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Graduate Student Transcription of Accented Speech

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COVINGTON, EMILY N., B.S. Graduate Student Transcription of Accented Speech. (2023) Directed by Dr. Alison R. King

Abstract

There are many speech sound differences between Standard American English and English spoken by an individual from a different language background, who speaks with an accent. The purpose of this study is to research graduate students' preparedness and ability to transcribe speech from varying cultural backgrounds. A transcription assessment was administered to current speech-language pathology graduate students with results compared to professionals in the field who completed the transcription based on both listening and spectrogram images. Graduate students were also surveyed regarding their phonetics education experiences. Overall, students were able to transcribe accented speech with 64.2% accuracy. Participants' transcription of consonants (78.1% accuracy) was significantly better than their transcription of vowels (49.1% accuracy). Students used diacritic markers with 0% accuracy. Participant accuracy scores were influenced by the number of phonetics courses they had previously taken, the number of speakers they had experience transcribing, and how comfortable they felt with phonetic transcription. Through analyzing graduate students' transcriptions of accented English speech from native Spanish, Italian, and Chinese speakers, the determination that students were unprepared to phonetically transcribe individuals with diverse linguistic backgrounds was made. Additional educational resources should be provided to students including more diverse transcription practices and diversity-focused continuing education opportunities. Additional research is recommended to include a larger, more diverse sample from an area with a high level of linguistic diversity and to include other speech sound differences and disorders encountered by speech-language pathologists.

GRADUATE STUDENT TRANSCRIPTION OF ACCENTED SPEECH

Emily N. Covington, B.S.

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of

Science in Communication Sciences and Disorders

Longwood University

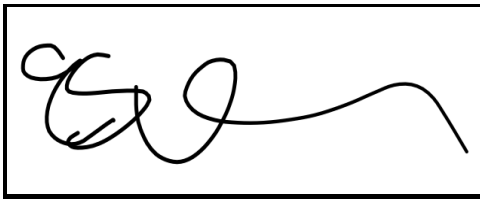Department of Social Work and Communication Sciences and Disorders Program

Dedication

To my family for their endless support and always encouraging me to be the best version

of myself. I truly could not be where I am without you all! To the Longwood CSD

faculty, especially my thesis committee and mentors: Dr. King, Dr. Wallace, and Dr.

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any typos you may find in this paper, courtesy of her many naps on the keyboard during
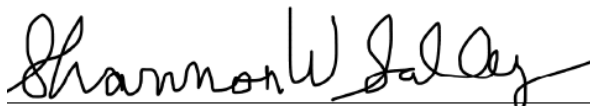
my writing.

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CHAPTER I

INTRODUCTION

Speech-language pathologists (SLPs) provide services to a variety of populations, including the growing population of individuals in the United States who are multilingual and speak English with accents (ASHA, 2021). Because SLPs are qualified to work with these diverse populations, the purpose of this study was to determine the degree to which speech-language pathology graduate degree programs adequately prepare their students for working with individuals who speak English with an accent.

Background research yielded information regarding phonetic differences between Standard American English speech and the test languages used in the study: Spanish, Italian, and Chinese. A review of literature did not yield information on student education and preparedness for using phonetic transcription in practice when working with various populations. There was a gap in the research regarding phonetics education practices and how those practices relate to student preparedness for providing services to linguistically diverse individuals. The researcher developed this study to determine what phonetics education practices programs use and how those practices relate to student success when transcribing speech from non-native English speakers, who speak with accents. The study included a graduate student transcription test, graduate student survey of phonetics education, and transcription analysis done by professionals in

the field. Speech-language pathology graduate students from Longwood University participated in a transcription test, where the researcher prompted them to phonetically transcribe individual English words recorded by native speakers of languages other than English. Inclusion criteria included the following: (1) must be full time graduate students in the speech-language pathology program at Longwood University, (2) must not be fluent speakers of any language included as a "test language," and (3) must not have traveled to a country where a "test language" is the primary spoken language. These requirements ensured minimal exposure to the accents presented during the transcription test. There was no exclusion based on age, gender, or socioeconomic status. Graduate student transcriptions were scored based on transcriptions completed by professionals in the field that were deemed accurate based on cross-comparison and spectrogram analysis. The researcher also administered graduate students a survey regarding their phonetics education experiences. We compared phonetic transcription accuracy scores and prior phonetics education experiences to determine the degree to which their educational experiences prepared them for clinical work with diverse populations.

Our hypothesis indicated that we did not believe speech-language pathology programs were adequately preparing their students to provide skilled services to individuals from diverse language backgrounds. Graduate students' transcription accuracy scores suggested our hypothesis was correct. Additionally, students reported phonetics education practices in place that did not contribute to their success when tasked with transcribing accented-English speech. This study did contain a small sample size, including graduate students from one university in Virginia; therefore, results may not be

representative of all speech-language pathology graduate students' phonetic transcription skills.

Results of this research may improve diversity, equity, and inclusion standards regarding the content taught in undergraduate and graduate level phonetics education courses. Additionally, similar studies have the potential to gain insight on students' preparedness for providing services to individuals with a variety of other speech sound differences and disorders.

CHAPTER II

LITERATURE REVIEW

Introduction

Phonetic transcription is an essential, career-long skill for speech-language

pathologists (SLPs). While it is a cornerstone skill, many speech-language pathology

graduate students display the inability to complete narrow phonetic transcription

accurately (Krueger, 2021). Broad transcription involves using the International Phonetic

Alphabet to transcribe the basic, contrasting speech sounds heard in speech, while narrow

transcription is a more detailed phonetic transcription using the International Phonetic

Alphabet and detail markers, such as diacritics (Reetz & Jongman, 2020). The lack of

transcription preparedness in non-Standard American English (Krueger, 2021) correlates

to the small number of American Speech-Language-Hearing Association (ASHA)

members, 8.2%, who identify themselves as multilingual service providers (ASHA,

2022). Though only a small number of SLPs are prepared to work with the multilingual

population, English phoneme production varies when produced with accented speech

(Shriberg et al., 2019). Individuals who primarily spoke a language other than English at

home made up 45% of the population in California, 35% of the population in Texas, 34%

of the population in New Mexico, and 32% of the population in New Jersey. Many of

these individuals may require speech therapy services at some point in their lives (ASHA,

2022). Speech-language pathology graduate programs should strive to include more diverse student populations, diversity-focused classroom education, and clinical experiences serving diverse populations to better prepare graduate students to accurately identify and transcribe these diverse accents (Stewart & Gonzalez, 2002).

Phonetics

Individual sounds, or phonemes, make up verbal speech. Phonemes are differentiated by how they are produced and how they sound (Shriberg et al., 2019). For example, we produce consonants with more constriction of the vocal tract, and their sound reflects this constriction (Shriberg et al., 2019). There are 24 consonant phonemes in Standard American English, produced within seven places of production, six manners of production, and two voicings (Behrman, 2017). We produce vowels with a more open vocal tract, sound more resonant, and are longer than consonant sounds (Shriberg et al., 2019). There are 20 vowel sounds in Standard American English with 12 single sound monophthongs and 8 double sound diphthongs (Shriberg et al., 2019). We categorize vowels by their tongue height and advancement, and affected by lip rounding and jaw placement (Shriberg et al., 2019).

Spectrograms

Spectrograms are the visual representations of sound depicting the time, frequency, and intensity of production (Behrman, 2017).We classify consonants by manner of articulation and separate them into six categories based on level of constriction: stops, fricatives, affricates, nasals, liquids, and glides. Consonant spectrograms are best differentiated by time and intensity, indicated by width, which

indicates timing, and darkness, which indicates intensity, on the spectrogram image (see figure 1) (Behrman, 2017). Stops, depicted by a gap in the spectrogram image, coordinate to a gap where air is stopped and there is no sound followed by a release of air (Behrman, 2017). Fricatives are depicted by the presence or noise in the upper frequencies of the consonant (Behrman, 2017). Affricates include the gap in sound, similar to stops, but follow the gap with frication noise similar to a fricative (Behrman, 2017). Nasals are depicted with a high-intensity band at the bottom frequencies, known as the nasal murmur, and low-intensity production throughout the upper frequencies (Behrman, 2017). Liquids and glides do not show a gap in time, like more constricted consonants do, but often show gaps in frequency and intensity (Behrman, 2017).

Vowel spectrograms are less differentiated by time and show more differentiation by their frequency formants, or areas of higher intensity, indicated by dark bands on the spectrogram image (see figure 1); (Behrman, 2017). The first formant indicates the presence of sound, the second formant depicts that the sounds are different, and the third formant depicts exactly what the sound is (Behrman, 2017). High vowels, such as /i/ and /u/ depict little intensity in the middle frequencies (Behrman, 2017). This is easily differentiated from the low vowels, such as /ae/, which display high levels of frequency in the middle (Behrman, 2017). Diphthongs, which are only present in English, display movement in the second formant, showing that there is a change in the sound (Behrman, 2017).

For each phoneme, the spectrogram displays a similar form regardless of the speaker (Behrman, 2017). There can be differences stemming from accented speech displayed on spectrograms that may contribute to different phoneme perceptions.

