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THE EFFECTS OF FACIAL CUES ON SENTENCE COMPREHENSION FOR MONOLINGUAL AND BILINGUAL LISTENERS: AN ERP STUDY

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ABSTRACT

In our growing global society, cross-cultural interactions are increasing which implies that many people are communicating through a common language but with differing accents. Recent research indicates that foreign-accented speech, relative to native-accented speech, affects the neural correlates of sentence comprehension for semantic and grammatical information (Grey &Van Hell, 2017). A question that arises is whether additional cues to speaker identity, such as facial information, change the neural effects found for foreign-accented speech. In a recent sociolinguistic study, McGowan (2015) found that when the face of the speaker coincides with the nature of the accented speech, listener performance on foreign-accented sentence transcription in noise improves. Additionally, recent research utilizing the fMRI technique found that face cues facilitate bilinguals' picture naming when the socio-cultural identity of the face was congruent with the language participants had to name the pictures in (Li, Yang, Scherf, & Li, 2013). These findings suggest that nonlinguistic cues, and faces in particular, can influence language processing.

The current study extends prior work by Grey and Van Hell (2017) on accented speaker identity by adding an additional non-linguistic cue to identity: the faces of the two speakers. Using the event-related potential (ERP) technique, the current project investigated the ERP correlates of semantic and syntactic processing during foreign- and native-accented sentence comprehension in monolingual native listeners and bilingual non-native listeners. Through measurement of the P600 response to pronoun errors and the correct equivalents, grammar processing was assessed. The N400 response was analyzed to index sensitivity to semantic anomalous relative to semantically correct sentences. The study was conducted with two groups of listeners: adult non-native Spanish-English bilinguals tested in Granada, Spain, and adult native English monolinguals tested in Central Pennsylvania. Both groups heard sentences that contained errors in grammar (English subject pronouns) or semantic meaning, or were matched correct sentences. These sentences were spoken by a non-native Chinese-accented English speaker and a native

American English-accented speaker. Listeners were not informed about accentedness of the two speakers, but were presented with an Asian face and a Caucasian face at the beginning of the comprehension task.

The addition of a face cue to speaker identity influenced the pattern of results for the neural correlates of grammatical and semantic processing. For the English monolingual listeners, pronoun errors elicited a P600 and semantic errors elicited an N400 in the native English-accented condition. In the non-native Chinese-English accented condition, there were no effects for pronoun processing, and an N400 with a delayed onset for semantics. For the Spanish-English bilingual listeners, who listened to these sentences in their second language English, there were no significant effects for pronoun mismatches in either accent condition, suggesting the bilinguals were not sensitive to the grammatical errors in their second language. For semantics, there was an N400-like response to semantic errors for both accent conditions. These patterns suggest that facial information of speaker identity combined with foreign- and native-accented speech has differential effects on monolingual listeners' and bilingual listeners' sentence processing.

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Chapter 1 Introduction

In our growing global society, the frequency of cross-cultural interactions continues to increase which implies that people are often communicating through a common language with differing foreign accents. Global networks are found across many disciplines, such as international business, medicine, and airline communication. Also in the United States, an increasing number of people frequently interact with foreign-accented speakers. In 1980, 23.1 million people spoke a language other than English at home in the United States, but 30 years later there has been a 158 percent increase in L2 speakers of English (59.5 million people in 2010) while the overall population has only grown 38 percent (U.S. Census Bureau, 2013).

Behavioral and neurocognitive research has found that foreign-accented speech impacts listeners' comprehension (Bent & Holt, 2013), but studies have also found that listeners use foreign-accented speech as a cue to adjust sentence comprehension processes (e.g., through increased tolerance to grammatical errors known to be common in these foreign-accented speakers; Hanulikova, Van Alphen, Van Goch, and Weber, 2012; Van den Brink, Van Berkum, Bastiaansen, Tesink, Kos, Buitelaar, Hagoort, 2012). However, these studies examined listeners who themselves are multilingual or who are regularly exposed to foreign-accented speech. A recent study testing monolingual speakers in Central Pennsylvania with little exposure to foreign-accented speech found that foreign-accented speech (i.e., Chinese-accented English) affects the neural correlates of sentence comprehension for semantic and grammatical information, and that speech comprehension did not markedly improve after a one-hour exposure to foreign-accented speech (Grey & Van Hell, 2017). Moreover, 30% of these monolinguals were unable to identify the nature of the foreign accent (here: Chinese-accented English), while another 11% actually believed that the foreign-accented speaker had a speech impairment (Grey & Van Hell, 2017). These first findings support the importance of research on foreign-accented speech comprehension, especially in predominately monolingual communities in which speakers have relatively little exposure to foreign-accented speech, such as Central Pennsylvania. A further question that arises is whether additional nonlinguistic cues to speaker identity, such as facial information, can impact the comprehension of foreign-accented speech.

1.1 Foreign-accented sentence comprehension in studies using the ERP technique

Neuropragmatics research on foreign-accented speech and sentence processing in different types of listeners has used the Event Related Potentials (ERP) technique. Before reviewing the most relevant studies for my thesis, I will describe the key ERP components in this type of research. The ERP technique measures highly precise temporal information on the neural activity related to sentence processing (for a review, see Swaab, Ledoux, Camblin, & Boudewyn, 2012). ERP studies on language processing typically employ the well-established violation paradigm (Kaan, 2007), in which the electrophysiological brain response to language errors, such as semantic anomalies or grammatical violations, is compared to correct items.

The P600 is a common ERP component found in response to violations of grammar (e.g., Osterhout & Nicol, 1999). The P600 typically has a posterior scalp distribution, occurs around 500-900ms post-stimulus onset, and is generally interpreted as reflecting reanalysis or repair processes during language comprehension (e.g., Kaan, 2007). In my thesis, I examined the grammatical processing of pronouns (*Peter had a lot of homework but he/she* was still in a very good mood.*). Pronouns have elicited P600s in some studies (e.g., Filik, Sanford, & Leuthold, 2008). In other studies, pronouns have elicited an Nref effect (e.g., Grey & Van Hell, 2017; Nieuwland, 2014). The Nref is a frontal negativity that occurs in the range of 270ms–1500ms post-stimulus onset. The P600 is considered to reflect generic grammatical processing, but the Nref is interpreted as reflecting a search in memory for the proper antecedent of the pronoun or attempts at resolving referential ambiguity induced by the pronoun violation (e.g., Nieuwland, 2014; Van Berkum, Zwitserlood, Bastiaansen, Brown, & Hagoort, 2004). Regarding semantic processing, violations of lexical/semantics typically elicit an enhanced N400; an example of a sentence with a semantic violation used in my thesis is: *Anna stapled the entire stack of papers/salads* together before closing the box*. The N400 is a negativity with a central-posterior scalp distribution that occurs around 300-500ms post-stimulus. The N400 effect is taken to reflect lexical/semantic access and integration processes (for a review see Kutas & Federmeier, 2011).

To date, there have been only a handful of studies that examined the neural correlates associated with the processing of sentences produced in a foreign accent or a native accent (Goslin, Duffy, Floccia, 2012; Grey & Van Hell, 2017; Hanulikova et al., 2012; Romero-Rivas et al., 2015; 2016). Only two of these studies examined both grammatical and semantic information during sentence processing (as I did in my thesis), and these studies will be discussed below.

Hanulikova et al. (2012) conducted a study in which Dutch participants were exposed to a foreign accent, Turkish, they were highly familiar with. Participants listened to Dutch sentences that could contain semantic anomalies or grammatical errors (gender agreement errors) as well as correct control sentences produced by a native or a Turkish-accented speaker; the type of gender agreement errors tested are common errors in the speech of Turkish-accented speakers of Dutch. An N400 effect was found for semantic violations in both accent conditions, whereas grammatical errors elicited a P600 only in the native-accent condition. In the foreign-accent condition, grammatical violations did not elicit any type of neural response relative to grammatically correct sentences. The authors explain their results by arguing that listeners who are familiar with the speaker's identity can adapt their expectations regarding the types of errors that are likely to be produced by this foreign-accented speaker and have an increased tolerance towards grammatical errors that are commonly made in these speakers. In contrast, semantic violations, which are less common in foreign speakers with high L2 proficiency, are processed in the same way in both native and foreign accents. In this study, the Dutch native listeners were familiar with the foreign accent, but it is also highly likely that, given the foreign language curriculum in the Dutch educational system, they had learned multiple languages at school and had reached a high level of proficiency at least in one foreign language, English. Their prior language learning experience, and their own experience as accented speakers of foreign languages, may make them more tolerant towards grammatical errors in foreign-accented speech, and their results may thus not generalize across all listeners confronted with foreign-accented speech.

To examine how monolingual speakers with little to no experience with foreign-accented speech process foreign-accent speech, and more generally how speaker identity as a social cue plays a role in language comprehension, Grey and Van Hell (2017) tested monolingual listeners with little exposure to foreign accented speech. They were presented with English sentences spoken with a Chinese-English accent and American-English accent while their brain activity was recorded using the ERP technique. Sentences contained a syntactic violation (pronouns) or a semantic violation, or did not contain any violations. ERPs showed different patterns of results for semantic and grammatical processing when listening to foreign and native accented speech. For semantics, listeners showed an N400 for both types of speech, but it was reduced and delayed in the foreign accent condition. For grammar, listeners showed a frontal negativity to errors spoken by the native accented speaker, but no effects for the foreign accented speaker. A follow-up analysis in which the data were separately analyzed for the group of participants who could and could not identify the foreign accent showed that the 36% listeners who correctly identified the foreign accent as being an Asian foreign accent demonstrated sensitivity to pronoun violation for the foreign accented speaker. Specifically, these listeners showed an N400. The participants who could not identify the foreign accent showed no sensitivity to pronoun violations. The ERP responses to the semantic errors showed similar results for the two group of listeners, a late negativity. This research indicates that foreign-accented speaker affects the neural correlates of sentence comprehension for semantic and grammatical information in monolingual listeners, but the pattern of effects differs depending on whether or not the listeners are able to identify the foreign accent.

For my own study, an additional cue was supplemented to speaker identity: faces of the two speakers. The addition of faces to the speech signal will show listeners they are listening to an Asian person or a Caucasian person. The addition of a visual cue to the study is presented in the beginning of the task with two images of the speakers' faces. I hypothesize that the visual cue will boost the impact speaker identity will have on language comprehension, in particular the comprehension of foreign accented speech. By presenting a face with each auditory voice the participants now have two cues to the identity of the speakers: a linguistic cue (accent) and a non-linguistic cue (face that indicates the speakers' ethnicity).

1.2 Foreign-accented speech and face cues

The linguistic information encoded by a speaker's accent is not the only cue that listeners can use to identify a native or non-native speaker. Face information may serve as an extra-linguistic cue for non-native (foreign-accented) speech (McGowan, 2015; Li, Yang, Scherf, & Li, 2013; Zheng & Samuel, 2017).

Listeners' use of social information in speech perception was analyzed in listeners who were presented with a Chinese-accented voice alongside a facial image of a congruent Chinese face, an incongruent Caucasian Face or an uninformative silhouette (McGowan, 2015). Each participant was presented with a facial image of the proposed speaker, they then listened to 60 English sentences spoken by a Chinese-English accented speaker. Listeners were asked to type as accurately as possible what they hear. When the listeners were presented with congruent facial and auditory information, the transcription accuracy increased. These results show that activation of a social category (such has facial cues) raise activation of speech perception.

McGowan found that the congruency of the auditory and visual facial images increases the transcription accuracy of the listener. Zheng and Samuel (2017) expanded upon previous research that stated that seeing an Asian face makes American English sound more accented – further analyzing whether this effect is perceptual or made at a later decision stage. The study by Zheng and Samuel (2017) showed that static images of Asian and Caucasian faces paired with auditory stimuli can alter participant self-reports about the accentedness of the auditory speech associated with the photos. In a second experiment, participants watch Asian-face and Caucasian- face videos. Participants' perception of accented speech was tested using the auditory stimuli with the continuous presentation of the static facial image in comparison to the Asian versus Caucasian videos –which reduced the demand on specific characteristics of the facial images. Although the perception of accented words was present in the static facial images paired with the auditory sentences, there was no adaptation effect with the added visual information of the videos (Zheng & Samuel, 2017). These results add to the findings of McGowan (2015) by demonstrating that visual information can affect the interpretation of the accented speech but not one's perception of accented speech.

Previous studies by McGowan (2015) and Zheng and Samuel (2017) used behavioral measures as the primary methodology for collecting their data. Li, Yang, Scherf, and Li (2013) used the fMRI technique to investigate similar research themes. Chinese- English bilinguals were presented with facial images of Asian or Caucasian faces. The bilinguals then had to name the picture in their first or second language, and the facial image was either congruent or incongruent to the naming language. The results showed that face cues facilitate naming when the identity of the face was congruent with the naming language. The results of this fMRI study support the idea that listeners integrate lexical and facial cues. The study reported in my honors thesis builds on this finding by adding facial cues to the foreign-accented and native-accented sentences.

The study reported in my honors thesis extends prior work by Grey and Van Hell on accented speaker identity by adding an additional non-linguistic cue to identity: the faces of the two speakers. Using the event-related potential (ERP) technique, the current project investigated the ERP correlates of semantic and syntactic processing during foreign and native-accented sentence comprehension in multiple groups of listeners. Two groups of listeners are tested: adult non-native Spanish-English bilinguals tested at the University of Granada, Spain, and adult native English monolinguals. Through measurement of the P600 response to pronoun violations, grammar processing was assessed. The N400 response was analyzed as part of semantic processing. Participants were provided facial images of the Chinese-English accented and English accented speakers during the introduction to the sentence listening task. This is the first study that examines the integration of linguistic cues (accented speech) and visual cues (faces) using ERPs.

