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Interspeech Posture in Spanish-English Bilingual Adults

by

Merrily R. Shary

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science
Department of Communication Sciences and Disorders
College of Behavioral and Community Sciences
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Abstract

Interspeech posture (ISP) is a term used to define the position of a person's articulators when they are preparing to speak. Research suggests that ISP may be representative of a speaker's phonological knowledge in a particular language, as determined empirically with ultrasound measures of the tongue in English-French bilinguals (Wilson & Gick, 2014). It is possible, therefore, that measuring ISP could be a diagnostic tool for determining phonological knowledge in bilingual speakers. However, more information on ISP in typical adult bilingual speakers is needed before diagnostic claims can be made. For example, ISP is believed to be language specific, and the typical ISP for each language must be determined. Therefore, the purpose of this study was to extend the research by Wilson and Gick (2014) to investigate ISP in Spanish-English speaking adults.

To this end, 13 bilingual Spanish-English adults were asked to produce 30 sentences while speaking in monolingual and bilingual modes. While they were speaking, ultrasound images of the oral cavity were obtained by placing a probe sub-mentally and analyzing the position of the tongue using Articulate Assistant Advanced 2.0 software (Articulate Instruments, 2012). Tongue and palate contour measurements were made by using a curved tongue spline that was manually drawn and semi-automatically fit to each speaker's tongue/palate contour. ISP was measured using the participant's tongue tip height along a reference angle from the probe to the alveolar ridge. Additionally, monolingual English speaking adults were asked to rate the accentedness of each bilingual's speech in English as a behavioral correlate of language proficiency.

Overall results of this study were non-significant; bilingual Spanish-English speakers utilized similar postures in monolingual Spanish and English modes, and in bilingual mode, in contrast with the findings of Wilson and Gick (2014). Accentedness ratings in English indicated that the bilingual

speakers were relatively uniform in their lack of accentedness. Although overall results from this study differ from those of Wilson and Gick (2014) a subset of their participants- speakers that were rated as having non-native accents- had similar results in that they also showed no difference in ISP. Related ISP's across languages may be due to participants having native sounding English but non-native Spanish. Due to contrasting findings from Wilson and Gick (2014), further investigation with accented speakers is needed to determine if distinct ISPs exist for bilingual Spanish-English speakers.

Chapter One:

Interspeech Posture of Spanish-English Bilingual Adults

Articulatory setting, the position of a speaker's tongue, lips, cheeks, jaw, pharynx and their combined action to produce speech (Honikman, 1964), is one thing that makes languages sound different (Mennen, Scobbie, Leeuw, Schaeffler, & Schaeffler, 2010). One of the best ways to measure articulatory settings is via Interspeech Posture (ISP), the specific articulatory posture mid-utterance that changes depending on the language being spoken (Wilson & Gick, 2014). While literature exists measuring ISP in monolinguals (Gick, Wilson, Koch & Cook, 2004) and French-English bilinguals (Wilson & Gick, 2014), research is needed on bilinguals speaking other languages. The aim of the current study was to expand previous research by measuring ISP in Spanish-English bilingual speakers.

Defining and Measuring ISP

Metaphorically speaking, ISP is akin to the neutral gear of a shifting lever in a manual transmission car as it is the location the “articulators tend to be deployed from and return to, in the process of producing fluent and natural speech” (Benítez, Ramanarayanan, Goldstein & Narayanan, 2014, p. 1). ISP has been found to change depending on which language is spoken and depends, in part, on phoneme frequency (Gick et al., 2004). For example, in English the tongue is “tethered laterally to the roof of the mouth by allowing the sides to rest on the inner surface of the upper lateral gums and teeth...whereas the tip constantly moves up and down...” (Honikman, 1964, p. 76). According to Colantoni, Steele, and Escuerdo (2015), it is the coronal (alveolar) consonants that establish articulatory setting in English because the most common sounds in English are produced by tongue contact to the alveolar ridge (Laver, 1994). In contrast, the tongue position is higher and

less retracted in German, the tongue tip is lower in French, and further back in Dutch (Benítez et al., 2014; Lowie & Bultena, 2007; Wilson, 2006; Wilson & Gick, 2014).

Because ISP is a neutral posture taken by articulators as they wait to begin speaking, it must be measured during quiet moments between utterances. ISP also differs from the articulators' posture for respiration, which has been found to have "relatively high variances" presumably due to the fact that the articulators are not "under active control" during respiration (Ramanarayanan et al., 2013, p 517). Therefore, it can be difficult to precisely measure ISP since one must find a quiet moment between utterances where the speaker is merely preparing to talk as opposed to taking a longer break to breathe.

Fortunately, advances in technology have enabled researchers to instrumentally measure ISP using several techniques such as X-ray images, Optical Tracking, and Tongue Ultrasound. Gick et al. (2004) first measured ISP using X-Ray images of articulators. This research revealed that monolingual speakers of English and French utilized different ISPs across five measurements: pharynx width, distance from tongue body to palate, distance from tongue tip to alveolar ridge, upper lip protrusion, and lower lip protrusion. Research attempting to determine the minimum number of sensors needed to encode articulatory information found that measuring the tongue tip offers the most information for discriminating consonants or words between languages (Wang, Samal, Rong, & Green, 2016). Furthermore, the only tongue measurement that was shown to have significant differences in ISP in monolingual speakers was tongue tip height (TTh; Wilson, 2006); a measurement assumed to be a valid representation of a speaker's ISP. Benítez et al. (2014) and Ramanarayanan, Byrd, Goldstein, & Narayanan (2010) used another imaging method, MRI, to measure features of the vocal tract representing ISP. Results indicated that tongue tip height was language specific, thus providing more evidence that this is a valid measurement to use in the comparison of ISP across different languages (Ramanarayanan et al., 2010).