Features that can be seen on spectrograms such as voicing, devoicing, and intensity (Wheelock, 2016), vowel duration and voice onset time (Shah, 2004), and sound replacements (Zhang & Yin, 2009) contribute to how phonemes are heard.
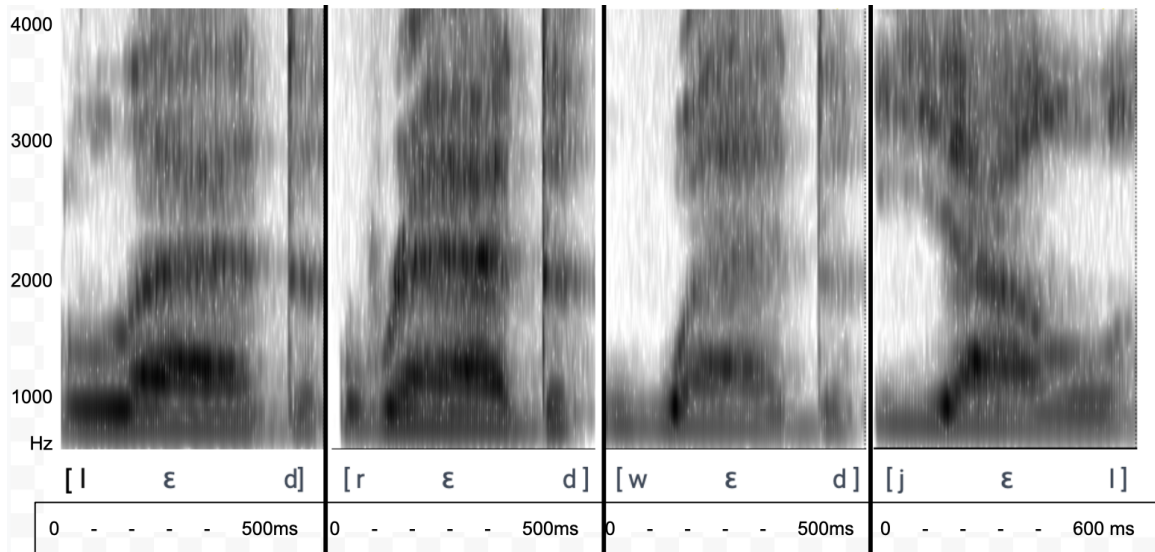
Figure 1. Spectrogram example featuring vowel and consonant phonemes

Speech Transcription

Phonetic speech transcription is an essential skill for SLPs, especially for the recognition and diagnosis of articulation delays or disorders. While this skill is essential, according to Krueger (2021), there is a significant difference in transcription proficiency for graduate students. Factors such as when and how students learn phonetic transcription, and their level of continued practice, affect graduate students' ability to accurately transcribe (Krueger, 2021). Krueger (2021) emphasized that graduate students do not accurately transcribe using Standard American English transcription, and Stewart and Gonzalez (2002) attested that graduate school SLP programs do not adequately prepare students to work with populations who may not use Standard American English.

Because graduate students often enter graduate programs with inadequate phonetic transcription skills, remediation is often necessary to give students the ability to adequately transcribe (Kruegar, 2021). In a study of 34 first year graduate students, students who received low pretest scores improved significantly after participating in peer review and assessment transcription activities (Kruegar, 2021). While phonetics pre- and post- tests with review in-between was an effective strategy for enhancing transcription proficiency, the peer assessment process boosted self-reflection and self-improvement skills and students enjoyed the peer assessment process for phonetic transcription (Krueger, 2021). Peer assessment was a beneficial way for graduate students to improve phonetic transcription skills (Krueger, 2021), but a study at Swarthmore College determined that a game-based approach was effective in making foreign accented speech transcription more enjoyable (Akasaka, 2009). Three hundred and sixty-eight participants played a speed and points based game found via social media in which they transcribed accented English speech and determined the native language of the speaker from a set of options. While participants only accurately identified the accent origin 55% of the time, participants accurately transcribed and returned to the website to play the transcription game multiple times, leading the researcher to state that this game turned transcription of accented speech into a more entertaining task (Akasaka, 2009).

Despite methods for improving phonetic transcription (Kruegar, 2021) and creating a more engaging accented speech transcription process (Akasaka, 2009), graduate students still benefit from education and resources aimed at improving their cultural and linguistic competence (Vale & Arnold, 2019). In Steward & Gonzalez's (2002) survey, 91 respondents detailed their programs' addressment of diversity. Students

stated that their programs lacked in their enrollment of minority students and even though they received content about diversity in the classroom, many clinical experiences did not adequately reflect the emphasis of diversity taught in the classroom (Stewart & Gonzalez, 2002). Additionally, Vale & Arnold (2019), discovered that communication sciences and disorders students demonstrated increased cultural competence and a higher level of comfort when working with individuals from diverse language backgrounds after they worked with ELL students as conversation partners. Without practicum placements that reflected the population's level of diversity or supplemental education opportunities that emphasized linguistic diversity, students felt unprepared to serve diverse populations upon graduation from their master's degree program (Stewart & Gonzalez, 2002; Vale & Arnold, 2019).

Language Variations

Individuals who primarily speak a language other than English in the home make up a large percentage of the population within the United States (United States Census Bureau, 2021). According to Shriberg et al. (2019), influences from individuals' first language often reflect in the pronunciation of English words for foreign language speakers. Language and accent variations in spoken English emerge due to limited cross-linguistic comparison by English as a second language (ESL) teachers (Gabriel & Thiele, 2017). ESL teachers often know the features of English, but with limited phonological knowledge regarding their students' native languages (Gabriel & Thiele, 2017). It is recommended that SLPs preparing to work with bilingual individuals familiarize themselves with the phonemic inventory of the client's native language and

compare that to Standard American English phonemes (Shriberg et al., 2019).

Italian-Accented English

The Italian language contains 23 consonant phonemes, produced within eight places, seven manners, and two voicings, and contains seven vowel phonemes categorized by tongue height and advancement. Compared to English, Italian has one fewer consonant and 13 fewer vowel phonemes (Wheelock, 2016). In a study of 27 native Italian speakers producing English, common phonemic errors included consonant devoicing and acquisition of phonemes that are present in English, but not in Italian (Wheelock, 2016). Common vowel malformations included /oʊ/ as [o], /ɜ/ as [ɛ], /ɪ/ as /i/, and /ɑ/ and /æ/ as any other vowel (Wheelock, 2016). Common consonant malformations included /z/ as /s/, /v/ as /f/, /ð/ as /d/, /θ/ as /t/, and /g/ as /k/ (Wheelock, 2016). Wheelock (2016) expected that longer residency in an English speaking country and earlier onset of language exposure would correlate to fewer errors, but found that length of exposure or residency is not as important as high-quality, immersive exposure to the English language.

According to Bassetti (2017), in a study of native Italian English speakers, learning English through spelling and reading rather than listening contributes to unnecessary phonemic contrast. When reading English words, native Italian ELL speakers displayed differences in phoneme duration when compared to native English speakers. The most common phonemic difference was that native Italian speakers produced single-letter phonemes as shorter duration and repeated-letter phonemes as longer duration; spelling did not affect duration for native English speakers (Bassetti, 2017). This effect still showed in native Italian individuals who are experienced English

speakers, living in English speaking countries (Bassetti, 2017).

Currently, there are 116 ASHA registered SLPs in the United States who state that they provide Italian services (ASHA, 2022). An effective practice for initially exposing a native Italian speaker to Standard American English pronunciation would involve intense exposure to English verbally, prior to introducing the orthographic form, to minimize the effects of grapheme presentation on phoneme production (Bassetti, 2017). In elective accent-modification speech therapy, an SLP providing Italian services may focus on phoneme listening discrimination and voicing exercises to adjust common phoneme errors toward Standard American English pronunciation (Wheelock, 2016).

Spanish-Accented English

The Spanish language contains 18 consonant phonemes categorized into 11 places, eight manners, and two voicings of production, and contains five vowel phonemes; compared to English, this is six fewer consonant phonemes and 15 fewer vowel phonemes (ASHA, 2021). Consonants such as /v/, /θ/, /ð/, /z/, /ʃ/, /ʒ/, and /dʒ/ do not exist in Spanish and are often replaced by similar sounds when a native Spanish speaker speaks English (ASHA, 2021). Additionally, in Spanish /r/ is produced as a trill, rather than a liquid (ASHA, 2021). Spanish includes 5 vowel sounds, categorized by tongue height; Standard American English central vowels and diphthongs do not exist in Spanish (ASHA, 2021).

A study in the Journal of Acoustical Society of America using recordings of native English and native Spanish speakers determined that differences in phonetic production lead to lower word recognition ability (Imai, 2005). Native English and native Spanish speakers recorded 80 lexically familiar words, then were asked to listen to the

recordings and write what each word was. When speakers produced certain words with Spanish-accented English, they showed high error levels for native English and native Spanish listeners (Imai, 2005). Words with the highest error levels included: fish was heard as feet, voice was heard as boys, boss was heard as bus (Imai, 2005). Both native English and native Spanish listeners recognized English produced words more accurately than Spanish accented words (Imai, 2005). Words that were known, but had a lower text frequency, were also recognized less in Spanish-accented speech than in native English speech (Imai, 2005).

Shah (2004) studied relative accentedness, the level of phonemic variation from Standard American English, in nonnative English speakers by developing a perception task, in which native English speakers would listen to recordings and rate the level of accentedness, and a production task, in which spectrogram analysis was used to determine the acoustic differences in Spanish-accent versus native English production. When listening to eight sentences that featured multisyllabic words with high lexical frequency, native English listeners accurately rated accentedness (Shah, 2004). Pronunciation with high variation correlated to higher accentedness scores (Shah, 2004). Researchers analyzed the same sentences via spectrogram for word duration, unstressed vowel duration, ratios of stressed to unstressed, voice onset time, voiceless stop consonants, and closure during intervocalic stops/flaps (Shah, 2004). Spanish-accented speakers produced significantly longer unstressed vowel durations, failed to distinguish between stressed and unstressed syllables, and produced a shorter voice onset time (Shah, 2004).

Spanish is the most common language, other than English, in the United States

(Shriberg et al., 2019). Spanish-Accented English is heard very frequently within the United States (Shriberg et al., 2019) and there are currently 10,807 SLPs in the US who identify themselves as Spanish service providers (ASHA, 2022). Despite the relative commonness of Spanish accents and the widespread availability of speech therapy services, there remains a low level of understandability when comparing Spanish-accented English to native English (Imai, 2005). The ability to understand Spanish-accented English can be attributed to acoustic differences in phoneme production (Shah, 2004).

Chinese-Accented English

The Mandarin Chinese language contains 23 vowels produced within nine places, six manners, and two voicings, and contains seven vowel phonemes; compared to English, this is one fewer consonant phonemes and 13 fewer vowel phonemes (ASHA, 2021). Consonants such as /v/, /b/, /d/, /j/, /θ/, /ð/, /z/, /ʃ/, /ʒ/, /tʃ/, and /dʒ/ do not exist; they are replaced by 12 Chinese-specific consonants (ASHA, 2021). When speaking English, sometimes native Chinese speakers will replace Standard American English sounds with sounds that do not exist in English at all (ASHA, 2021).

