

**AN INVESTIGATION OF BILINGUAL PRESCHOOL CHILDREN'S
INTELLIGIBILITY IN SPANISH AND ENGLISH: COMPARING MEASURES OF
PERFORMANCE WITH LISTENER RATINGS IN BOTH LANGUAGES**

A Dissertation by

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The following faculty have examined the final copy of this dissertation for form and content, and recommend that it be accepted in partial fulfillment of the requirement for the degree of Doctor of Philosophy with a major in Communication Sciences and Disorders.

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DEDICATION

To my late grandmother, Delia Pro de Muñoz
Abuelita, “esta rosa, eres tú”

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ABSTRACT

The purpose of this study was to determine if intelligibility ratings of bilingual (Spanish-English) preschool children by unfamiliar listeners are predicted by age, gender, and/or measures of rate of speech, receptive vocabulary, and phonological deviations. A second purpose was to ascertain whether significant differences exist among predictor variables in both Spanish and English. Participants for this study were 60 bilingual preschool children ranging in age from 4:0 (years:months) to 5:10. Unfamiliar listeners rated connected speech samples for each child in both languages using a 5-point Likert scale. A total occurrence of major phonological deviations score was obtained for each child in both languages. In addition, a number of syllables per 30-second connected speech sample provided the means for rate of speech calculations. One bilingual receptive vocabulary score was obtained for both languages.

Based on a multiple regression analysis, two significant predictor variables emerged for each language. In English, phonological deviations and vocabulary predicted intelligibility ratings of preschool children. Phonological deviations also predicted intelligibility ratings of preschool children in Spanish, followed by rate. Results of a 2 X 2 X 2 MANOVA revealed significant main effects related to language and age, but not gender. Follow-up univariate analyses revealed that 5-year-old children across the two languages were found to be significantly more intelligible than 4-year-olds. In addition, children were found to speak significantly faster in Spanish than in English and 5-year-old children also were found to speak significantly faster in Spanish than 4-year-olds.

TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION	1
Statement of the Problem	4
Statement of Purpose	5
II. REVIEW OF LITERATURE	6
Intelligibility	6
Studies Involving English-Speaking Children	6
Measures of Intelligibility	7
Measures of Spanish Intelligibility	11
Understanding Bilingual Children	11
Bilingual Development	12
Cross-Language Analysis and Early Literacy in Bilingual Children	14
Sound Characteristics of Bilingual Preschool Children	17
Dialectal Considerations	19
Possible Predictors of Intelligibility	20
Phonological Deviations	20
Phonological Comparisons of English and Spanish	21
Sound Development of Monolingual Spanish-Speaking Children	23
Phonological Patterns in Predominantly Spanish-Speaking Children	28
Studies of monolingual Intelligible versus Unintelligible Children	36
Comparison Studies of Bilingual and Monolingual Children	37
Spanish Phonological Assessment Tools	41
Language Related Factors That May Influence Intelligibility	44
Vocabulary	44
Rate of Speech	46
Other Considerations That May Influence Intelligibility	48
Age	48
Gender	49
Summary and Research Questions	49
III. METHOD	51
Participants	51
Procedures	52
Preliminary	52
Data Collection	53
Assessment Tasks	54
Criterion Variables	55

TABLE OF CONTENTS (Continued)

Chapter	Page
Continuous Speech Samples	55
Listener Ratings	56
Predictor Variables	58
Phonological Deviations	58
Receptive Vocabulary	59
Rate of Speech	60
Gender and Age	61
Data Analysis	61
 IV. RESULTS	 62
Predictor Variables and Intelligibility	62
Predictor Variables for English	62
Predictor Variables for Spanish	63
Relationships of Variables in Spanish and English	64
Summary	66
 V. SUMMARY AND DISCUSSION	 67
Summary	67
Discussion	69
Ratings of Intelligibility	70
Phonological Deviations	71
Rate of Speech	73
Vocabulary	73
Age and Gender	74
Implications	74
 VI. REFERENCES	 80
 VII. APPENDIXES	 102
A. Parent Letter	103
B. Consent Form	104
C. Survey	106
D. Four Pictures	110
E. Stories	111
F. Instructions for Rating	112
G. Listener Rating Form	113
H. Descriptive Statistics	114
I. MANOVA Results	118

LIST OF TABLES

TABLE	PAGE
3.1 Numbers of Children in Each Group.....	52
3.2 Summary of Assessment Tasks.....	54
4.1 Regression Analysis Results for English Variables.....	63
4.2 Correlation Matrix for English Variables.....	63
4.3 Regression Analysis Results for Spanish Variables.....	64
4.4 Correlation Matrix for Spanish Variables.....	64

LIST OF FIGURES

FIGURE	PAGE
4.1 Rate of Speech Means for Language X Age Interaction.....	66

LIST OF ABBREVIATIONS / NOMENCLATURE

ACI	Articulation Competence Index
APP-S	Assessment of Phonological Processes - Spanish
APPS-2	Assessment of Phonological Patterns in Spanish – 2 nd Edition
CPAC-S	Contextual Probes of Articulation Competence - Spanish
ELL	English Language Learners
HAPP-3	Hodson Assessment of Phonological Patterns – 3 rd Edition
MANOVA	Multivariate Analysis of Variance
PCC	Percentage of Consonants Correct
ROWPVT-SBE	Receptive One-Word Picture Vocabulary Test- Spanish Bilingual Edition
SLP	Speech-Language Pathologist
TOMPD	Total Occurrences of Major Phonological Deviations
USCB	United States Census Bureau

CHAPTER I

INTRODUCTION

Human interaction, which begins early in childhood, relies upon communicative exchanges that are intelligible (i.e., understood). Through hearing, observation, and application, children initially learn the rules for language and speech through meaningful interactions, first with parents/family members, and later with peers as they enter daycare or classroom environments. Typical development of a child's speech sounds and the understanding of a child's speech (i.e., intelligibility) are important for his/her success in school. Children with reduced intelligibility (e.g., unintelligible speech) encounter peers and adults who have difficulty understanding their speech. These children often are referred to a speech-language pathologist (SLP) for assessment. If treatment is needed, SLPs generally target speech-sound productions.

For the majority of these children (i.e., English speakers), the SLP has developmental milestones, available assessments, and background knowledge to diagnose and determine if treatment is necessary. When an SLP, however, is assessing a child who is learning to become intelligible in two languages (i.e., bilingual), the practitioner must evaluate available information not only in English, but also in the additional language. This is critical because children who are bilingual in this country typically come from a home environment where English is the second language.

Although valid normative data related to intelligibility are needed for all bilingual children, there is a dire need for data on children who speak Spanish as their first language. According to the United States Census Bureau (USCB, 2008), the Hispanic population is the largest and fastest growing minority in the United States (US),

constituting approximately 13.7% of the US population. The USCB projects the Hispanic population to increase to 102.6 million by July 1, 2050, representing 24% of the nation's total population. In 2004, the USCB released information indicating that approximately 4.3 million children (10% of the population) under the age of 5 years were of Hispanic origin. In addition, the National Clearinghouse for English Language Acquisition and Language Instruction Educational Programs (2006) estimated that the number of English Language Learners (ELL) in US schools has more than doubled from 2,030,451 in 1990 to 5,119,561 in 2005. Of the total ELL population, 80% are reported as being Spanish speakers (Zehler, Fleischman, Hopstock, Stephenson, Pendzick, & Sapru, 2003). This has sparked a greater demand for services (e.g., speech/language) for Spanish-speaking children, especially as the numbers of children in the schools who speak Spanish as their first language continue to rise.

Children from Spanish-speaking households in the US typically learn English as they enter school environments. In fact, some researchers have found that once bilingual children enter a school setting and begin learning English, vocabulary scores in English improve from kindergarten to first grade, while Spanish vocabulary scores show no significant gains during this period (e.g., Uccelli & Pérez, 2007). In addition, investigators have found that children who are predominantly Spanish-speaking in early childhood will eventually become proficient in English (e.g., Kohnert & Bates, 2002). These conditions occur only as a Spanish-speaking child progresses through a slow transitional period learning the English language. This may, in part, be a result of the nature of the US curriculum (e.g., Spanish-speaking children immersed in English-speaking classrooms;

USCB 2008). As a result, intelligibility in English may be delayed at first for bilingual children.

In the case of a child with highly unintelligible speech, assessing intelligibility becomes more complex with the addition of another language. Monolingual children with highly unintelligible speech, for example, often have concomitant difficulties with skills related to literacy (e.g., Rvachew & Grawberg, 2006). There is a dire need, therefore, to determine intelligibility for bilingual children in both languages.

Defining Speech Intelligibility and Intelligibility Measures

Speech intelligibility may be defined as the “degree of clarity with which one’s utterances are understood by the average listener” (Nicolosi, Harryman, & Kresheck, 1989, p. 132). Many different factors are related to intelligible speech, including the spoken language competence of the speaker, the listener’s familiarity with the speaker, context, and visual and acoustic input from speech (Kent, 1992b). In relation to speech/language assessment, intelligibility has been described as the “most important factor when determining the need for intervention and for evaluating the effectiveness of intervention strategies” (Bernthal & Bankson, 1998; p. 271). For purposes of this investigation, speech intelligibility is defined as the degree of clarity with which a participant’s recorded utterances are understood by an unfamiliar listener.

Measures of speech intelligibility are important and necessary for various populations of individuals with speech impairment (Flipsen, 2006). Many analyses play a substantial role in the determination of intelligibility (including levels of severity). These include assessments of continuous speech samples (e.g., Percentage of Consonants Correct; Shriberg & Kwiatkowski, 1982), phonological analyses (e.g., Hodson

Assessment of Phonological Patterns-Third Edition; Hodson, 2004), and word-level intelligibility (e.g., Preschool Speech Intelligibility Measure; Morris, Wilcox, & Schooling, 1995). Other related factors that may influence intelligibility include vocabulary, rate of speech, age, and gender.

Statement of the Problem

In order to provide appropriate services to Spanish-speaking children, SLPs must consider intelligibility decisions in both languages. In many cases, practitioners rely on normative data in English to assess intelligibility of a bilingual (Spanish-English) child. Spanish-speaking children, therefore, are often under or over identified for services due to a lack of well-defined information related to intelligibility in Spanish (e.g., milestones and normative data). In addition, many practitioners assess Spanish-speaking children's English productions via English assessments that have not been norm-referenced on bilingual Spanish-English children. Improvements to assessment instruments and procedures that effectively diagnose Spanish-speaking children are needed (e.g., Goldstein, 1995; Goldstein, 2002; Iglesias, 2001; Kaiser, 1998).

Although there have been large-scale investigations of typically-developing English-speaking children's speech sounds/patterns (e.g., Prather, Hendrick, & Kern, 1975; Sander, 1972; Smit, Hand, Freilinger, Bernthal, & Bird, 1990; Templin, 1957), there are only a few studies involving Spanish-speaking children. Most of the studies of Spanish-speaking children that exist have fewer than 20 participants (e.g., Goldstein & Washington, 2001). In addition, there is a paucity of data related to productions of English and Spanish in bilingual children whose first language is Spanish. There also is a

need for current research studies that examine multiple variables in relation to overall intelligibility in both languages, including age, gender, assessments used, languages evaluated (i.e., Spanish, English), and classifications of deviations (e.g., phonological patterns).

Comparisons between performance variables across languages are critical. Not only is it important to report information regarding Spanish-speaking children's productions in Spanish, but it also is important to explore their intelligibility in English, along with the potential differences between languages, age groups, and gender. Moreover, these data would be beneficial for clinicians who are working with this population.

Statement of Purpose

This investigation was designed to address critical issues regarding intelligibility of bilingual English/Spanish-speaking children. The main purpose of this study was to determine which variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary) significantly predict listener ratings of intelligibility of bilingual (Spanish-English) preschool children in both languages. A second purpose was to ascertain whether significant differences exist among predictor variables across languages, ages, and gender.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter begins with an overview of research related to intelligibility. Studies involving intelligibility measures of English-speaking preschool children are summarized first, followed by an introduction to studying intelligibility in Spanish, which includes an overview of bilingualism and a discussion of factors that may influence intelligibility in bilingual Spanish-English preschool children. Studies of phonological developmental data for Spanish-speaking children are compared to what is known about English-speaking children. In addition, language factors that may predict intelligibility (i.e., vocabulary, rate) are discussed. Moreover, other considerations that may contribute to intelligibility (i.e., age, gender) are explored.

Intelligibility

Studies Involving English-Speaking Children

Investigations of intelligibility have centered primarily on specific aspects of communication disorders. Research on intelligibility, for example has involved analyses of adults with neurological impairments (e.g., dysarthric speech in adults; Yorkston & Beukelman, 1981), adults who are alaryngeal speakers (e.g., Fujimoto, Madison, & Larrigan, 1991), and speakers with hearing impairment (e.g., Metz, Samar, Schiavetti, Sitler, & Whitehead, 1985). Still, there has been a growing interest in exploring the intelligibility of preschool children (e.g., Gordon-Brannon & Hodson, 2000).

Measures of Intelligibility

Historically, investigators have categorized intelligibility measures into three general approaches: open-set word identification, closed-set word identification, and rating scale procedures (Gordon-Brannan, 1994). Gordon-Brannan and Hodson (2000) provide descriptions of these three approaches. Open-set word identification involves the analysis of orthographic or phonetic transcriptions of spoken words (i.e., single words, sentences, or continuous speech). Closed-set word identification occurs when listeners select words from a pool of word choices. Rating scales, on the other hand, involve listener judgments of intelligibility via scales.

Kent, Miolo, and Bloedel (1994) offer summary descriptions of 19 procedures which include measures that can be classified as open-set, closed-set, or rating scales. These measures are used to assess intelligibility of children. The authors report that not all of the procedures need to be addressed with each individual and write that “the most appropriate selection depends on the child’s age, his or her speech-language capabilities, the presence of other disabilities, the purpose of the intelligibility testing, the time available for assessment, and the availability of other information that may be used to interpret the results of intelligibility assessment” (p. 91).

The measure considered to be most valid for intelligibility reported in the literature is the percentage of words understood in continuous-speech samples (Kent et al., 1994; Kwiatkowski & Shriberg, 1992). Under this analysis, which is an open-set word identification method, speech samples are orthographically transcribed by an examiner, who determines the percentage of words identified. One disadvantage of using

the percentage of words understood, however, is that the procedure is time consuming (Bacon, 1995).

The other procedures reviewed by Kent et al. (1994) were grouped into five categories, depending on the emphasis of analysis: (1) phonetic contrast analysis, (2) phonological analysis, (3) word identification, (4) phonetic accuracy in continuous speech, and (5) scaling method of continuous speech. The authors point out that different assessment tools are used for different populations. Children with varying levels of hearing impairment, for example, may be best evaluated through the use of procedures that emphasize phonetic contrast analysis (e.g., CID picture SPINE; Monsen, Moog, & Geers, 1988) or procedures that rely on a scaling method of continuous speech (e.g., Meaningful Use of Speech Scale; Osberger, 1992). The three other categories (i.e., word-level intelligibility, phonetic accuracy in continuous speech, and phonological analysis) essentially can be used with all children who have normal hearing.

Word-level intelligibility. Word-level intelligibility assessments (i.e., closed-set) are used to measure a percentage of correctly identified words. In many instances, productions of words are collected through word imitation (e.g., Preschool Speech Intelligibility Measure; Morris, Wilcox, & Schooling, 1995). One of the pitfalls of word-level intelligibility, however, is word familiarity (Kent et al., 1994). It is difficult to ensure that children are familiar with all of the words that comprise an articulation or intelligibility test. In addition, researchers have noted that it is important to consider linguistic and contextual factors, in addition to articulation parameters, when assessing intelligibility (Weston & Shriberg, 1992).

Phonetic accuracy in continuous speech. One of the most widely used approaches for collecting data to determine intelligibility of children is the transcription of continuous-speech samples. Two procedures for determining phonetic accuracy in continuous-speech samples (i.e., open-set) include the Percentage of Consonants Correct (PCC; Shriberg & Kwiatkowski, 1982) and the Articulation Competence Index (ACI; Shriberg, 1993). The PCC is calculated by dividing the correct productions of consonants by the total number of consonants and multiplying by 100. Prezas and Hodson (2007) described how the PCC does not “differentiate types of deviations (omission, substitution, distortion) in the overall scoring process” (p. 3). Distortions (e.g., lisps), for example, are given the same weight as omissions. Omissions, however, have more of an adverse effect on intelligibility (Hodson, 2007). The same is true with the ACI, which is calculated by summing the PCC with the relative distortion index (i.e., dividing the total number of distortion errors in a sample by the total number of articulation errors). Omissions and substitutions are not differentiated with the ACI. As a result, children with very different phonological systems often receive the same scores.

Phonological Analysis. Phonology refers to the sound system of a language (Hodson, 2007). Phonological analysis of children is used to determine whether a child has a phonological impairment. Children with phonological impairment demonstrate phonological deviations (e.g., omissions), involving more than one sound in a phonological pattern (e.g., /s/ clusters; Prezas & Hodson, 2007). An analysis of phonological patterns (e.g., Hodson Assessment of Phonological Patterns-Third Edition; Hodson, 2004) and treatment of target patterns is critical to expediting intelligibility gains of children with highly unintelligible speech (Hodson, 2007).