Articulation and Phonological Knowledge

Evidence suggests that a relationship exists between speech sound error patterns in children and articulation and phonological representations (Preston, Hull, & Edwards, 2013). In the aforementioned research, Preston, Hull, and Edwards (2013) found that unusual speech sound errors may be indicative of weak phonological representations which may lead to long-term issues in phonological awareness. This suggests that there may be a link between phonological knowledge and articulation. However, research regarding second language and phonological systems in adults is limited (Wilson, 2006). Flege (1981) argues that a foreign accent results from the formation of “stable phonological representations for sounds and words” in the first language (p 443). According to Flege (1981), phonological knowledge in one language may cause a speaker to code novel sounds from a second language in their native language. Although accentedness and speech sound errors are not necessarily the same phenomenon, both are cases where there is a link between phonological awareness and articulation may exist.

Research concerning phonological knowledge in monolingual and bilingual speakers suggests that bilingual speakers have separate phonological systems that interact in ways that make their systems dissimilar to monolingual phonological systems (Hambly, Wren, McLeod & Roulstone, 2013). Bilingual speakers often show different developmental patterns and a dissimilar pattern of phoneme acquisition when compared to monolingual children, as phonemes that are shared between both of their languages often develop in one language before the other (Hambly et al., 2013). This aligns closely with Grosjean (1989) who maintains the philosophy that a bilingual speaker is not equal to two monolinguals in one brain. This is further supported by research suggesting that languages in a bilingual influence one another (Paradis, 2001) and even second language experience can influence the speaker’s native language performance (Kaushanskaya, Yoo, & Marian, 2011). This

suggests that a bilingual speaker's two languages impact their articulation as well as their phonological knowledge in ways that require more in depth research to gain a greater understanding.

ISP and phonological knowledge in Monolingual speakers

Language specific ISPs are currently being studied because they provide information as to how speakers cognitively control their speech mechanism, whether ISP represents a speaker's phonological knowledge, and if ISP is important in the acquisition of more native sounding speech (Benitez et al., 2014; Ramanarayanan et al., 2010; Wilson & Gick, 2014). Research concerning ISP in monolinguals only is notably uncommon (Wilson, 2006). However, previous research by Gick, Wilson, Koch, and Cook (2004) specifically focused on monolingual French and monolingual English speakers and provides evidence that language specific postures exist in these populations.

Research by Gick, et al. (2004) also suggests that because English and French speakers exhibit different postures, this implies that ISP has "...far reaching effects on language's phonetic and phonological inventory" (p 231). This supports the notion that a relationship exists between articulatory setting and phonological competence in a language (Benitez et al., 2014). This is further evidenced by studies that show that children diagnosed with Phonological Impairment (PI) have co-existing speech sound errors hypothesized to be related to a lack of phonological knowledge (Munson, Edwards, & Beckman, 2005).

ISP and phonological knowledge in Bilingual speakers

While there are many factors that contribute to the definition of bilingualism, the current study considers a bilingual speaker to be anyone who reports native or near-native fluency in another language besides English. The bilingual speaking mode, as explained by Grosjean (1989), is also used as a means to define the linguistic environment of the bilingual. Specifically, Grosjean postulates that bilinguals can speak in one of two modes: speaking in one language with another monolingual (monolingual mode) and speaking in both languages, via codeswitching, with another bilingual

(bilingual mode). It is important to note, however, that even in monolingual mode, speakers are “often influenced by their other language,” evidence that the two languages interact (Grosjean, 2010, p. 42).

It is crucial that clinicians have an understanding of a bilingual’s language system to perform clinical assessment and treatment. Assessment and treatment in one of a child’s languages may or may not have an impact in the child’s other language (Fabiano-Smith & Barlow, 2010). Although there are several theories regarding whether the language systems of bilinguals are stored together or separately, results from past studies are inconsistent and use a variety of methodologies. Existing studies indicate that there are three aspects that impact neural activities depending upon which language is spoken in bilinguals including “age of acquisition, language proficiency, and computational demands of each language” (Hernandez, 2009, p 134). For example, recent evidence suggests that with regard to age of acquisition, younger second language learners are more likely to have separate phonetic systems for their two languages. However, with regard to neural activity, early bilinguals share the same areas of the brain for language processing (Baker, 2005; Kim, Relkin, Lee, & Hirsch, 1997).

From a motoric perspective, evidence suggests that sounds from one language can interact and transfer to another (Goldstein, Fabiano, & Washington, 2005). For example, Spanish-English bilinguals may add an /e/ to the beginning of words in English that begin with /s/ (Goldstein, Fabiano, & Washington, 2005) in order to fit the phonological system of Spanish. Other research by Paradis (2001) suggests that bilingual children may not differentiate initial syllables in English in the same ways as monolingual children, possibly due to differentiated phonological systems. Measuring ISPs in bilingual speakers could provide information on articulatory proficiency and bilingual phonological systems. If speakers that are not perceived as having native-like speech also do not

employ language-specific postures this could signify that they do not have as much phonological knowledge when compared to speakers that do employ different postures for that language.