Many sounds that exist in English do not exist in Chinese, which causes the replacement of Standard American English phonemes with similar, familiar sounds (Zhang & Yin, 2009). Commonly, native Chinese speakers will replace phonemes in English words with the Chinese equivalent sounding phoneme without realizing that the sounds are produced very differently; commonly, the English palatal fricative "sh" will be replaced with the Chinese alveolar affricate "ts^h" (Zhang & Yin, 2009). Zhang and Yin (2009) also describe Chinese as a tone language, in which pitch variations change word

meanings, while English is an intonation language, where variations in pitch and stress enhance pronunciation but do not change meaning. Native Chinese speakers often display differences and difficulties with stress in English words (Zhang & Yin, 2009). The Chinese language is distinct and children pick up the Chinese accent very quickly, which can interfere with learning Standard American English pronunciation, even when education is begun at a young age (Zhang & Yin, 2009).

Hack et al. (2012) completed an articulation study on 29 Chinese-English bilingual children and 25 English speaking monolingual children. All Chinese-English bilingual children in the Hack et al. (2012) study spoke English with an accent. The monolingual children were presented with the GFTA-2 test of articulation only, and showed age-expected results (Hack et al., 2012). Bilingual children were presented with the GFTA-2 and scored significantly lower than their monolingual peers, then were presented with a Chinese phonology test and showed age-expected results (Hack et al., 2012). The differences in results show that Chinese-accented speech does affect Standard American English phoneme articulation, but there is a need for phonological testing in the native language and English because differences in articulation may indicate accent influence, rather than a speech disorder (Hack et al., 2012).

There are currently 424 SLPs in the United States that identified themselves as providers of multilingual services in Chinese-Mandarin (ASHA, 2022).

Conclusion

The ability to understand individual speech sounds and phonetically transcribe is an essential skill for SLPs, but it is a skill that is often overlooked by students entering

SLP graduate school programs (Krueger, 2021). Lack of adequate transcription skill is exacerbated when students are asked to prepare to work with individuals of diverse language backgrounds (Stewart & Gonzalez, 2002; Vale & Arnold, 2019). Despite lack of preparation, SLPs within the United States serve a very diverse client population (ASHA, 2022). Each diverse population within the US presents their own unique speech and language differences, often distinguished by individual accents (Shriberg et al., 2019). Differences in pronunciation due to speaking with an accent should be recognized and transcribed accurately, but not treated as a speech disorder; the American Speech-Language-Hearing Association does not recognize dialectal or culture-influenced speech differences as clinical disorders (Saad & Polovoy, 2009).

Following a review of phonetics, speech transcription protocols, and native language influenced accent differences, further research is necessary to determine if SLP graduate students are prepared to work with the diverse client population present within the US. Future research can be conducted with the focus on graduate students' ability to recognize and accurately transcribe the speech differences presented by individuals speaking English with different accents. Spectrogram analysis allows the comparison of accented English and Standard American English phonemes, and we can determine the phonemes causing the greatest margin of transcription error.

CHAPTER III

METHODOLOGY

The researcher conducted a mixed methods study, featuring a qualitative survey of phonetics education and a quantitative assessment of transcription skills, delivered to graduate students in the communication sciences and disorders program at Longwood University. The study aimed to answer the following research question: Are speech-language pathology graduate school programs preparing their students to provide services to linguistically diverse populations, specifically individuals who speak English with an accent?

Recordings of Accented Speech

Development of Recordings

We obtained participants for the accented speech recordings through convenience sampling via personal connections. To record for the accented speech recordings, the individuals were native speakers of a language other than English and were fluent English speakers. The participants self reported their language background and English language fluency. Participants included a native Spanish speaker, a native Chinese speaker, and a native Italian speaker. The researcher obtained recordings at three separate dates via in person recording sessions that took place in quiet academic offices. During the initial meeting and recording session, each participant

received a copy of an explanation of the study and the purpose of their recording (appendix A).

Target Word Selection and Recording Procedure

The researcher developed a list of ten words using Standard American English, Chinese, Spanish, and Italian phoneme inventories and then native speakers of each language recorded the list. We obtained written consent prior to completing the voice recordings and voice recordings contain no identifying information.

The researcher developed a list of phonemic similarities and differences after analyzing each phoneme inventory. Using these similarities and differences, the researcher created a test list of 10 words to include the following characteristics: words with phonemes present in all four languages (boot - /b/ and /t/ are present in all included languages, but the vowel /u/ may differ slightly), words with phonemes present in some test language but not all (fling - "ing" exists in Standard American English, Chinese, and Italian, but does not exist in Spanish), and words with phonemes only present in Standard American English (runner - which includes a retroflexed 'r' that is only present in Standard American English). The inclusion of these characteristics ensured that the researcher could get the most realistic picture of each accent's influence on spoken English, because English language learners work to obtain sounds that are and are not present in their native languages. The full word list of 10 words was recorded by each individual. The recording list included the following words:

- This
- Much
- Fling

- Runner

- Batches

- Boot

- Annoy

- Vacuum

- Spout

- Book

I obtained the recordings using the built-in microphone on a MacBook Pro computer in a quiet academic office environment. During recording, I measured background noise and noise greater than 50 dB-SPL was grounds for re-recording. I combined the individual recordings together, creating a total of 30 words in the recording. Each word was repeated two times with four second pauses in between. In the recording presented to the study participants, I randomized the order of the words and accent influence. The same recording was played for all study participants.

Spectrogram Analysis

The researcher uploaded all recordings to the Praat application for spectrogram analysis. The Praat application is a computer program designed to analyze phonetics and visualize speech (Boersma, 2014). The Praat application turned all voice recordings into spectrogram images and they were printed for comparison between each language background. Each of the ten words in each language background was uploaded and printed into an individual spectrogram image.

The voice recordings of each word from each language background were uploaded into individual spectrogram images and printed for analysis. The researcher

analyzed differences in frequency and intensity depicted in the spectrogram images and compared the differences between the same words spoken by individuals from different language backgrounds.

Survey and Transcription Assessment

Participants and Setting

I obtained survey participants through convenience sampling via the Longwood University Communication Sciences and Disorders graduate program. Participants self reported their enrollment in the program at the time of the study. For inclusion, participants were native English speakers and did not speak any of the languages from the recordings - Spanish, Italian, or Chinese. Additionally, participants did not meet inclusion criteria if they had previously traveled to a Spanish, Italian, or Chinese speaking country in order to minimize potential previous exposure to the test accents. The researcher distributed the survey and transcription assessment in an academic classroom at Longwood University. I played the recording for the transcription assessment out loud via a speaker in the classroom at a volume appropriate for all participants to hear. The researcher provided participants a description of the study prior to consenting to participation (appendix B).

Data Collection Procedures

The researcher distributed the printed survey and transcription assessment (appendix C) in person at Longwood University. The survey included a demographic section, which assessed the participants' language background and determined inclusion criteria, as well as a phonetics education section, which included their educational

background. The researcher developed the phonetics education section using prior knowledge of SLP undergraduate and graduate programs and knowledge of the skills required to phonetically transcribe. Participants were given approximately five minutes to complete the demographic and phonetics education portion of the survey.

Prior to the transcription assessments, I informed participants of the length of the assessment and instructed them to use the International Phonetic Alphabet and diacritic markers where appropriate. The transcription assessment portion of the study included 30 recorded words played out loud for participants via the classroom speakers. The transcription test took approximately seven minutes to complete. The survey and transcription assessment did not include any identifying information and I obtained consent prior to completing the survey and assessment. Additionally, I received Institutional Review Board approval through Longwood University before beginning this study.

Data Analysis

Following the survey collection, I screened the demographic section of the survey to ensure inclusion criteria. The researcher analyzed the phonetics education section to determine what phonetics education experiences students recieved. I compared phonetics education practices assessed in the survey, such as: number of speakers transcribed during the introductory phonetics course and students' experience with transcribing non-native English speakers, to transcription accuracy.

Additionally, I compared participant transcriptions to transcriptions done by professionals in the field of speech-language pathology with significant clinical transcription experience to determine overall accuracy. The researcher provided student

transcriptions four scores: a consonant score, a vowel score, a diacritics score, and an overall score. Each component (consonant phoneme, vowel phoneme, and diacritic) counted as one point and scores were reported as percentages out of 100%. Based on professional transcriptions, there were a total of 72 consonants, 44 vowels, 5 diacritic markers, and 121 total transcription components assessed.

The researcher created charts for each test word which included the spectrogram image and professional transcription for each language background. The differences depicted on the spectrogram images explain why the transcriptions among language backgrounds differ; below the chart depicts these differences.