1.3 Foreign-accented speech and sentence comprehension in the first and the second language

One participant group in the experiment that was conducted for my honors thesis includes American-English monolingual listeners who listened to sentences in their first language (produced by a foreign-accented and a native-accented speaker). However, in an increasingly global society, there are quite a number of bilingual speakers (e.g., Spanish-English bilinguals) who listen to sentences in their second language (such as the language in this study: English) produced by speakers who have a different foreign accent than their own (e.g., Chinese-accented English). This second group of bilingual listeners studied are hearing the auditory stimuli in their non-native language (English), but like the monolinguals who are hearing the auditory stimuli in their native language, they have little exposure to Chinese-accented English (as their live in Spain). Moreover, the bilinguals are listening to an accent (Chinese-accented English) that is incongruent with their own accent (Spanish-accented English).

Few studies addressed the question how bilingual speakers process sentences in their second language produced by speakers with a different accent than their own (Lev-Ari, Heugten, & Peperkamp, 2017; Weber, Di Betta, & McQueen, 2014). Past research has provided evidence that foreign accented speech is generally harder to understand than native accented speech. Moreover, the less proficient an individual is in another language, the less likely they are to have precise representations of that other language, and therefore less deviant non-native productions are perceived (Lev-Ari et al., 2017). Lev-Ari et al. (2017) tested native French speakers' perception of Dutch words spoken by native and accented (non-native) speakers of Dutch following a short or longer Dutch word learning session. The idea is that after the longer Dutch word learning session, French speakers develops a higher proficiency of Dutch, so there is a greater chance of recognizing the learned words spoken by a native speaker of Dutch as compared to a second language learner of Dutch (who speaks Dutch with a foreign accent). When a larger vocabulary base exists for the French speaker, the improvement in language comprehension is greater when listening to a native Dutch speaker than a foreign-accented one. The process of second language acquisition is related to an increased difficulty in understanding a foreign accented speaker of that language (Lev-Ari et al., 2017). In my current study, two groups of listeners are tested; English monolinguals from State College, Pennsylvania and Spanish-English bilinguals from Granada, Spain. Based on the study by Lev-Ari et al. (2017), I hypothesize that the English monolinguals will have more difficulty perceiving the errors produced by the Chinese-accented speaker of English. Additionally, the Spanish-English bilinguals will not differentiate the American-accented and the Chinese-English accented speakers of English because both are considered non-native accents –since they are not immersed in a primarily English language environment.

One other study examined bilingual listeners processing accented speech in their non-native language. Weber, Di Betta, and McQueen (2014) examined whether accent adaptation for the recognition of words, that are either genuinely accented or arbitrarily accented, depends of the language experience of the listener. In the experiment, an Italian speaker pronounced lengthened or shortened vowels in English words. Only the bilingual Italian-English listeners recognized both variants of the word while the native English monolinguals could only recognize the lengthened vowels. In the second part of the experiment, a native Italian speaker pronounced Dutch words that were genuinely accented or arbitrarily accented. In this case, the Dutch-English bilinguals recognized both variants of the words. The results of the study show that the non-native bilingual listeners (Italian-English and Dutch-English) could adapt to arbitrary accent markers better than monolingual listeners. Based on these results, I hypothesize that the bilingual group in the present study could also adapt to the errors of the foreign-accented speakers better than the monolinguals and therefore not show as strong of an ERP response to both semantic anomalies and pronoun mismatches. No studies to date have examined the neural correlates of whether Spanish-English bilinguals use facial cues of speakers whose accented speech they have little exposure to for facilitating their language comprehension of the non-native speech, using ERPs.

1.4 Current study: Research Questions and Hypotheses

Using the event-related potential (ERP) technique, the current project investigated the ERP correlates of semantic and syntactic processing during foreign and native-accented sentence comprehension in monolingual native listeners and bilingual non-native listeners. The central question this study addressed is whether additional non-linguistic cues to speaker identity, i.e., facial information, change the neural effects found for the comprehension of foreign-accented and native-accented speech? To examine this central question, the research reported in this thesis addressed three more specific research questions.

1. Do listeners use facial information as a cue during online sentence comprehension of native and foreign accented speech?

   Both groups of listeners (see question 2) will use facial information as a cue during online sentence comprehension.

2. Are the effects of facial information similar between native monolingual listeners and non-native bilingual listeners?

   The effects of facial cues may be more apparent in response to foreign accented errors in the monolingual native listeners than in the bilingual listeners, as measured by the magnitude, timing, and distribution of ERP effects (Nref, N400, and P600).

3. Are the effects of facial information similar for semantic and grammatical information?
   The effects of facial cues may be stronger for grammar than for semantics in both groups of listeners.

The addition of a face cue identifying the speaker to sentences produces in foreign-accented and native-accented speech may affect listeners' sensitivity to grammatical and semantic violations in foreign-accented versus native-accented speech. More specifically, with the face cue in addition to the accent information, I predict that ERPs will become more similar for the foreign accent and native accent conditions in the monolingual native listeners: frontal negativity for grammar and similar N400s for semantics. For the Spanish-English bilingual listeners, I predict that the facial cue will also affect the ERPs, but since they are listening in their non-native language (English) the results may not show that much a difference, because the facial cues may not help the listener that much when listening to non-congruent foreign accented speech.

Chapter 2 Methods

2.1 Participants

Two groups of participants were tested, monolinguals and bilinguals. The monolingual group that was tested included 38 monolingual native English participants from Penn State University –college students living in a highly monolingual context. Eleven participants were excluded due to high percentages of poor recordings in the raw electroencephalogram (EEG) data. The remaining 27 participants (Mean age = 18.73, *SD* =0.80) were included in the analyses. All participants were right-handed as assessed by an abridged version of the Edinburgh Handedness Inventory (Oldfield, 1971), and none reported a history of learning, hearing, or neuropsychological disabilities. The participants were not studying a foreign language at time of testing and none reported daily interactions with foreign-accented speakers.

A group of 27 Spanish-English bilinguals who are non-native listeners were tested in Granada, Spain. Ten participants were excluded due to high percentages of poor recordings in the raw EEG data. The remaining 17 participants (Mean age = 24.1, *SD*=2.51) that were analyzed had proficiency in both Spanish and English languages. The bilinguals' language learning history and proficiency in Spanish and English languages are shown below in Tables 1 and 2. All participants were right-handed as assessed by an abridged version of the Edinburgh Handedness Inventory (Oldfield, 1971), and none reported a history of learning, hearing, or neuropsychological disabilities.

Table 1. Age and Exposure of Spanish-English Bilinguals

	Mean	*SD*
Age	24.1	2.51
Age of formal exposure to English	6.53	2.12
Number of years of formal English study	16	3.93
Age of first exposure to English	6.58	3.28

Table 2. Proficiency in Spanish and English Languages of the Spanish-English bilinguals

	Mean	*SD*
English Speaking	7.29	**1.31**
English Understanding	8.17	**1.42**
English Reading	8.41	**1.58**
English Writing	7.5	**1.46**
Spanish Speaking	9.64	**.61**
Spanish Understanding	9.88	**.33**
Spanish Reading	9.88	**.33**
Spanish Writing	9.88	**.33**

2.2 Materials

The sentence listening task used the same stimuli as Grey and van Hell (2017). All sentences were pre-recorded by two female speakers, one with a native accent (standard American English) and one with a foreign accent (Chinese-English accent). The 480 stimuli in the study consisted of declarative sentences that were grammatically and semantically well-formed, or had an error in English subject pronouns (he/she; example 1a below) or semantics (were semantically anomalous; example 1b below).

1.*Example Sentences*

a. **Pronoun Sentence**:

Thomas was planning to attend the meeting but he/she* missed the bus to school.

b. **Semantic Sentence**:

Kaitlyn traveled across the ocean in a plane/cactus* to attend the conference.

Based on the research conducted by Hanulikova et al. (2012) which examined the common Turkish-Dutch speaker production error of grammatical gender agreement, the common grammatical error that was used for the target foreign accented speech condition of Chinese-English accented speech was subject pronouns. This continues to be a common error produced by Chinese-English bilinguals, even after years of immersion in English speaking environments (Johnson & Newport, 1989).

Correct/error and native/foreign accented sentences were distributed throughout 4 experimental lists; each list containing 240 sentences (Latin-square list design). Of the 240 sentences, half of the sentences were spoken by a Standard American English accented speaker and half were spoken by a Chinese English Accented Speaker. Within each speaker condition, 60 sentences were grammatically (30) and semantically (30) correct while the other 60 contained errors (30 target grammatical errors, 30 semantic errors). There were 48 comprehension questions throughout the task to check the participants' understanding of the sentences. During the EEG task, the sentence stimuli were presented as an auditory sentence listening task.

Participants were told that they were going to listen to two speakers talk about their friends' lives. Participants were provided facial images of the Chinese-English accented and American-English accented speakers during the introduction to the sentence listening task. The images used in the McGowan (2015) study have subtle differences that were removed for the Penn State study; the two females wore different colored shirts and had different facial expressions. In order to remove any confounding variables, the facial images in the ongoing study have the same dress and similar facial expressions –besides their racial differences, the facial images look relatively similar. The participants were then introduced to 10 friends of the speakers (5 female, 5 male names); no mention was made of foreign accent, grammar or semantics.

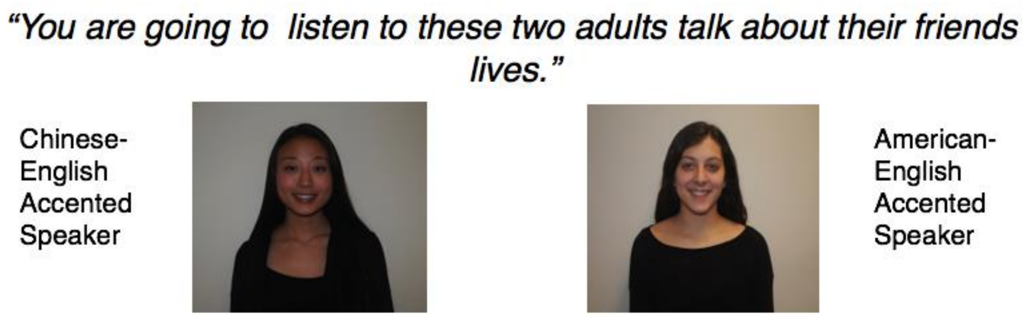

Figure 1. Replica of the screen shown to each participant at the beginning of each task.

2.3 Procedure

Participants attended a single session of approximately 2.5 to 3 hours in length. After providing informed consent, the participants completed an extensive background survey which discussed their handedness, language experience, socio-demographic information, and neuropsychological background. Participants then moved to a sound-attenuated room where they sat in a chair to perform the sentence listening task with the EEG cap on their head. Before beginning the full experiment of 240 sentences, participants read the instructions and listened to a practice set of sentences. The participants were asked to minimize eye movements and blinks during the listening portion of the task. After the EEG portion, participants concluded the session with a series of behavioral tasks that measured cognitive and language abilities. These tasks included: the debriefing and language attitudes questionnaires, a working memory task (automated operation span task, O-span; Unsworth, Heitz, Schrock, & Engle, 2005), an arrow-based Flanker task (Eriksen & Eriksen, 1974), verbal fluency (Luo, Luk, & Bialystok, 2010), the MELICET English proficiency test, Raven's Standard Progressive Matrices (Raven & Court, 1998) and an Implicit Association Task. These behavioral tasks measuring cognitive and language abilities were administered to quantify participants' cognitive and verbal abilities, and, if necessary, to include these as a co-variate in the analyses. Collecting these data is particularly important because I recruited participants from two different populations (i.e., monolingual students at Penn State University and bilingual students at the University of Granada, Spain).

2.3.2 Language Attitude Survey

A language attitude survey was administered to each participant to measure the explicit attitudes towards foreign languages and accents. This survey consisted of 30 statements such as “When I hear someone speak with an accent that is different from my own, I expect to have difficulty understanding them” and “I would work well in a professional or school environment with a person who speaks with a foreign accent.” The participants ranked these statements on a scale from 1 = “do not agree at all” to 10 = “agree completely”.

2.3.3 Debriefing Survey

After the participants completed the sentence listening task (the EEG portion of the session), participants completed a debriefing survey which asked whether they detected a difference in the accents of the two speakers. If the participants selected that they did indeed hear a difference, they then needed to identify to their best ability the accents of the two speakers. The following questions asked the level of difficulty it was to understand each speaker as well as the degree of each accent (on a scale from 1 to 7).