Rating Scales. Rating scales or impressionistic statements historically have been used to measure intelligibility (Kent, 1992a). Although Kent et al. (1994) recommended using rating scales primarily to assess intelligibility of children with hearing impairment, investigators have reported high correlations between listener ratings and intelligibility in children with typical hearing. Gordon-Brannan and Hodson (2000) studied intelligibility/severity measures from continuous-speech samples of 48 children between the ages of 4:0 (years:months) and 5:6. The phonologies of the children varied from no speech sound errors to extensive omissions. The method used as the most valid measure of intelligibility was the percentage of words understood (Kent et al., 1994; Kwiatkowski & Shriberg, 1992). This measure was derived from the 48 continuous-speech samples of the participants. Four additional intelligibility/severity measures also were investigated: (a) imitated sentences, (b) imitated words, (c) listener ratings of intelligibility, and (d) phonological deviation averages.

Imitated sentences consisted of “10 five-word simple, declarative, present tense sentences that contained fricatives, affricates, liquids, /s/ clusters, liquid clusters, and /θ, ð/” (p. 143). For the word imitation procedure, The Preschool Speech Intelligibility Measure was used (Morris, Wilcox, & Schooling, 1995). Listener ratings of intelligibility were obtained from 100-word continuous-speech samples. Four listeners rated each sample on a 7-point Likert scale. The Assessment of Phonological Processes-Revised (Hodson, 1986a) and the Computer Analysis of Phonological Deviations (Hodson, 1992) were used to assess and analyze phonological deviations.

Although Gordon-Brannan and Hodson (2000) found that all four measures were strongly correlated with the percentage of words understood, listener ratings (which were

scored via a 7-point Likert scale) received the highest relationship. This was an important finding, because listener ratings of intelligibility are not as time consuming as transcribing continuous-speech samples (Bacon, 1995). Moreover, the results of this study allow for the conclusion that listener ratings of intelligibility can be used in the analysis of overall intelligibility.

Measures of Spanish Intelligibility

Studies of intelligibility measures of Spanish-speaking children are sparse. The aforementioned assessments outlined by Kent et al (1994) to measure intelligibility were intended to be used primarily on English-speaking children, with the exception of measurements that can be derived from continuous speech (e.g., PCC) and phonological analyses measures that currently are available in Spanish; which will be discussed in detail later (e.g., Assessment of Phonological Patterns in Spanish-2nd edition; Hodson, 2008). Researchers of bilingual children have separately examined variables that may be related to overall intelligibility. In order to examine prior research related to intelligibility of bilingual (Spanish-English) children, an overview of bilingualism is offered, followed by discussions of variables that have been studied which may predict intelligibility in bilingual children (i.e., phonological deviations, vocabulary, rate, age, gender).

Understanding Bilingual Children

Bilingualism is difficult to study for many reasons. The United States Census Bureau (USCB; 2008) reported that approximately 29 million people speak Spanish in the home. Spanish-speaking households generally fit into one of the following categories:

(a) monolingual Spanish, or (b) bilingual Spanish/English of varying levels. The linguistic diversity among Spanish-speaking children has led researchers to re-analyze normative data in more current studies to reflect these differences (e.g., levels of bilingualism; Goldstein, Fabiano, & Washington, 2005). In addition, a surge of contemporary research has begun, devoted to defining and explaining bilingual language acquisition. The resulting data have provided models of many factors, including a bilingual individual's phonological representation via the structure of his/her two languages (i.e., defining the first language, L1, and second language, L2).

Bilingual Development

Investigators in child language acquisition have considered whether bilingual children carry one system of language or two to represent L1 and L2. Researchers advocating a one system model (i.e., Unitary System Model) believe that both languages are developed in one system that later separates into two (e.g., Genesee, 1989; Schnitzer & Krasinski, 1994). Advocates of a two system model of acquisition (i.e., Dual System Model), however, believe that bilingual children develop separate systems for L1 and L2 from birth (e.g., Watson, 1991). Interestingly, investigators also have made adaptations to these models (i.e., Interactionist Dual System Model; Paradis, 2001; for review, see Goldstein, 2006), suggesting that the two models interact in other ways. Conflicting results, however, have led some researchers to conclude that neither system captures the essence of language storage (Schnitzer & Krasinski, 1996).

Investigators of bilingual language characteristics also have examined changing proficiency of skills in both languages. Kohnert and Bates (2002), for example, reported

developmental changes in the lexical comprehension skills of bilingual Spanish-English children. Participants in the study included 100 children in five different age groups (i.e., 5-7 [age in years], 8-10, 11-13, 14-16, and adults). All participants in the study were (a) from Spanish-speaking households, (b) reported Spanish as their first language, and (c) acquired English as a second language between the ages of 4 and 6. Through visual and auditory stimuli, participants were asked to determine if the spoken word accurately named the picture in trial of three conditions: “Blocked-Spanish, Blocked-English, and Mixed-Spanish and English” (p. 351). The investigators reported that lexical gains were made in both languages across age; however, gains were greater in English. Whereas the crosslinguistic performance of younger participants was similar in both languages, performance was better in English by middle childhood.

Researchers also have compared bilingual and monolingual speakers of Spanish and English. Gollan, Montoya, Fennema-Notestine, and Morris (2005), for example, examined adults and found that bilingual individuals named pictures more slowly than monolingual speakers when accessing lexical representations. In the same study, the bilingual speakers made more errors than monolingual individuals in the production of target words via pictures. This phenomenon suggests that bilingual speakers access a single semantic store, instead of two separate stores. Furthermore, it leads to the hypothesis that bilingual individuals spend more time processing both languages and less time using words of each language compared to monolingual speakers. This may, therefore, account for the slight differences found between bilingual and monolingual phonological acquisition data in studies of children.

Cross-Language Analysis and Early Literacy in Bilingual Children

Researchers of bilingual language development have discovered that cross-over effects occur between two languages (e.g., Ellis, 1997; Scheffner Hammer & Lawrence, 2007). This has led to the study of many areas of bilingual language, including phonotactic constraints, placement of stress, pitch changes, vowel differences, and allophonic variations (for review, see Goldstein, 2004). In a comparison of Spanish and English bilingualism, for example, some sounds exist in Spanish (e.g., /ɣ/ for /g/ in the intervocalic position) that do not occur in English (Cotton, 1988). In addition, the phoneme /j/ is not found in most dialects of Spanish (Goldstein, 2004a). As a result, theorists have been challenged to determine plausible ways of modeling the idea that phonological transfer and cross-linguistic effects often occur in the productions of bilingual children (Goldstein, 2001b; Goldstein, 2006).

Investigations of the linguistic environment of bilingual children have yielded additional findings of cross-linguistic analysis. There is reason to believe, for example, that the language structure of a caregiver may give the illusion that a cross-linguistic effect exists in a child. In a study examining cross-linguistic interference in the acquisition of Spanish and English, Paradis and Navarro (2003) paid particular attention to the input (i.e., parent) and found that cross-linguistic effects may occur as a result of the input, rather than internal cross-language contact. The researchers postulated that a parent or other speaker may present a mixed language structure to a child who already evidences a cross-linguistic effect (Silva-Corvalán, 1994; Genesee, Paradis, & Crago, 2004). This would, in essence, create a cross-linguistic imprint upon an already existing language structure. The data from the study, however, did not allow for conclusions to be

made. It may be more appropriate to admit that some occurrences may fall under a different classification (e.g., dialectal variations), rather than completely ruling out the idea that a cross-language interference exists between languages.

Pre-literacy cross-linguistic development has yielded insightful data regarding bilingual preschool children's phonological awareness skills. Phonological awareness, which is the ability to think about and manipulate speech sound segments of words into smaller units (Blachman, 1994; Swank & Catts, 1994; for review, see Anthony & Francis, 2005), has been found to be an early predictor of later reading success in young children (e.g., Ball & Blachman, 1991; Gillon, 2007; Hogan, Catts, & Little, 2005). Investigators also have examined phonological awareness skills in Spanish-speaking children (e.g., Adrian, Alegria, & Morais, 1995; Anthony, Williams, McDonald, Corbitt-Shindler, Carlson, & Francis, 2006; Braunum-Martin, Mehta, Fletcher, Carlson, Ortiz, Carlo, & Francis, 2006; Carillo, 1994; Hammer & Miccio, 2006). Phonological awareness, for example, has been found to correlate and transfer from one language to another (e.g., Cisero & Royer, 1995; Durgunoglu, 1998; Durgunoglu, Nagy, & Hancin-Bhatt, 1993; Gillon, 2004). In addition, children who are better readers in a second language have been found to possess better phonological awareness in the first language (for review, see Culatta, Reese, & Setzer, 2006; e.g., Durgunoglu et al., 1993).

Phonological awareness was found to contribute to achievement in English reading comprehension among Spanish-speaking first, second, and third graders who were becoming bilingual (Carlisle, Beeman, Davis, & Spharim, 1999). Bilingualism, therefore, facilitates certain types of metalinguistic awareness (for review, see Malakoff & Hakuta, 1991; e.g., Bialystok, 1988; Galambos & Hakuta, 1988). The actual language

for which a child is bilingual, however, determines the level of “helpfulness” in this regard (i.e., tonal versus alphabetic phonological awareness). Knowing the combination of Chinese and English, for example, is less helpful than knowing another language more closely related to English (Liow & Poon, 1998).

With the knowledge that phonological awareness in one language can transfer to another language in young children, it is no surprise that investigators have examined cross linguistic effects of speech sounds in bilingual (Spanish-English) preschool children. Bilingual children (Spanish-English), for example, make more consistent substitution errors of allophonic (e.g., /g/ for /ɣ/) and liquid (i.e., American /ɹ/ and trilled /r/) phoneme productions than monolingual Spanish-speaking children (Gildersleeve-Neumann & Davis, 1998; Goldstein & Washington, 2001). Substitution errors also can result in cross-linguistic effects. One example of a cross-linguistic effect of this kind would be a substitution of the American /ɹ/ for trilled /r/ (e.g., *perro* pronounced [peɹo]). In addition, a cross-linguistic effect may change the produced word to a different word found in the language (e.g., *pero* becomes [pelo]; *dog* changes to *hair*). Interestingly, the substitution is only a cross-linguistic effect if the child produces the American /ɹ/; distinguishing from the Spanish “l.” It is important to make the distinction that cross-linguistic effects not be called “errors.” Doing so would imply that the child has atypical development. This would be incorrect, due to the aforementioned findings that cross-linguistic productions have been shown to occur among typically developing bilingual children of similar age groups.

Although cross-linguistic effects often occur, the rate of occurrence has been found to be relatively low (e.g., Genesee, Nicoladis, & Paradis, 1995). Substitution

errors, however, also remain relevant to this discussion, due to the differences between bilingual and monolingual children (i.e., bilingual children make more substitution errors around 4 years of age (Goldstein & Washington, 2001). Interestingly, cross-linguistic effects and substitutions in general have been found to decrease with age (Fabiano & Goldstein, 2005; Genesee, 1989; Gildersleeve-Neumann & Davis, 1998; Goldstein, Fabiano, & Washington, 2005), suggesting a learning process occurs with time where bilingual children approximate monolingual children in both languages.

Sound Characteristics of Bilingual Preschool Children

When children acquire the phonological structure of the language in their immediate environment, they subsequently learn the phonological structure of the language through a process of deductive reasoning (Watson, 1991). Children establish a phonological inventory of sounds of the language and the permissible ways those sounds can be combined (e.g., recognizing that the sound /ð/ occurs in the language and that it is produced for “d” in the intervocalic position). In the case of a child who is bilingual, therefore, sound and syllable structures of both languages must be established and differentiated in some way (Goldstein, 2004b). Whereas monolingual children acquire only one phonological inventory, bilingual children acquire two.

Hammond (2001) reported information of shared and unshared phonemes in both Spanish and English. There are 15 shared phonemes in both languages. Nine English consonants do not exist in Spanish and five Spanish consonants do not exist in English. In another study by Goldstein and Iglesias (2002), the researchers found that shared phoneme accuracy was significantly larger than unshared phonemes. Of course, all of the

reported studies assume that similar consonants (e.g., /p/ in both languages) are produced exactly the same. The literature does not consider research in voice onset time (i.e., differences between onset times of similar stops between languages, the discussion of which is beyond the scope of this paper).

It is generally accepted that there are 18 consonants and five monophthong vowels in Spanish (Cotton & Sharp, 1988; Goldstein, 2002; Núñez-Cedeño, & Morales-Front, 1999). According to Nuñez-Cedeño and Morales-Front (1999), the 18 consonants that exist in Spanish are as follows: Stops: /p, t, k, b, d, g/, Fricatives: /f, s, x/ (x = velar fricative, i.e., *espejo*), Affricate: /tʃ/, Glides: /w, j/, Lateral: /l/, Flap /ɾ/, Trilled /r/ and Nasals /m, n, ɲ/ (ɲ = voiced palatal nasal, i.e., *niño*). Goldstein (2001a) reported that the five monophthong vowels Spanish are: /i/, /e/, /u/, /o/, and /ɨ/. In addition, certain sounds also exist in Spanish that are not a part of the English language. These sounds are known as *allophones* and consist of the voiced and voiceless bilabial fricative, voiced interdental, and voiced velar (see Goldstein, 2001b; Goldstein 2004). The four prevalent allophones of Spanish include three that are known as spirants (/b/ = /β/ voiced bilabial fricative as in /aβlar/ “hablar;” /d/ = /ð/ voiced interdental as in /deðo/ “dedo;” /g/ = /ɣ/ voiced velar as in /laɣo/ “lago”) and another known as the voiceless bilabial fricative (/ɸ/ as in /emɸermo/ “enfermo”), which is only found in specific dialects of Spanish (e.g., Puerto Rican Spanish).

Dialectal Considerations

During the past decade, investigators have focused on similarities and differences among the pronunciation of Spanish dialects and as well as the differences in vocabulary associated with dialects of Spanish (Goldstein, 2001a; Goldstein, 2001b; Mann & Hodson, 1994). Unlike English, where vowel differences generally define dialectal variations, Spanish dialectal differences primarily occur in consonant sound classes (Goldstein, 1995). More specifically, variations in Spanish dialects commonly occur via deletions and aspirations of specific consonants.

In 2000, the USCB released data that listed Hispanics by Origin and found that Hispanics in the US identify themselves as follows: 66.1% Mexican; 14.5% Central and South American; 9% of Puerto Rican; 4% Cuban; 6% from other Hispanic origins. Due to the various Spanish-speaking cultures that exist in the US, it is critical to consider dialectal differences in speech/language assessments. In the past, investigators have reported data regarding the typical productions of Spanish-speaking children from various dialects and countries, including studies of Spanish-speaking children of Mexican descent (e.g., Acevedo, 1991; Albarrán-Frias, 1996; Bailey, 1982; Becker, 1982; Diamond, 1983; Eblen, 1982; Jiménez, 1987; Macy, 1979; Melgar de González, 1980; Meza, 1983; Summers, 1982), Bolivian descent (Fantini, 1985), Dominican descent (De la Fuente, 1985) and Puerto-Rican descent (e.g., Anderson & Smith, 1987; Goldstein, 1988, Goldstein & Iglesias, 1996a, 1996b; Gonzales, 1981; Stepanof, 1990).

According to Iglesias and Goldstein (1998) and Goldstein (2001b), the two most prevalent dialects of Spanish in the US are Mexican and Puerto Rican, comprising the Southwestern US dialect (i.e., Mexican Spanish) and the Caribbean dialect (i.e., Puerto

Rican Spanish, including Cuban Spanish), respectively. Interestingly, the Mexican and Puerto Rican dialects (which are known to be spoken by many Spanish-speaking children in the US) are, in many cases, different from one another. In the Puerto Rican dialect of Spanish, for example, /s/ is often deleted in final position, and /r/ may be substituted by other consonants (e.g., /l/, /x/, /R/, /r/) in different words (Goldstein, 2004a; Goldstein & Iglesias, 2004). This does not occur in the Mexican dialect of Spanish, where all final consonants (including /s/) are produced (in some way) and only slight variations (e.g., substitution of /l/) exist for the /r/ (Jiménez, 1987). For assessment purposes, therefore, it is important to avoid as much as possible the scoring of these dialectal features as errors. Doing so may increase the percentage of occurrence for deviations (e.g., omissions), resulting in inappropriate data for planning intervention (Goldstein, 2001a).

Possible Predictors of Intelligibility

Phonological Deviations

In order to begin a review of research literature on typical acquisition of phonological patterns, it is necessary to first define specific terminology. The American Speech-Language-Hearing Association currently prefers the term “Speech-Sound Disorders” as the umbrella term for disorders of phonology. This term also is used to describe children with “articulation” errors and suspected Childhood Apraxia of Speech (Prezas & Hodson, 2007). The term *phonological processes* (Ingram, 1976), is still used by some researchers to refer to error regularities (e.g., final consonant deletion) that are evidenced in children’s speech productions. Hodson and Paden (1981) described phonological processes as *phonetic* and *phonemic changes* in speech occurring in sound

classes or sound position. More recently, however, the term has evolved to *phonological patterns* (Hodson, 2004). This is because the term *processes* suggests the inclusion of other factors in the phonological development of children (e.g., storage and retrieval of phonological information). The term processing, for example, has referred to the use of phonological information in processing written and oral information (e.g., Wagner & Torgesen, 1987). In order to determine whether a child had a speech-sound disorder, practitioners need to know what typically developing children of similar backgrounds do in regards to sound system development (e.g., speech-sound errors and/or phonological deviations).