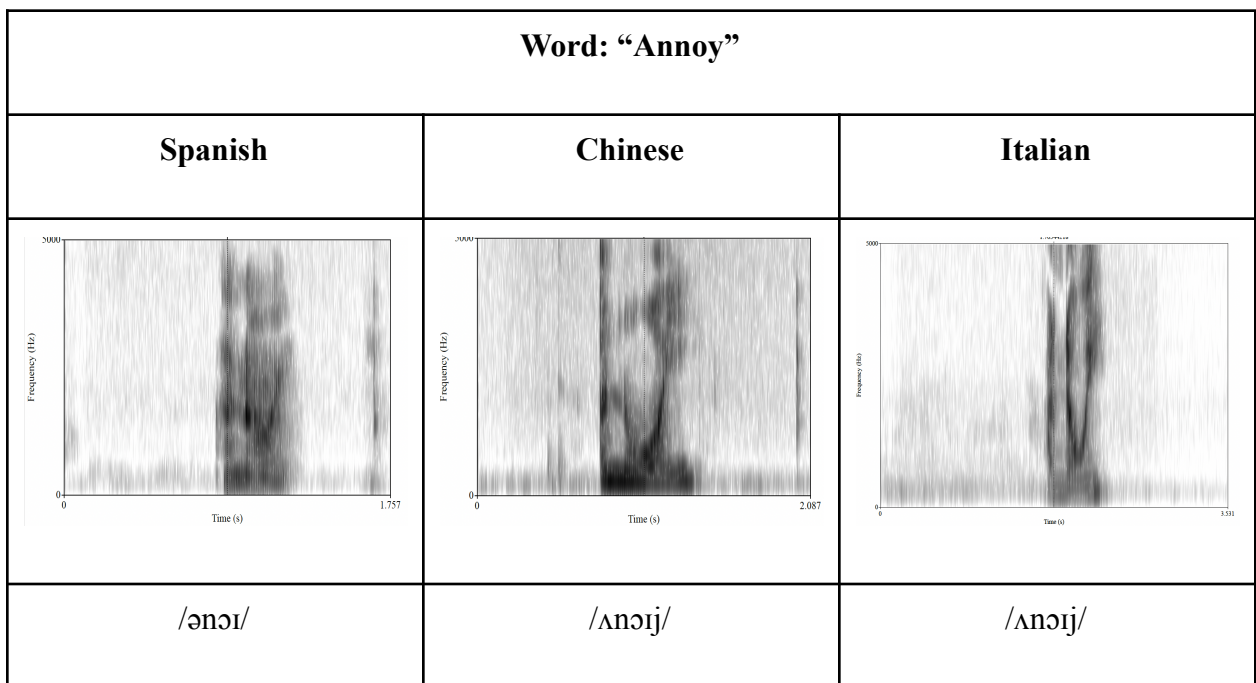| Word: "Annoy"		
Spanish	**Chinese**	**Italian**
/ənɔɪ/	/ʌnɔɪj/	/ʌnɔɪj/

Figure 2. Spectrogram Comparison (all words in appendix D)

Spectrogram images confirmed the accuracy of professional transcriptions prior to scoring student assessments. The professional analysis of the word list included the following transcriptions:

Table 1

Professional Transcription of Accented Words

Test Word	Spanish Transcription	Chinese Transcription	Italian Transcription
Annoy	/ənɔɪ/	/ʌnɔɪj/	/ʌnɔɪj/
Batches	/mætʃɪz/	/pʰætʃɪz/	/bætʃɪz/
Book	/buk/	/bʊk/	/buk/
Boot	/but/	/but/	/bu/
Fling	/flɪŋ/	/flɪŋ/	/flɪ̃ŋ̃/
Much	/mɑtʃ/	/mʌtʃ/	/mætʃ/
Runner	/rʌnɜ^/	/rʌnɜ^/	/r:ʌnɜ^/
Spout	/spɑʊt/	/spat/	/spɑʊt/
This	/ðɪs:/	/dɪs/	/ðɪs/
Vacuum	/vækjum/	/bækjum/	/vækju:m/

By comparing the professional transcriptions of accented words (table 1) with the graduate student transcriptions, I determined if graduate students could detect and distinguish the slight sound differences present among the language backgrounds.

I used a Pearson's statistical correlation to determine the correlation between transcription scores and phonetics education practices. Each phonetics education practice

(number of phonetics courses taken, number of speakers transcribed during the introductory phonetics course, students' experience with transcribing non-native English speakers, and comfort with phonetic transcription) was correlated to consonant transcription accuracy, vowel transcription accuracy, and overall transcription accuracy.

CHAPTER IV

RESULTS

Through convenience sampling of students enrolled in the communication

sciences and disorders graduate program at Longwood University in spring 2022 and

spring 2023, I obtained 46 responses. Eighteen of those responses did not meet inclusion

criteria for the following reasons; students were fluent speakers of Spanish, Italian, or

Chinese, students were not native English speakers, or they traveled to a country that

primarily speaks Spanish, Italian, or Chinese. Twenty-eight students met inclusion

criteria; 78.5% received their undergraduate degree in communication sciences and

disorders and 71.5% of students had taken their introductory phonetics course greater

than two years ago.

Transcription Scores

I scored student transcriptions on consonant accuracy, vowel accuracy, diacritic

accuracy, and total accuracy (table 2); then compared them to a key developed by

comparing transcriptions from three professionals in the field of speech-language

pathology with significant transcription experience.

Table 2

Transcription Accuracy Scores

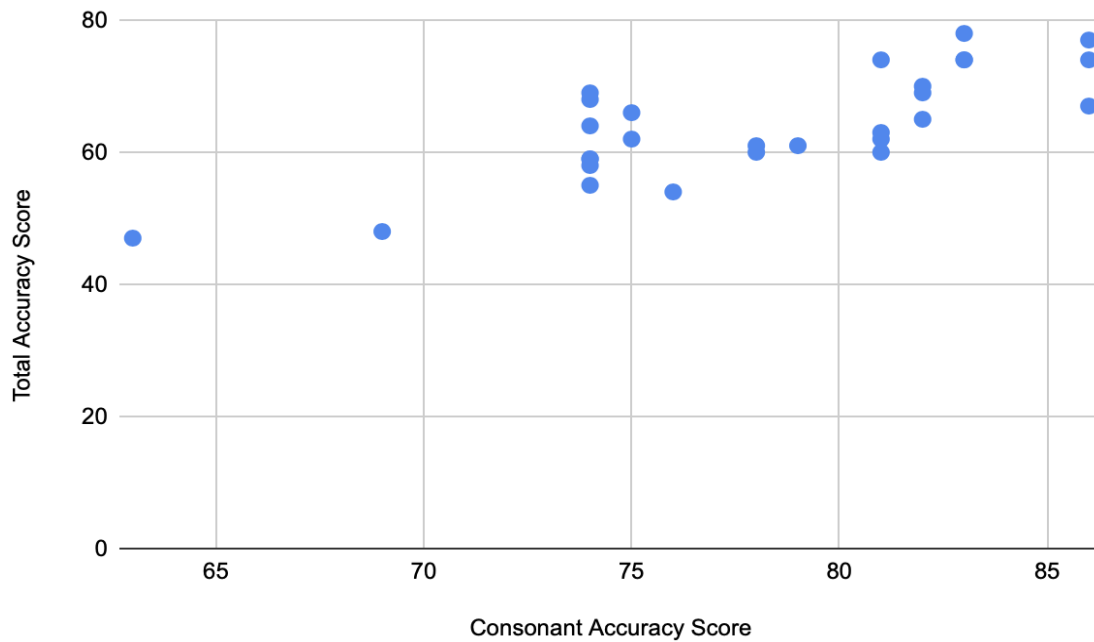|	Mean (%)	Range (%)
Consonants	78.1	63 - 86
Vowels	49.1	18 - 77
Diacritics	0	0
Total	64.2	48 - 78

Figure 3. Consonant / Total Accuracy

As shown in figure 4, a high consonant accuracy score was a statistically significant indicator of receiving a high total accuracy score ($r = 0.738$).
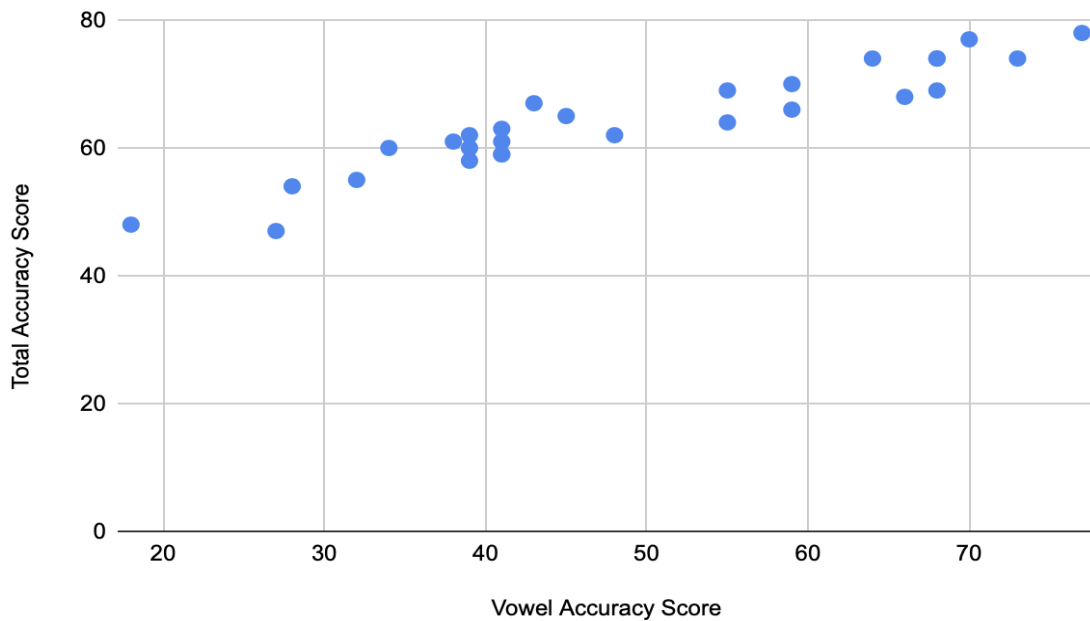
Figure 4. Vowel / Total Accuracy

A high vowel score had a higher statistically significant indicator of receiving a high total accuracy score (r = 0.939), as shown in figure 5. Though the average vowel accuracy score was lower than consonants, a high vowel accuracy score was a reliable indicator that the student would receive an above-average total transcription accuracy score.