To test this hypothesis, Wilson & Gick (2014) studied ISP in French-English bilinguals using optical tracking and tongue ultrasound. They found that speakers employed different ISPs depending on the language they were speaking while in monolingual mode (Wilson & Gick, 2014). However, when these speakers were required to alternate between their languages in bilingual mode they utilized the monolingual posture of their most commonly used language (Wilson & Gick, 2014). This pattern of behavior was correlated with ratings of accentedness, and the findings suggested that when speakers were judged to have native sounding speech in each language, they used a different ISP for each language while speaking in monolingual mode. In other words, ISP could be an indication of language proficiency in bilingual speakers.

Clinical Implications

Assessment of speech and language disorders in bilingual children requires evaluation in both languages in order to differentiate a language disorder from a language difference (ASHA Bilingual Service Delivery, 2013). Clinicians who do not have the resources to test children in both languages may misdiagnose a child with a language disorder. If there is a connection between phonological ability and ISP, measuring ISP may be useful as a supplemental diagnostic tool in assessing bilingual children.

It has long been thought that a child could have a pure disorder of language (Specific Language Impairment; SLI) or of speech (Childhood Apraxia of Speech; CAS). However, recent research has started to show this idea of a “pure disorder” does not exist. For example, it is known that children diagnosed with SLI also show difficulties with fine motor skills and speech-motor ability (DiDonato Brumbach & Goffman, 2014; Sanjeevan et al., 2015). It is also known that children diagnosed with CAS are at risk for problems in the “phonological foundations for literacy”

(ASHA, 2007). Based on these recent findings, it can be hypothesized that a motor measurement, like ISP, could provide a useful indicator of the risk of a language impairment, making ISP another means to assess a bilingual child suspected of having a language disorder. In order to make ISP a viable assessment tool for bilingual children, more information is needed on ISP for typical bilingual speakers.

Purpose

The purpose of this research was to add to the literature on ISP in bilingual speakers by investigating ISP in Spanish-English bilinguals. This study was an expansion of the work by Wilson and Gick (2014) who studied ISP in French-English bilinguals. Their results indicated that bilingual speakers who were perceived as native in each of their languages exhibited distinct ISP in each language. Following Wilson and Gick (2014) the following hypotheses were made:

1. Bilingual Spanish-English speakers will exhibit language specific ISPs in Spanish and English
2. These speakers will use one of their monolingual ISPs while speaking in bilingual mode
3. There will be a relationship between perceived accentedness in a language and the ISP used in that language.

Chapter Two:

Methods

Participants

After receiving IRB approval (see Appendix A), all participants were recruited from the University of South Florida via advertisements placed on campus and by word-of-mouth. All participants were required to have no history of speech, language, or hearing disorders and to be under the age of 40. Student participants were offered extra credit in their classes, but no other form of compensation was given.

Bilingual Participants. Data was collected from 16 bilingual Spanish-English speakers. However, data were unable to be used from 3 speakers due to technical issues. The final data were provided by 13 bilingual Spanish-English female speakers between the ages of 20-33 ($M = 24.7$). All of the speakers completed a questionnaire regarding age, gender, education level, use of both Spanish and English language, when each language was learned (simultaneously or sequentially) and if they spoke other languages. Age of Spanish and/or English acquisition ranged from birth-12 years of age. Nearly half of the participants reported learning Spanish and English simultaneously (6/13). The bilingual participants spoke a variety of Spanish dialects from both Central and South America and the Caribbean, with the Cuban dialect being the most common. On average, participants reported using Spanish during 19% of the day. All participants reported feeling more comfortable using English in academia, but speakers were relatively split on their preferred language in social situations. The majority of participants reported feeling more comfortable using English (8/13) with the remaining participants feeling more comfortable using either language (5/13). None of the

participants reported feeling more comfortable using Spanish rather than English in social situations or overall. Details on these speakers can be found in Table 1.

Monolingual Participants. Data was collected from 11 female and 4 male monolingual listeners with the average age of 27. Listeners were asked to judge the accentedness of the bilingual participants' speech. The monolingual participants completed a questionnaire on their years of education, gender, where they were born, and how often they heard Spanish. Most of the participants had completed some graduate course work (7/15), two participants reported having a Bachelor's degree, and five participants reported having some undergraduate coursework. The majority of speakers (13/15) rated themselves as having heard some Spanish frequently, and only two reported hearing Spanish often.

Stimuli

Bilingual Speaking Task. The stimuli consisted of 30 phonetically balanced sentences, 15 in English and 15 in Spanish. Each sentence included a carrier phrase ("Dame otro/a _____ para" or "Say a _____ each") containing a key word that started with /k/, followed by a high or low vowel, a labial plosive or nasal, and a final vowel. Each carrier phrase started with a proper name and ended with another word. The names all started with a variety of phonemes and the final words all ended with a variety of phonemes. This was done to control the phonetic context of the ISP measurements. For example, a speaker could have the following two sentences back to back: "Nick, say a commit each foe ____ "Matt, say a combo each holiday." The space between these two sentences is where the ISP was measured. Therefore, this ISP was measured in the context of /o/____/m/. Varying the phonetic context in this way forced the speakers to alternate the position of their articulators, mimicking more natural speech. This was done to control for phoneme effects on ISP where a repetitive tongue position caused by a specific, repeated phoneme occurring at the