Phonological Comparisons of English and Spanish

Many investigators have examined English-speaking children's typically developing phonological patterns. Large studies of phonological patterns in typically developing English-speaking children began early in the 1930s and have continued in more recent studies (e.g., Olmstead, 1971; Poole, 1934; Prather, Hendrick, & Kern, 1975; Templin, 1957; Sander, 1972; Smit, Hand, Freilinger, Bernthal, & Bird, 1990; Wellman, Case, Mengert, & Bradbury, 1931). It is important to point out that considerable methodological differences exist between the studies, including the size and characteristics of the samples used, location and time of the conducted studies, methods and procedures, sound positions that were tested, and criteria of mastery (for review see Kelman, 2007; Smit, 1986; Stoel-Gammon & Dunn, 1985; Vihman, 1998). Researchers also have established that it is inappropriate to use normative data for English-speaking children on Spanish-speaking children (e.g., Goldstein, 2004b; Jiménez, 1987). It should

be noted, however, that other researchers have found the order of phoneme acquisition of Spanish to be similar to English (e.g., Becker, 1982, Diamond, 1983; Gonzáles, 1981). Furthermore, data from normative studies of English-speaking children (in regards to bilingualism) become more important as the phonological inventories and patterns of Spanish-English bilingual children are considered.

The same differences in mastery of sounds that already have been discussed in studies of English-speaking children (e.g., Poole, 1934; Templin, 1957; Wellman et. al., 1931) also occur in studies of Spanish-speaking children. Acevedo (1993) and De la Fuente (1985), for example, determined mastery of sounds if the children accurately produced them at least 90% of the time, whereas other investigators used different measures (e.g., 95% mastery, Ramírez-Morales, 1977; when 75% of children produced phonemes correctly 90% of time, González, 1981). Differences among methodologies of research studies (including age differences), therefore, must be considered when analyzing reported data differences. If these details are not examined, it is possible to misrepresent acquisition data from studies.

Researchers have identified similar phonological patterns and phoneme acquisition milestones in Spanish and English, with a few exceptions (for reviews, see Goldstein, 1995, 2004b). The majority of Spanish phonemes, for example, are reported to be acquired by age 4 years (e.g., Acevedo, 1989; Jiménez, 1987; Linares, 1981; Mann & Hodson, 1994; Mason, Smith, & Hinshaw, 1976; Melgar de González, 1980; Terrero, 1979; Wilson, 1984) and the phonemes reported to be mastered last are flapped r, trilled r, /s/, /l/, and /tʃ/ (Acevedo, 1989; Jiménez, 1987; Linares, 1981; Terrero, 1979). Many investigators, however, are in disagreement. Some investigators, for example, purport

that phoneme acquisition is more gradual and that certain sounds (i.e., /g/, /f/, /s/, /ɲ/, /r/, /r/) are not mastered until after age 5 (e.g., Acevedo, 1991; Fantini, 1985; Mason et al., 1976; Summers, 1982). Furthermore, some examiners argue that certain sounds (i.e., /x/, /s/, /tʃ/, /l/, /r/, /r/) and consonant clusters are not mastered until age 7 (e.g., Acevedo, 1993; De la Fuente, 1985; Mason et. al., 1976).

Sound Development of Monolingual Spanish-Speaking Children

Prior to the 1980s, clinicians had to rely primarily on norms established for English-speaking children due to a lack of normative data on Spanish-speaking children. Only a few investigations in phonological development were available (e.g., Ferguson, 1971; Mason et al., 1976; Ramírez-Morales, 1977; Stoel, 1973). In general, researchers have taken various approaches to studying the sound system of Spanish-speaking children. In some cases, investigators have focused only on specific sound classes (e.g., Stoel, 1973; Macken, 1975, 1978; Macken & Barton, 1980), whereas others have examined the acquisition of phonetic inventories (e.g., Acevedo, 1991; De la Fuente, 1985; Eblen, 1982; Jimenez, 1987; Summers, 1982) and phonological patterns (e.g., Becker, 1982; Cabello, 1986; Goldstein, 1988; Mann, Kayser, Watson, & Hodson, 1992; Stepanof, 1990) in typically developing Spanish-speaking children.

As part of a series of studies from ongoing research at Stanford University in the 1970s and early 1980s, Stoel (1973) examined nasals and liquids by elicited nonsense syllables (i.e., V-CV form) and spontaneous speech from six typically developing Spanish-speaking children of Mexican descent between the ages of 2:4 and 3:3 years. The six children were followed for 6 months in Redwood City, California. Stoel concluded

the following from the study: (a) that the last Spanish phonemes to be acquired are /l/, /r/, and /r/, (b) /n/ can be a substitute for /ɲ/, (these substitutions were evidenced by the participants in the study), and (c) nasals are acquired sequentially in a front-to-back pattern (/m/, /n/, /ɲ/, /ŋ/). Of the six children in the study, only one had acquired liquids.

Macken (1975) examined intervocalic consonants in imitative non-word repetition tasks by children who also were of Mexican descent (as part of continued research from Stanford University). Along with the six children from the study conducted by Stoel (1973) between the ages of 2:4 and 3:3 years, ten children (i.e., seven girls and three boys) from Mexico City, Mexico between 1:6 and 6:1 years of age participated in the study. Based on the results of the study, Macken hypothesized the following sequence of order for the acquisition of Spanish consonants: (a) stops are acquired before nasals; (b) nasals are acquired before fricatives; (c) fricatives and affricates are acquired before liquids (i.e., /l/, tapped /r/ and trilled /r/) which are the last to be acquired; and (d) frontal consonants precede back consonants.

Mason, Smith, and Hinshaw (1976) examined 424 primarily Spanish-speaking children in California. The study was, in part, to provide normative data for La Medida de Articulación Española, a picture articulation test. The participants ranged in age from 4- to 9-years-old. The examiners concluded that all of the vowels were acquired (i.e., 90% criterion) by age 4 except the vowel /e/ (acquired at 6 years). The consonants /p, b, t, k, g, m, x, y/ and allophonic variations of /b, g/ (i.e., /β, ɣ/) also were acquired by age 4 years. The consonants /t, l/ were found to be acquired by 5 years. At 6 years of age, the consonants /n, ɲ, f, s, r/ and the allophonic variation of /d/ (i.e., /ð/) were found to be acquired by children in the study. The trilled /r/ was found to be acquired by age 7 and

the /d/ at age 9. Variations of dialect were not considered in this study, which may explain the discrepancies that exist between other studies, including those that have used *La Medida de Articulación Española* (e.g., see Bailey, 1982; Macy, 1979; Summers, 1982). Furthermore, discrepancies among these studies also may be due to the differences in age ranges, methodologies, sample sizes, and differing criterion standards for acceptable dialectal variation.

In one of the earliest studies of children with a Puerto Rican dialect, Ramírez-Morales (1977) analyzed productions of 94 children between the ages of 3:0 and 5:0 in San Juan, Puerto Rico. Each child was shown 29 pictures and asked to name them spontaneously. The children were divided into three groups based on age. The first group contained 40 children (i.e., 20 boys and 20 girls) between the ages of 3:0 and 3:11. The second group included 30 children (i.e., 16 boys and 14 girls) between the ages of 4:0 and 4:11. In the third group, there were 20 children (i.e., 11 boys and 9 girls) between the ages of 5:0 and 5:11. Phoneme mastery for this study was defined as a sound that was correctly produced by 95% of the children within an age group. Ramírez-Morales found the following: (a) the phonemes /m, n, ɲ, p, b, t, k, ç, y, f/ were mastered by children between the ages of 3:0 and 3:11, (b) the phonemes /l, r, g, x, ɲ/ and the blend /bl/ were mastered by children between the ages of 4:0 and 4:11, and (c) the blends /kl, pl/ were mastered by children between the 5:0 and 5:11 age range. Based on the data, Ramírez-Morales determined the following order of feature acquisition in Spanish-speaking children: nasality, sonorance, consonantal, continuity, and stridency. Interestingly, Ramírez-Morales obtained differing results from Mason et al. (1976). Specifically, blends

that were acquired much later in the Mason et al. study (i.e., /bl, kl, pl/) were mastered earlier in the Ramírez-Morales study.

Melgar de González (1980) studied 200 monolingual children of Mexican descent between the ages of 3:0 and 6:6. Fifty-six pictures served as stimuli. Children were asked to name each picture spontaneously. In this study, phoneme mastery was set at 90% correct for all children in an age range in all positions (i.e., initial, medial, final). Results of the study revealed that children between the ages of 3:0 and 3:6 mastered the phonemes /m, n, ɲ, p, t, k, ç, ý, f, l/. The phonemes /r, b, g/ and the clusters /pl, bl/ were mastered between the ages of 4:0 and 4:6. By ages 5:0 and 5:6, the children mastered the clusters /kl, fl, br, kr, gr/, followed by the phonemes /s, r/ and the clusters /gl, fr, tr/ between the ages of 6:0 and 6:6.

In 1981, Linares reported results from two investigations of consonant acquisition in Spanish-speaking children. Two studies of children were conducted. In the first study, the productions of 97 3- to 6-year-old Spanish-speaking children living in Mexico were assessed. Using an experimental test, consisting of 40 black and white drawings, the researcher concluded that more than half of the investigated consonant sounds were correctly produced by 90% of the 3-year-old children. The /b/, /s/, and /r/ sounds were observed to be acquired after 5 years of age. In a second study, 148 5- to 8-year-old predominantly Spanish-speaking children living in New Mexico were investigated. In some cases, the participants also spoke English. The researcher reported that 90% of all participants (i.e., both monolingual and bilingual children) produced the majority of consonants, with the exception of /b/, /s/, /r/, /r/, and /B/, which were found to be developed after age 5.

Jiménez (1987) investigated the consonant productions of 120 Spanish-speaking children of Mexican descent in California. All children were equally distributed in age from 3:0 to 5:7 (i.e., 67 boys and 53 girls). Eighteen consonants of Spanish were examined in initial, medial or final positions of 38 words. Stimuli consisted of line drawings. Dialectal variations of Mexican Spanish (e.g., /h/ substituted for /x/) were scored correct in the investigation. Interestingly, the researcher reported that “if no appropriate response was obtained using at least delayed imitation, the item was omitted,” indicating that direct imitation was not used (p. 359). From the data, the investigator concluded that half of the consonants were acquired (i.e., 90% criterion) by 4 years of age (i.e., /p, b, t, k, j, w, m, n, l/). These results are very similar to the productions of English-speaking children (e.g., Sander, 1972; Templin, 1957; Wellman, Case, Mengert, & Bradbury, 1931). All consonant sounds except /t, l, j/ were found to be acquired by 4 years of age in the studies of English-speaking children. Some differences in these studies (e.g., the medial /t/ sound; Templin, 1957), however, may account for the differences found between English and Spanish.

Jiménez (1987) also concluded that only two consonants did not reach 90% criterion among participants by age 5 (i.e., /s, r/). These results also were found in the aforementioned studies of English-speaking children as a whole. It would have been interesting to see the results if Jiménez had extended her study to include older children. Interestingly, in another finding from the study, the researcher indicated that a *reversal* (Prather et al., 1975) occurred with the /x/ sound, which is when a criterion of 75% is achieved for a given phoneme at a particular age level but drops below the 75% mark at a later age. The researcher concluded that the reversal is indicative of a sound that is “not

yet stable” (p. 359). No information, however, is given regarding the actual productions for /x/ by the children. It is assumed, therefore, that all dialectal variations were accounted for. Furthermore, allophones of Spanish were not examined in this study.

The findings from the studies of speech-sounds mentioned above improved the understanding of sound acquisition in Spanish-speaking children at a time when little was known in the area. Subsequent investigations of speech-sounds included a look at phonological patterns. Jiménez (1987) acknowledged how an added look at phonological patterns further enhances the knowledge base.

Phonological Patterns in Predominantly Spanish-Speaking Children

Analysis and intervention of simplified/disordered phonological patterns in children has been described as the most effective method for improving the speech of highly unintelligible children (e.g., Hodson, 2007; Hodson & Paden, 1991). Due to several phonological deviations that are characteristic of this population, however, Speech-language practitioners must prioritize several phonological patterns for treatment (Klein & Flint, 2006). Clinicians often have to rely on intuition when determining which rules (e.g., final consonant deletion) are most damaging to intelligibility (Klein, 1996). Although much has been studied related to the phonological patterns of English-speaking children, a paucity of investigations exists regarding the phonological patterns of typically developing Spanish-speaking children.

Researchers also have studied phonological patterns of typically developing Spanish-speaking children. Many examiners (e.g., Becker, 1982; Diamond, 1983; Mann, Kayser, Watson, & Hodson, 1992), for example, have reported that commonly occurring

patterns among typically developing children are consonant sequence reduction, stridency deletion, and deviations of liquids (i.e., tap /r/ and trill /r/). Other researchers (e.g., Goldstein, 1996a), however, have concluded that only certain processes (e.g., cluster reduction) are exhibited among typically developing children. The discrepancies that are evidenced among studies of typically developing Spanish-speaking children can be attributed to differences between research methodologies (i.e., targeted phonological processes, age groups, assessments) as well as the aforementioned dialectal differences between dialects of Spanish (e.g., Mexican and Puerto Rican). In an attempt to accurately highlight what is known from studies of phonological patterns of Spanish-speaking children, a more thorough analysis of research investigations of Spanish-speaking children within the ages of acquisition of phonological inventories and patterns is necessary.

Many studies have focused on the phonological patterns of typically developing Spanish-speaking children or a combination of both the sound development and phonological patterns. Gonzáles (1981), for example, was one of the first researchers to report data that included a look at both phonological inventories and processes of Spanish-speaking children. In her study, 150 preschoolers of Puerto Rican descent served as participants in three age groups (i.e., 50 children in each group; 2:6-3:0, 3:6-4:0, 4:6-5:0). The children in the study were selected randomly from daycare centers, nursery schools and preschools in Ponce, Puerto Rico.

Gonzáles (1981) used a total of 109 word stimuli in imitation and sentence recall tasks. A C-CV structure was followed to elicit a single phoneme production in the medial position. If the phoneme /p/ was targeted, for example, researchers might use the word

“campo” not taking into account the fact that the word elicits a /mp/ consonant sequence instead of an isolated /p/ phoneme. Each phoneme and phoneme combination was tested in initial and medial positions. Only three phonemes were tested in final position, /n, l, r/. The researcher did not consider the deletion of /s/ at the end of syllables an incorrect articulation, due to the fact that it is a common dialectal feature of Puerto Rican Spanish. Substitution of /l/ for tapped /r/ was marked correct only in syllable final position. Mastery of phonemes was defined as 90% or more correct phoneme articulation by 75% or more of the children within an age group. The researcher concluded that there was evidence for a hierarchical order of phonological development similar to English-speaking children. She concluded that by the age of 4 years, all phonemes of Puerto Rican Spanish were found to be used customarily.

In the determination of typical phonological patterns among participants, Gonzáles (1981) outlined three parameters for consideration:

- (1) the number of children who exhibited the process at least once by either delayed imitation or sentence recall;
- (2) the number of children who exhibited each process more than 50% of the time for responses elicited by delayed imitation and sentence recall; and
- (3) the percentage of occurrence of each process within an age group for all responses elicited by each child. (p. 50)

From these parameters, the investigator arrived at several conclusions. She reported, for example, that the use of epenthesis in clusters by speakers of Spanish was found (uncommon in English) along with deletion of final consonants (i.e., final /l/ was the most commonly deleted final consonant). The majority of children who were ages 2:6 to 3:0 were found to delete final consonants. Of the children who were ages 3:6 to 4:0, only

half (24) deleted final consonants at least one time and only 15 of these children deleted consonants 50% of the time. Thirty-six children from the third group, on the other hand, deleted final consonants at least once, and all of these did so more than 50% of the time. It is important to note, however, that final consonant deletion also was measured at the ends of syllables. The investigator, therefore, counted a final /m/ in the word /*comprɑ*/ even though the phoneme is a consonant sequence with /p/ and /r/. This may explain why the older children of the study evidenced more final consonant deletion than the second group of children in the 3:6-4:0 age range. It has been established, for example, that consonant clusters are perfected in later development as children commonly substitute for previously missing elements until the word is produced correctly (McLeod, van Doorn, & Reed, 2001). Furthermore, all observed “true” final consonants appeared in weak syllables of words. Weak syllables already have been established as normal processes for children in the 4:0-5:0 range (as well as many adults) and should not be classified as a disorder (Hodson, 2007). The only listed examples of final consonants that did not appear in weak syllable position were those that appeared in consonant sequences with other phonemes (i.e, contiguous consonants; e.g., the /m/ in the word *bombas*).