2.3.4 Working Memory Task: Automated Operation Span Task (O-span)

The Automated Operation Span (O-Span) test (Unsworth, Heitz, Schrock, & Engle, 2005) was used to test the participants’ working memory ability. The task contained three parts. First, letters appeared on the computer screen one at a time and the participants were required to recall the letters in the same order that they were presented. The letters appeared on the screen for 800 milliseconds. For the untimed recall, the participants were shown a 4X3 matrix of letters and had to select the letters in the correct order of being given. Second, the participant was presented with a simple solved arithmetic equation on the screen and needed to answer, as quickly and accurately as possible, if the solution provided on the following screen was correct. They used the mouse to click True or False to answer if the solved problem was correct or not. After each question, the participants were given feedback on their accuracy. In the last portion of the task, the letter recall and arithmetic equations were combined. After the screen of an arithmetic equation, the participant clicked to the screen for solving the math but was then shown a letter for recall. As the task progressed, the participants were encouraged to keep their math accuracy an average of 85% at all times. During the letter recall potion, an accuracy percentage was shown in the corner of the screen. At the end of the task, five scores are reported: Ospan score, total number correct, math errors, speed errors, and accuracy errors. The task takes about 20-25 minutes to complete.

2.3.5 Selective Attention Task: Flanker Task

Participants completed a selective attention task known as the Flanker task (Eriksen & Eriksen, 1974). They were presented with visual stimuli on the screen and had to respond by clicking on either side of the mouse. There were arrows presented on the screen facing left or right and the participants needed to click the left or right side of the mouse corresponding to the direction of the arrow. As the task continued, there were distractor arrows that the participants needed to ignore in order to complete the task correctly. The task included six subsets which increased or decreased in difficulty depending on the percentage of successful performance in the previous subsets. There was a practice session with feedback that occurred before each subtest so that the participants fully understood the task instructions for each individual subset. The overall Flanker task lasted for approximately 10-15 minutes.

2.3.6 Verbal Fluency Task

This task varied between the monolingual and bilingual participant groups. The English monolingual participants were instructed that they would be presented with a series of categories, and would have 60 seconds to say aloud as many items that belonged to that category as possible. The categories included: vehicles (practice sessions), fruits, clothing, furniture, and animals. They were recorded and their response were evaluated on every correct word that belonged to each category. The Spanish-English bilinguals were administered this same task which they needed to record their responses in English. After this portion, the bilingual group was given a second task with similar categories but this time they needed to say their items in Spanish. The categories for this additional task included: vehicles (practice session), body parts, colors, vegetables, and instruments. Their recorded responses in Spanish were analyzed the same in the English only task.

2.3.7 English Proficiency Task: MELICET

The Michigan English Language Institute College Entrance Test (MELICET) is an advanced English language proficiency test. It is used to test non-native speakers of English. In this study, both groups of participants completed this task. The portion of the test that has been adapted for this study is the language comprehension that contained conversational grammar, a cloze test, reading comprehension and vocabulary. All of the items were fill in the blank with multiple choice options and there were 50 items in total.

2.3.8 Raven's Standard Progressive Matrices

This task is used to measure abstract reasoning abilities. There are 36 items presented in order of easiest to more difficult. Each item is a matrix of geometric shapes with the bottom portion of the pattern missing. There are 6 or 8 pattern options for the participant to select the correct missing portion that will complete the matrix pattern. The participant clicks, using the mouse, the correct pattern piece and then moves on to the next matrix. The task usually takes about 15 minutes or however long to complete all 36 items. Every participant, both monolingual and bilingual groups, completed this task.

2.3.9 Implicit Association Task

This implicit measure of individuals' attitudes towards accented speech was the final behavioral task that the participants completed. This task was administered to reveal a possible relationship between the neural correlates of foreign-accented speech comprehension and listeners' attitudes towards foreign-accented speech. Participant was asked to rate words as Pleasant or Unpleasant, and they were also asked to rate names as to whether they sounded American-English accented or Foreign accented. As the task progressed, the categories of names and words were paired (e.g. press the 'e' key for any unpleasant words or foreign accented names). The response times of the participants were measured as an indicator of associations. Performance is faster with highly associated categories than with less associated ones (Greenwald et al. 1998).

2.3.10 EEG Acquisition and Analysis

During the sentence listening task, scalp EEG was recorded at a sampling frequency rate of 500 Hz from 32 Ag/AgCl active electrodes (extended 10-20 system; Jasper, 1958) using an elastic cap (Brain Products ActiCap, Germany). The EEG data was amplified with a Neuroscan Synamps RT system and was filtered online with a 0.05-100 Hz bandpass filter and off-line with a 30 Hz half- amplitude low-pass filter (24 dB/octave roll-off). Electrodes on the scalp were referenced online to a vertex point and referenced offline to the averaged activity of the left and right mastoids. Facial electrodes were placed on the outer side of the eyes and above and below the left eye. Impedances were kept below 5 kΩ.

This data was collected using an EEG measuring Event Related Potentials (ERPs). ERPs help capture neural activity related to cognitive and sensory processes, measuring an electro-physiological response to a stimulus. In this study, the stimulus is time locked to the onset of the critical word for each sentence. Through measurement of the time-window of 500-900 ms, a P600 was selected to represent a response to language errors, grammar processing was assessed. A P600 effect occurs to sentences that (a) contain a syntactic violation, (b) have a non-preferred syntactic structure or (c) have a complex syntactic structure (Osterhout and Holcomb, 1992). The N400 response was analyzed as part of semantic processing (Hanulikova et al. 2012). A time-window of 300-500 ms was selected to capture N400 which describes the context of semantic incongruity and are inversely related to the expectancy of a given word towards the end of a sentence (after given the precursor). The ERPs were averaged off-line for grammar and semantic target conditions in each participant.

Chapter 3 Results

3.1 Behavioral Task Results for English Monolinguals

The behavioral tasks were administered to measure the overall linguistic and cognitive abilities of the participants included in the study. Each task is presented accompanied by averaged mean and standard deviation scores of all 27 monolingual participants.

Table 3. Behavioral Task Result Averages for the English Monolingual Group (n=27)

Behavioral Task Analyzed	Mean	Standard Deviation
Automated OSpan Percentage	70.507	17.479
Flanker Effect	63.552	30.609
Flanker Accuracy Percentage	86.45	11.638
Verbal Fluency in English	50.375	6.473
Ravens Percentage	76.972	13.101
Ravens Raw Score	46.192	7.859
IAT Average Quotient	0.443	0.266
MELICET Score	43.423	3.613

3.1.1 Sentence comprehension for English Monolinguals

The English monolingual listeners (N= 27) showed high comprehension accuracy overall. Accuracy (in percentages) in the American English accented condition was *M* = 94.5 (*SD* = 4.1). Accuracy (in percentages) in the Chinese English accented condition was *M* = 92.4 (*SD* = 5.8). There was no significant difference, *p*=.072.

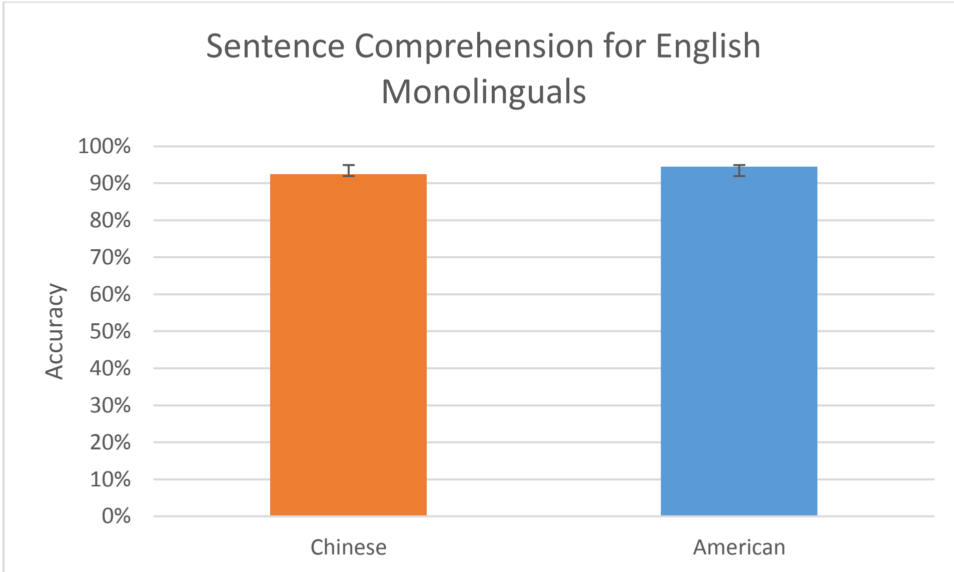

Figure 2. Sentence Comprehension Data for English Monolinguals

3.2 ERP Results for Monolinguals

3.2.1 Grammar

Accent (native, foreign) by Well-formedness (correct, error) by Distribution (anterior, central, and posterior) ANOVAs, for the 300-500ms and 500-900ms time windows, were conducted for the syntactic processing of the monolingual participants. For the 300-500ms time window, there are no 2-way or 3-way interactions. The effect of Accent, $F(1,26)=.066$, $p=.8$, $n_p^2= .003$ was not significant. For the 500-900ms time window, there is a significant effect in Well-formedness *x* Distribution ($F(2,52)=6.405$, $p=.003$, $n_p^2= .198$). Accent x Well-formedness is trending ($F(1,26)=3.241$, $p=.083$, $n_p^2= .111$) and there are no main effects. These results suggest a P600 in response to the syntactic error for the American-accented and Chinese-accented speaker conditions (Figures 3, 5).

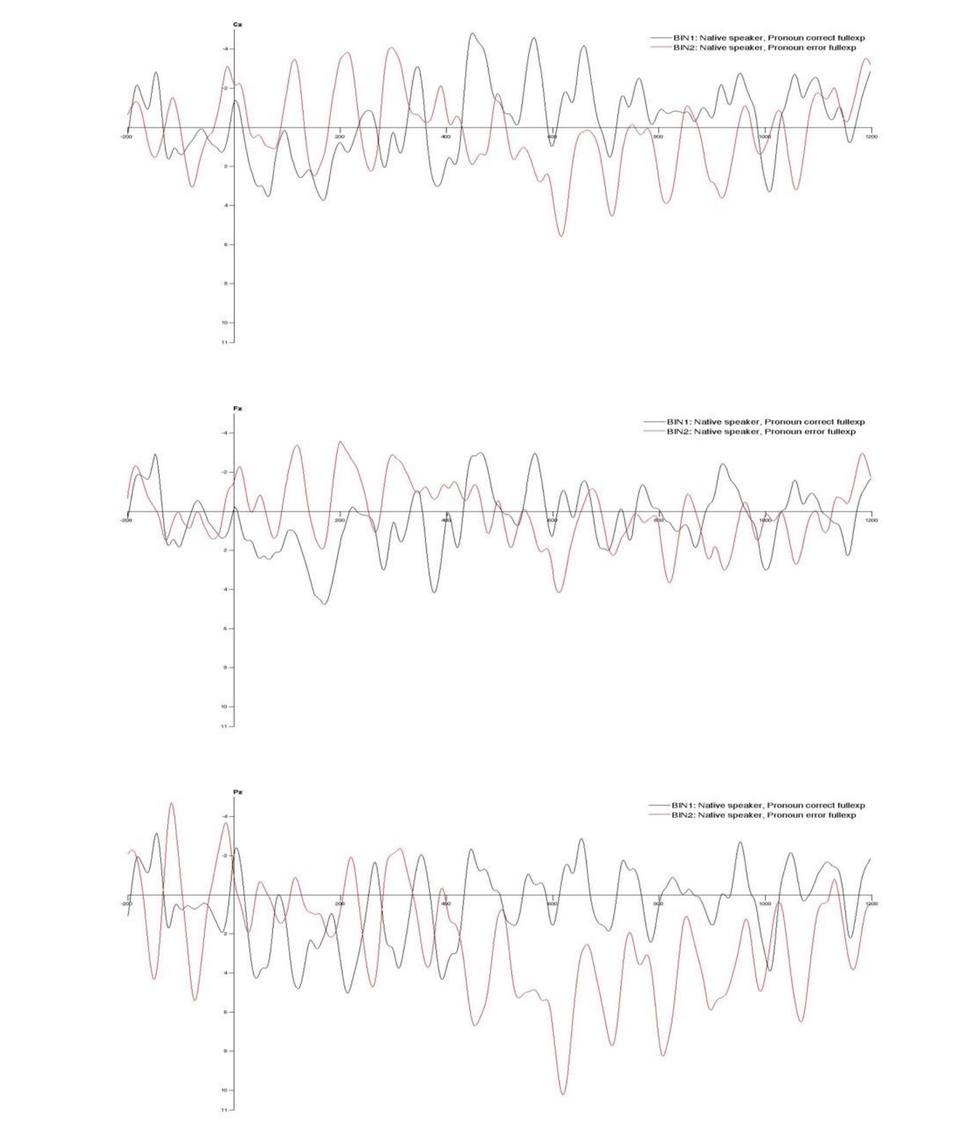

Figure 3. ERP Data of Syntactic Processing for English Monolinguals in the American English Speaker Condition: Analysis of FZ, CZ, PZ.