Table 1. Bilingual Speaker Characteristics

Part.#	Age	Birthplace	Dialect of Spanish	Age of Spanish acquisition	Age of English acquisition	% of day Spanish	% of day English	Preferred Academic Lang.	Preferred Social Lang.	Preferred Overall Lang
1	25	USA	Cuban	Birth	Birth	20	80	English	English	English
2	24	USA	Cuban	Birth	Birth	15	85	English	Both	English
3	22	Puerto Rico	Puerto Rican	Birth	Birth	10	90	English	Both	Both
4	24	Colombia	Columbian-Cuban	Birth	3	25	75	English	Both	English
5	20	USA	Panamanian	Adolescent/Teens	Birth	5	95	English	English	English
6	24	Cuba	Cuban	Birth	9	50	50	English	Both	Both
7	23	USA	Cuban/Puerto Rican	Birth	Birth	10	90	English	Both	English
8	27	USA	Central American	2	Birth	2	98	English	English	English
9	25	USA	Nicaraguan	Birth	3	10	90	English	English	English
10	22	USA	Columbian	Birth	Birth	25	75	English	English	Both
11	27	Puerto Rico	Puerto Rican	Birth	Birth	25	75	English	English	English
12	33	Costa Rica	Costa Rican	Birth	Elementary School	50	50	English	Both	Both
13	26	Cuba	Cuban	Birth	12	5	95	English	Both	Both

beginning or end of each sentence would likely lead to a phoneme specific speech posture rather than a language-based ISP.

Each bilingual speaker read all 30 sentences organized in three blocks of ten sentences: one block of 10 English sentences, one block of 10 Spanish sentences, and one block of five English and five Spanish sentences presented randomly. The order of the monolingual blocks was counterbalanced across participants, but the last block of sentences was always the bilingual block. The participant was told which language would be in the block and was given breaks between blocks. Six different versions of the stimulus lists were counterbalanced across participants so that each of the individual sentences could occur in all possible speaking conditions (see Appendix B).

Monolingual Listening Task. To create the listening stimuli, each bilingual's spoken sentences were recorded via a microphone using the Articulate Assistant Advanced, 2.0 software (Articulate Instruments, 2012). The audio files were exported from that program and imported into Praat (Version 6.0.1; Boersma & Weenink, 2013). The clearest production of each sentence for each speaker was extracted from the full audio file and made into its own file. The amplitude was normalized for all files and, in some cases, background noise was removed using Audacity software version 2.0.0 (Audacity, 2012). This resulted in a total of 195 spoken sentences (15 sentences from 13 speakers) that monolingual participants were asked to judge.

Procedure

Bilingual Speaking Task. Before each participant entered the testing room, she was randomly assigned to one of the six stimuli lists. If her first speaking block was going to be English, she was met by the English speaking experimenter. If her first speaking block was going to be Spanish, she was met by the Spanish speaking experimenter. After being greeted by the researcher, each participant was asked to sign informed consent and was asked (in both English and Spanish) if

she understood what was going to happen and if she had any questions. Following this, the participant was asked to complete a short questionnaire about her bilingual history.

After consent was obtained each participant was seated in a wheel-less chair and fitted with a specially designed facemask which held the adjustable head ultrasound, designed by Articulate Instruments (2008), along the mid-sagittal line of the head, underneath the participant's chin (see Figure 1). The facemask also stabilized the ultrasound and controlled for extraneous movement. The ultrasound used was an Aloka SSD1000 with a 90-degree convex probe. All participants used a probe measurement angle of 30°. The ultrasound was connected to the Articulate Assistant Advanced, 2.0 software (Articulate Instruments, 2012) which presented the stimuli sentences while simultaneously recording each participant's tongue movements and speech (via a microphone positioned ~15cm from the participant).

Figure 1. Facemask and ultrasound

After the participant was fitted with the ultrasound, the experiment began. Each participant was first recorded while swallowing three sips of water. Data from the participant's swallow was later used for tracing the hard palate since the tongue approximates the palate during the oral stage of the

swallow (Massey, 2006). The experiment then moved to familiarizing the participant with example stimuli. The participant was told which language would be in the block and was given breaks in-between blocks. Before each sentence was presented to the speaker to read, a beep was played to signify that the sentence would appear soon. A second, lower-pitched beep was played as the sentence appeared on the screen, and the speaker was asked to read each sentence three times. The ISP was measured during the time between the two beeps since it was assumed that the speaker was in a ready state as she waited for her stimulus sentence to appear.

Breaks were offered between each block of sentences with the participant choosing when she was prepared to continue with the remaining sentences. During these breaks researchers spoke to the participant in the language corresponding to her upcoming block. For example, if the upcoming block was going to be Spanish, then the Spanish speaking researcher would speak to the participant in Spanish during the break between her first and second block. If the upcoming block was going to be the bilingual block, the Spanish speaking researcher would speak to the participant in bilingual mode, code-switching between the two languages.

Monolingual Listening Task. Each monolingual participant was greeted by the researcher and asked to sign informed consent. Following this, each listener completed a short questionnaire regarding their monolingual status. Once this was completed, the listener was given instructions to rate each sentence using a scale of 1-5 (1-English is the speaker's second language and she speaks it very poorly, 5- English is the speaker's native language) modeled after the same five-point scale used by Wilson and Gick (2014). The experiment was presented on a 2012 Macbook Pro laptop via Praat (Boersma & Weenink, 2013).