The most widely used phonological deviations in the investigation were cluster reduction of consonants /l, n, m, r/. In most cases, patterns of cluster reduction emerge in children, with anticipated patterns (e.g., Hodson, 2007, Ingram, 1976). The stop + /r/ clusters were the most commonly reduced by all children in the study. For children in group 1 (2:6-3:0; 20 children) and group 3 (4:6-5:0; seven children), the subsequent frequent pattern was the fricative + /r/ patterns. For children in group 2 (3:6-4:0), the subsequent frequent pattern was the stop + /l/ combination (29 children), followed by the

fricative + /r/ pattern (12 children). Gonzáles also found substitution patterns to exist among the children in her study. In testing stopping of fricatives, the researcher only considered two fricatives (i.e., /s/ and /f/). Groups one and two (2:6–3:0; 3:6–4:0) were the only groups where children substituted a stop for a fricative (e.g., /d/ for /s/). None of the children in group 3 (4:6–5:0) stopped fricatives. As described by the investigator, the children from all three age groups were found to do what was described as “fronting alveolars,” with almost half of each group fronting alveolars at least 50% of the time.

One of the concerns with the aforementioned data by Gonzáles (1981) is that the researcher did not determine a total number of errors for each category per child. Instead, the investigator counted the total number of errors across potential patterns. With fronting of alveolars, for example, the investigator reported that 65 children from group one fronted an alveolar at least one time, even though there are only 50 children in each group. Other pertinent data worth mentioning from Gonzáles (1981) include the observed patterns of labial assimilation (i.e., in both clusters and non-clusters) and alveolar assimilation. Both groups 1 and 2 (2:6–3:0; 3:6–4:0) evidenced labial assimilation for almost half of all participants, indicating the children did this at least once. Alveolar assimilation was found only with the children between the ages of 2:6 and 3:0. Gonzáles also found cluster reduction and fronting of alveolars to be the patterns most observed among all children (i.e., up to age 5:0). This study of phonological patterns has been discussed thoroughly to point out the challenges that are faced with classifying sounds and analyzing the data, especially when consonant sequences are not accounted for.

Other important findings regarding phonological patterns of typically developing Spanish-speaking children were reported in master’s theses from the 80s and 90s. It is

important to mention that the researchers of these unpublished studies did, in fact, consider consonant sequences via unpublished versions of the Assessment of Phonological Processes-Spanish (APP-S; Hodson, 1986b). Becker (1982) examined the phonological deviations of 20 4-year-old monolingual Spanish-speaking children in Baja California, Mexico. The researcher found that the most frequently occurring pattern in her participants was consonant sequence reduction. The researcher also found that participants of this study evidenced deviations which included tap/trill /r/, deaffrication, and tongue protrusion. In a study by Martínez (1986), the productions of 10 typically developing 3-year-old children from Mexican descent were analyzed. The tap/trill /r/ deficiency was the most frequently occurring phonological deviation, followed by consonant sequence reduction. From this study, the investigator concluded that although the tap/trill /r/ is not fully acquired by age 3, it is emerging at this age.

Anderson and Smith (1987) provided additional data regarding productions of six monolingual Spanish-speaking children of Puerto Rican descent. The children ranged in age from 2:4 to 2:10. Taking a different perspective from previous researchers, Anderson and Smith assessed children's productions by spontaneous verbal interactions. From this analysis, the only phonological deviation found to occur in more than 50% (of the possible occurrences) was cluster reduction. Other phonological deviations that occurred (i.e., less than 50% of the time) were initial, medial, and final consonant deletion, unstressed syllable deletion, and *glottalization of alveolars* (i.e., stops). In an examination of slightly older children from Puerto Rican descent, Stepanof (1990) studied phonological patterns in 20 3- and 4-year-old children. The investigator reported that the phonological deviation of tap/trill /r/ occurred in over 50% of the possible occurrences.

Stridency deletion and postvocalic singleton omission occurred in 25-50% of the possible occurrences for participants in the study.

Goldstein and Iglesias (1996a) reported a study that was originally completed as part of the first author's MA thesis (Goldstein, 1988). In it, they studied 54 typically developing Spanish-speaking children enrolled in a bilingual Spanish-English Head Start program in Philadelphia, Pennsylvania. According to school records, all children were of Puerto Rican descent and spoke the Puerto Rican dialect of Spanish in the home. The productions of each child were analyzed using the Assessment of Phonological Disabilities (Iglesias, 1978). Mean percentages, standard deviations, and ranges were reported for the following phonological processes: cluster reduction, final consonant deletion, liquid simplification, weak syllable deletion, assimilation, velar fronting, stopping, palatal fronting, initial consonant deletion, and non-targeted errors (i.e., errors not categorized by the nine targeted processes; e.g., backing, deaffrication, and addition). The investigators found that cluster reduction was the most commonly occurring process overall (i.e., 15.2% occurrence in the 3-year-old age group). According to the investigators' classifications, the following four types of consonant cluster errors were observed: deletion of liquids (e.g., /plato/ *plate* pronounced /pato/; 75% of total), epenthesis (e.g., /plato/ pronounced /pɤlato/; 7.5% of total), deletion of stop member of the cluster (e.g., /plato/ pronounced /lato/; 2.5%) and substitution of /l/ for /r/ (e.g., /tren/ pronounced /tlen/). It is important to note, however, that epenthesis is often classified under syllable-structure/context-related changes, rather than as cluster reduction (Hodson, 2007).

The findings by Goldstein and Iglesias (1996a) are similar (to some degree) to previous studies of typically developing Spanish-speaking children (e.g., Anderson & Smith, 1987; Gonzáles, 1981; Mann et al., 1992; Stepanof, 1990). Researchers for all studies, for example, did report that cluster reduction and liquid simplification were the two most commonly occurring phonological processes. There are, however, some differences between studies worth mentioning. Goldstein and Iglesias (1996a), for example, reported percentage-of-occurrence values of final consonant deletion and initial consonant deletion that were different from other studies. This may be due primarily to the classification of phonological patterns among researchers. Goldstein and Iglesias (1996a) used the Assessment of Phonological Disabilities (Iglesias, 1978), whereas Mann et al. (1992) and Stepanof (1990) used the Assessment of Phonological Processes-Spanish (Hodson, 1986) to assess participants. The differences in classification of phonological processes across research studies make it difficult to accurately compare normative data of Spanish-speaking children. Goldstein and Iglesias (1996a), for example, did not consider consonant sequences (i.e., sequences of contiguous consonants beyond syllable boundaries; Hodson, 2007). Analysis of consonant sequences is critical, especially in the assessment of children with multiple phonological deviations. Hodson and Paden (1981) reported that consonant sequence/cluster reduction is an extremely common phonological deviation among children with highly unintelligible speech.

Studies of Monolingual Intelligible versus Unintelligible Spanish-Speaking Children

Spanish-speaking children with phonological disorders have been found to evidence some similar phonological patterns as typically developing Spanish-speaking children (i.e., cluster reduction, liquid simplification, stopping; Goldstein & Iglesias, 1996b). These researchers, along with others (e.g., Meza, 1983), also have found that children with phonological disorders evidenced initial consonant deletion (e.g., /sopa/ pronounced [opa]), weak syllable deletion (e.g., /elefante/ pronounced [fante]) and velar fronting (e.g., /boka/ pronounced [bota]).

Albarrán-Frías (1996) examined the phonological deviations of 20 typically developing Spanish-speaking preschoolers and compared them with three Spanish-speaking preschoolers with unintelligible speech. All participants resided in the Mexico City area and were monolingual speakers of Spanish. Phonological deviations were assessed via the APP-S (Hodson, 1986b). Typically developing 4-year-olds were found to have fewer phonological deviations than the 3-year-olds. Three-year-olds produced more consonant sequence reductions and deficiencies of stridents, lateral /l/, and tap/trill /r/. Significant differences were reported between the 4-year-old typically developing male participants and three male children with unintelligible speech. The children with phonological disorders had occurrences of consonant sequence reduction, postvocalic singleton omissions, and deviations involving stridents and tap-trill /r/.

Additional data regarding the phonological productions of Spanish-speaking children with phonological disorders were reported in unpublished research papers. González-Bettenhauser-Weeks (1984) examined the phonological deviations of 5 bilingual children (5:0-7:8) who were described as “experiencing multiple

misarticulations” (p. 12). Earlier versions of the HAPP-3 and the APP-S (Hodson, 2004; 1986) were used to evaluate phonological productions in both languages. The examiner reported that the bilingual children in the study demonstrated similar phonological deviations in both English and Spanish. Only one participant was reported to have different severity levels for each language.

Villanueva (1990) investigated phonological deviations in five Puerto Rican Spanish-speaking children who had phonological disorders. The APP-S was used to determine phonological deviations of participants. The examiner reported that omissions of postvocalic singletons and deficiencies of stridents and tap/trill /ɾ/ phonemes were produced by the children.

Further research comparing Spanish-speaking children who are typically developing and who have intelligibility difficulties is still needed. Studies with larger sample sizes would more accurately define specific phonological patterns/deviations of typically developing Spanish-speaking children and children with phonological disorders. In addition, an analysis of phonological patterns/deviations of bilingual (Spanish-English) children is needed.

Comparison Studies of Bilingual and Monolingual Children

Aside from the monolingual normative studies conducted in the 80s, there is a paucity of studies that examine large numbers of monolingual and bilingual children. Methodological differences between the studies are considerable. These differences include criteria for mastery, characteristics of the samples used, and sound positions that were evaluated (e.g., Gonzáles, 1981; Goldstein, 2004b). In addition, dialectal differences

must be considered, due to the difficulty of generalizing findings from one dialect to another (Goldstein, 1996a).

The majority of studies are unpublished Master's theses (e.g., Gonzáles, 1981). Although this is essentially not an issue in relation to the design of the research, it certainly establishes the argument that a limited amount of current published research exists on the phonological development of Spanish-speaking children. This is especially true for bilingual children. Part of the challenge stems from the complexities that surround research of bilingual individuals. Determining the actual level of bilingualism, for example, is difficult. Many researchers, for example, rely on school records rather than performing a language assessment; which may result in inaccurate data (e.g., Fabiano & Goldstein, 2005).

In two unpublished Master's theses, Diamond (1983) and Becker (1982) collectively examined the phonological deviations of 40 typically developing Spanish-speaking 4-year-olds. Diamond studied the phonological deviations of 20 bilingual Spanish-speaking children of Mexican descent in San Diego, California, whereas Becker investigated the phonological deviations of 20 monolingual Spanish-speaking children in Baja California, Mexico. A comparison of both studies revealed that phonological patterns of both the monolingual and bilingual participants were comparable. The tap/trill /r/ evidenced the highest percentage-of-occurrence.

Limitations of studies in bilingual children exist (for review, see Goldstein, Fabiano, & Washington, 2005). Some studies, for example, only examine the English skills of Spanish-English bilingual children (e.g., Gildersleeve-Neumann, & Davis, 1998). Gildersleeve-Neumann, Kester, Davis, and Peña (2008) collected single-word

English speech samples from 33 children that made up three groups (monolingual English children, English-Spanish bilingual children who were predominantly exposed to English, and English-Spanish bilingual children with relatively equal exposure to English and Spanish). All participants were evaluated at two different intervals for change over time. The investigators found that children demonstrated similar phonetic inventories. Monolingual English-speaking children averaged fewer errors than bilingual children who were predominantly exposed to English. Bilingual children with relatively equal exposure to both languages averaged more errors than both groups in English. Spanish productions were not assessed in this study.

Other investigations have relied on previous norms (from other studies) to compare potential language differences. Goldstein and Washington (2001) examined phonological patterns in 12 typically developing 4-year-old Spanish-English bilingual children. The researchers reported that no significant differences were found between the two languages on percentage of consonants correct, percentage of consonants correct for voicing, place of articulation, manner of articulation, or percentage of occurrence of phonological processes. Researchers also concluded that frequency and types of errors were similar between bilingual (Spanish-English) children and monolingual Spanish-speaking children (with the exception of the flap/trill /r/). Although these results were found among monolingual and bilingual speakers, monolingual data were used retrospectively from other studies to compare with bilingual children (e.g., Goldstein & Iglesias, 1996a). Differences in administration of testing procedures (e.g., word identification), therefore, may have impacted the findings that Goldstein and Washington reported in their study.

In an attempt to compare data from bilingual (Spanish-English) and monolingual children and not rely on retrospective comparisons, Goldstein, Fabiano, and Washington (2005) examined 15 Spanish-speaking children. The investigators explained that the purpose of the study was to examine the relationship between the amounts of output (i.e., percentage of time each language was spoken) in each language and the phonological skills between children of varying degrees of mastery of Spanish and/or English. Fifteen children participated in the study and comprised three groups: (1) five predominantly English-Speaking, (2) five predominantly Spanish-speaking, and (3) five speakers of bilingual English-Spanish. The researchers found that there was no significant correlation between the amount of output in each language and phonological skills among all three groups. It is important to point out, however, that Goldstein et al. (2005) used a small sample size. In addition, the investigators only studied children between the ages of 5:0 and 5:5. More data are needed to determine how children in different age groups compare.

Other studies also have been conducted where investigators examined small numbers of children; often three or fewer participants (e.g., Fabiano & Goldstein, 2005; Walters, 2000). Although case studies offer valuable information to some degree, more normative data from larger studies is needed. In addition, studies that control for research methodologies, phonological patterns tested, and language differences (e.g., bilingual versus monolingual) are needed. Despite the observed limitations of studies on Spanish-speaking children, researchers frequently cite these investigations due to a lack of current data.

Spanish Phonological Assessment Tools

Diagnostic tools are essential to the analysis of phonological deviations. In order to make this critical diagnostic decision, practitioners require access to protocols that effectively distinguish typically developing children from children with phonological deviations (e.g., omissions). Articulation and phonological assessments are sometimes used interchangeably to identify children with potential disorders in these areas. If it is determined that an English-speaking child is in need of further speech-sound assessment, practitioners can choose from a number of current, updated and revised assessments (e.g., Fudala & Reynolds, 2001; Goldman & Fristoe, 2000; Hodson, 2004; Kahn, & Lewis, 2002; Lippke, Dickey, Selmar, & Soder, 1997; Secord, 1999).

If a language assessment indicates that a child has a Spanish dominance, there currently are a limited number of assessments available for the diagnosis of speech sound disorders in Spanish-Speaking children. All Spanish tools except two are outdated by a minimum of 20 years. Currently, there are a few articulation tests that are available to assess Spanish-speaking children (e.g., Mason, Smith, & Hinshaw, 1976; Carrow, 1974; Tsugawa, 2004), including one screening tool for articulation (Zimmerman, Steiner, Evatt Pond, 2002). Spanish tests that focus on articulation only present target sounds once throughout the test, and SLPs mark whether the child produces the sound correctly or not (Carrow, 1974; Mason, Smith, & Hinshaw, 1976; Melgar de González, 1980).

There are limitations to articulation tests. Phonemes, for example, are assessed in a single word, with no opportunities to consider it in other words. Children may not be familiar with a word that is used in a particular test or may not recognize the object or picture form of the word (Langdon, 1992). This especially is true when word differences

from various dialects of Spanish are considered. Moreover, phonological analysis already has been regarded as a more valid measure of intelligibility (Gordon-Brannan & Hodson, 2000; Hodson, 2007; Kent et al., 1994). Tests of phonological patterns, therefore, are more appropriate than test of articulation in the determination of a child's intelligibility.

Very few tests of phonological patterns exist that assess Spanish-speaking children who may have expressive phonological impairment (i.e., Hodson, 1986b, 2008; Iglesias, 1978; Goldstein & Iglesias, 1996a; Goldstein & Iglesias, 2006; Mattes, 1987). In tests of phonological patterns, error patterns are featured rather than single errors in phonemes, allowing the child multiple opportunities to produce the target patterns. For purposes of a full phonological assessment of Spanish-speaking children, these tests offer a more complete and comprehensive identification of patterns, facilitating remediation and helping to determine the most stimulable patterns; which is critical to treatment (Hodson, 1986; Hodson, 2004).

The *Assessment of Phonological Disabilities* (Iglesias, 1978) is an unpublished assessment that contains 79 single-word items. Words contain a CVCV structure in most cases, and certain words are classified as *clusters* (e.g., *tren*; “train”), whereas others are categorized as multisyllabic (e.g., *cuchara*; “spoon”). According to Goldstein and Iglesias (1996a), stimulus items are attempted to be elicited first via spontaneous production, followed by delayed (i.e., description of object), and then imitated means, if necessary. The targeted patterns, as described by Goldstein and Iglesias (1996a), include “final consonant deletion (12 possible occurrences), velar fronting (33), stopping (64), palatal fronting (15), liquid simplification (39), assimilation, weak syllable deletion (74), cluster reduction (29), and initial consonant deletion (76)” (pg. 85).

In the *Assessment of Phonological Processes-Spanish* (Hodson, 1986b), 40 single words are used to assess 10 phonological patterns (e.g., consonant omissions, syllable reduction, and strident, labial, velar, glide and nasal deficiencies). Multiple opportunities are given for production of phonemes (at least 10 opportunities per each deviation assessed). Practitioners can identify broad error patterns in highly unintelligible utterances of Spanish-speaking children. The *Assessment of Phonological Patterns in Spanish – 2nd edition* (Hodson, 2008) is an unpublished test that is a revised version of the APP-S (Hodson, 1986b). The APPS-2 contains 44 target words that have been updated from the previous version. Stimuli that have been tested and found to be produced spontaneously by Spanish-speaking children were included (Prezas & Hodson, 2006, 2007). In addition, the APPS-2 allows for multiple opportunities for production of particular phonemes and differentiates phonological deviations (e.g., omissions, substitutions).