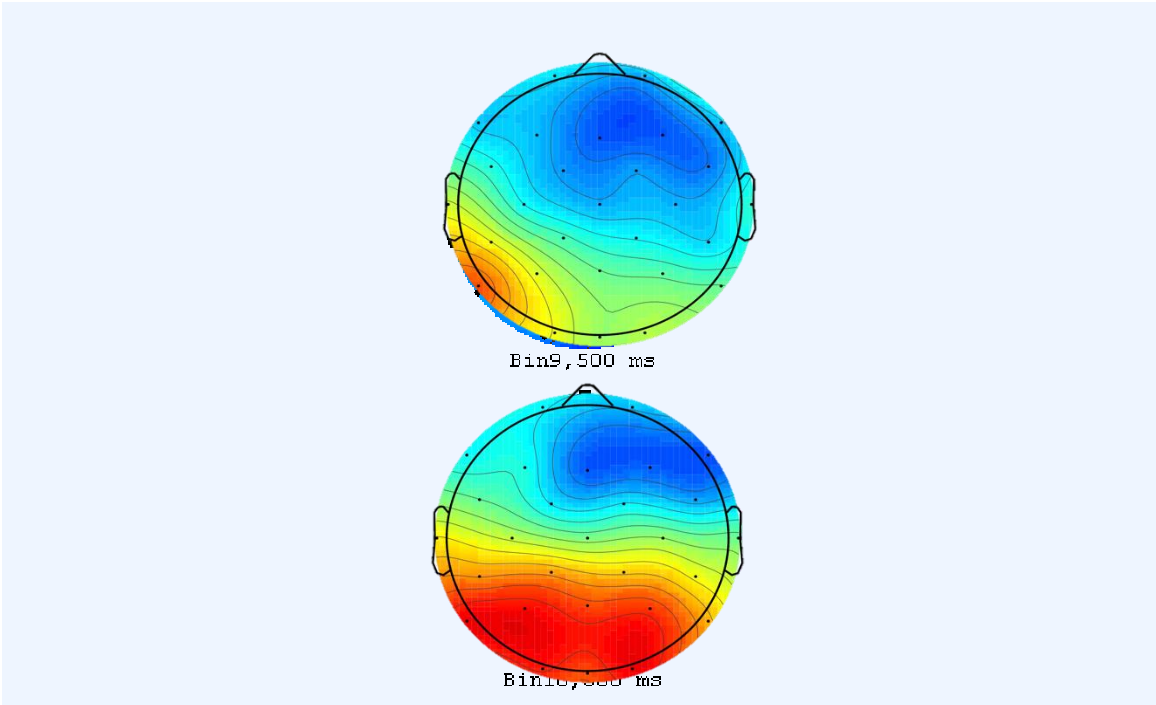

Figure 4. Topographic map that shows the distribution of activity in the syntactic error minus correct conditions for the American English accented speaker. Averaged for the 300-500ms time window and 500-900ms time window. Calibration scale is ±2 mV.

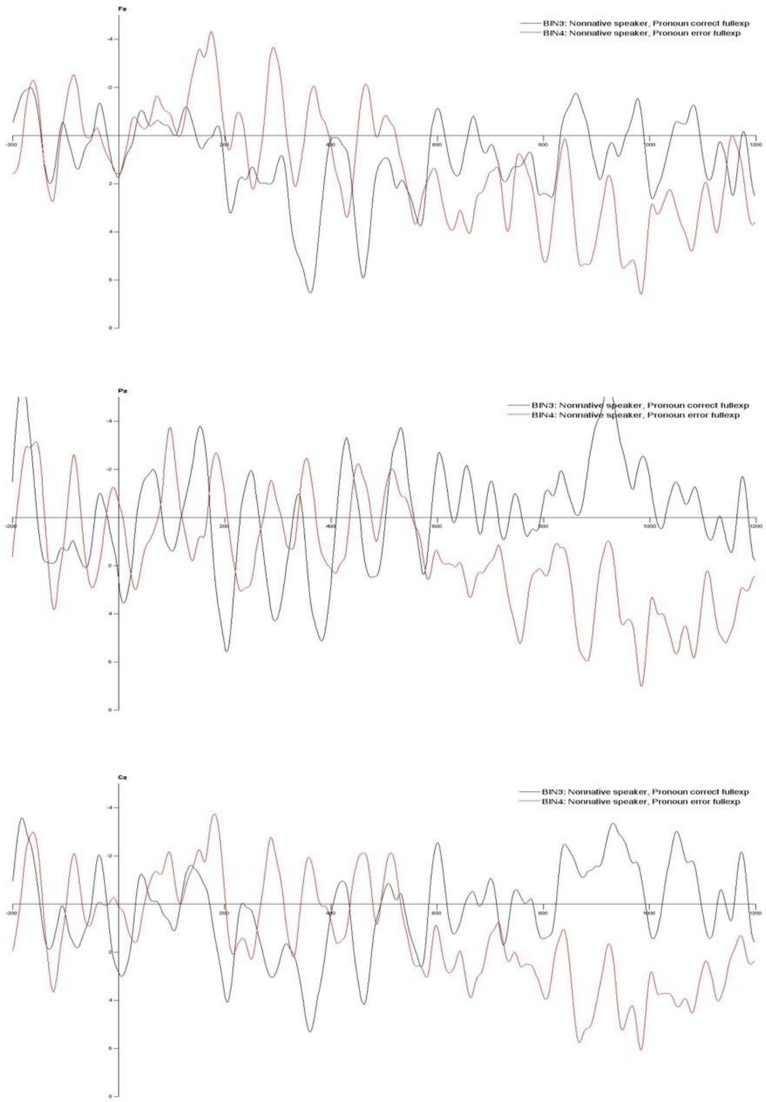

Figure 5. ERP Data of Syntactic Processing for English Monolinguals in the Chinese English Speaker Condition: Analysis of FZ, CZ, PZ.

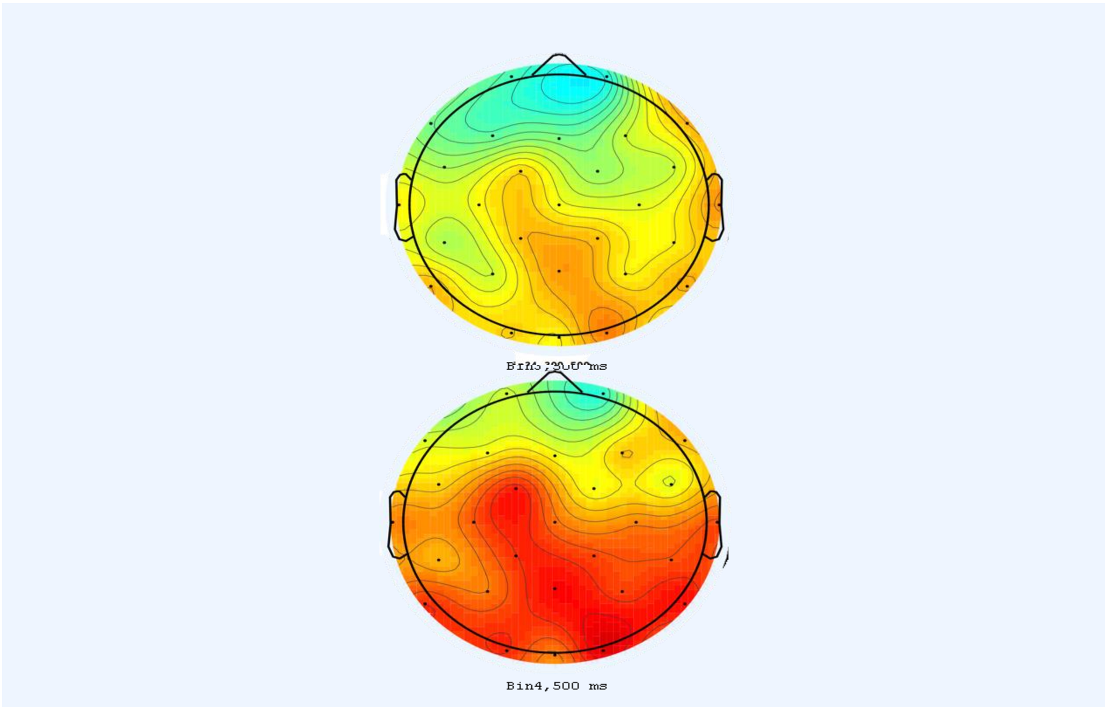

Figure 6. Topographic map that shows the distribution of activity in the syntactic error minus correct conditions for the Chinese English accented speaker. Averaged for the 300-500ms and 500-900 time windows. Calibration scale is ±2 mV.

3.2.2 Semantics

The results from the Accent (native, foreign) by Well-formedness (correct, error) by Distribution (anterior, central, and posterior) ANOVAs, for the 300-500ms and 500-900ms time windows align with the visual assessments of the ERP data. For the 300-500ms time window, the ANOVA showed no 3-way interaction between Accent x Well-formedness x Distribution; $F(2,52)=.918$, $p=.406$, $n_p^2= .034$. There was a significant interaction between Accent and Well-formedness ($F(1,26)=5.566$, $p=.026$, $n_p^2=$ .176). There was a main effect of Distribution ($F(2,52)=5.854$, $p=.005$, $n_p^2= .184$) and of Well-formedness ($F(1,26)=16.068$, $p<.0001$, $n_p^2=.382$). These analyses suggest an N400 response (see Figures 3 and 5), in the Chinese-accented and the American-accented conditions. For the 500-900ms time window, analysis shows a 3-way interaction between Accent x Well-formedness x Distribution, $F(2,52)=3.936$, $p=.026$,

n_p^2= .131. The interaction between Accent and Well-formedness is marginally significant, $F(1,26)=3.056$, $p=.092$, n_p^2= .105. The ANOVA showed a significant main effect of Distribution ($F(2,52)=14.086$, $p<.0001$, n_p^2= .351). Additionally, there remains a trend of Well-Formedness ($F(1,26)=3.129$, $p=.089$, n_p^2= .107). These analyses from the 500-900ms time window may suggest late negativity for the Chinese-English accented speaker condition (Figure 7).

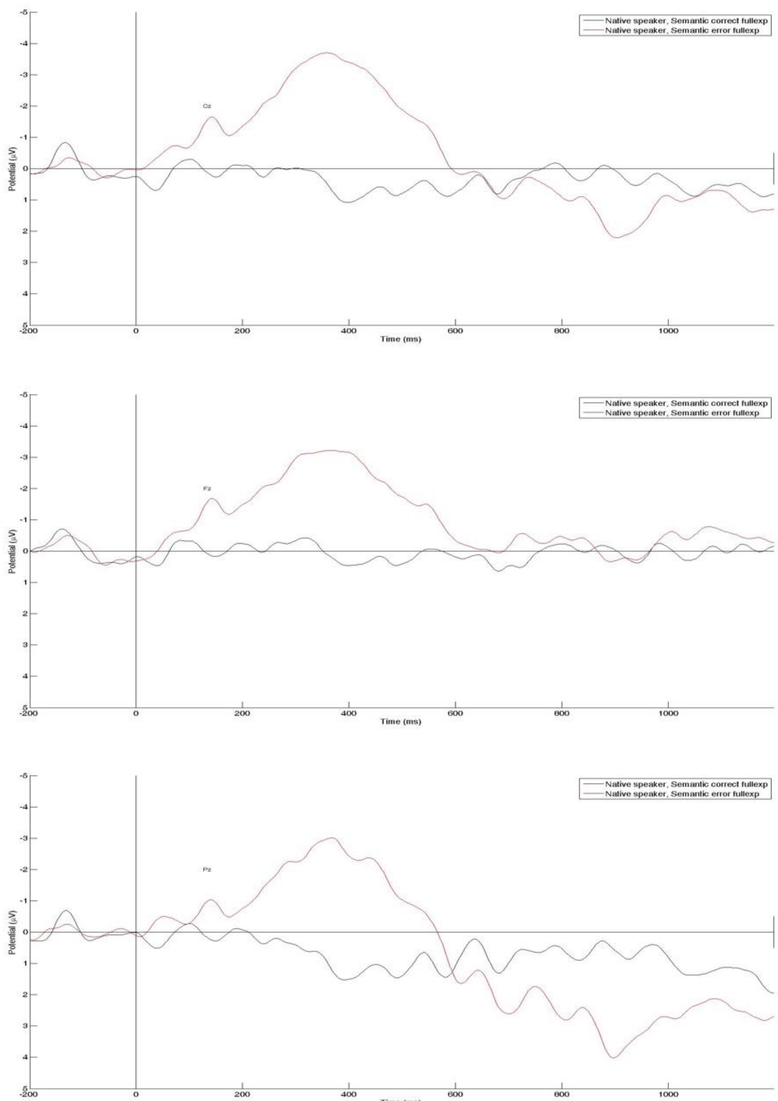

Figure 7. ERP Data of Semantic Processing for English Monolinguals in the American English Speaker Condition: Analysis of FZ, CZ, PZ.