Data Analysis

The main measurement collected for this study was Tongue Tip Height (TTht). TTht was defined as the distance between the tongue tip and the alveolar ridge as measured on the ultrasound

fan line that intersected the alveolar ridge (see Figure 2). The general procedure for obtaining this measurement was: (1) tracing the palate and determining the point to represent the alveolar ridge, (2) tracing the tongue while in the assumed ISP timeframe, (3) measuring the distance from the probe center to alveolar ridge along the specified ultrasound fan line, (4) measuring the distance from the probe center to the point on the tongue that intersected with the alveolar ridge fan line, (5) taking the difference between the alveolar ridge measurement and the tongue measurement. The specifics of each step are described below.

Figure 2. Ultrasound image showing alveolar fan spline. The tongue tip is to the right, and the red line is the tongue tracing.

Tracing the Palate. During the participant's three recorded swallows, frames displaying the palate location were identified manually and drawn on the ultrasound image using Articulate Assistant Advanced 2.0 software (Articulate Instruments, 2012). The frame used to obtain the spline for the palate was determined by the moment when the tongue dorsum was visibly pressed against the palate during the swallow at the most anterior and superior position, highlighting the alveolar ridge. The spline for the palate was manually traced and automatically adjusted in order to obtain to the most accurate palate shape.

Tracing the Tongue. In order to determine the most accurate location for ISP tongue measurement, two specific beeps were used: one higher pitched beep signified when the participant was anticipating the sentence and another slightly lower pitched beep signaled when the sentence appeared on the screen. It was between these two beeps that tongue tracings were drawn manually and then fit semi-automatically when the tongue was relatively stable for at least 10 frames (.333 ms) in accordance with Wilson and Gick (2014). The shape of the tongue was initially hand drawn to account for the hyoid shadow created by using a 90° probe and then was fit to the position using the software's semi-automatic spline fitting tool. Participant pauses ranged from 10-30 seconds, and splines were drawn for every ten seconds that the tongue was relatively stable. When a participant had more than one tongue tracing per sentence the multiple tracings were averaged together in order to obtain a general ISP setting. If a participant swallowed or had excessive tongue movement before she was shown the sentence, that trial was not included.

Computing Tongue Tip Height. In order to replicate the measurement of ISP used by Wilson and Gick (2014) the measurements of the alveolar ridge and tongue were used to obtain the tongue tip height (TTht) that would be used as the main measurement for ISP. To begin, the researcher carefully reviewed the swallowing ultrasound clips and determined the ultrasound fan line that most closely aligned with the alveolar ridge. Once the alveolar fan line was chosen, the point at which that line intersected the tongue tracing was recorded as the tongue tip distance measurement. The distance (in millimeters) was measured along the alveolar fan line from the probe center to the tip of the tongue and from the probe center to the alveolar ridge. After collecting all of the tongue and alveolar ridge distances, they were exported into an Excel file where the tongue distance was subtracted from the alveolar ridge distance providing a TTht measurement for each speaker on each sentence. Tongue-tip heights for all participants in each speaking mode were compared using IBM SPSS Statistics 22 to address the research hypotheses.

Chapter Three:

Results

Accentedness Ratings

Monolingual accentedness ratings for each participant were obtained from Praat software (Version 6.0.1; Boersma & Weenink, 2013) and subsequently averaged to obtain an overall accent rating for each speaker. The scale ranged from a score of 1 indicating that “English is the speaker’s second language and she speaks it poorly” to 5, “English is the speaker’s native language” following the ratings used in Wilson and Gick (2014). Overall, bilingual speakers were rated as fairly native speakers of English ($M = 4.18$, $SD = .56$). All speakers, but one, fell within one standard deviation of the mean. One speaker, P 12, received an average rating of 2.67 placing her almost 2 standard deviations below the mean. As such, more in depth measurements were computed on her data to explore ISP in a non-native sounding speaker.

English vs. Spanish Monolingual Modes

In order to test the hypothesis of whether bilingual English and Spanish speakers used a different ISP in monolingual English mode compared with monolingual Spanish mode, paired t -tests were computed to measure possible differences. As can be seen in Table 2, no significant results were observed. A significant, positive, paired samples correlation did exist between the two monolingual measures (see Table 3), supporting the notion that there was no difference in ISP between monolingual speaking modes.

Bilingual vs. Monolingual Modes

In order to test the hypothesis of whether bilingual English and Spanish speakers used a different ISP in bilingual mode compared to monolingual modes, paired t -tests were computed. No

significant differences were observed between these language modes (see Table 2). A Pearson correlation was also computed between ISPs in all language modes to determine the strength of the relationship between these variables. The correlation results show a significant, positive relationship between language modes (see Table 3).