The *Spanish Articulation Measures* (Mattes, 1987) is a test that contains seven basic patterns (e.g., initial consonant deletion, final consonant deletion) as well as connected speech. The test by Mattes only evaluates seven basic patterns, whereas the APPS-2 incorporates 10 phonological patterns, including syllable and consonant sequence reductions, pre and post-vocalic singleton consonant omissions, and strident, velar, lateral /l/, tap/trilled /r/, glide and nasal deficiencies.

The *Contextual Probes of Articulation Competence Spanish* (CPAC-S, Goldstein & Iglesias, 2006) measures both articulation and phonological productions. Similar to other assessments of phonological patterns (e.g., Hodson, 2008) the CPAC-S requires that the practitioner analyze the data with consideration of dialect. The assessment

includes an evaluation of eight *common patterns* (i.e., cluster reduction, liquid simplification, stopping, velar fronting, initial consonant deletion, weak syllable deletion, assimilation, final consonant deletion, and palatal fronting). It is important, however, to point out that the test does have limitations. Consonant sequences, for example, are not considered in the scoring of children's potential error patterns. Researchers already have documented the critical nature of including consonant sequence patterns (e.g., Hodson, 2007). Furthermore, the test relies primarily on normative data originally published from the first author's master's thesis (Goldstein, 1988; Goldstein & Iglesias, 1996a). Without sufficient and accurate assessments that rely on adequate and complete normative data, Spanish-speaking children may be over or under identified for special education instructional services.

Language Related Factors That May Influence Intelligibility

Vocabulary

Researchers have noted that assessment of English vocabulary development only for bilingual (Spanish-English) children is problematic (e.g., Peña, Bedore, & Rappazzo, 2003). Assessment in only one language does not give an accurate picture of the child's vocabulary development. This is especially true when the language tested is the child's second language. It has been determined, for example, that children from bilingual backgrounds have a tendency to score lower on English vocabulary assessments than monolingual English speakers (Peña & Quinn, 1997; Valdez & Figueroa, 1993).

In an investigation of narrative and vocabulary development of bilingual children, Uccelli and Páez (2007) examined 24 bilingual children in both languages using a

narrative task as well as an English and Spanish expressive language task. Assessment measures were assessed across two grade levels (i.e., kindergarten, first grade). Significant gains were realized for all English expressive language measures. Bilingual children did, however, continue to score below monolingual English children in first grade. Interestingly, kindergarten Spanish vocabulary scores predicted first-grade English narrative quality. First-grade Spanish narrative quality also was best predicted by Spanish vocabulary.

Studies of bilingual vocabulary have primarily focused on expressive measures (e.g., Uccelli & Páez, 2007). Investigations of receptive vocabulary have focused primarily on the acquisition and transfer of vocabulary from the native language to the second language (e.g., Perozzi, 1985). Currently, there also are a limited number of assessments of Spanish vocabulary development. Many of these assessments, such as the Test de Vocabulario en Imágenes Peabody (Dunn, Lugo, Padilla, & Dunn, 1986), have normative data based on monolingual Spanish-speaking children. It has been noted, however, that children in the US (who are predominantly bilingual Spanish-English speakers) do not score as high on these tests as those children for which it was designed for (Peña, Bedore, & Rappazzo, 2003).

The Receptive One-Word Picture Vocabulary Test, Spanish-Bilingual Edition (ROWPVT-SBE; Brownell, 2000), on the other hand, contains normative data from bilingual children in the US. In addition, the testing battery was designed to allow for dual responses in both languages. If a child, for example, incorrectly responds to a question in Spanish, the clinician re-administers the same question in the other language. A record of preferred language per question is kept by placing a slash mark over the

language from which a correct response was received. Analysis of the ROWPVT-SBE yields a total receptive vocabulary score for both languages.

Rate of Speech

Rate of speech analysis often has been used in studies of intelligibility. Investigators, for example, have used rate analysis in the study of patients with dysarthria (e.g., Yorkston & Beukelman, 1981) and in studies of populations who stutter (e.g., Vanryckeghem, Glessing, Brutten, & McAlindon, 1999). Researchers also have examined rate of narrative speaking in older children. Sturm and Seery (2007) investigated speech and articulatory rates of 36 typically developing 7-, 9-, and 11-year-olds. Words per minute, syllables per minute, and syllables per second were used as measures. The results revealed that speaking rates increased with age between ages 7 and 9, but that rates were not significantly different between ages 9 and 11. In addition, the investigators found that conversational and narrative speech rates were not significantly different when measured with words per minute and syllables per second.

Investigations of rate of speech in preschool children's speech samples are sparse. Walker, Archibald, Cherniak, and Fish (1992) measured articulation rate in both spontaneous and imitated speech samples. Twenty 3-year-olds and 20 5-year-olds participated in the study. From the results, the researchers concluded that the articulation rate of 5-year-olds was significantly faster than that of the 3-year-olds. Imitated speech was found to be significantly slower and less variable than spontaneous speech. In addition, syllables per second and phones per second were found to be highly correlated.

Walker et al. (1992) also investigated whether there was a relationship between articulation rate and length of utterance. Mean length of utterance (MLU) has been widely used as a benchmark for linguistic maturation (e.g., Bennett-Kastor, 1988). The researchers compared syllables and phones per second with MLU across age groups and linguistic context (i.e., spontaneous and imitated speech). The investigators found that a significant correlation existed between articulation rate (in syllables or phones per second) and length of utterance in the spontaneous speech context.

Whereas MLU has been investigated in monolingual Spanish-speaking children (e.g., Bedore & Leonard, 2001; Kvaal, Shipstead-Cox, Nevitt, Hodson, & Launer, 1988), MLU and rate of bilingual children's intelligibility and other variables that may predict intelligibility have not been studied in great detail. Although rate and MLU have been found to be highly correlated, the use of rate analysis is more applicable to the study of bilingual Spanish-English children, for many reasons. The Spanish language, for example, is more multisyllabic than English. In addition, some dialects of Spanish (e.g., Cuban, Puerto Rican) have instances where speakers may omit or inconsistently produce final consonants (Gutiérrez-Clellan, Restrepo, Bedore, Peña, & Anderson, 2000).

From what is known regarding the use of rate in intelligibility of older children in English (e.g., Sturm & Seery, 2007), further study to determine if rate predicts intelligibility of bilingual (Spanish-English) children is warranted. Comparisons between Spanish and English may reveal significant differences between languages. Moreover, an analysis of rate of speech and other factors (i.e., age, gender) is necessary.

Other Considerations That May Influence Intelligibility

Age

Historically, investigators have considered the age in an analysis of a child's intelligibility. Weiss (1982) reported normative data in relation to age and intelligibility. The investigator determined the following percentages based on a child's age: (1) 26-50% intelligible by 2:0, (2) 71-80% intelligible by 3:0, and (3) 100% intelligible by 4:0. In addition, Vihman (1993) reported similar findings with 10 3-year-old children. All participants in her study received intelligibility ratings above 50%.

Investigations of age in Spanish-speaking children primarily come from normative studies (e.g., Albarrán-Frías, 1996). While a majority of investigators have focused on specific ages of Spanish-speaking children (e.g., Anderson & Smith, 1987), other researchers (e.g., Albarrán-Frías, 1996) reported that differences between age groups exists. Albarrán-Frías, for example, found that typically developing 4-year-olds had fewer phonological deviations than 3-year-olds. Furthermore, three-year-olds evidenced more consonant sequence reductions and deficiencies of stridents, lateral /l/, and tap/trill /r/.

Other investigators have found that by the time Spanish-speaking children reach the age 3:5, they do not exhibit the majority of phonological error patterns (e.g., (Albarran-Frias, 1996; Goldstein & Iglesias, 1996a; Stepanof, 1990). Still, investigations of age differences among Spanish-speaking children with larger sample sizes are needed. Moreover, an analysis of how age may predict intelligibility of Spanish-speaking children is warranted, due to the relationships that have been found between age and phonological deviations.

Gender

In regards to gender differences, normative investigations of Spanish-speaking children have led to mixed results (e.g., Albarrán-Frías, 1996; Paulson, 1991). Some investigators (e.g., Martinez, 1986; Paulson, 1991), for example, reported that girls tended to use less phonological deviations than boys. This trend also has been reported by researchers of English phonological development (e.g., Roberts, Burchinal, & Footo, 1990). On the other hand, more investigators have reported that no significant differences exist between phonological patterns of Spanish-speaking boys and girls (Becker, 1982; Diamond, 1983; Mason, Smith, & Hinshaw, 1976) and in monolingual English-speaking children (e.g., Haelsig & Madison, 1986). Additional information is needed to determine if gender predicts intelligibility.

Summary and Research Questions

Although studies of English intelligibility in monolingual English-speaking preschool children exist (e.g., Gordon-Brannan & Hodson, 2000), there is a paucity of data related to bilingual Spanish-English children in both languages. Researchers of Spanish-speaking children have focused primarily in three main areas: (a) bilingual language acquisition (e.g., Kohnert & Bates, 2002; Paradis & Navarro, 2003) (b) speech-sound acquisition of singleton consonants (e.g., Linarez, 1981), and (c) developmental phonological patterns of monolingual Spanish-speaking children (e.g., Anderson & Smith, 1987), English productions of bilingual Spanish-English children (Gildersleeve-Neuman, Kester, Davis, & Peña, 2008), and bilingual Spanish-English children (Goldstein, Fabiano, & Washington, 2005). A limited amount of data exists regarding

how variables may predict intelligibility of bilingual Spanish-English children in both languages. Moreover, additional data are needed to examine if significant differences exist across languages, age, and gender.

The primary purpose of this investigation was to analyze information regarding bilingual Spanish- and English-speaking preschool children's performances in both the Spanish and English languages. A second purpose was to determine whether significant differences exist among Spanish and English performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) across languages, gender, and age groups. Research questions were as follows:

1. Which variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary) predict unfamiliar listeners' intelligibility ratings of both Spanish and English connected speech samples?
2. Are Spanish and English performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) significantly different across (a) languages, (b) age groups, and (c) gender?

CHAPTER III

METHOD

The purpose of this investigation was to determine which variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary), if any, significantly predict ratings of intelligibility of bilingual (Spanish-English) preschool children in both languages. A second purpose was to determine whether significant differences exist among Spanish and English performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) across languages, gender, and age groups. Information regarding participants, procedures, assessment tasks, and data collection are provided in this chapter.

Participants

The participants for this study were 60 bilingual (Spanish-English) preschool children of Mexican descent attending a Head Start program in the Wichita, Kansas area. Sixty-six children participated in preliminary assessment procedures. Four of these children moved out of the Head Start program prior to completion of data collection. One child did not want to continue after partial assessment. Another child was identified as being tri-lingual (English, Spanish, Laos) and was excluded from the study. Participants ranged in age from 4:0 (years:months) to 5:10.

For analysis purposes, the children were divided into two groupings by year (groupings in years:months: 4:0 – 4:11; 5:0 – 5:10). The chronological age mean for all participants was 4:11. Thirty of the 60 children included in the investigation were boys and 30 were girls. Table 3.1 provides information regarding age and gender. Criteria for participation in the study included: (a) no evidence of organic anomalies related to the

speech and hearing mechanisms, (b) passing a pure-tone hearing screening (i.e., 25 dB at 500, 1000, 2000, 4000 Hz), (c) no prior history of speech/language treatment services, and (d) Spanish being the primary language spoken in their home (according to school records and caregiver questionnaire reports).

Table 3.1 Numbers of Children in Each Group

Gender	4:0 – 4:11	5:0 – 5:10
Boys	16	14
Girls	14	16
TOTAL	30	30

Procedures

Preliminary

Initially, the investigator was invited to attend a parent meeting at each Head Start center. The meetings are typically held each month and are provided for Spanish- and English-speaking caregivers in both languages. At the meetings, caregivers were informed about the study and the importance of the study to the population. After the investigator attended the meetings, a parent letter was handed out (See Appendix A), and authorization was obtained from caregivers through a signed informed consent form (see Appendix B). The consent form provided information to the caregivers regarding the purposes of the study. In addition to the consent form, caregivers were asked to complete a survey (see Appendix C) in order to obtain information related to (a) linguistic exposure (i.e., language dominance in the home), (b) Spanish dialect (i.e., Mexican), (c) languages use by the child/family, and (d) additional background information about the child (e.g., number of siblings in the household).

After an initial meeting with the main director of Head Start in Wichita, directors from the four Head Start centers with large populations of bilingual (Spanish-English) children agreed to have the investigation conducted at their facilities. The investigator discussed the purpose of the study, the caregiver consent process, and the testing procedures with the directors. Bilingual staff in each center assisted with the consent form and survey collection process. Testing was completed during preschool hours.

All participants were tested individually in a quiet room at a Head Start center. Testing for each child took place over two or three days. Depending on the linguistic responses sought for each session, instruction in the appropriate language (Spanish or English) was given. Prior to the testing procedure, the examiner (a licensed bilingual speech-language pathologist) established language preference for each session with a short conversation (in the target language) with the child. A bilingual graduate student from the Department of Communication Sciences and Disorders at Wichita State University administered the receptive vocabulary test.

Data Collection

Two continuous-speech samples (i.e., Spanish, English) were obtained from all participants (see *Criterion Variables* for complete description). Data collection for phonological productions (i.e., phonological deviations) in both languages were recorded using the Assessment of Phonological Patterns in Spanish-Revised (APPS-2; Hodson, 2008) and the Hodson Assessment of Phonological Patterns – Third Edition (HAPP-3; Hodson, 2004). Data from the Receptive One-Word Picture Vocabulary Test, Spanish-Bilingual Edition (ROWPVT-SBE; Brownell, 2000) also were collected. Moreover,

calculations of rate for each child in both Spanish and English were derived from portions of the conversational samples.

All continuous-speech samples and word productions for phonological assessment (i.e., APPS-2; HAPP-3) were recorded using a Marantz (PMD 670) digital recorder and a SHURE microphone. The recording equipment was connected to a Sony VAIO laptop. All digital files for each participant were transferred from the digital recorder and stored onto the laptop computer for later playback and analysis. These data also were used for reliability measures.

Assessment Tasks

The assessment tasks for the criterion and predictor variables are described in this section. Each measure was administered according to instructions in the respective manuals, with the exception of the APPS-2 (which does not have a manual at this time, but follows similar guidelines to the HAPP-3). Administration, scoring, and reliability information are provided for each task. Table 3.2 provides an overview of the assessment tasks and what they measure.

Table 3.2 Summary of Assessment Tasks

Assessment	Description
• <i>ROWPVT-SBE</i>	Receptive vocabulary in Spanish and English
• <i>APPS-2</i>	Phonological productions/deviations in Spanish
• <i>HAPP-3</i>	Phonological productions/deviations in English
• Continuous-speech samples in Spanish and English	Child recalling a story with pictures
• Rate Analysis of speech in Spanish and English	Calculation of total number of syllables per second for 30-second conversation sample

Criterion Variables

Continuous-Speech Samples

Two 30-second continuous-speech samples from each participant (Spanish and English) were used to obtain speaker understandability ratings. Ratings of samples in Spanish and English served as criterion variables for each language.

Administration. In order to avoid possible cross-language responses, Spanish and English continuous-speech samples for each participant were obtained on two separate days. A narrative story and four corresponding pictures from the Evaluating Communicative Competence – Revised Edition (Simon, 1994) were used for this study. The narrative was translated into Spanish from a modified English version. The examiner presented each participant with the four pictures first (see Appendix D). The investigator then read the story (see Appendix E) to each child in the targeted language for the assessment date (i.e., either Spanish or English). After the story was read, the participants were asked to retell the story using the four pictures. Open-ended questions and requests (e.g., “What happened in this picture?”) along with gestures (i.e., pointing to specific points of interest in the pictures) were used to facilitate communication when a participant was reluctant to respond. Each child’s conversation samples were recorded on a Marantz (PMD 670) digital recorder and transferred to a Sony laptop. Thirty-second segments from each child’s samples were extracted using WavePad software. Each sample was converted into an mp3 file for later playback. These digital audio files were used to obtain speaker understandability ratings by unfamiliar listeners.

Listener Ratings

Two bilingual (Spanish-English) graduate students from the Department of Communication Sciences and Disorders at Wichita State University served as listeners. Both students passed a pure tone audiometric screening procedure (i.e., 20 dB at 500, 1000, 2000, 4000 Hz). The listeners were unfamiliar to the participants in the study. Both listeners rated the Spanish (N = 60) and English (N = 60) continuous-speech samples of each participant. Ten additional samples were used for intrajudge reliability.

Administration and Scoring. The procedures described in this section occurred for both sets of speech samples (i.e., 60 in Spanish and 60 in English, respectively). In order to determine order of presentation for each language set, the mp3 speech sample files were selected randomly and reorganized in a file on a Sony Laptop for playback. In addition, 10 of the 60 speech samples were selected randomly and repeated at the end of the 60 files. Each language presentation, therefore, included a total of 70 speech samples (i.e., 70, 30-second samples). The listeners were not told that they were rating 10 speakers a second time. These data were used for intra-judge reliability measures.