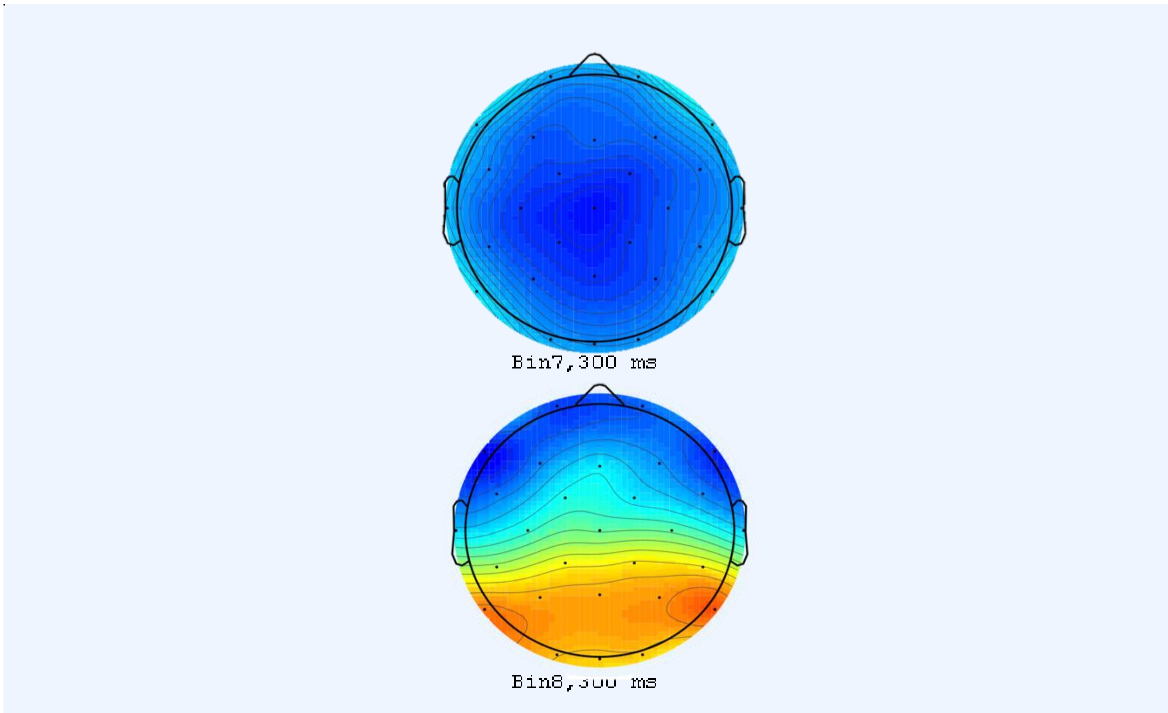

Figure 8. Topographic map that shows the distribution of activity in the semantic error minus correct conditions for the American English accented speaker. Averaged for the 300-500ms time window and the 500-900ms time window. Calibration scale is ±5 mV.

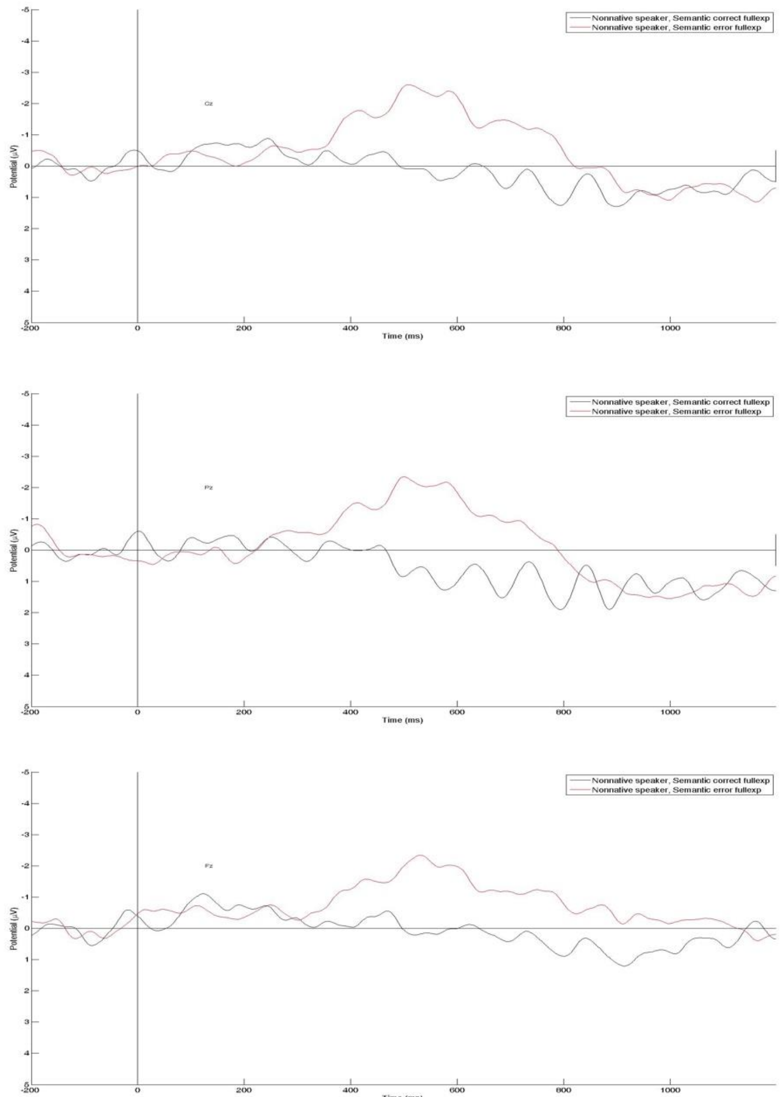

Figure 9. ERP Data of Semantic Processing for English Monolinguals in the Chinese English Speaker Condition: Analysis of FZ, CZ, PZ.

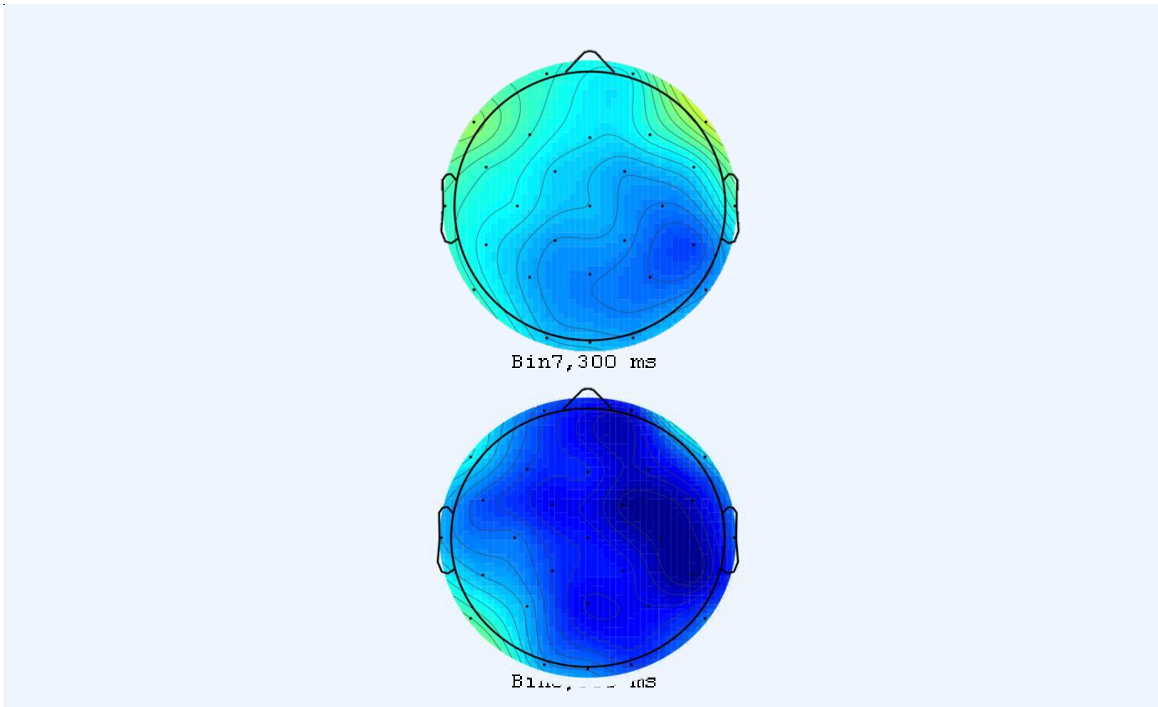

Figure 10. Topographic map that shows the distribution of activity in the semantic error minus correct conditions for the Chinese English accented speaker. Averaged for the 300-500ms time window and 500-900ms time window. Calibration scale is ±2 mV.

3.2.3 Language attitudes and ERP Effects

Pronoun errors elicited a P600 and semantic errors elicited an N400 (Figure 7 and 8) in the native English-accented condition. P600 to pronoun errors (as shown in Figures 3 and 5) in this study differs from the Nref (referential processing) observed in Grey and Van Hell (2017), who did not provide facial cues, so this suggests that the facial cue promoted grammatical (P600) rather than referential (Nref) processing. In the non-native Chinese-English accented condition there were no effects for pronoun processing.

In the Chinese-English accented condition there was an N400 with a delayed onset for semantics (as shown in Figures 9 and 10). This delayed N400 fits with the pattern from Grey and Van Hell (2017), suggesting that facial cues do not aid semantic processing. The absence of effects for grammar fit with related research showing that native listeners may not process grammatical information when they know the speaker is non-native (e.g., Hanulikova et al., 2012).

3.3 Behavioral Task Results for Spanish-English Bilinguals

The behavioral tasks were administered to measure the overall linguistic and cognitive abilities of the participants included in the study. These tasks were important to measure for the bilingual group to further support their proficiency of English. Each task is presented accompanied by averaged mean and standard deviation scores of all 17 bilingual participants.

Table 4. Behavioral Task Result Averages for the Spanish-English Bilingual Participant Group (n=17)

Behavioral Task Analyzed	Mean	Standard Deviation
Automated OSpan Percentage	66.165	18.464
Flanker Effect	61.266	24.875
Flanker Accuracy Percentage	82.438	2.139
Verbal Fluency in English	41.588	9.994
Verbal Fluency in Spanish	52.235	13.363
Ravens Percentage	83.028	12.372
Ravens Raw Score	49.824	7.418
IAT Average Quotient	0.289	0.274
MELICET Score	35.111	10.448

3.3.1 Sentence Comprehension for Spanish-English Bilinguals

The Spanish-English bilinguals tested in Granada also showed that they understood the sentence stimuli task (number of participants is 15 when analysis was completed). Accuracy in American English accented condition was M = 70.4 (SD = 26.4). Accuracy in Chinese English accented condition was M =

70.7 (*SD* = 29.5). There was no significant difference, $p = .485$. Both the English Monolinguals and Spanish-English Bilinguals had reasonably high comprehension of the two accented speakers.

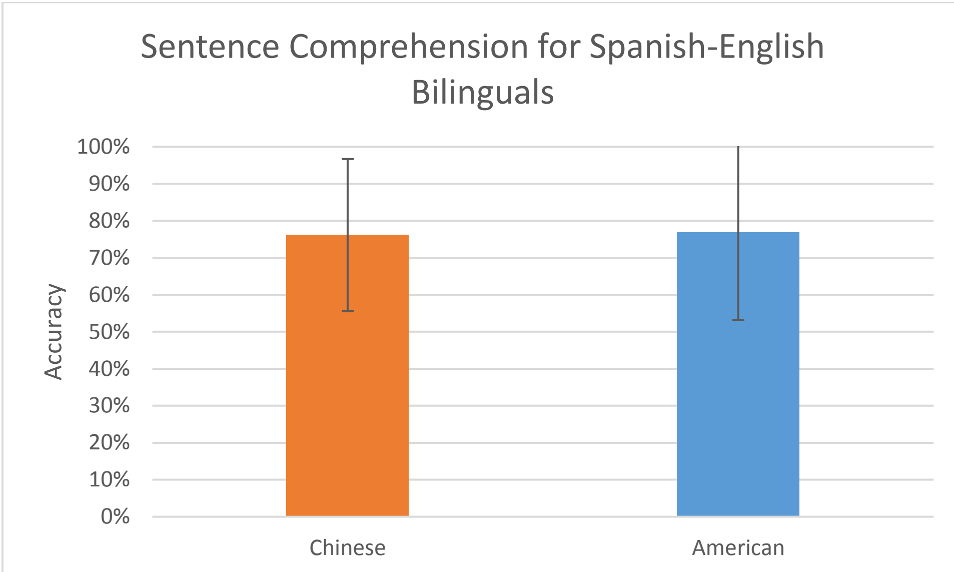

Figure 11. Sentence Comprehension Data for Spanish-English Bilinguals

3.4 ERP Results for Spanish-English Bilinguals

3.4.1 Grammar

ANOVAS were completed for syntactic processing of the Spanish-English bilinguals for Accent x Well-formedness x Distribution for both the 300-500ms and the 500-900ms time windows. Analysis of the data between both time windows elicited no interactions or main effects. This aligns with the visual analyses of ERP data –no clear responses from the pronoun errors produced by either speaker for the Spanish-English bilingual participant group.