Table 2. Summary of Paired *t*-tests Comparing ISP in all Speaking Conditions

Comparison	Mean (SD)	<i>t</i> (<i>df</i>)	<i>p</i>
T*Tht English vs. T*Tht Spanish	4.22 (2.72) 4.74 (3.13)	<i>t</i> (12) = .75	.189
T*Tht English vs. T*Tht Bilingual	4.22 (2.72) 4.25 (2.43)	<i>t</i> (12) = -.08	.94
T*Tht Spanish vs. T*Tht Bilingual	4.74 (3.13) 4.25 (2.43)	<i>t</i> (12) = -.96	.36

Table 3. Summary of Paired Sample Correlations between all Speaking Conditions

Comparison	N	Correlation
T*Tht English vs. T*Tht Spanish	13	<i>r</i> (11) = .9, <i>p</i> < .0001
T*Tht English vs. T*Tht Bilingual	13	<i>r</i> (11) = .84, <i>p</i> < .0001
T*Tht Spanish vs. T*Tht Bilingual	13	<i>r</i> (11) = .81, <i>p</i> = .001

Participant 12

As mentioned previously, Participant 12 (P 12) was the only participant that fell almost two standard deviations below the mean with regard to the accent rating suggesting she did not sound native in English and would have likely been rated as native sounding in Spanish¹. Wilson and Gick (2014) found that accentedness in a language influenced ISP. Therefore, it was hypothesized that there may be significant differences in ISP for P 12 that were not found when speaker results were collapsed. Paired *t*-tests were computed comparing ISP across all three language modes for P 12. As

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¹ Monolingual Spanish-speakers were not asked to judge accentedness in Spanish, so only assumptions can be made in regards to nativeness in Spanish.

shown in Table 4, none of the t -tests were significant. However, the paired samples correlations for P 12 were different than the group correlations. As shown in Table 4, there were no significant correlations between language modes, suggesting that TTht for P 12 were not closely related as was the case for the group data.

Table 4. Paired t -test and correlation results for P 12

Comparison	Mean (SD)	t -test	Correlation
TTht English vs. TTht Spanish	2.84 (4.15) 3.82 (2.63)	$t(8) = -.63, p = .58$	$r(7) = .09, p = .81$
TTht English vs. TTht Bilingual	2.84 (4.15) 3.96 (4.8)	$t(8) = .46, p = .66$	$r(7) = -.34, p = .37$
TTht Spanish vs. TTht Bilingual	3.82 (2.63) 3.96 (4.8)	$t(8) = .06, p = .95$	$r(7) = -.61, p = .08$

Chapter Four:

Discussion

The purpose of this study was to determine if Spanish-English bilinguals used language specific ISPs in order to obtain more information to expand the literature base concerning this population. Overall, results were non-significant, suggesting that bilingual Spanish-English speakers in this study did not utilize language specific postures but instead used a constant ISP across language modes. It is possible that these speakers did not sound native in Spanish, which would align with the results obtained by Wilson and Gick (2014), who found that French-English bilinguals perceived as native in only one of their languages did not employ language-specific ISPs across language modes.

Accentedness Ratings

In general, the speakers in this study were perceived by monolingual English speakers as native speakers of English, with the exception of one speaker (P 12). This was in contrast to Wilson and Gick (2014) who had speakers judged to be native in both their languages, only one language, or in neither language. One limitation of the current study is that only accentedness ratings in English were obtained, as monolingual Spanish speakers could not be found to provide ratings. Without having accentedness ratings in Spanish it can only be hypothesized that our speakers may have been considered non-native in Spanish.

This hypothesis is strengthened by the fact that one speaker was obviously mispronouncing Spanish words beginning with “qu” + vowel. In Spanish, “qu” + vowel is pronounced as /k/ + vowel. The fact that one of the Spanish speakers pronounced the “qu” as /kw/ is an indication that her Spanish would not likely have been judged as native. Further support for the notion of non-

native Spanish is the fact that the majority of our speakers (8/13) stated that they felt more comfortable using English rather than Spanish overall. Therefore, the current study may have been measuring bilingual ISPs in speakers that were not proficient enough in Spanish to produce different ISPs in that language. This follows Wilson and Gick (2014) who only found significantly different cross-linguistic ISPs in speakers judged as native in *both* languages.

There was one participant in the current study who was rated as having fairly non-native sounding English (P 12). Again, she does not have any ratings of her accent in Spanish, but her questionnaire data suggest that she uses Spanish more frequently than the other speakers because she reported speaking exclusively Spanish at home with her mother. She also reported using English exclusively at school. Taken together, these data suggest that P 12 may be more bilingual than the other speakers, and thus her data was analyzed separately.

ISP Across Language Modes

The current study did not find differences across language modes in bilingual ISPs likely due to the fact that the speakers were only native sounding in English. This follows Wilson and Gick (2014) who suggest that a person judged as non-native in a language does not have enough phonological knowledge in that language to form an independent ISP. This is supported by research from Flege suggesting that foreign accents and phonological knowledge are related (1981). The bilingual Spanish-English speakers in the current study used the same ISP for English, Spanish, and in a bilingual mode as suggested by data obtained between the different speaking conditions.

This was not the case for P 12, the sole participant whose accent was not perceived as native sounding. While she did not have significantly different ISPs across speaking conditions, her postures did follow a pattern different from the other speakers. P 12 did not have any correlated ISPs across speaking conditions suggesting that her tongue tip height (T*Tht) was somewhat different across conditions. Specifically, her ISPs fell in what can be described as a continuum of

similarity. At one end, her ISP for Spanish and bilingual mode were most similar with a strong correlation ($r = -.61$) that approached significance ($p = .08$). At the other end, her ISP for Spanish and English were least similar with very weak correlation ($r = .09$) that was clearly not significant ($p = .81$). In the middle were the ISPs for English and the bilingual mode which were mildly correlated ($r = -.34$) but not significant ($p = .34$). This pattern of correlations suggests that P 12, who had a perceivable accent in English, was using a Spanish ISP that was different from the English ISP, but that matched her bilingual ISP. This finding supports Wilson and Gick (2014) who found significantly different ISPs across English and French in two speakers who were perceived as native speakers in French, but not English (the pattern that is presumably the same as the current study's P 12).