Number of Phonetics Courses

I determined, using student-reported phonetics education background information, the effects of various phonetics education practices on transcription scores. The survey asked students "How many phonetics courses did you complete during your undergraduate program?" to assess the extent of their phonetics education prior to arriving at their graduate level speech-language pathology programs. Eighty nine percent of students reported that they completed one or less phonetics courses during the undergraduate program. Eleven percent of students reported completing two phonetics courses. Zero percent of students completed 3 or more phonetics courses during their undergraduate program.
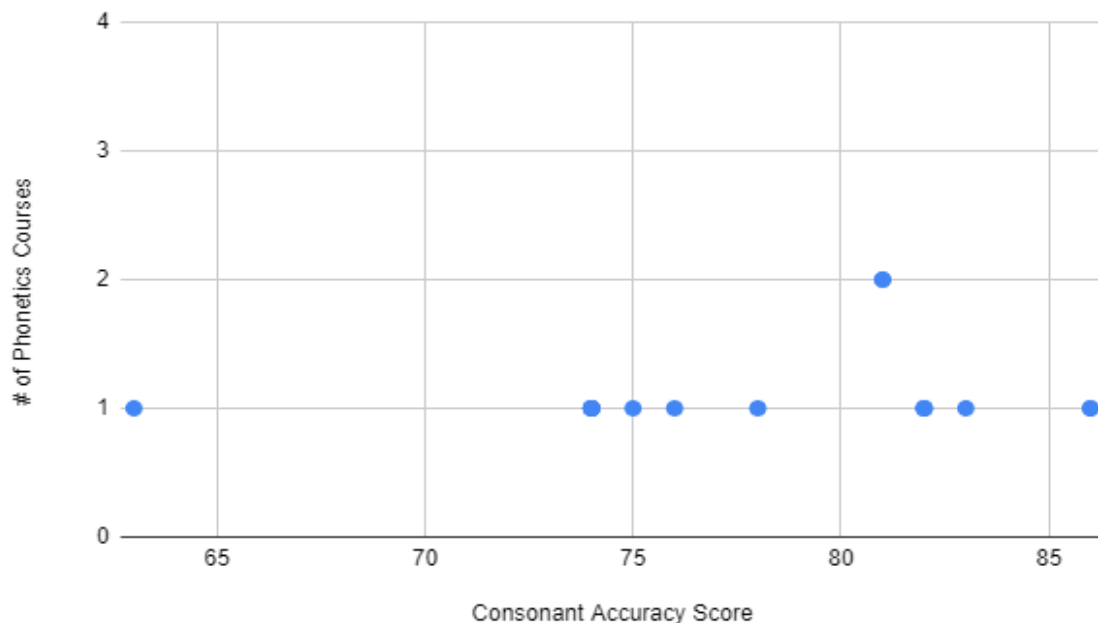
Figure 5. Consonant Accuracy / Phonetics Courses

As shown in figure 6, taking more phonetics courses during their undergraduate program was not a statistically significant indicator that students would receive a high consonant transcription score ($r = 0.224$). Students who took more phonetics courses

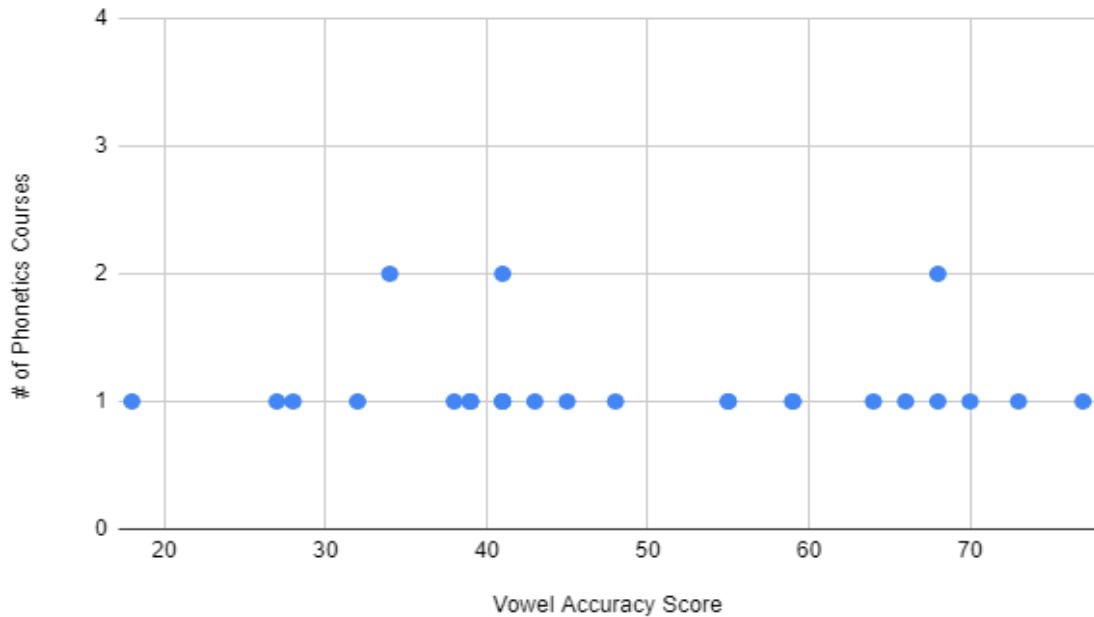during their undergraduate program received slightly higher consonant transcription scores.

Figure 6. Vowel Accuracy / Phonetics Courses

Completion of more phonetics courses during undergraduate programs was also not a statistically significant indicator that students would receive a high vowel transcription score on the accented speech transcription assessment ($r = -0.043$), as shown in figure 7. The negative correlation coefficient present when comparing the number of phonetics courses and vowel transcription scores indicates that students who took fewer phonetics courses (one or less) received slightly higher vowel transcription scores on the assessment.
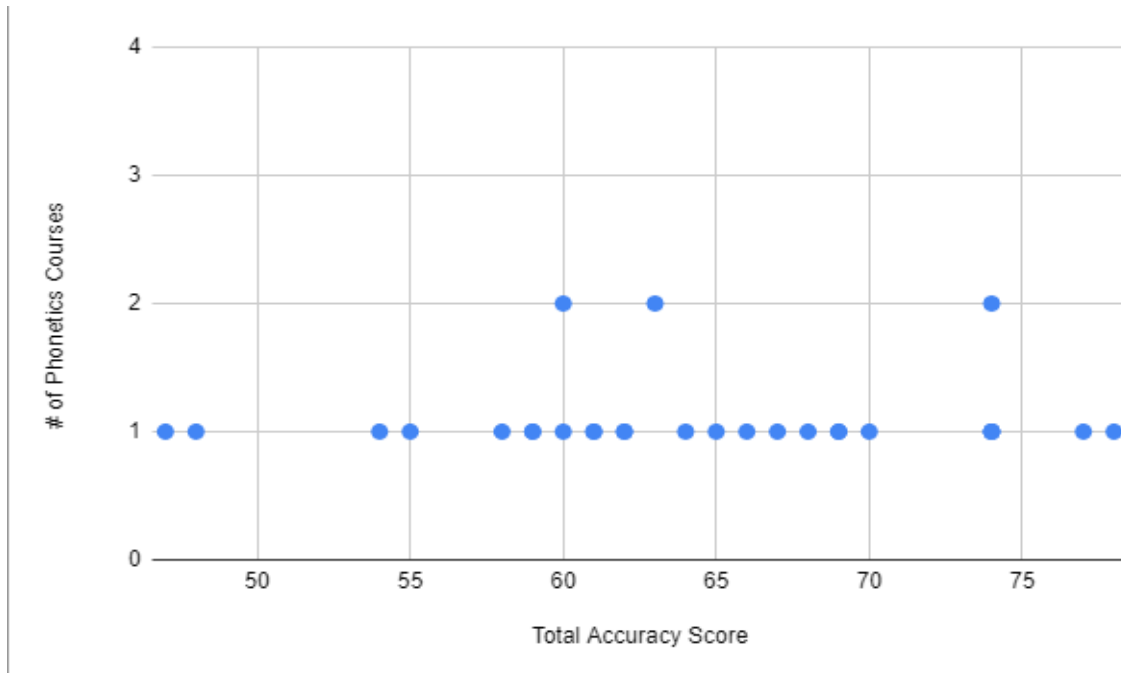
Figure 7. Total Accuracy / Phonetics Courses

Additionally, completion of more than one phonetics course during the undergraduate experience was not a statistically significant indicator that students would perform better, overall, on the transcription assessment ($r = 0.050$), as shown in figure 8. There was no relationship found between the number of phonetics courses taken during undergraduate programs and performance on the overall transcription task.

It should be noted that, due to the low number of students who completed more than one phonetics course during their undergraduate education, a reliable impact on transcription accuracy could not be assessed.

Number of Speakers Previously Transcribed

Students reported the number of speakers they transcribed during their undergraduate level phonetics course(s); speakers could include professor(s), other student(s), recording(s), or any other means of listening for transcription. Sixty four percent of participants reported that they transcribed three or more speakers during their

undergraduate phonetics course(s). Meanwhile, 28.6% of participants transcribed one speaker and 7% of participants transcribed two speakers.
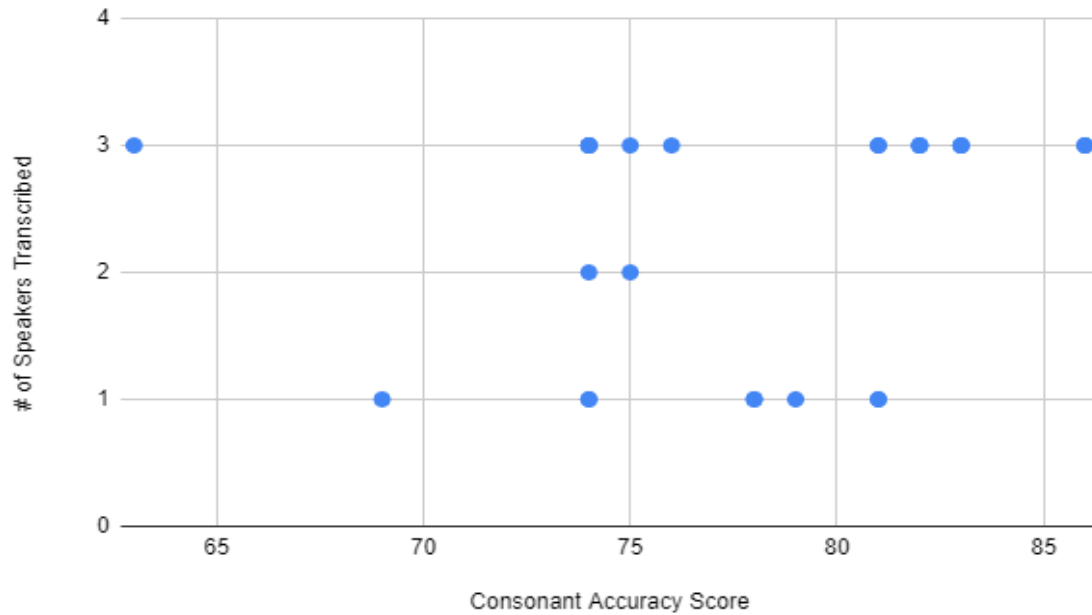