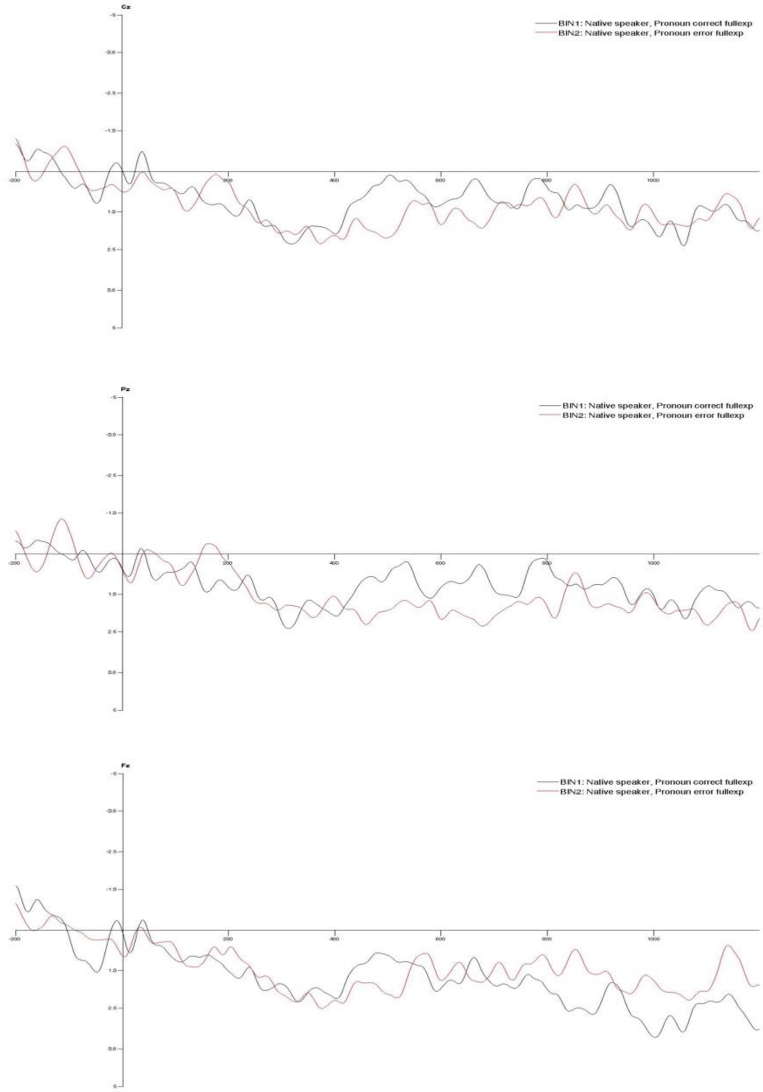

Figure 12. ERP Data of Syntactic Processing for Spanish-English Bilinguals in the American English Speaker Condition: Analysis of FZ, CZ, PZ.

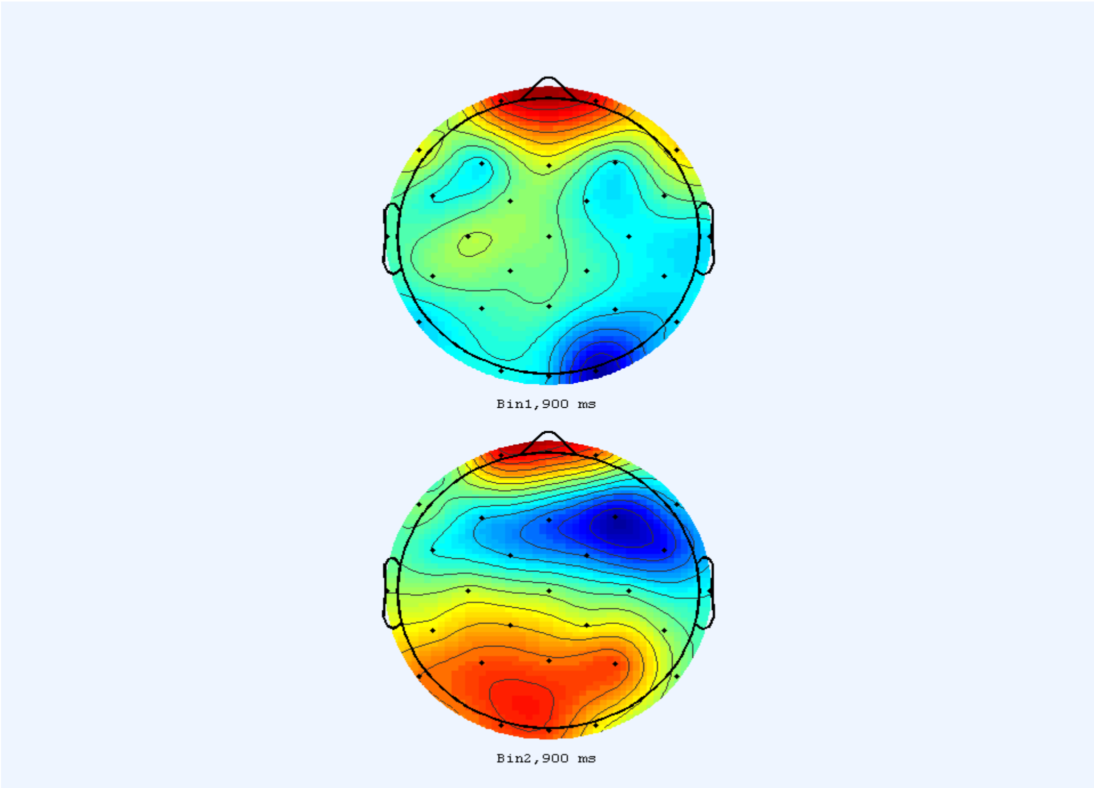

Figure 13. Topographic map that shows the distribution of activity in the syntactic error minus correct conditions for the American English accented speaker. Averaged for the 900ms time window. Calibration scale is ±2 mV.

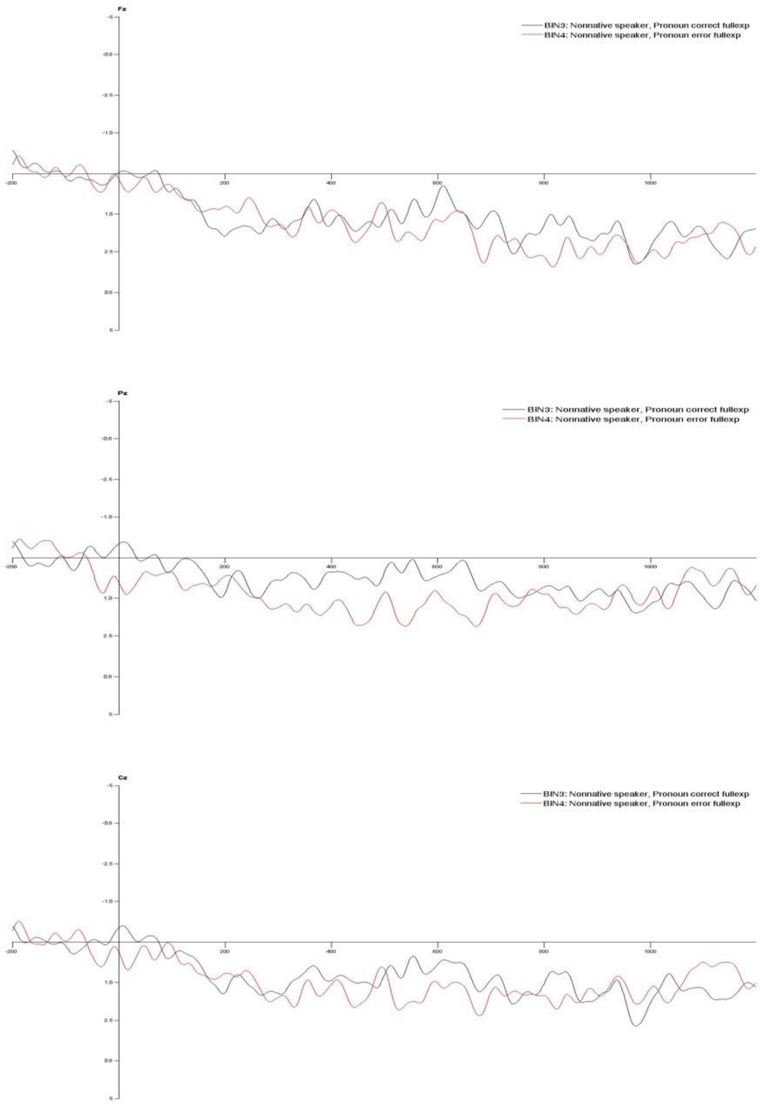

Figure 14. ERP Data of Syntactic Processing for Spanish-English Bilinguals in the Chinese English Speaker Condition: Analysis of FZ, CZ, PZ.

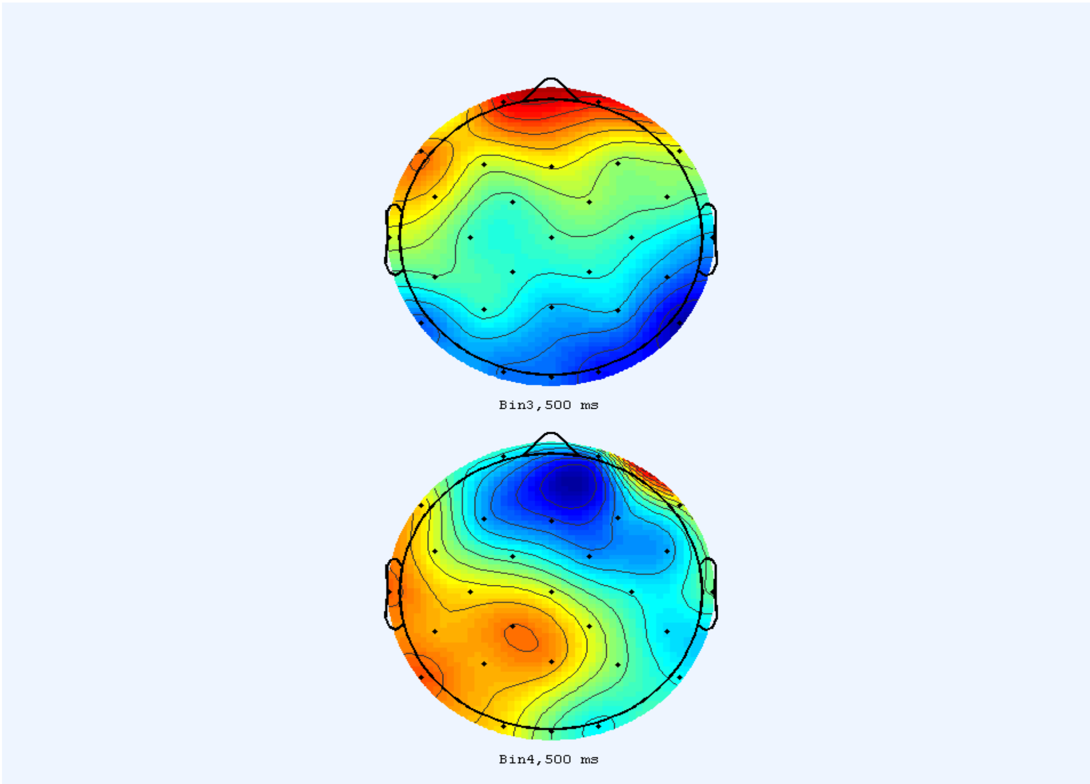

Figure 15. Topographic map that shows the distribution of activity in the syntactic error minus correct conditions for the Chinese English accented speaker. Averaged for the 500ms time window. Calibration scale is ±2 mV.

3.4.2 Semantics

Accent (native, foreign) by Well-formedness (correct, error) by Distribution (anterior, central, and posterior) ANOVAs, for the 300-500ms and 500-900ms time windows were assessed for the semantic processing of the Spanish-English Bilingual participants. For the 300-500ms time window, there is no 3-way interaction between Accent x Well-formedness x Distribution. There is a main effect for Well-formedness, $F(1,26)=4.460$, $p=.050$, $n_p^2= .208$. These analyses support the visual inspection of an N400-like response (Figure 12 and 13). For the 500-900ms time window, there is a 3-way interaction between Accent x Well-formedness x Distribution ($F(2,52)=3.620$, $p=.038$, $n_p^2= .176$). This further supports the N400-like response elicited that could also be interpreted as a late negativity (Figure 14 and 15).

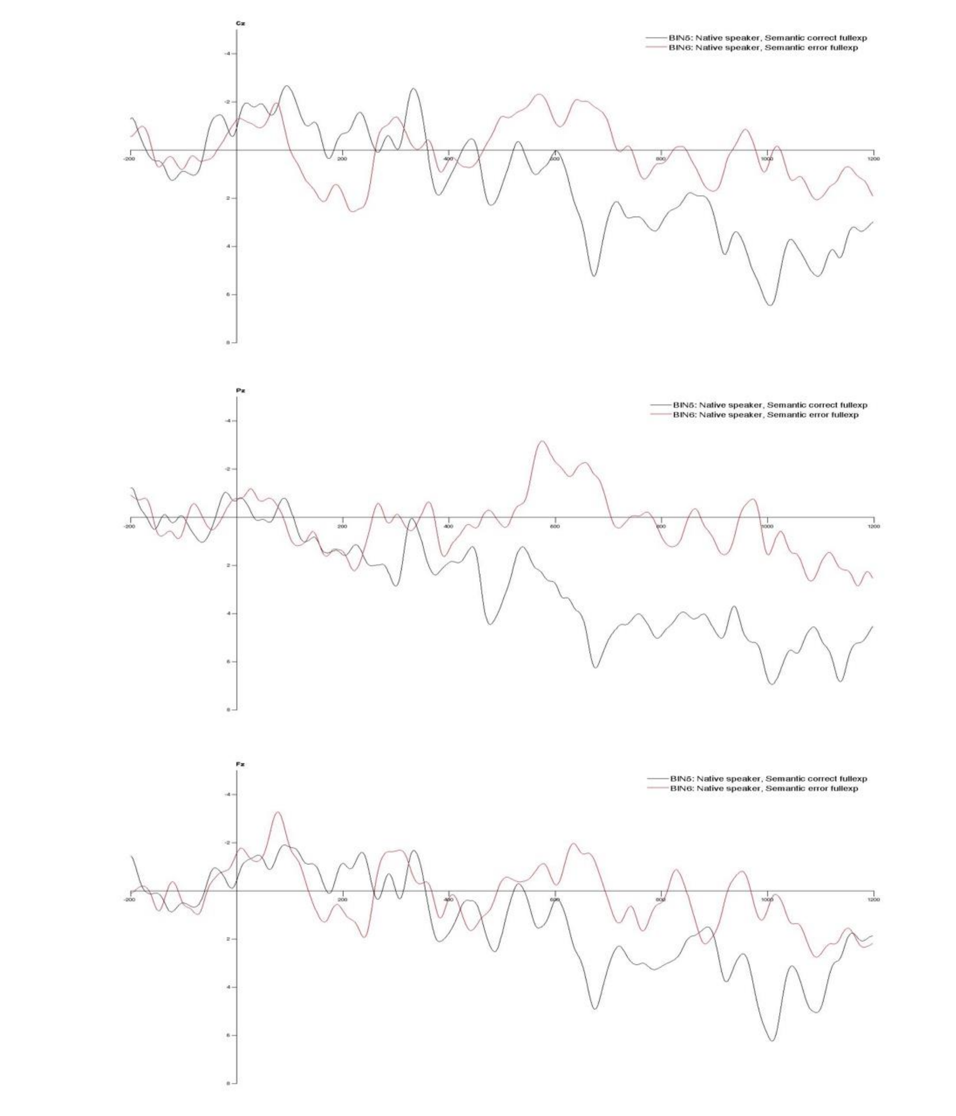

Figure 16. ERP Data of Semantic Processing for Spanish-English Bilinguals in the American English Speaker Condition: Analysis of FZ, CZ, PZ.