Two group rating sessions were conducted (i.e., one in English and one in Spanish). Each group rating session lasted approximately 90 minutes. Prior to listening to the continuous-speech samples, listeners were given instructions on how to rate samples (see Appendix F) and were familiarized with the context of the samples (i.e., four pictures and the story). In addition, listeners were trained to rate samples that were not part of the study. A 5-point Likert scale was used to rate speaker understandability of samples. The Likert scale was modeled from a 7-point Likert scale described by Gordon-Brannan and Hodson (2000). The 5-point scale was used to rate samples by unfamiliar

listeners and consisted of the following descriptors: 1 - “Extremely difficult to understand”; 2 - “Somewhat difficult to understand”; 3 - “Average understandability”; 4 - “Can generally be understood”; 5 - “Easy to understand.” Responses were recorded on separate rating forms (see Appendix G).

The Likert scale was chosen for several reasons. First, listener ratings can be used with continuous-speech samples. Moreover, listener ratings have been shown to correlate highly with the continuous-speech intelligibility percentage measures (Gordon-Brannan & Hodson, 2000), which are considered to be one of the better measurements of intelligibility (Kent, Miolo, & Bloedel, 1994; Kwiatkowski & Shriberg, 1992). Furthermore, the listener rating system takes considerably less time to complete than the percentage of words understood from a continuous-speech sample (Bacon, 1995).

Reliability. Intra-judge reliability (internal consistency) was obtained for each language by having both listeners rate 10 of the continuous-speech samples a second time and computing Chronbach’s coefficient alpha for each listener. In English, both raters received coefficient alphas of .944 and .934 with a median of .939. Ratings in Spanish were .802 and .892 with a median of .847.

Inter-judge reliability between the two bilingual listeners was determined using Chronbach’s coefficient alpha for each language (i.e., Spanish, English). For listener ratings of English, inter-judge reliability for both listeners was .88. Inter-judge reliability of listener ratings of Spanish was .77. Spanish language fluency and use differences between the two listeners may have accounted for the lower Spanish coefficient alpha between listeners.

Predictor Variables

Phonological Deviations

In order to assess Spanish phonological productions, the APPS-2 (Hodson, 2008) was administered to all participants. In addition, the English phonological productions of all children were assessed via the HAPP-3 (Hodson, 2004). The APPS-2 and HAPP-3 assessments were selected because they provide an extensive analysis of phonological deviations (i.e., differentiation of omissions and substitutions) and are similar in scoring procedures. Furthermore, both instruments were selected because they are similar in sound elicitation, procedures, and scoring.

Administration and Scoring. The APPS-2 and HAPP-3 were administered according to testing guidelines. The investigator (a licensed bilingual speech-language pathologist) administered the APPS-2 and HAPP-3 to all participants. Each participant's phonological productions for both assessments were transcribed by the investigator at the time of utterance. All utterances were recorded by a Marantz (PMD 670) digital recorder and converted to mp3 files for later transcription by a reliability assistant and for obtaining consensus between both transcribers. One graduate student from the Department of Communication Sciences and Disorders at Wichita State University skilled in phonetic transcription of both languages also independently transcribed all phonological productions for each child. Independent transcriptions were set aside (for reliability measurement) and consensus between both transcribers was reached for all productions. A Total Occurrences of Major Phonological Deviations score was derived for each child in both languages.

Reliability. Independent transcriptions of both the APPS-2 and HAPP-3 were compared and analyzed using a point-by-point agreement index. The reliability was assessed by computing:

$$\text{Point-by-point agreement index} = \frac{A}{A + D} \times 100 = \text{percentage of agreement}$$

Where (A) represents the number of measured points on which the reliability assistant and the investigator agreed and (D) the number of points on which they disagreed. The percentage of agreement value was 95%. The phonetic transcriptions of the two transcribers were generally in agreement.

Receptive Vocabulary

The Receptive One-Word Picture Vocabulary Test-Spanish Bilingual Edition (ROWPVT-SBE; Brownell, 2000) was administered as an overall measure of each participant's receptive vocabulary ability. The ROWPVT-SBE is an individually administered norm-referenced instrument that allows administration in either Spanish or English. This test was normed on bilingual children in the US. In addition, the assessment battery was designed to allow for dual responses in both languages.

Administration and scoring. The ROWPVT-SBE was administered according to the general testing guidelines described in the examiner's manual. Prior to testing, participants were given a series of questions in order to establish a "preferred" language for test purposes (i.e., Spanish or English). According to the test manual instructions, the examiner administered the test in the preferred or dominant language of the child.

Each child was instructed to look at four pictures in a quadrant format and point to the one named by the examiner. Following test guidelines, if a child incorrectly responded to a question in the preferred or dominant language, the test administrator re-administered the same question in the other language. A record of Spanish versus English responses per question was kept by placing a slash mark over the language from which a correct response was received. Analysis of the ROWPVT-SBE yields a total receptive vocabulary score for both languages.

Reliability. According to the manual, two types of reliability were computed for the ROWPVT-SBE (i.e., Cronbach's coefficient alpha, split-half reliability coefficient). Coefficient alpha and split-half reliability coefficients were computed by age group and ranged from .96 to .98 with a median of .97. Split-half coefficients ranged from .97 to .99 with a median of .98.

Rate of Speech

The rate of each continuous speech sample was computed using a syllable per second model. The syllable per second model was chosen, rather than a mean length of utterance approach, because Spanish is a more multisyllabic language than English. Measurements of syllables per second allow for a more appropriate comparison between Spanish and English. For this study, the syllable per second model was modified to a syllable per 30-second model. Rate of speech, therefore, was calculated by counting the total number of syllables per 30-second mp3 sample file.

Scoring and Reliability. The investigator and a graduate assistant independently calculated the total number of syllables per 30-second sample in both Spanish and

English. WavePad software was used in order to slow sample files down to 40% of the total speed. Each rater counted the total number of syllables per continuous speech sample. Each continuous speech sample was approximately 30-seconds (within a hundredth of a second). Inter-judge reliability between both scores was determined using Chronbach's coefficient alpha for each language (i.e., Spanish, English). For rate scores in English, inter-judge reliability between both scorers was .98. In Spanish, inter-judge reliability for rate scores was .99.

Gender and Age

All participants were grouped by gender and age. Ages of children were converted into exact months of age. Gender was coded as either 1 (male) or 2 (female). These data served as predictor variables for regression analyses.

Data Analysis

SPSS 16.0 was used for all statistical analyses. A multiple regression analysis was used to examine the variance of each of the following predictor variables for speaker intelligibility in English and Spanish: (a) age, (b) gender, (c) phonological deviations, (d) rate of speech, and (e) vocabulary. A 2 X 2 X 2 multivariate analysis of variance and follow-up univariate analyses were conducted to assess differences in language across age and gender.

CHAPTER IV

RESULTS

The purpose of this investigation was to determine which variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary), if any, significantly predict ratings of intelligibility of bilingual (Spanish-English) preschool children in both languages. A second purpose was to determine whether significant differences exist among Spanish and English performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) across languages, gender, and age groups. Descriptive statistics for performance variables are provided in Appendix H.

Predictor Variables and Intelligibility

The first research question was: Which variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary) predict unfamiliar listeners' intelligibility ratings of both Spanish and English conversational samples? A multiple regression analysis was used for both languages to determine which variables predicted ratings of intelligibility.

Predictor Variables for English

Two variables predicted intelligibility of English in the following order as a result of this regression model: (1) phonological deviations and (2) vocabulary. Phonological deviations entered first, accounting for 48% of the variance ($F = 54.49, p = .000$). Receptive vocabulary entered second, accounting for an additional 4% of the variance ($F = 4.75, p = .033$). Total prediction measures accounted for 52% of the variance of the criterion variable ratings of speaker intelligibility (see Table 4.1). Table 4.2 provides correlations and associated levels of significance for English.

Table 4.1 Regression Analysis Results for English Variables

Variable	R Square Change	B Weight	<i>F</i>	<i>p</i>
Phonological Deviations	.480	-.036	54.49	.000
Receptive Vocabulary	.040	.015	4.75	.033

Table 4.2 Correlation Matrix for English Variables

	1	2	3	4	5	6
1. Intelligibility Ratings	--	.308**	-.042	.387**	-.696**	.445**
2. Age		--	.091	.458**	-.275*	.113
3. Gender			--	-.100	-.004	.028
4. Vocabulary				--	-.281*	.082
5. Phonological Deviations					--	-.470**
6. Rate of Speech						--

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

Predictor Variables for Spanish

Two variables predicted Spanish intelligibility in the following order as a result of the regression model: (1) phonological deviations and (2) rate of speech. Phonological deviations entered first, accounting for 38% of the variance. Rate of speech entered second, accounting for an additional 10% of the variance. Total prediction measures accounted for 48% of the variance of the criterion variable ratings of speaker intelligibility (see Table 4.3). Table 4.4 provides correlations and associated levels of significance for Spanish.

Table 4.3 Regression Analysis Results for Spanish Variables

Variable	R Square Change	B Weight	<i>F</i>	<i>p</i>
Phonological Deviations	.380	-.026	35.60	.000
Rate	.103	.024	11.30	.001

Table 4.4 Correlation Matrix for Spanish Variables

	1	2	3	4	5	6
1. Intelligibility Ratings	--	.282*	.199	.329**	-.617**	.513**
2. Age		--	.091	.458**	-.253*	.331**
3. Gender			--	-.100	-.027	.093
4. Vocabulary				--	-.265*	.404**
5. Phonological Deviations					--	-.345**
6. Rate of Speech						--

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

Relationships of Variables in Spanish and English

The second research question was: Are Spanish and English performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) significantly different across (a) languages, (b) age groups, and (c) gender? Participants were divided into two age groupings (4:0 – 4:11; 5:0 – 5:10). A 2 (Language: English and Spanish) X 2 (Age: 4-year-olds vs. 5-year-olds) X 2 (Gender: boys vs. girls) X 6 multivariate analysis (MANOVA) was conducted. See Appendix I for details of the multivariate results.

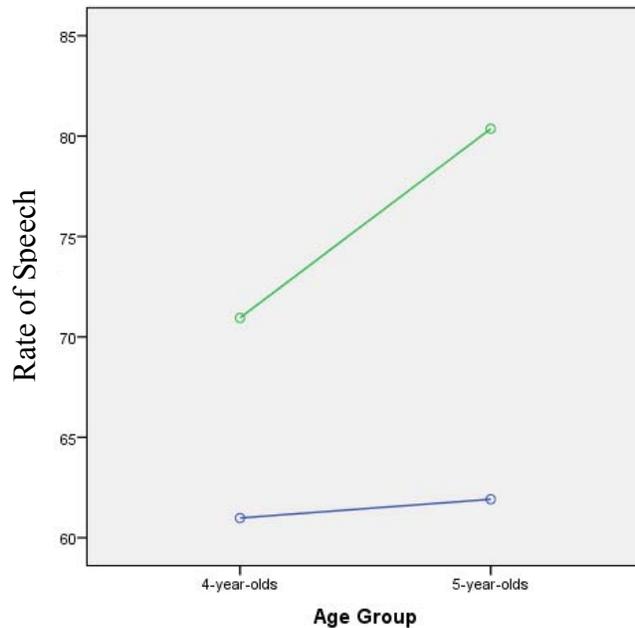
The multivariate test was significant for main effect of Language and the Language X Age interaction. A main effect of Age approached significance. In light of the sample size and exploratory nature of the study, follow-up univariate tests were conducted on the main effects of Language and Age, as well as the interaction between these variables.

Differences in ratings of intelligibility were examined. There was a significant main effect for Age Group. Intelligibility ratings for 5-year-olds were found to be significantly higher than for 4-year-olds ($F(1,58) = 7.94, p = .007, \text{partial } \eta^2 = .124$). There were no other significant effects for intelligibility ratings.

Phonological deviations in both languages also were analyzed across language, gender, and age. No significant differences between groups were found for phonological deviations.

Differences in rate of speech between languages, gender, and age groups were analyzed. There was a main effect for Language ($F(1,56) = 57.36, p = .000, \text{partial } \eta^2 = .506$). Children spoke significantly faster in Spanish. There also was a significant interaction effect of Language X Age: ($F(1,56) = 4.95, p = .030, \text{partial } \eta^2 = .081$). Post hoc analyses revealed that 5-year-old children had a significantly faster performance rate in Spanish than 4-year-olds ($t(52) = -2.53, p = .014$). Age differences for English, however, were not significant. Figure 4.1 provides a graphic display of Language X Age.

Figure 4.1 Rate of Speech Means for Language X Age Interaction*



*Languages are defined as: (1) = English and (2) = Spanish

Summary

Results of stepwise multiple regression analyses indicated that the variable accounting for the largest amount of variance for ratings of intelligibility in both languages was phonological deviations. Receptive vocabulary also predicted ratings of intelligibility for English; rate of speech also predicted Spanish ratings of intelligibility.

A 2 X 2 X 2 multivariate analysis of variance and follow-up univariate analyses were used to determine if differences on performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) were significant for language, age, and gender. Overall, children spoke faster in Spanish than in English. In addition, 5-year-olds spoke faster than 4-year-olds in Spanish, but not in English. Intelligibility ratings for 5-year-olds also were found to be significantly higher than for 4-year-olds. Differences were not found between boys and girls.

CHAPTER V

SUMMARY AND DISCUSSION

This chapter provides a summary and discussion of the findings for this investigation. Educational and research implications, which include limitations of the study and future research needs, are discussed as well.

Summary

The purpose of this investigation was to determine which variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary), if any, significantly predict ratings of intelligibility of bilingual (Spanish-English) preschool children in both languages. A second purpose was to determine whether significant differences exist among Spanish and English performance variables (i.e., intelligibility ratings, phonological deviations, rate of speech) across languages, gender, and age groups.

Data were collected from 60 bilingual (Spanish-English) preschool children of Mexican descent, ranging in age from 4:0 (years:months) to 5:10. Children were divided into two age groupings (groupings in years:months: 4:0 – 4:11; 5:0 – 5:10). The chronological age mean for all participants was 4:11. Thirty of the 60 children included in the investigation were boys and 30 were girls. All participants were tested individually in a quiet room at a Head Start center.

Data collection for phonological productions (i.e., phonological deviations) in both languages were recorded using the Assessment of Phonological Patterns in Spanish-2nd edition (APPS-2; Hodson, 2008) and the Hodson Assessment of Phonological Patterns – 3rd edition (HAPP-3; Hodson, 2004). Data from the Receptive One-Word

Picture Vocabulary Test, Spanish-Bilingual Edition (ROWPVT-SBE; Brownell, 2000) also were collected. Moreover, calculations of rate of speech (e.g., number of syllables per 30-second sample) for each child in both Spanish and English were derived from portions of the connected speech samples. Two continuous-speech samples (i.e., Spanish, English) were obtained from all participants. A 5-point Likert scale was used to rate speaker intelligibilities for the samples. Trained listeners, who were unfamiliar with the speakers but familiar with the story, rated the intelligibility of the children using a 5-point scale.

A multiple regression analysis was used to evaluate the criterion variable (ratings of intelligibility by unfamiliar listeners) and determine whether predictor variables (i.e., age, gender, phonological deviations, rate of speech, vocabulary) were significant. The variable accounting for the largest amount of variance for ratings of intelligibility in both languages was phonological deviations. Receptive vocabulary also had a small but significant variance for English; whereas rate of speech also predicted Spanish ratings of intelligibility.

A 2 X 2 X 2 multivariate analysis of variance was used to determine if differences were significant across language, age, and gender. Follow-up univariate analyses were conducted to examine performance variables (i.e., ratings of intelligibility, phonological deviations, rate of speech). Overall, the bilingual children in this study spoke faster in Spanish than in English. In addition, 5-year-olds spoke faster than 4-year-olds in Spanish, but not in English. Intelligibility ratings for 5-year-olds also were found to be significantly higher than for 4-year-olds. Differences were not found between boys and girls.

Discussion

Bilingual (Spanish-English) children often are over- or under-identified for speech-language services. In order to make decisions related to intelligibility, practitioners often rely on speech-sound acquisition norms of monolingual English and monolingual Spanish children separately. Although there have been large-scale investigations of typically developing monolingual English-speaking children's speech sounds/patterns (e.g., Prather, Hendrick, and Kern, 1975; Sander, 1972; Smit, Hand, Freilinger, Bernthal, & Bird, 1990; Templin, 1957), there are only a few published studies involving typically developing monolingual Spanish-speaking children (e.g., Anderson & Smith, 1987; Goldstein & Iglesias, 1996a; Goldstein & Iglesias, 1996b; Stepanof, 1990). Fewer published studies exist related to bilingual children (Goldstein, Fabiano, & Washington 2005; Goldstein & Washington, 2001). It also should be noted that the majority of published studies have involved children of Puerto Rican descent. Additional studies involving children of Mexican descent (the majority of the Spanish-speaking population of the United States; USCB, 2008) are greatly needed.

Investigations of variables that may be related to intelligibility of children are lacking. These data are critical, however, because children with speech-sound disorders comprise the largest number of individuals on caseloads of school-based practitioners (ASHA, 2004). Furthermore, less is known regarding intelligibility of bilingual children and relationships of predictors of intelligibility across languages, ages, and gender. Within the limits of the design and conduct of the investigation, it can be concluded that ratings of intelligibility in both languages for bilingual (Spanish-English) children are significantly determined by phonological deviations. Although significant differences

between languages were not found for gender, differences were found for age groups and rate of speech.

