. D., Austin, D., Lewis, B. A., McSweeny, J. L. , & Wilson, D. L. (1997). The percentage of consonants correct (PCC) metric: Extensions and reliability data. *Journal of Speech, Language, and Hearing Research*, 40, 708–722.

Shriberg, L., & Kwiatkowski, J. (1982). Developmental Phonological Disorders III: A procedure for assessing severity of involvement. *Journal of Speech and Hearing Disorders*, 47, 256–270.

St. Louis, K. O., & Ruscello, D. M. (2000). *Oral Speech Mechanism Screening Examination,* Third Edition (OSMSE-3). Austin, TX: Pro-Ed.

United States Census Bureau. Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States: April 1, 2010 to July 1, 2019. Available from www.census.gov