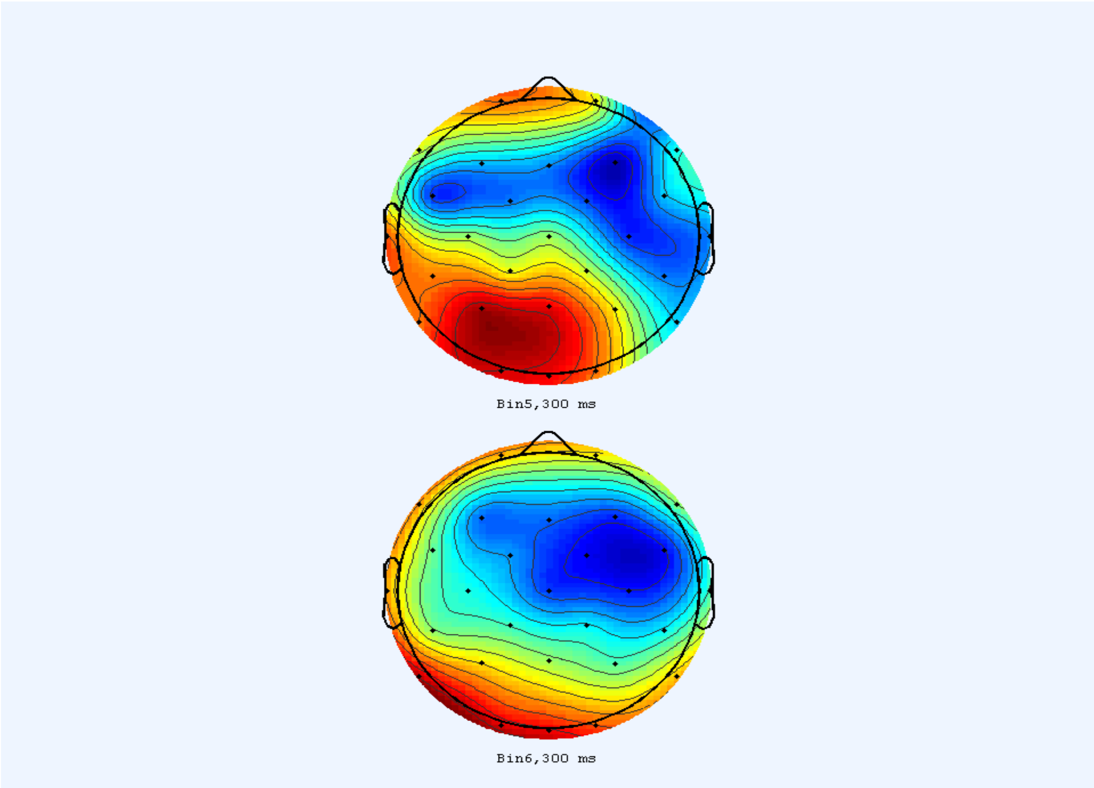

Figure 17.Topographic map that shows the distribution of activity in the semantic error minus correct conditions for the American English accented speaker. Averaged for the 300ms time window. Calibration scale is ±2 mV.

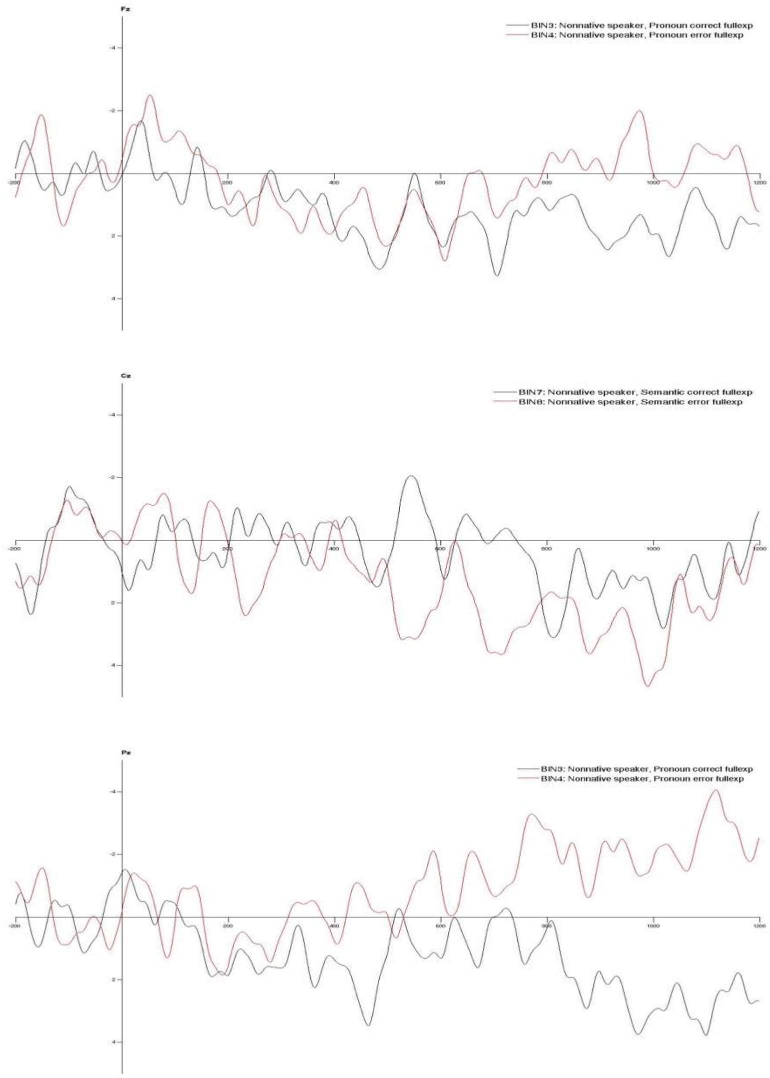

Figure 18. ERP Data of Semantic Processing for Spanish-English Bilinguals in the Chinese English Speaker Condition: Analysis of FZ, CZ, PZ.

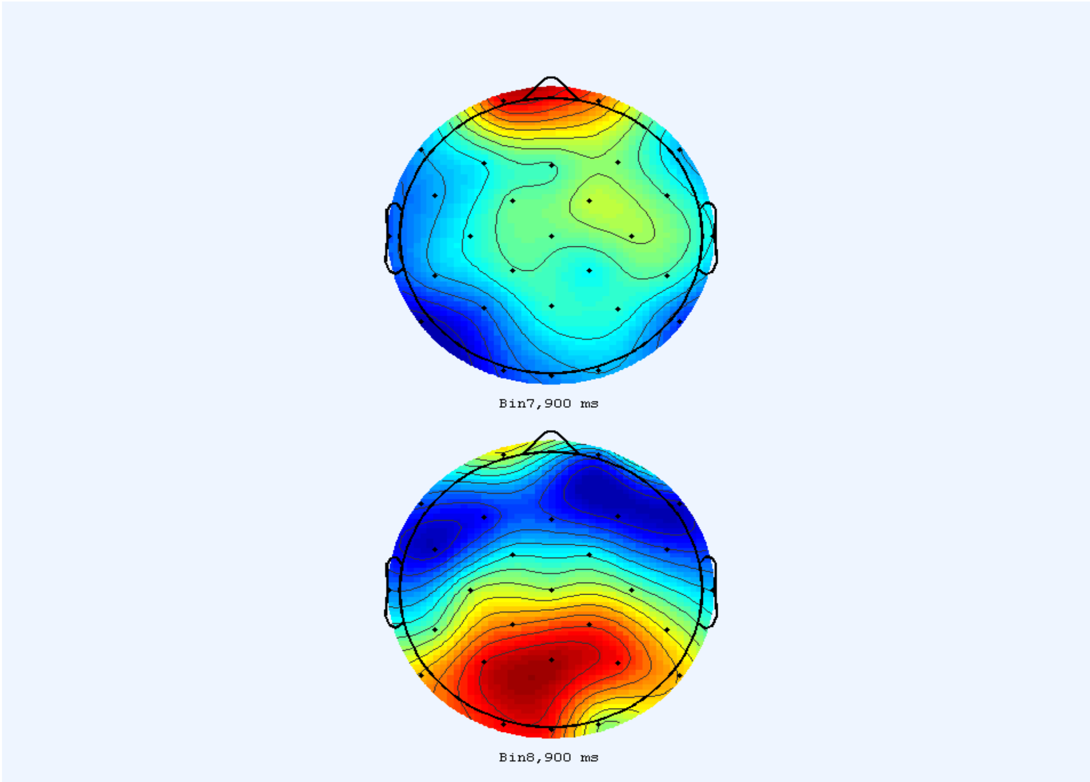

Figure 19. Topographic map that shows the distribution of activity in the semantic error minus correct conditions for the Chinese English accented speaker. Averaged for the 900ms time window. Calibration scale is ±2 mV.

3.4.3 Language attitudes and ERP Effects

There were no significant effects for pronoun mismatches in either accent condition. This indicates that the bilinguals were not sensitive to the grammatical error. These results align with the hypothesis because pronoun mismatches are common errors in Spanish English bilinguals (as well as Chinese English bilinguals).

For semantics, there was an N400-like response (as shown in Figure 16 and Figure 18) to semantic errors for both accent conditions. The Spanish-English bilinguals processed semantics similarly for both speakers. For the bilingual group, the face cue did not aid in either syntactic or semantic processing.

Chapter 4 General Discussion

The face cue, provided as non-linguistic information, had a different effect on the syntactic processing of the pronoun mismatches in English monolinguals as compared to Spanish-English bilinguals. Specifically, monolinguals demonstrated a P600 in response to pronoun violations in both the American-accented English speaker condition and the Chinese-accented English speaker condition. In contrast, the bilinguals showed no significant effects in response to pronoun violations in American-accented and Chinese-accented speech. Zooming in on the monolingual English listener data, the effect observed in the present study differs from the effect observed in the monolingual listeners tested by Grey and Van Hell (2017) who listened to speech without being presented with the facial cues. These listeners demonstrated only sensitivity to pronoun violations in American-accented speech (in the form of an Nref), but no sensitivity to pronoun violations in Chinese-accented speech. This suggests that English monolinguals utilize the facial cue signaling the speaker's ethnicity that was presented at the beginning of the task as an aid to processing speech produced by speakers with different accents.

The native English listeners, after presented with the facial cue, produce a strong N400 response to the semantic errors produced by the American English accented speaker. When the same type of semantic error is made by the Chinese-English accented speaker, a delayed N400 occurs. The initial response time to a semantic error is affected by the accented speech (native vs. foreign). The bilingual speakers' response to the semantic anomalies elicited by the two speakers resulted in an N400 like effect. This effect could also be interpreted as a later negativity –in which the Spanish-English bilinguals realized that there was an error in the speech later than the native listeners. The N400 effect differences between the Grey and van Hell (2017) study and the current study are less pronounced. However, the N400 with the additional facial cue is heightened as compared to the auditory alone stimulus. This more dramatic N400 could concur with McGowan's (2015) study showing that when sociolinguistic cues, such as face, coincide with the voice of the speaker, performance in comprehension (especially through noise or foreign accented speech) improves.

The results of the behavioral tasks and sentence comprehension for both native and foreign accented speech were comparable but not significantly different from each other. Accuracy in sentence comprehension was very high for both monolingual and bilingual listener groups. Within groups, there were no significant differences between sentence comprehension for the American-English accented speaker and the Chinese-English accented speaker. Between participant groups, overall sentence comprehension varied between the 90th percentile for native English listeners and 70th percentile for non-native English listeners. These results align with behavioral research showing that foreign accented speech is lower in comprehension when compared to native accented speech (Anderson-Hsieh & Koehler, 1988).

4.1 Previous Research Findings in Relation to the Present Study

As mentioned in the introduction, past research has provided evidence that foreign-accented speech is generally harder to understand than native-accented speech. The less proficient an individual is in another language, the less likely they are to have precise representations of that other language and therefore less deviant non-native productions are perceived (Lev-Ari, et al. 2017). Additionally, this study suggested that monolinguals would not be able to process foreign accented speech since they do not have significant exposure to the language. The English monolingual group had very little exposure to Chinese-accented speech based on their geographic area of living. As stated in the previous paragraph, the monolinguals did not demonstrate sensitivity to grammatical errors produced by the Chinese English accented speaker.