Future Directions and Limitations

Although the non-significant results of the current study are in line with the general findings of Wilson and Gick (2014), more research with significant results is needed on bilingual ISPs in Spanish-English bilinguals. To better replicate Wilson and Gick (2014), a study would need to find bilingual speakers rated as native in *both* Spanish and English, something that was missing in the current study. This research would need to obtain evidence regarding how bilingual these speakers are in both of their languages in order to best represent this population.

Forthcoming research could also look at other measures of articulatory differences between languages. For example, tongue tracings from the current study were used in a preliminary study measuring velar closure in both Spanish and English. Preliminary findings suggested that roughly 66% (4/6) of participants had tongue displacement patterns that differed between languages meaning speakers had different velar closure patterns for Spanish, English and bilingual speaking modes. This suggests that differences in tongue position exist between Spanish and English when

measured by another method, which provides support for measuring co-articulation patterns in bilingual speakers.

A second extension of the current study would be to investigate inter- and intra-speaker variability. The current data has fairly large standard deviations suggesting a large amount of variance. It would be interesting to see if bilingual speakers, in general, have a larger amount of articulator variability during speech either in the production of phonemes or in their ISP. Further research in this area could determine if co-articulation patterns and stability measurements could be used to identify, or rule out, the diagnosis of speech deficits and language delays in bilingual speakers.

Clinical Implications

In order to use ISP in a clinical setting it is necessary that further research be conducted to determine how this posture can be utilized. Due to contrasting findings between this study and the study by Wilson and Gick (2014) a comprehensive understanding of clinical implications is not available. If evidence of language-specific ISP's is obtained this posture may be used to measure phonological knowledge in the diagnosis of speech or language deficits in bilingual speakers. Monolingual speech pathologists would especially benefit from a tool that would measure phonological knowledge as they do not have the ability to assess the child in both languages themselves.

Conclusion

The current study measured tongue tip height in 13 bilingual Spanish-English speakers to determine if ISP was language specific in order to extend the research of Wilson and Gick (2014). It was hypothesized that speakers would have different postures in each language that would correlate with their accentedness in English. No significant differences were observed as speakers used a similar position across all language modes. The only speaker that was perceived to have an accent in

English did appear to use different ISPs across language conditions. Overall, results from this study align with some of the results obtained from Wilson and Gick (2014) and suggest that bilingual ISPs should receive further investigation in order to determine if these postures can be used as a diagnostic tool for bilingual children.

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Appendix A:

IRB Approval

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4795
(813) 974-5638 • FAX (813) 974-7091

October 14, 2015

Merrily Shary Communication Sciences and Disorders Tampa, FL 33612

RE: **Expedited Approval for Initial Review**

IRB#: Pro00023357

Title: Bilingual Articulatory Settings in Spanish-English Speaking Adults

Study Approval Period: 10/13/2015 to 10/13/2016

Dear Ms. Shary:

On 10/13/2015, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):

Protocol Document(s):

[Shary_Protocol Final.docx](#)

Consent/Assent Document(s)*:

[Adult Version#1, 9.16.15.pdf](#)

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s).

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The

research proposed in this study is categorized under the following expedited review category:

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing.

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

A handwritten signature in black ink that reads "John A. Schinka, Ph.D." The signature is written in a cursive, flowing style.

John Schinka, Ph.D., Chairperson
USF Institutional Review Board

Appendix B:

List of Stimuli Sentences

Spanish, English, Bilingual		
List 1	List 2	List 3
Fernando, dame otra capa para el sartén. Marta, dame otro cabo para la Hermosa. Enrique, dame otra copa para que aprendan. Bernardo, dame otro copo para el juguete. Jaime, dame otra quepa para la caridad. Bruno, dame otro quemo para la tarde. David, dame otra cuba para la canción. Valeria, dame otro cubo para lo mal. Lucia, dame otro campo para agosto. Daniela, dame otra cama para el jardín. Gavin, say a cobweb each aw. Dave, say a caboose each ase. Vance, say a coma each house. Danny, say a kabob each call. Casey, say a coffee each mouse. Nate, say a comma each pa. Joyce, say a copy each go. Becky, say a cabbie each piece. Mason, say a covey each April. Sandy, say a comet each doe.	Emilio, dame otro cabo para un día. André, dame otro cupo para la cara. Gabriel, dame otra quepa para que comen. Carmelo, dame otra cama para la cantidad. Bianca, dame otra copa para el redondel. Mario, dame otra quema para el jueves. Florencia, dame otro copo para más tarde. Pablo, dame otro quimo para la niña. Lucero, dame otro como para prepararte. Gustavo, dame otra coma para mayo. Tanya, say a kabob each law. Whitney, say a cabbie each bow. Edwin, say a caffeine each soiree. Chuck, say a comma each place. Fred, say a coffee each tide. Noah, say a commit each bun. Hannah, say a comet each monsoon. Ivan, say a combo each ma. Autumn, say a coffin each flood. April, say a covet each grid.	Carlos, dame otra coma para mi edad. Reyes, dame otro campo para la familia. Damián, dame otro cupo para la calidad. Felipe, dame otro quemo para el piel. Diego, dame otro cubo para la pared. Luz, dame otro como para el viernes. Andrea, dame otro quimo para la calidad. Sergio, dame otra cuba para el sábado. Leandro, dame otra capa para lo normal. Jose, dame otra quema para abril. Kelly, say a copy each foe. Annie, say a covey each straw. Judy, say a coffin each subway. Betty, say a commit each time again. Matt, say a combo each holiday. Cindy, say a covet each vase. Tina, say a cobweb each case. Wes, say a caboose each foray. Eddie, say a coma each girl. Charlie, say a caffeine each fall.