Figure 8. Consonant Accuracy / Speakers

When correlated to students' consonant transcription scores, the number of speakers previously transcribed in the undergraduate phonetics course(s) was a statistically significant indicator of achieving a higher consonant transcription score ($r = 0.328$), as shown in figure 9. Twelve of the 13 students who scored above 80% accuracy on the transcription of consonants during the assessment reported that they previously transcribed three or more speakers during their undergraduate phonetics course(s).
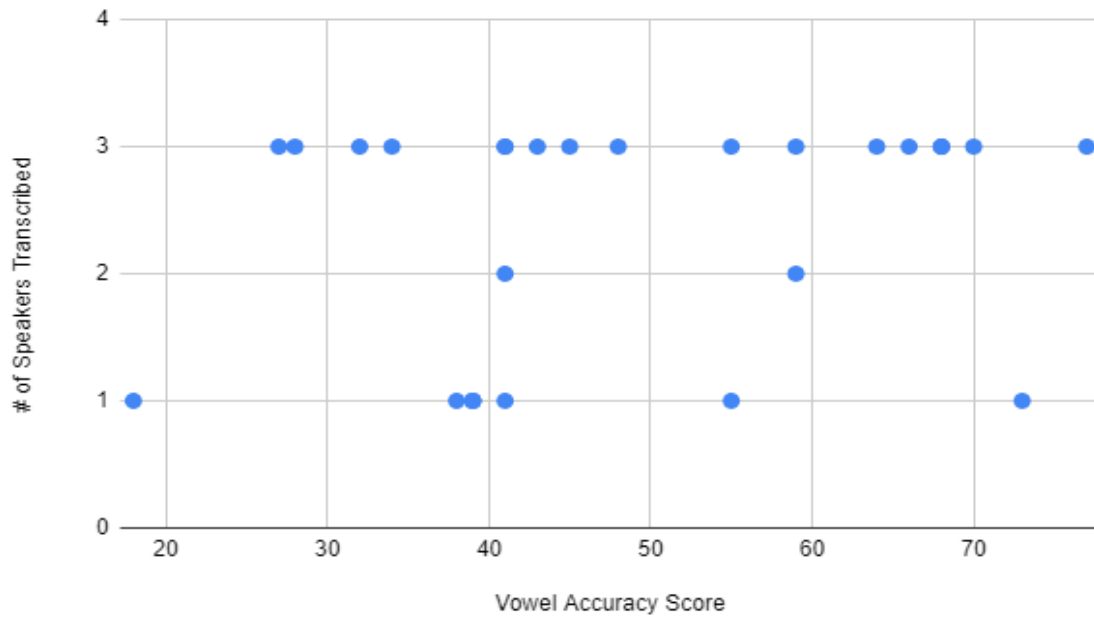
Figure 9. Vowel Accuracy / Speakers

As shown in figure 10, experience with transcribing more speakers during their undergraduate phonetic(s) course was not a statistically significant indicator that students would receive a high vowel transcription score ($r = 0.270$). Students with academic experience transcribing more speakers were at a slightly higher likelihood of receiving a high vowel transcription accuracy score.
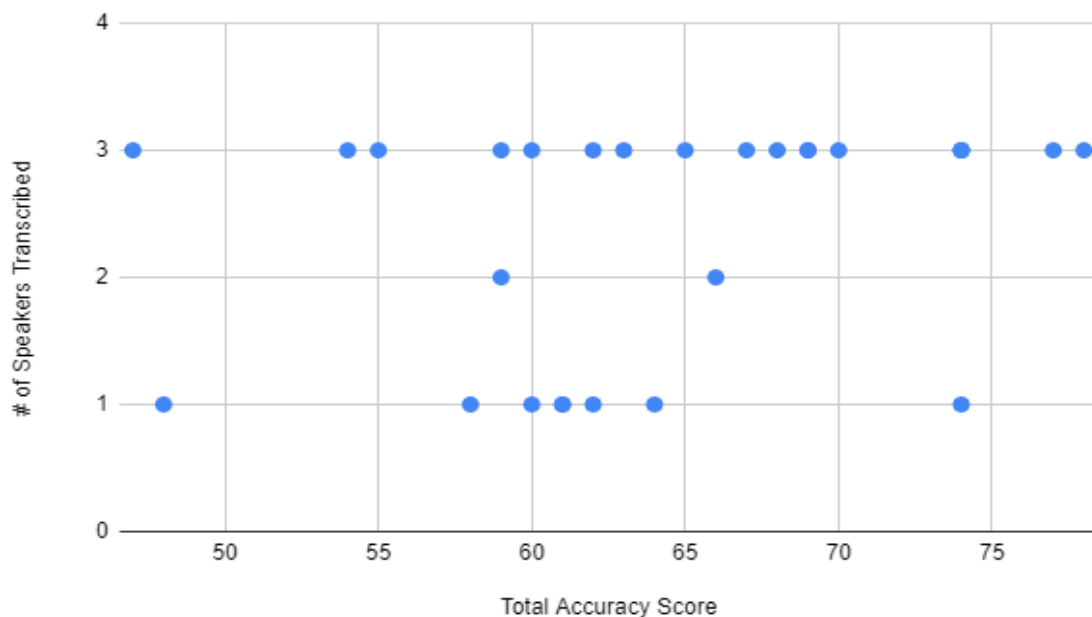
Figure 10. Total Accuracy / Speakers

      Overall, students who reported transcribing more speakers during their

undergraduate phonetics course(s) received slightly higher total transcription accuracy

scores. This correlation, however, was not statistically significant ($r = 0.304$). This is

shown in figure 11.

Experience Transcribing Non-Native English Speakers

      In the phonetics education background section, the survey asked students to report

"Have you ever transcribed speech from someone who is not a native English speaker?"

Seventy nine percent of participants reported that they have never transcribed speech

from someone who is not a native English speaker, while 14% of participants reported

that they previously transcribed speech from someone who is not a native English

speaker. Seven percent of participants reported that they were unsure whether they

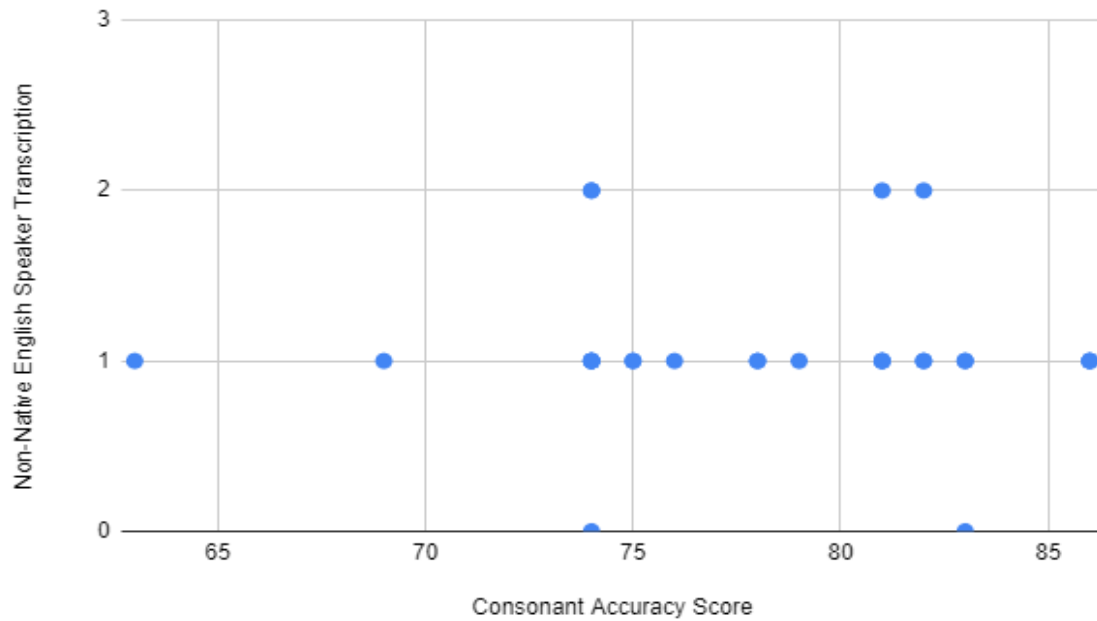transcribed speech from someone who is not a native English speaker.

Figure 11. Consonant Accuracy / Non-Native English Speaker

       As shown in figure 12, experience with transcribing speakers who were not native English speakers was not a statistically significant indicator of performing better on consonant transcription accuracy ($r = -0.085$). No relationship was found to exist between students' previous experience with transcribing individuals who were non-native English speakers and their performance on consonant transcription accuracy.
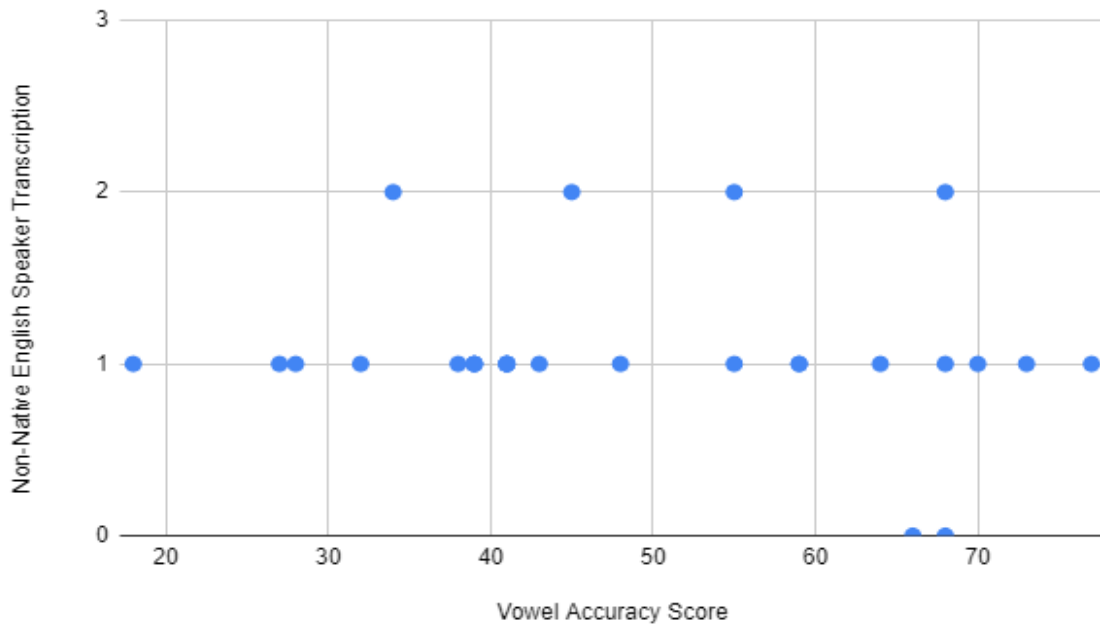
Figure 12. Vowel Accuracy / Non-Native English Speaker