I now turn to discussing the bilingual listeners' data. Previous research analyzing bilingual's ability to use facial cues to aid in speech production (Woumans, Martin, Bulcke, Van Assche, Costa, Hartsuiker, & Duyck 2015) showed that faces can prime a language. Production of a language was faster when faces aligned with the expected spoken language. Based on the findings of this study, the Spanish-

English bilinguals can be expected to use facial images as cues to improve the processing of foreign-accented speech. However, Woumans et al. (2015) also found that once the faces are no longer strongly associated with the spoken language, they are no longer used as language cues. In the present study, the facial images were presented on the screen for only 30 seconds, at the beginning of the experimental task. The face cues were not reinforced following the initial showing. The short presentation of the faces at only the beginning of the study may have been too subtle to affect the processing of foreign-accented speech in the bilingual listeners (although it did affect processing in the monolingual listeners if we compare the present finding to those of Van Hell and Grey (2017)).

As discussed in the introduction, individuals who have less proficiency in another language are less likely to have precise representations of that other language (Lev-Ari et al., 2017). The predictions the Spanish-English bilinguals will not differentiate the two different accented speakers because both the Chinese-English accent and the American –English accent are considered non-native accents were supported by the results of this participant group. There were no significant effects for pronoun mismatches in either accent condition. In both accented conditions, the Spanish-English bilinguals were not sensitive to the grammatical error and produced an N400 like response for semantic anomalies. Additionally, during the debriefing after the EEG task, the bilinguals could not correctly identify the speakers. The bilingual group may not have had specific representations on the English language and therefore could not differentiate the linguistic errors between the two speakers.

Based on the results of Italian-English and Dutch-English non-native bilingual listeners processing accented speech by Weber, Di Betta, and McQueen (2014), bilingual listneres could adapt to arbitrary accented speech more so than the monolingual comparison group. My study further supports this research since the Spanish-English bilinguals, even with presentation of the facial cues of the speakers, did not show as strong of an ERP response to both semantic anomalies and pronoun mismatches which could indicate that they adapted to the errors of the foreign-accented speaker better than the English monolinguals that were tested.

Research analyzing the effect of foreign accent on listeners' syntactic processing typically focuses on syntactic structures that are not present in the foreign-accented speakers' native language (such as pronouns in Chinese) and are common in the foreign-accented speakers' usage of English. So, the ecological validity of these items is high. In what way do native listeners process grammatical errors that are common in foreign-accented speakers (Hanulíková et al., 2012)? Pronoun mismatches in sentences (as used in the present study) spoken by a native speaker were compared with the same errors spoken by a non-native speaker. Gender agreement errors in native-accented speech resulted in a P600 effect in Hanulíková et al. (2012), but there was no P600 response when these same violations were produced by a Turkish-accented speaker of Dutch; gender agreement errors are quite common in this type of speakers. For semantic violations, Hanulíková et al. (2012) observed N400 effects for both the native and non-native speaker conditions. Relevant for the current study, gender violations (or pronoun mismatches) are very common in Chinese-English bilinguals, but they also occur in the speech of Spanish-English bilinguals (Antón-Méndez, 2010). Possibly, this can explain why the Spanish-English bilinguals did not notice grammatical errors in either speaker accent condition.

Another reason why adding facial cues affected the sensitivity to pronoun violations in monolingual listeners (when comparing the present data to Grey and Van Hell, 2017), but not in bilingual listeners may be driven by the fact that none of the Spanish-English listeners correctly identified the Chinese-American English accent, as was shown in the post-experiment debriefing. In contrast, 48% of the monolingual listeners were able to correctly identify the identity of the foreign-accent speaker. It is not entirely clear why none of the Spanish-English bilinguals were able to correctly identify the foreign accent (not even when facial cues were presented at the beginning of the experiment), but general lack of experience with Chinese-accented speakers of English in their everyday live may underlie this inability. A parallel study that tested Dutch-English bilinguals who are living in the Netherlands also found that only 8% of the bilingual listeners were able to correctly identify the identity of Chinese-accented English (Grey, Schubel, McQueen, & Van Hell, in revision). The present debriefing result, combined with that of

Grey et al.'s (in revision) Dutch-English bilingual listeners, aligns well with work on foreign accent perception and intelligibility in L2, which has found that L2 listeners do not uniformly perceive strong accent differences between foreign- and native-accented speech (e.g., Munro, Derwing, & Morton, 2006), especially for accents they are unfamiliar with (e.g., Witteman, Weber, & McQueen, 2013).

4.2 Theoretical Implications and Suggestions for Future Research

The facial information of the two speakers has a stronger effect on monolingual listeners than bilingual listeners. This effect could be attributed to the ability to accurately identify the speakers. The 11 of the 27 monolingual adults included for the analysis of this study correctly identified the Asian accent. None of the Spanish-English bilinguals were able to identify the Asian accent, the majority of the participants thought the accent was a different dialect of English in the United States or Great Britain. The monolinguals who recognized the Asian face may have had a stronger response to the linguistic errors in the speech as they were able to integrate nonlinguistic cues (face) with linguistic cues (accent) to enhance their comprehension of foreign-accented speech. The number of participants in the monolingual listeners group was too low to conduct a reliable analysis separating the listeners who could identify (*n*=11) or could not identify (*n*=16) the foreign accent. The differential sensitivity to pronoun violations (but not semantic violations) in the listeners who could and could not identify the identity of the foreign-accent speakers (Grey and Van Hell, 2017) suggests that this follow-up analysis can provide more detailed insights into how the integration of facial cues and accent cues affects performance. Therefore, it is commendable to test additional participants to enable a reliable two-group analysis.

For future research, some changes should be made to this project to see if response patterns could be strengthened. First, the static facial images for the current study were only presented to the participants at the beginning of the task for 30 seconds. If the facial information was paired with the auditory stimuli and shown throughout the entire task, the identity of the speakers could be further reinforced.

Additionally, if the listeners were presented with videos of the speakers talking instead of static images, this could further strengthen the effect of face cues on the listener processing of foreign-accented and native-accented speech. Finally, to examine the impact of stereotypical biases of how faces relate to accented speech, a future project could also include mismatching the facial image of the speaker with the accent (e.g. having a Caucasian face with a Chinese-English accent or a Chinese face with an American-English accent).

The same methodology of this study could be used for different participant groups. The monolingual participants of the current study are between the ages of 18 and 22 years. To gain an age-related perspective, two aspects of the lifespan could be analyzed: children and older adults. By testing children, the study will be enhanced and given a developmental perspective on language processing. Children around the age of 5 begin to show friendship preferences for native-accented as compared to foreign-accented speakers (Kinzler, Dupoux, & Spelke, 2012). Additionally, 3 to 5 year olds show tendencies to use a native-accented identity as reference for trusting an informant (Kinzler, Corriveau, & Harris, 2011). This would be the first study analyzing the neural correlates of foreign-accented speech comprehension in monolingual children, and specifically address the question of whether children are (still) more flexible in adjusting to wider varieties of speech than monolingual adults, or whether they perform similar to adults at this age.

A study conducted to compare the effects of a novel accent on younger and older adult listeners primarily showed that older adults between the ages of 65-87 have much more difficulty depicting the novel accent as compared to younger adults between the ages of 18-41 (Adank & Janse, 2010). This study found that hearing impairments interfere with identifying the auditory speech sounds and therefore processing of the novel accent’s differences. Declining hearing acuity results in poorer language comprehension under peculiar situations such as foreign-accented speech. This idea is supported by a study by Fitzgibbons and Gordon-Salant (2010) with simple accented tone sequences. They found that older adults exhibited a reduced temporal sensitivity to the accent sequence component as compared to younger listeners. Extending Grey and Van Hell's (2017) methodology to include older listeners could provide results that align well with Fitzgibbons and Gordon-Salant's (2010) study and would provide more insight into how hearing impairment affects the comprehension of foreign-accented speech.

As the globalization market expands and the ability to speak more than one language fluently becomes a more widespread phenomenon, interactions among native and non-native language speakers will increase. In this study, the results showed that sentence comprehension for monolingual and bilingual listeners were not only influenced by foreign accented speaker identity but also non-linguistic cues such as facial information of the speaker.

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ACADEMIC VITA

ABIGAIL L. COSGROVE

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EDUCATION

The Pennsylvania State University **| Schreyer Honors College** **University Park, PA**

Bachelor of Arts in Psychology *Graduation: May 2018*

Bachelor of Arts in Spanish

Honors Thesis in Psychology (Advisor: Dr. Janet G. Van Hell):

The Effects of Facial Cues on Sentence Comprehension for Monolingual and Bilingual Listeners: An ERP Study

HONORS AND AWARDS

- Schreyer Honors College Academic Excellence Scholarship *Aug 2014 — Present*
- Dean's List (every semester) *Aug 2014 — Present*
- Partnerships for International Research and Education (PIRE) Fellowship *May 2016 — Jul 2016*
- Summer Erickson Discovery Grant *May 2017 — Sept 2017*

RESEARCH EXPERIENCE

Bilingualism and Language Development Lab **University Park, PA**

Research Assistant *Aug 2015 — Present*

- Work with Dr. Sarah Grey and Dr. Janet G Van Hell on the Neurocognition of Speech Comprehension Project to further clarify the impact of speaker identity on language comprehension
- Conduct behavioral and event related potential (ERP) experiments on monolingual and bilingual participants in response to grammar and semantic incongruencies
- Conducted statistical analyses on behavioral data behavioral and ERP data using MATLAB and E-Prime Processing
- Awarded Erickson Discovery Grant to independently study the effects of nonlinguistic facial cues for foreign-accented speaker identity in children

Development of Self-Regulation Lab **University Park, PA**

Research Assistant *Nov 2016 — Present*

- Work with Dr. Pamela Cole on the Development of Self-Regulation Project to capture the dynamic nature of self-regulation using intensive time-series data
- Analyze children's ability of self-control; how children stop themselves from reacting poorly to not getting what they want; managing those emotions in the context of fear, frustration
- Work with the ASEBA Software and Qualtrics Research Software; trained to look at the recorded videos and perform second by second standardized analysis of emotion; specifically, facial expressions and behaviors of the child and parents

Partnerships for International Research and Education (PIRE) **Granada, Spain**

Undergraduate Fellow as part of the Bilingualism and Language Development Lab *May 2016 — Jul 2016*

- Applied for and received a Partnerships for International Research and Education (PIRE) undergraduate fellowship, a National Science Foundation-sponsored grant awarded to the Center for Language Science at Penn State and The University of Granada, Spain
- Conducted independent research on foreign and native-accented sentence comprehension in monolingual and bilingual participants using ERP
- Troubleshoot the data using EPrime Processing, the results showed that sentence comprehension for monolingual and bilingual listeners were not only influenced by foreign accented speaker identity but also non-linguistic cues such as facial information of the speaker

CONFERENCES AND PRESENTATIONS

Undergraduate Exhibition **University Park, PA**

Poster Presenter *April 2018*

- Will present the methodology and analyzed results of the Erickson Grant Research project analyzing the neural responses to monolingual children in Central Pennsylvania in respect to foreign accented speech comprehension

American Association for Applied Linguistics Annual Meeting **Portland, OR**

Paper Presenter *March 2017*

- Grey, S., **Cosgrove, A.,** and Van Hell, J.G. *Face Cues to Speaker Identity Affect the Neural Correlates of Native- and Foreign-Accented Sentence Comprehension*
- Promoted the principled approaches to language related concerns, specifically in psycholinguistics and bilingualism

Psychonomic Society 57th Annual Meeting **Boston, MA**

Poster Presenter *November 2016*

- Grey, S., **Cosgrove, A.,** and Van Hell, J.G. *Face Cues to Speaker Identity Affect the Neural Correlates of Native- and Foreign-Accented Sentence Comprehension*
- Performed and promoted the basic science behavior in cognitive psychology, specifically in the language area

PSUxLING3 Meeting **University Park, PA**

Poster Presenter *October 2016*

- Presented a poster on the effects of facial cues on sentence comprehension for monolingual and bilingual listeners, an ERP study
- Discussed the methodology and analyzed results of the research conducted over the previous year in Granada, Spain and at Penn State University

LEADERSHIP EXPERIENCE

Love Your Melon Foundation **University Park, PA**

Ambassador, Vice President (Aug 2017-Present) *Sep 2015 — Present*

- Served as VP for an organization dedicated to giving half of the proceeds go to pediatric cancer research organizations such as the Cure Search and Pinky Swear Foundation
- Raise awareness through state-wide outreach events and social media posts for childhood cancer
- Represent the brand through promotions and sales events every week
- Personally engage with the national foundation’s charitable programming initiatives through hospital and family visits

Personality Psychology Course **University Park, PA**

Teaching Assistant *Jan 2017 —May 2017*

- Selected by Dr. Drais-Parillo to assist her in teaching a 200-level psychology course with 80 undergraduate students
- Organized and advised about 20 four person teams on case studies about personality attributes and disorders
- Graded and provided feedback on group projects and individual essay-based assignments

INTERESTS & ACCOMPLISHMENTS

- Proficient in the Spanish Language: reading, writing, speaking, and comprehension