Ethel, say a commit each cold. Ivan, dame otra quema para la información. Chad, say a caffeine each child. Fran, say a combo each full moon. Vicente, dame otro cupo para el ratón. Mariana, dame otra coma para la mañana. Hank, say a covet each ceramic mold. Iris, say a coffin each sunray. Susana, dame otro quimo para el sol. Ángel, dame otro como para mi suegra.	August, say a coma each fold. Christian, dame otro cubo para los usuarios. Eva, dame otra capa para el paquete. Aiden, say a copy each scenario. Gill, say a cobweb each day. Gael, dame otra cuba para la humanidad. Fernanda, dame otro campo para julio. Dean, say a covey each row. María, dame otro quemo para el desayuno. Nancy, say a caboose each mile.	Frank, say a comet each rainbow. Val, say a cabbie each crawl. Joanna, dame otra copa para el domingo. George, say a coffee each fan. Julio, dame otro cabo para las fresas. Paula, dame otro copo para la muñeca. Wayne, say a comma each hurrah. Tomas, dame otra cama para los huevos. Chase, say a kabob each burrow. Ana, dame otra quepa para enero.

English, Spanish, Bilingual		
List 4	List 5	List 6
Gary, say a cobweb each van. Vick, say a caboose each spoon. Cathy, say a coma each bureau. Adam, say a kabob each June. John, say a coffee each raw. Ben, say a comma each word. Mike, say a copy each meal. Seth, say a cabbie each May. Tom, say a covey each fopaux. Wanda, say a comet each straw. Samuel, dame otra capa para lunes. Sebastián, dame otro kabo para septiembre. Carmen, dame otra copa para el almuerzo. Nicola, dame otro copo para junio. Alonso, dame otra quepa para que sepan. Reina, dame otro quemo para los investigadores. Dante, dame otra cuba para la felicidad. Roberto, dame otro cubo para que aprende. Pilar, dame otro campo para el igual. Isaac, dame otra cama para mi edad.	Nicky, say a kabob each saw. Chance, say a cabbie each base. Frank, say a caffeine each house. Harry, say a comma each call. Ira, say a coffee each mouse. Otto, say a commit each pa. Eva, say a comet each go. Gus, say a combo each piece. Dan, say a coffin each April. Vicky, say a covet each doe. Ignacio, dame otro kabo para el sarten. Valentino, dame otro cupo para la Hermosa. Minerva, dame otra quepa para que aprendan. Yolanda, dame otra cama para el juguete. Jorge, dame otra copa para la caridad. Marco, dame otra quema para la tarde. Alfredo, dame otro copo para la cancion. Javier, dame otro quimo para lo mal. Santiago, dame otro como para agosto. Alejandro, dame otra coma para el jardin.	Fabian, say a copy each law. Heidi, say a covey each bow. Ilene, say a coffin each soiree. Aubrey, say a commit each place. Avery, say a combo each tide. Guy, say a covet each bun. Violet, say a cobweb each monsoon. Carrie, say a caboose each ma. Asher, say a coma each flood. Jim, say a caffeine each grid. Rafael, dame otra coma para un dia. Yuliana, dame otro campo para la cara. Elizabeth, dame otro cupo para que comen. Isadora, dame otro quemo para la cantidad. Bautista, dame otro cubo para el redondel. Luciano, dame otro como para el jueves. Victoria, dame otro quimo para más tarde. Catalina, dame otra cuba para la nina. Nicolas, dame otra capa para prepararte. Christobal, dame otra quema para mayo.

Nick, say a commit each foe. Julián, dame otra quema para la familia. Ann, say a caffeine each subway. Ken, say a combo each time again. Veronica, dame otro cupo para la calidad. Daniel, dame otra coma para el piel. Evan, say a covet each holiday. Steve, say a coffin each vase. Cecilia, dame otro quimo para la pared. Elsa, dame otro como para el viernes.	Bob, say a coma each case. Isabella, dame otro cubo para la calidad. Rosa, dame otra capa para el sábado. Mel, say a copy each foray. Ted, say a cobweb each girl. Israel, dame otra cuba para lo normal. Natalia, dame otro campo para abril. Hailey, say a covey each fall. Beatrice, dame otro quemo para la información. Emma, say a caboose each cold.	Bonnie, say a comet each child. Maggie, say a cabbie each full moon. Lola, dame otra copa para el raton. Sam, say a coffee each ceramic mold. Esteban, dame otro kabo para la mañana. Francisco, dame otro copo para el sol. Tony, say a comma each sunray. Benjamin, dame otra cama para mi suegra. Will, say a kabob each fold. Ricardo, dame otra quepa para los usuarios.