Ratings of Intelligibility

Using a 5-point Likert scale, trained unfamiliar listeners listened to 120 continuous-speech samples (60 English and 60 Spanish) and made judgments of intelligibility for 60 children in both languages. The ratings of intelligibility were used as the criterion variable for the regression analysis because Gordon-Brannan and Hodson (2000) found that listener ratings (which were scored via a 7-point Likert scale) received the highest relationship with percentage of words understood (a variable found to be highly correlated with intelligibility). This was an important finding, because listener ratings of intelligibility are not as time consuming as transcribing continuous-speech samples (Bacon, 1995).

In the current study, 5-year-old children were given higher scores of intelligibility than 4-year-old children as a whole. No significant differences were found for ratings of intelligibility across languages. Interestingly, unfamiliar listeners did not rate the intelligibility of bilingual participants significantly different across Spanish and English. Within the boundaries of the study, therefore, the rating of a participant's intelligibility in Spanish was not significantly different from his/her intelligibility rating in English.

Phonological Deviations

The scores used for phonological deviations reflect the Total Occurrences of Major Phonological Deviations (TOMPD) from assessment measures used in this study (Hodson, 2004; Hodson, 2008). Based on results from a multiple regression analysis, phonological deviations significantly predicted ratings of intelligibility in both languages. From these data, it can be concluded that bilingual children with more proficient phonological inventories received higher ratings of intelligibility by unfamiliar listeners than the children with less proficient phonological inventories in both languages. As expected, children who had fewer speech-sound errors were understood better by unfamiliar listeners than children with more speech-sound errors. These findings also were realized in monolingual English-speaking children by Gordon-Brannan and Hodson (2000).

Based on results of a multivariate analysis of variance, English and Spanish TOMPD scores for participants in this investigation were not found to be significantly different across languages. Although Goldstein, Fabiano, and Washington (2005) used a different measure to determine an overall phonological deviations score for participants in their study, similar findings were obtained. Based on these data, typically developing bilingual children are more likely to have TOMPD scores in both languages that approximate one another.

Studies of phonological patterns of bilingual (Spanish-English) children in both languages primarily have focused on differences between the two languages (i.e., Goldstein & Washington, 2001) and relationships between amount of output of each language and phonological deviations (Goldstein, Fabiano, & Washington, 2005).

Researchers have not reported data related to highest percentages of phonological deviations of bilingual children in both languages. Based on descriptive statistics of phonological deviation data for all participants of the study, the deviations that received the highest percentages of occurrence in English were liquids (24%), consonant sequences/clusters (22%), glides (17%), and stridents (12%). The consonant deviations that received the highest percentages of occurrence in Spanish were similar to English. These included liquids (27%), consonant sequences/clusters (20%), and glides (12%). The highest percentages of phonological deviations for both languages were liquids, consonant sequences/clusters, and glides (see Appendix H).

The findings of this study are comparable to other investigations of phonological patterns in bilingual children. Previous researchers who studied Spanish productions of monolingual Spanish-speaking children (e.g., Anderson & Smith, 1987; Goldstein & Iglesias, 1996a; Gonzáles, 1981; Mann et al., 1992; Stepanof, 1990) found that phonological deviations of consonant clusters and liquids occurred more frequently than other categories. Gildersleeve-Neumann, Kester, Davis, and Peña (2008) evaluated English productions of monolingual English, predominantly English, and bilingual Spanish-English children. The researchers reported that, overall, cluster reduction, cluster deletion, final consonant deletion, and glide deficiencies occurred more frequently in English. The investigators also found that bilingual groups (i.e., predominantly English and bilingual Spanish-English) showed higher error rates than English-only children overall. In the current study, predominantly Spanish-speaking children were found to not have significant differences in both languages. This was a similar finding in the results of Gildersleeve-Neumann et al.

Rate of Speech

In Spanish, rate was the second predictor variable behind Spanish TOMPD. A multivariate analysis of rate revealed that there was a significant difference between rate scores in Spanish and English. Children on average received higher rate scores in Spanish than in English. An interaction effect was found for rate scores in both languages by age groups. Further analysis revealed that 4- and 5-year-old children's rate scores in Spanish were significantly different. Rate scores of the 5-year-old children were significantly faster than 4-year-olds in Spanish. These results are similar to results found by Sturm and Seery (2007), where speaking rates increased in age between 7- and 9-year-old children.

Interestingly, rate scores in English for the bilingual children in this study were not significantly different between the two age groups. These findings suggest that increases to rate of speech in a bilingual child's second language takes longer to develop than increases to rate of speech in the dominant language. Kohnert and Bates (2002) described an acquisition period of 5 to 7 years for full development of a second language. Spanish-speaking children have more opportunities of experience in their native language. The results found with rate of speech suggest that with more experience and mastery of the second language, rate of speech will increase.

Vocabulary

In English, a stepwise multiple regression analysis revealed that vocabulary (i.e., bilingual measure of receptive vocabulary) emerged as a second predictor variable to ratings of intelligibility. In an investigation of vocabulary scores and narrative quality, Uccelli and Páez (2007) found that kindergarten Spanish vocabulary scores predicted

first-grade English narrative quality. Based on the results from Uccelli and Páez and the vocabulary findings from the current investigation, it is possible that vocabulary knowledge from the first language (e.g., Spanish) plays a role in development of vocabulary knowledge in the second language. Although specific factors related to language dominance and vocabulary knowledge in both languages were not in the scope of this investigation, it was found that children with higher vocabulary scores received higher ratings of intelligibility in English by unfamiliar listeners.

Age and Gender

Although significant age differences did occur across intelligibility ratings and rate variables, phonological deviations were not found to be significantly different across age groups (i.e., 4- and 5-year-olds). Significant differences between boys and girls across all performance measures also were not found in this study. The conclusion that phonological deviations are not significant for gender is consistent with previous data regarding typically developing children (e.g., Becker, 1982; Diamond, 1983; Mason, Smith, & Hinshaw, 1976).

Implications

Clinical

This investigation yielded important information related to intelligibility of bilingual Spanish-English children in both languages. Phonological deviations emerged as the most significant predictor of ratings of intelligibility in both languages. Clinically, a phonological assessment often is used to diagnose children who have highly

unintelligible speech (Hodson, 2007; Prezas & Hodson, 2007). Based on the results from this study, however, typically developing children did not receive significantly different TOMPD scores in English and Spanish. From a clinical perspective, this information suggests that a typically developing bilingual child who receives a TOMPD score in one language is likely to receive a comparable TOMPD score in the other language.

Based on data from this investigation related to phonological deviations of typically developing children in both languages, it is possible that phonological analysis of a bilingual (Spanish-English) child's productions in one language may be sufficient to identify a speech-sound disorder. This, of course, entirely depends on the assessment used for phonological analysis. The APPS-2 and the HAPP-3 were used to assess bilingual children in this study. Scores on both assessments were found to be highly correlated. SLPs must consider the assessments that are used and the information that is provided from a diagnostic tool before deciding to test in only one language. In addition, it is important to note that typically developing children were evaluated in this investigation. Further research is needed to determine if the same results are found with children who have highly unintelligible speech. Until additional research between Spanish and English productions is conducted, this investigator still recommends that bilingual Spanish-English children be given phonological assessments in both languages.

Although it is not recommended that bilingual Spanish-English children only be assessed in one language (e.g., English), results from this investigation yielded another important finding. Phonological deviation categories that had higher percentages of occurrence in both languages were found to be similar (e.g., liquids, consonant sequences/clusters, and glides). The data from this investigation are important, because

they reveal that a bilingual child's phonological deviations are less likely to be significantly different in English and Spanish. Furthermore, this information supports the idea that phonology is more global, rather than language specific (Paradis, 2001). Although additional research still is needed to examine cross-language effects in treatment, results from this investigation do support the idea that monolingual SLPs (if properly trained) may assess bilingual children's English productions. This also is dependent (as previously mentioned) on the phonological assessment that is used.

Speech-sound data from both languages are critical in order to identify and develop optimal intervention goals for Spanish and English. Moreover, clinical research is needed in order to determine if cross-linguistic effects occur across languages and during treatment in one language. So far, researchers have concluded that cross-linguistic effects do occur in the phonological acquisition of two languages. Phonological rules of one language, for example, may transfer to the second language during acquisition (e.g., Gildersleeve-Neumann, Kester, Davis, & Peña, 2008). In most cases, second-language acquisition for bilingual children in the US occurs when children begin school (USCB, 2008).

Practitioners should be aware that cross-linguistic sound substitutions from Spanish to English may be typical for bilingual children (e.g., Goldstein, 2001a) and should not be counted as errors during a phonological assessment. Results from this investigation also revealed that cross-linguistic sound substitutions from English to Spanish may occur. Some participants in this study, for example, were found to produce American English versions of liquids (i.e., /r/, /l/) while naming APPS-2 stimuli.

Just as cross-linguistic data are critical, dialectal differences must be noted during the assessment of bilingual children. Researchers who have studied the Puerto Rican dialect, for example, have found that final consonant deletion is common for this population but not for speakers of the Mexican dialect (e.g., Goldstein, 2001a; Goldstein, Fabiano, & Washington, 2005). A detailed case history for all children is always needed. Questions that ask about languages spoken in the home and dialects for all household members should be included.

The current investigation yielded important findings related to intelligibility ratings and phonological deviations of bilingual children. The two phonological assessments that were used in this investigation, for example, were found to be highly correlated (i.e., HAPP-3 and APPS-2). It is the hope of this investigator that with continued research, the numbers of bilingual Spanish-English children who are over- or under-identified for services will decline.

Research

Along with clinical implications mentioned above, additional research is needed for evaluating intelligibility of bilingual Spanish-English children in both languages. Multiple factors, for example, potentially determine overall intelligibility (e.g., voice quality, breathiness). Moreover, relationships between TOMPD and other measures of intelligibility (e.g., percentage of identifiable words; Gordon-Brannan & Hodson, 2000) should be explored in both Spanish and English. Future research into these (and other) areas also should consider using larger numbers of listeners for rating intelligibility of speech samples.

In regards to age groups, participants of this investigation included 60 bilingual (Spanish-English) children ranging in age from 4:0 – 5:10. Although results for rate and ratings of intelligibility were significantly different between 4- and 5-year-olds in this study, future investigations are needed to examine younger and older bilingual children (i.e., 3-, 6-, and 7-year-olds). It is possible, for example, that an investigation of more age groups would yield additional important information for each of the variables studied in this investigation.

Studies involving children from other dialects of Spanish (e.g., Puerto Rican, Cuban) are needed. Spanish-speaking children from different dialectal backgrounds have been found to produce certain consonants differently (e.g., /r/; Goldstein, 2001a). Additional investigations are needed in order to determine if results from this investigation occur in other dialects of Spanish. Moreover, normative data regarding typical phonological productions of bilingual Spanish-English preschool children across other dialects of Spanish are needed.

A closer look at vocabulary and rate in greater detail is recommended. Different vocabulary tests for Spanish and English, rather than a combined bilingual score for vocabulary, may reveal language similarities or differences between Spanish and English vocabulary knowledge. These variables also could be used as separate predictor variables for ratings of intelligibility. A closer look at rate differences between Spanish and English is warranted. Future investigations that are designed to examine differences in rate between predominantly English, predominantly Spanish, and bilingual Spanish-English children (in both languages) may yield additional data that provide further analysis of potential differences between Spanish and English rate.

Based upon the research findings of this investigation, the best predictor of ratings of intelligibility in bilingual Spanish-English children (in both languages) is phonological deviations. More research is necessary to examine the degree of differences between the phonological deviations of typically developing bilingual (Spanish-English) children and children classified as having a phonological impairment. Collecting additional normative data in both languages is recommended. First, it is important to compare English and Spanish productions in order to provide monolingual SLPs phonological developmental milestones for bilingual (Spanish-English) children. In addition, normative data are needed to develop appropriate diagnostic materials for bilingual (Spanish-English) children. As researchers continue in this line of inquiry, practitioners will be able to serve bilingual Spanish-English children more effectively.

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APPENDIXES

APPENDIX A

Parent Letter

Estimados Padres de la Familia:

En Wichita State University, nosotros estamos estudiando la pronunciacion de los sonidos en español y ingles por los niños de habla hispana. El estudio consiste en que los niños nombren ciertos objetos y dibujos. Nosotros escribemos los sonidos que digan los niños y tambien los grabaremos. Si ustedes dejan participar a su niño, el/ella tendra un examen de hablar y lenguaje. Además, tendremos a su niño cuenta de nuevo una historia en ambos idiomas. Las actividades tomaran aproximadamente 50 minutos. Los resultados del probar estarán disponibles a usted

Si ustedes permiten que su niño participe en este studio, por favor, firmen la autorizacion y contestan las preguntas que aparecen en la página siguiente.

Atentamente,

Raúl Prezas, MA
Estudiante Graduado
Wichita State University

Dear Parents/Caregivers:

At Wichita State University, we are studying the English and Spanish speech sounds of children from a Hispanic background. The study consists of having children name certain objects and pictures. Children's responses will be written down and recorded. If you allow your child to participate, he/she will be given a test of speech sounds and language. In addition, we will have your child retell a story in both languages. The testing will last approximately 50 minutes. Results of the tests will be made available to you.

If you give permission for your child to participate in this study, please sign the consent form and answer the questions that appear on the subsequent page.

Sincerely,

Raúl Prezas, MA
Graduate Student
Wichita State University

APPENDIX B

Consent Form

PURPOSE: Your child is invited to participate in a study of speech sounds in Spanish and English. We hope to collect more information about the speech sounds of 60 bilingual children (4-and 5-year-olds). This information will be used to improve speech/language testing materials for Spanish-speaking children.

PARTICIPANT SELECTION: Your child was selected to be a participant in this survey because your child is part of the Early Child Start Program, is 4- or 5-years-old, comes from a Hispanic background, and speaks Spanish.

EXPLANATION OF PROCEDURES: If you decide to allow your child to participate, your child will be presented with speech/language tests in English and Spanish. Testing will last approximately 50 minutes over 2 days. Your child will be asked to give responses in both Spanish and English. The moderator will make note of your child’s responses on a form and audio-record the session in order to document the results.

DISCOMFORT: If at any time during the session your child indicates that he/she is tired or your child is showing fatigue, a short break from the testing will be provided. Before testing resumes, your child will be asked if he/she wants to continue testing. Testing will continue only if your child indicates a “yes” response.

BENEFITS: Should you choose to allow your child to participate in this study, he/she will be part of a project that attempts to obtain information regarding speech and language of bilingual children. This information will serve as a foundation to help develop adequate testing materials for Spanish-speaking children. A great need for testing materials designed to assess Hispanic children exists. With you and your child’s help, we can continue to better serve and assist the Spanish-speaking population in the United States of America.

CONFIDENTIALITY: Any information obtained in this study in which you or your child can be identified will remain confidential and will only be disclosed with your permission. Your child will be assigned and represented by a number in order to protect your child’s privacy.

REFUSAL/WITHDRAWAL: Participation in this study is entirely voluntary. Your decision whether or not to participate will not affect your future relations with Wichita State University or the Early Child Start program. If you and your child agree to participate in this study, you are free to withdraw from the study at any time without penalty.

CONTACT: If you have any questions about this research, please contact us: Raúl Prezas, 1845 Fairmount, Wichita, KS 67260, telephone (620) 200-2939; or Barbara Hodson, 1845 Fairmount, Wichita, KS 67260, telephone (316) 978-6342. If you have questions pertaining to your child’s rights as a research subject, you can contact the Office of Research Administration at Wichita State University, Wichita, KS 67260-0007, telephone (316) 978-3285.

You and your child are under no obligation to participate in this study. Your signature indicates that you have read the information provided and have voluntarily decided to participate. You will be given a copy of this consent form to keep.

Signature of Parent or Legal Guardian

Date

Signature of Witness

Date

APPENDIX B (Continued)

Forma Del Consentimiento

PROPÓSITO: Invitamos a Su niño que participe en un estudio de los sonidos del discurso y lenguaje en español y inglés. Esperamos recoger más información sobre los sonidos del discurso de 60 niños bilingües (4 y 5 años de edad). Esta información será utilizada para mejorar los materiales de los sonidos del discurso y lenguaje de prueba para los niños de habla hispana.

SELECCIÓN DEL PARTICIPANTE: Seleccionaron ser un participante en este estudio porque su niño esta en la programa de Early Child Start, tiene 4 o 5 años, viene de un fondo hispánico, y habla español.

EXPLICACIÓN DE PROCEDIMIENTOS: Si usted decide permitir que participe su niño, presentarán su niño con las pruebas de los sonidos del discurso y lenguaje en español y inglés. La prueba durará aproximadamente 50 minutos sobre 2 días. Pedirán su niño dar respuestas en español y ingles. El asesor escribirá las respuestas de su niño en una forma y grabará la sesión para documentar los resultados y las diferencias entre participantes.