When correlated to vowel transcription accuracy, previous experience with transcribing speech from individuals who were not native English speakers was not a statistically significant indicator of receiving a higher vowel transcription score ($r =$ -0.122), as shown in figure 13. Again, the negative correlation coefficient indicates that students who had not previously transcribed a non-native English speaker received slightly higher vowel transcription accuracy scores.
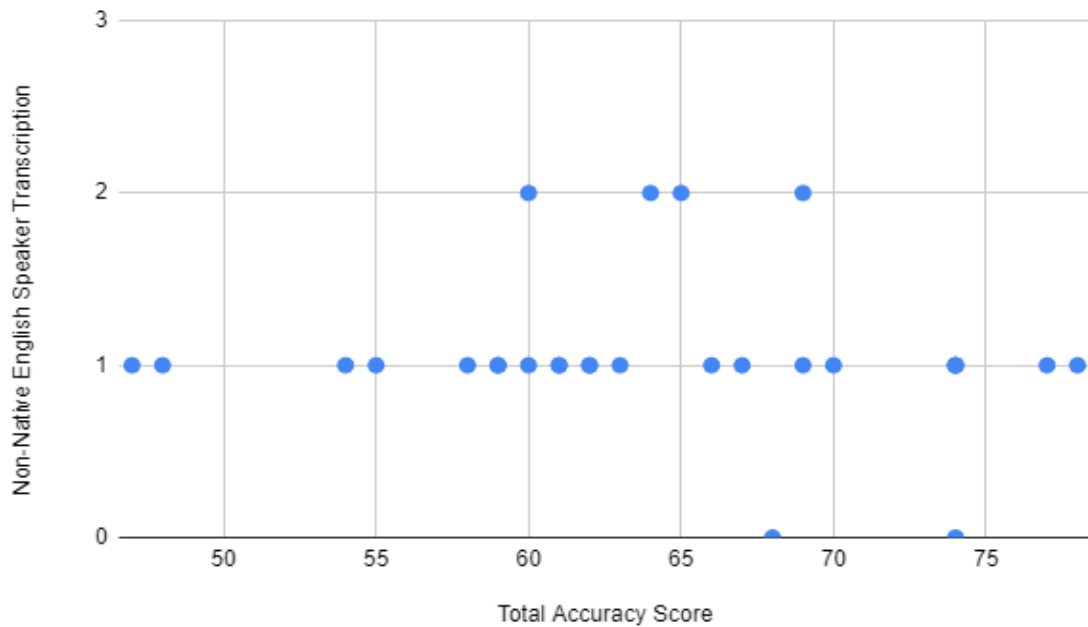
Figure 13. Total Accuracy / Non-Native English Speaker

Student-reports of previous experience with transcribing speech from someone who is not a native English speaker were not statistically significant indicators of receiving higher overall transcription scores during the assessment ($r = -0.113$), as shown in figure 14. While not statistically significant, students who reported having no experience with previous transcription of non-native English speakers performed slightly better on the accented speech transcription task.

Overall Comfort with Speech Transcription

Students were asked to report, on a scale ranging from very poor to very good, their overall comfort with speech transcription using the International Phonetic Alphabet. Reports from students included the following: 0% reported very poor, 18% reported poor, 57% reported neutral, 21% reported good, and 0% reported very good. Despite all participants having experience with phonetic transcription and having completed at least

one phonetics course, the majority of students reported that their comfort level with phonetic transcription was at the poor or neutral level.
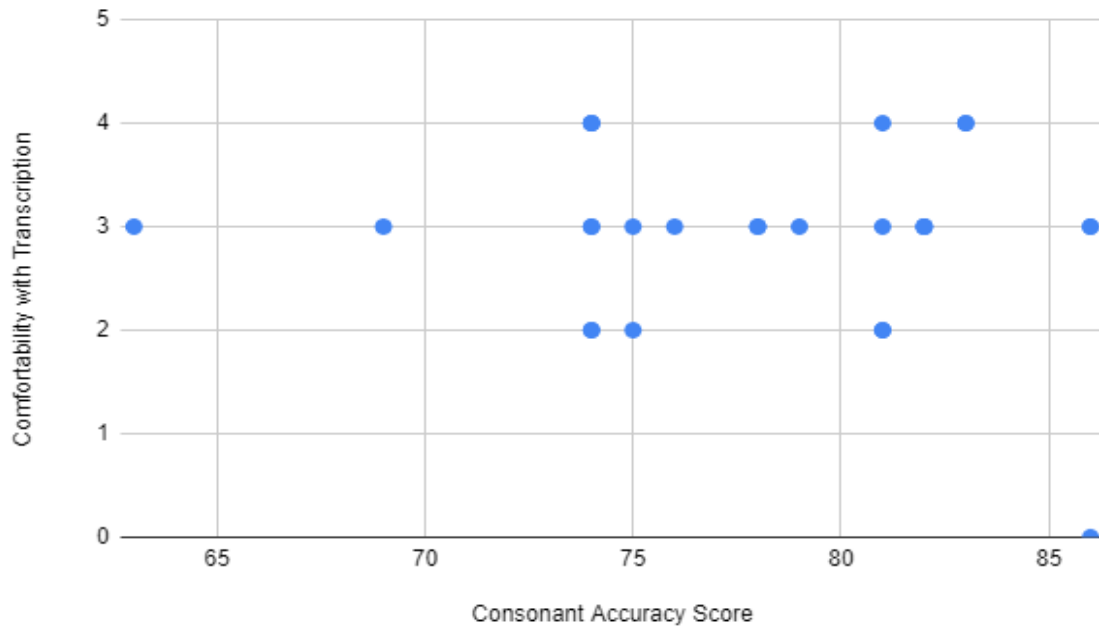

Figure 14. Consonant Accuracy / Comfort

Shown in figure 15, the level at which students rated their comfort with phonetic transcription was not a statistically significant indicator of how students would perform regarding their consonant transcription accuracy ($r = -0.031$). No relationship existed between students' self-report of transcription comfortability and their consonant transcription accuracy score.
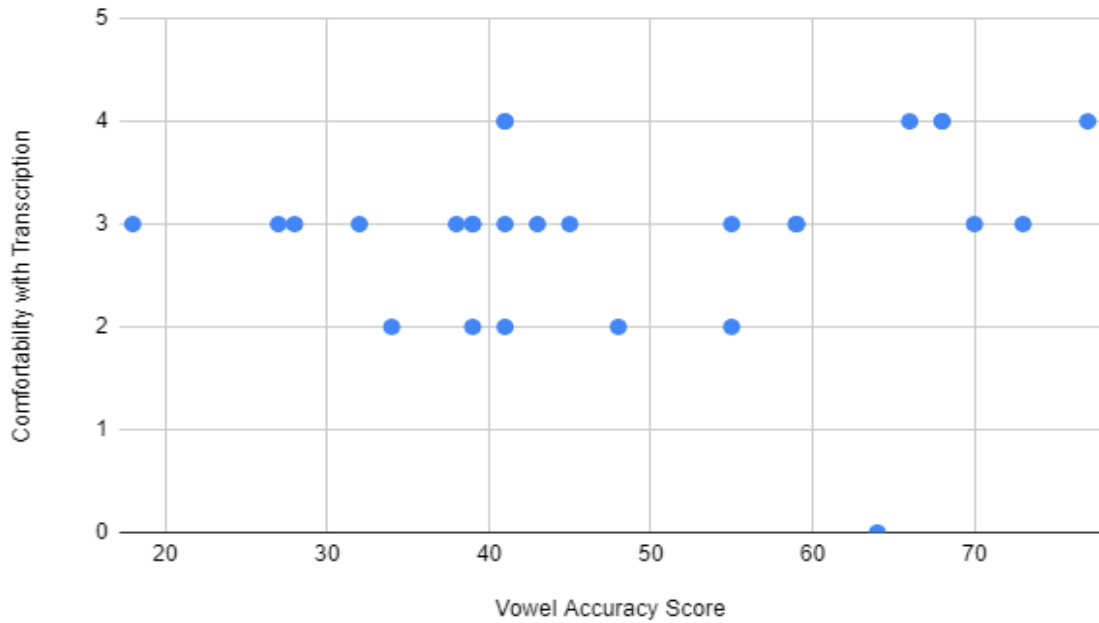
Figure 15. Vowel Accuracy / Comfort