MALESTAR: Si durante la sesión su niño se parece cansado o está demostrando fatiga en cualquier momento, una pausa corta será proporcionada. Antes de recomenzar la preba, preguntarán a su niño si él/ella desea continuar probando. La prueba continuará solamente si su niño dice “sí.”

VENTAJAS: Si usted elige permitir que su niño participe en este estudio, él/ella será parte de un proyecto con las experanzas de obtener la información del discurso y lenguaje con respecto a niños bilingües. Esta información servirá una fundación desarrollar materiales mejores para los niños de habla hispana. Una gran necesidad existe para materiales que son preciso para los niños hispánicos. Con ayuda de su niño, podemos continuar mejorando servicio a la población de habla hispana en los Estados Unidos.

SECRETO: Cualquier información obtenida en este estudio en el cual usted o su niño puedan ser identificados sigue siendo confidencial y será divulgada solamente con su permiso. Un número asignará y será representado su niño para proteger aislamiento su niño.

DENEGACIÓN/RETIRO: La participación en este estudio es enteramente voluntaria. Su decisión si o no participar no afectará sus relaciones futuras con Wichita State University o la programa del Child Care Association. Si quiere que su niño participar en este estudio, usted está libre retirarse del estudio en cualquier momento sin pena.

CONTACTO: Si usted tiene cualesquiera preguntas sobre esta investigación, usted puede entrarnos en contacto: Raúl Prezas, 1845 Fairmount, Wichita, KS 67260, teléfono (620) 200-2939; o Barbara Hodson, 1845 Fairmount, Wichita, KS 67260, teléfono (316) 978-6342. Si usted tiene preguntas sobre a las derechas de su niño en la investigación, usted puede llamar a la oficina de la administración de la investigación en Wichita State University, Wichita, KS 67260-0007, teléfono (316) 978-3285.

Usted y su niño no obligan participar en este estudio. Su firma significa que usted ha leído la información proporcionada y ha decidido voluntariamente a participar. Le darán una copia de esta forma del consentimiento a guardar.

Firma del Padre o del Guarda Legal

Fecha

Firma del Testigo

Fecha

APPENDIX C

Survey

Dear parents/caregivers:

Please answer the following questions. The information that you provide us is confidential. The name of your child will not appear in the study.

Child's Name: _____

Date of Birth: _____

Age: _____ Gender: _____

School: _____

Demographic Information:

How many adults live in the household? _____ How many children live in the household? _____

How many children in the home are: younger than the child? _____ Older than the child? _____

Circle the regional background(s) that best identifies your child's nationality:

Mexican Cuban Puerto Rican Central American South American

Other nationality: _____

Language Preference Information:

Please check which languages your child speaks in the home: Spanish _____
English _____ Other _____

Please list other languages: _____

At what age did your child start speaking: Spanish? _____ English? _____
Other _____

When **adults** speak to one another in the home, what is the preferred language?

Spanish _____ English _____ Both _____

APPENDIX C (Continued)

When **children** speak to one another in the home, what is the preferred language?

Spanish _____ English _____ Both _____

Which language does your child use more in the home? _____

Speech, Language, and Hearing Information:

Has your child ever had any speech or language difficulties? Yes _____ No _____

If "Yes," please describe: _____

Has your child ever had a speech language evaluation? Yes _____ No _____

If "Yes," did your child receive services? Yes _____ No _____

Has your child ever had ear infections? Yes _____ No _____ If "Yes," how many? _____

At what age did your child say his/her first word? _____ What was the first word?

Do family members have trouble understanding your child's speech? Yes _____
No _____

Do persons outside the family have difficulty understanding your child's speech?
Yes _____ No _____

Additional Comments:

APPENDIX C (Continued)

Cuestionario

Estimados Padres de Familia:

Por favor contestan las siguientes preguntas. La información que nos proporcionen es confidencial. El nombre de su hijo(a) no aparecerá en el estudio.

Nombre del niño(a): _____

Fecha de nacimiento: _____

Edad: _____ Sexo: _____

Escuela: _____

Información Demográfica:

¿Cuántos adultos viven en la casa? _____ ¿Cuántos niños viven en la casa?

¿Cuántos niños en el hogar son: más menor que el niño(a)? _____ más mayor
que el niño(a)? _____

Rodee el fondo regional (los fondos) eso identifica mejor su nacionalidad de niño(a):

mexicano cubano puertorriqueño de america central
sudamericano

Otro nacionalidad:

Información de Preferencia de Idioma:

Por favor cheque que idiomas que su niño(a) habla en el hogar: español _____ inglés
_____ Otro _____

Liste por favor otros
idiomas: _____

¿En qué edad empezó su niño(a) que habla: español? _____ inglés? _____
Otro _____

¿Cuándo adultos hablan con el uno al otro en el hogar, que es el idioma preferido?

español _____ inglés _____ ambos idiomas _____

APPENDIX C (Continued)

¿Cuándo niños hablan con el uno al otro en el hogar, que es el idioma preferido?

español _____ inglés _____ ambos idiomas _____

¿Cuál idioma utiliza su hijo(a) más en el hogar?

Información del Habla, Lenguaje, y Oído:

¿Su hijo(a) ha tenido dificultades en el habla o lenguaje? Sí _____ No _____

Si la respuesta es afirmativa, describe por favor: _____

¿Le han hecho alguna evaluación del habla o lenguaje a su hijo(a)? Sí _____
No _____

¿Si la respuesta es afirmativa, recibió su hijo(a) los servicios? Sí _____
No _____

¿Su hijo(a) ha tenido infecciones del oído? Sí _____ No _____ ¿ Si la
respuesta es afirmativa, cuántas? _____

¿En qué edad dijo su niño su primera palabra? _____ ¿Qué fue la primera palabra?

¿Tienen los miembros de la familia dificultad entender el discurso de su hijo(a)?
Sí _____ No _____

¿Tienen las personas fuera de la familia dificultad entender el discurso de su hijo(a)?
Sí _____ No _____

Comentarios adicionales:

APPENDIX D

Four Pictures

Task 8a ■ 3



APPENDIX E

Stories

English Story Version:

Once upon a time there was a girl named Mary. She was watching a movie on TV while her dog Spot was sleeping behind the chair. When Maria reached for a cookie, she accidentally knocked the bowl off the table. The cookies spilled which made Mary mad. “Oh my goodness, how clumsy of me”, she said. Then Mary got up and went to the kitchen to get a broom and a dustpan. Spot woke up when the cookies fell and decided to eat them. While Mary was gone, he ate all the cookies. When she came back, she was surprised that the cookies were gone. Mary didn’t see spot smiling behind the chair. He was happy because his tummy was full of all the cookies.

Spanish Story Version:

Había una vez una chica que se llamaba Maria. Ella estaba viendo una película en la televisión mientras su perro, Chuey, estaba dormido detrás de la silla. Cuando Maria fue para unas galletas, los tomo accidentalmente de la mesa. Las galletas cayeron y Maria fue enojada. “¡Ay Dios mio, que torpe soy!” Entonces Maria se levantó y fue a la cocina para agarrar una escoba y un recogedor. Chuey se despertó cuando las galletas cayeron y él decidió comerlos. Mientras María fue ido, él comió todas las galletas. Cuando ella regresó, ella fue para recoger las galletas pero no estaban allí. María no vio a Chuey sonriendo detrás de la silla. Él estaba feliz porque su estómago estaba lleno de todas las galletas.

APPENDIX F

Instructions for Rating

Rating Scales and Descriptors for Listening Analysis

All listening samples should be rated on a five point scale. Below are descriptors that should be used to help you determine which number to give each sample. After listening to a sample, circle the number which corresponds to the rating for that child.

1 – (Extremely difficult to understand)

2 – (Somewhat difficult to understand)

3 – (Average understandability)

4 – (Can generally be understood)

5 – (Easy to understand)

After you circle your response, please include any additional features you heard under the comments section of each sample rating:

- Soft voice
- Heavy dialect
- Congestion
- Hoarse/breathy voice
- Other

APPENDIX G

NAME: _____

LANGUAGE: _____

SAMPLE 1				
Rating:				
1	2	3	4	5
Comments:				
SAMPLE 2				
Rating:				
1	2	3	4	5
Comments:				
SAMPLE 3				
Rating:				
1	2	3	4	5
Comments:				
SAMPLE 4				
Rating:				
1	2	3	4	5
Comments:				
SAMPLE 5				
Rating:				
1	2	3	4	5
Comments:				

APPENDIX H

Descriptive Statistics

Means and Standard Deviations of English and Spanish Performance Measures (N=60)

Measure	English Mean	English SD	Spanish Mean	Spanish SD
Intelligibility Ratings	3.15	1.20	3.39	1.05
Phonological Deviations	27.75	22.91	28.90	25.13
Rate of Speech	61.45	11.86	75.65	15.01
Vocabulary	54.98	16.323	54.98	16.323

Note: Intelligibility Ratings = the mean of listener ratings for all participants (5-point scale); Phonological Deviations = the mean phonological deviations score for all participants; Rate of speech = the mean rate score; Vocabulary = the mean receptive vocabulary score from all participants (score was the result of a bilingual test and, therefore, is the same score for both languages)

Intelligibility

Frequencies of Speaker Understandability Ratings in English and Spanish by Rating (N=60)

Speaker Understandability Ratings	English Frequencies	English Percent	Spanish Frequencies	Spanish Percent
1 – 1.9	11	18	4	7
2 – 2.9	10	17	13	22
3 – 3.9	11	18	15	25
4 - 5	28	47	28	47
TOTAL	60	100	60	100

Note: Intelligibility ratings based on 5-point scale: The 5-point scale was used to rate samples by unfamiliar listeners and consisted of the following descriptors: 1 - “extremely difficult to understand”; 2 - “somewhat difficult to understand”; 3 – “average understandability”; 4 - “can generally be understood”; 5 – “easy to understand.”

APPENDIX H (Continued)

Phonological Deviations

Mean Percentages of English Phonological Deviations Evidenced by Bilingual (Spanish-English) 4-and 5-year-old Children (N=60)

Phonological Deviations	Mean Percentage in Error	Mean Percentage Correct	SD
Syllable Deletion	2	98	4.023
Consonant Sequences/Clusters Red.	22	78	19.318
Initial Consonant Deletion	1	99	1.407
Medial Consonant Deletion	2	98	3.432
Final Consonant Deletion	5	95	5.328
Liquids	24	76	26.268
Nasals	4	96	7.531
Glides	17	83	20.488
Stridents	12	88	11.105
Velars	9	91	13.146
Other Anterior Obstruents (e.g., Backing)	11	89	7.266

Mean Percentages of Spanish Phonological Deviations Evidenced by Bilingual (Spanish-English) 4- and 5-year-old Children (N=60)

Phonological Deviations	Mean Percentage in Error	Mean Percentage Correct	SD
Syllable Deletion	5	95	4.866
Consonant Sequences/Clusters Red.	21	79	20.734
Initial Consonant Deletion	1	99	4.517
Medial Consonant Deletion	1	99	1.535
Final Consonant Deletion	7	93	10.898
Liquids	27	73	25.371
Nasals	2	98	5.137
Glides	12	88	14.950
Stridents	5	95	8.777
Velars	5	95	13.322
Other Anterior Obstruents (e.g., Backing)	6	94	6.292

APPENDIX H (Continued)

English Phonological Deviations by Age Group

Mean Percentages of English Phonological Deviations of Bilingual 4-year-olds (N=30)

Phonological Deviations	Mean Percentage in Error	Mean Percentage Correct	SD
Syllable Deletion	3	97	4.675
Consonant Sequences/Cluster Red.	27	73	20.766
Initial Consonant Deletion	1	99	1.712
Medial Consonant Deletion	1	99	3.390
Final Consonant Deletion	6	94	5.521
Liquids	29	71	25.425
Nasals	5	95	9.160
Glides	19	81	23.302
Stridents	15	85	12.607
Velars	9	91	8.432
Other Anterior Obstruents (e.g., Backing)	13	87	7.489

Mean Percentages of English Phonological Deviations of Bilingual 5-year-olds (N=30)

Phonological Deviations	Mean Percentage in Error	Mean Percentage Correct	SD
Syllable Deletion	1	99	3.148
Consonant Sequences/Cluster Red.	17	83	16.810
Initial Consonant Deletion	1	99	1.015
Medial Consonant Deletion	2	98	3.528
Final Consonant Deletion	3	97	4.945
Liquids	18	82	26.401
Nasals	3	97	5.265
Glides	14	86	17.357
Stridents	9	91	8.634
Velars	9	91	16.746
Other Anterior Obstruents (e.g., Backing)	9	91	6.725

APPENDIX H (Continued)

Spanish Phonological Deviations by Age Group

Mean Percentages of Spanish Phonological Deviations of Bilingual 4-year-olds (N=30)

Phonological Deviations	Mean Percentage in Error	Mean Percentage Correct	SD
Syllable Deletion	5	95	5.018
Consonant Sequences/Cluster Red.	26	74	21.700
Initial Consonant Deletion	1	99	2.140
Medial Consonant Deletion	1	99	1.683
Final Consonant Deletion	9	91	13.880
Liquids	33	67	24.537
Nasals	3	97	6.231
Glides	14	86	14.197
Stridents	6	94	10.984
Velars	5	95	5.561
Other Anterior Obstruents (e.g., Backing)	6	94	4.955

Mean Percentages of Spanish Phonological Deviations of Bilingual 5-year-olds (N=30)

Phonological Deviations	Mean Percentage in Error	Mean Percentage Correct	SD
Syllable Deletion	5	95	4.795
Consonant Sequences/Cluster Red.	16	84	18.772
Initial Consonant Deletion	2	98	6.073
Medial Consonant Deletion	1	99	1.398
Final Consonant Deletion	5	95	6.099
Liquids	22	78	25.534
Nasals	1	99	3.605
Glides	10	90	15.516
Stridents	3	97	5.569
Velars	6	94	18.151
Other Anterior Obstruents (e.g., Backing)	6	94	7.468

APPENDIX I

MANOVA Results

Results for a 2 X 2 X 6 multivariate analysis of variance

(Language: English vs Spanish within subject variable) X (Age: 4-year-olds vs. 5-year-olds) X 2 (Gender: boys vs. girls)*

Multivariate Tests^b

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Between Subjects	Intercept	Pillai's Trace	.988	1498.314 ^a	3.000	54.000	.000	.988
		Wilks' Lambda	.012	1498.314 ^a	3.000	54.000	.000	.988
		Hotelling's Trace	83.240	1498.314 ^a	3.000	54.000	.000	.988
		Roy's Largest Root	83.240	1498.314 ^a	3.000	54.000	.000	.988
	Gender	Pillai's Trace	.011	.203 ^a	3.000	54.000	.894	.011
		Wilks' Lambda	.989	.203 ^a	3.000	54.000	.894	.011
		Hotelling's Trace	.011	.203 ^a	3.000	54.000	.894	.011
		Roy's Largest Root	.011	.203 ^a	3.000	54.000	.894	.011
	Age_by_year	Pillai's Trace	.130	2.683 ^a	3.000	54.000	.056	.130
		Wilks' Lambda	.870	2.683 ^a	3.000	54.000	.056	.130
		Hotelling's Trace	.149	2.683 ^a	3.000	54.000	.056	.130
		Roy's Largest Root	.149	2.683 ^a	3.000	54.000	.056	.130
	Gender * Age_by_year	Pillai's Trace	.050	.957 ^a	3.000	54.000	.420	.050
		Wilks' Lambda	.950	.957 ^a	3.000	54.000	.420	.050
		Hotelling's Trace	.053	.957 ^a	3.000	54.000	.420	.050
		Roy's Largest Root	.053	.957 ^a	3.000	54.000	.420	.050
Within Subjects	factor1	Pillai's Trace	.566	23.428 ^a	3.000	54.000	.000	.566
		Wilks' Lambda	.434	23.428 ^a	3.000	54.000	.000	.566
		Hotelling's Trace	1.302	23.428 ^a	3.000	54.000	.000	.566
		Roy's Largest Root	1.302	23.428 ^a	3.000	54.000	.000	.566
	factor1 * Gender	Pillai's Trace	.052	.993 ^a	3.000	54.000	.403	.052
		Wilks' Lambda	.948	.993 ^a	3.000	54.000	.403	.052
		Hotelling's Trace	.055	.993 ^a	3.000	54.000	.403	.052
		Roy's Largest Root	.055	.993 ^a	3.000	54.000	.403	.052
	factor1 * Age_by_year	Pillai's Trace	.140	2.921 ^a	3.000	54.000	.042	.140
		Wilks' Lambda	.860	2.921 ^a	3.000	54.000	.042	.140
		Hotelling's Trace	.162	2.921 ^a	3.000	54.000	.042	.140
		Roy's Largest Root	.162	2.921 ^a	3.000	54.000	.042	.140
	factor1 * Gender * Age_by_year	Pillai's Trace	.017	.312 ^a	3.000	54.000	.817	.017
		Wilks' Lambda	.983	.312 ^a	3.000	54.000	.817	.017
		Hotelling's Trace	.017	.312 ^a	3.000	54.000	.817	.017
		Roy's Largest Root	.017	.312 ^a	3.000	54.000	.817	.017

a. Exact statistic

b.

Design: Intercept+Gender+Age_by_year+Gender * Age_by_year
Within Subjects Design: factor1

*Factor 1 = Language (English and Spanish)