   When comfortability rating and vowel transcription score were correlated, students' self-reported comfort with phonetic transcription was not a statistically significant indicator of student performance on vowel transcription ($r = 0.270$), shown in figure 16. It is determined that students who self-reported higher comfortability levels (neutral, good, very good) received higher vowel transcription accuracy scores.
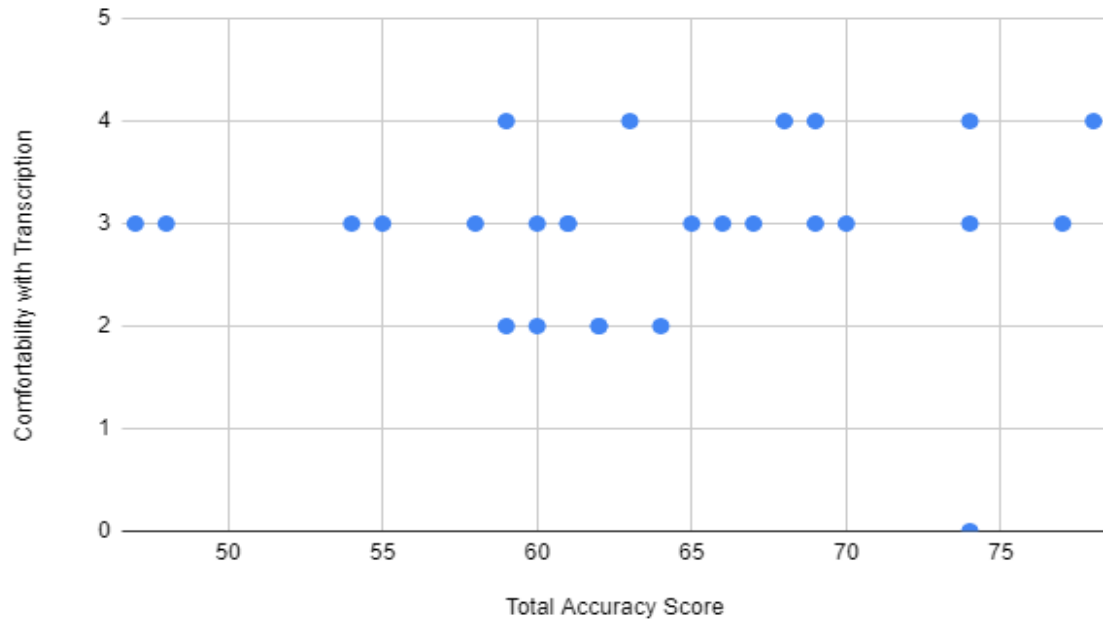
Figure 16. Total Accuracy / Comfort

As shown in figure 17, student reports of overall comfort with phonetic transcription were not statistically significant indicators of higher total transcription accuracy scores (r = 0.202). Students who self-reported high levels of comfort performed slightly better, overall, on the transcription assessment.

Validity and Reliability

The reliability of this study was dependent on the number of participant responses received that met inclusion criteria. Encountered limitations included a lack of literature regarding this research topic, inexperience in conducting a research study compared to experienced researchers, a small sample size from only one university, and use of a convenience sampling method. Use of participants from only one speech-language pathology graduate program in Virginia led to both a small sample size and results that may not be representative of all speech-language pathology graduate students. Ethical considerations consisted of keeping the participants' identity confidential and allowing

their responses to be reported anonymously, obtaining their informed consent on what their study responses were being used for, and having voluntary participation. All survey submissions were stored securely, with the researcher being the only one who had access to submissions. A description was provided before the submission of the survey and assessment informing participants that this information was being used for research and by submitting they were consenting to the use of their responses. Content validity was determined by submitting the survey and transcription assessment to Dr. Alison King (Communication Sciences and Disorders at Longwood University), and Dr. Lissa Power-deFur (Communication Sciences and Disorders at Longwood University) for feedback on relevance and appropriateness

CHAPTER V

DISCUSSION

The purpose of this study aimed to determine if speech-language pathology graduate school programs are adequately preparing their students to provide intervention to individuals whose first language is something other than English. The majority (79%) of students enrolled in the speech-language pathology graduate program at Longwood University reported that they did not have previous exposure to transcribing speech from individuals that speak with accents whose first language is something other than English. On average, the students in the study accurately transcribed 64.2% of speech from individuals who speak English with Chinese, Spanish, and Italian influenced accents.

Transcription of Consonants

During the assessment, students transcribed consonants with an average of 78.1% accuracy. The range for student consonant score was between 63% and 86% accuracy. The consonant transcription accuracy score was significantly higher than both the vowel transcription accuracy score, the diacritic accuracy score, and the total transcription accuracy score. The test languages of Spanish, Italian, and Chinese share many consonant phonemes with Standard American English. Spanish has six fewer

consonants than Standard American English (ASHA, 2021). Italian has one fewer consonant than Standard American English (Wheelock, 2016). Chinese also has one fewer consonant phoneme than Standard American English (ASHA, 2021). Because each of the test languages share many consonant phonemes with Standard American English, there were few consonant replacements made when the individuals with accented speech spoke the English words.

Students showed greater signs of transcription success when transcribing familiar phonemes, such as phonemes that would be said the same by the speakers with accents and a speaker who uses Standard American English. On average, students still incorrectly transcribed over 20% of consonants spoken by non-native English speakers. The inability to accurately transcribe consonants when working with children and adults whose native language is something other than English, or children and adults who speak with accents, puts those individuals at risk of misdiagnoses of speech sound disorders. Inaccurately transcribing phonemes will also disrupt the ability to compare common speech sound replacements made when speaking English influenced by an accent. Common accent-influenced speech sound replacements would be classified as a speech difference, rather than a speech disorder, and would not be targeted as errors.

Transcription of Vowels

Student participants in the study transcribed vowels with an average of 49.1% accuracy during the accented speech transcription assessment; the range of vowel transcription accuracy scores was between 18% and 77%. While the vowel transcription accuracy scores were higher than diacritic use scores, they were significantly lower than consonant and total transcription accuracy scores. Low vowel transcription scores may be

influenced by the extreme difference in vowel phonemes present in Standard American English and in Spanish, Italian, and Chinese. Spanish has 15 fewer vowel phonemes than Standard American English (ASHA, 2021). Italian has 13 fewer vowels than are present in Standard American English (Wheelock, 2016). Chinese also has 13 fewer vowel phonemes than Standard American English (ASHA, 2021). Typically, when English is influenced by an accent, individuals will replace Standard American English vowels with vowels that are present in their native language.

The ability to transcribe vowels in accented speech with less than 50% accuracy puts students at a major disadvantage if they are assigned to work with an individual who speaks English with an accent. Individuals whose speech is transcribed inaccurately may be misdiagnosed with disorders that affect vowel production, such as childhood apraxia of speech. The inability to accurately transcribe vowels will also affect a clinician's ability to distinguish vowel production that is influenced by a difference, rather than a disorder.

Use of Diacritics

When asked if students received education regarding diacritics in their undergraduate level phonetics courses, 71% of Longwood University graduate students reported "yes." Despite the majority of students receiving diacritics education, 0% of participants accurately used diacritic markers during the accented speech transcription assessment. Majority of students did not attempt diacritic use during the transcription assessment. Ultimately, despite receiving education in the use of diacritics during phonetics courses, students were not prepared to use diacritics while transcribing speech in real-time.

Professionals in the field who completed the accented speech transcription assessment for standardization purposes used a total of five diacritic markers throughout the assessment. They noted that there may have been additional phonemes that required a symbol to mark a sound difference or distortion, but they did not feel that the current International Phonetic Alphabet diacritic markers represented what they heard when accents influenced the phonemes. This statement suggests that, for SLPs, there may not be adequate education or resources available when working with individuals who speak English with an accent. For example, despite the ability to use the International Phonetic Alphabet to transcribe speech in any language, there is a lack of diacritic markers available to represent speech sound differences and distortions made when speech is influenced by an accent.

Speakers for Transcription Practice

In undergraduate level phonetics courses, students complete assignments that include practicing speech transcription using recordings or in person speakers. The survey asked participants of this study to identify how many speakers they had experience transcribing as part of their undergraduate phonetics courses. Majority of students reported that they experienced transcribing three speakers, but there were still 28.6% of participants who only transcribed one speaker as part of their phonetics courses. In the classroom setting, speakers provided for transcription practice often include the professor and other students in the classroom.

According to The ASHA Leader in 2019, the population of SLPs in the United States, which includes SLPs who serve as educators at the university level, was 92% white and 96% women. This leads to the conclusion that the majority of transcription

experience during phonetics courses is transcribing speech by adult, white, female SLPs who serve as educators. While transcribing speech by a familiar speaker is a good starting place for learning how to phonetically transcribe, the speech that students practice transcription skills with in the classroom is not representative of the populations that they are tasked to provide services to upon graduation.

Comfort with Transcription

In the survey presented to graduate students, 75% of participants self-rated their comfort with phonetic transcription as "poor" or "neutral." The ability to phonetically transcribe, however, is an essential skill for SLPs and is necessary with almost any population that SLPs serve. The inability to confidently phonetically transcribe speech from a variety of speakers is a disservice to the populations that we serve because it puts them at risk for misdiagnoses, miswriting goals, or labeling a difference as a disorder, which can all be detrimental to an individual's success in therapy.

Despite students rating their transcription comfort negatively, the study found that student self-ratings accurately indicated transcription accuracy performance. The students who rated themselves in the "good" category typically received higher scores than the students who rated themselves as "poor." This leads to the conclusion that educators on the undergraduate and graduate level should be regularly checking in with their students regarding their comfortability with completing essential skills, such as speech transcription. If students rate their comfort poorly in a given area, educators will be able to provide extra support, practice, and resources to increase student abilities and better prepare them for working with the populations they are serving.

Limitations

This study took place at Longwood University in Farmville, Virginia with two cohorts of graduate students in the communication sciences and disorders program; the majority of participants in the study also attended undergraduate programs in the state of Virginia. It should be noted that this small sample size from a single university may not be an accurate representation of student performance in speech-language pathology graduate programs across the United States. Additionally, the recordings used for the phonetic transcription assessment were recorded with a beginner level microphone and software, on three separate occasions (one for each speaker). While conditions were kept consistent to the best of the researcher's ability, having all speakers record the test in the same location at the same time would create a higher quality, more cohesive recording for students to listen to and transcribe.

Future Implications

Practice

SLPs serve a large variety of populations and should take the necessary measures to be prepared to work with the individuals they will provide services to in their workplace. Because graduate schools may not be adequately preparing their students to work with multilingual individuals who speak with accents, current SLPs who encounter this population regularly should engage in continuing education opportunities to expand their knowledge of accent-influenced English. As of 2021, there were 15,728 SLPs in the United States who identified themselves as multilingual service providers (ASHA, 2021). Multilingual service providers, who provide speech and language services in English and

the native language of the individual receiving services, are more prepared to distinguish accent-influence on English speech. Non-multilingual SLPs may want to refer to multilingual service providers when possible.

Educationally, there should be resources in place to adequately prepare speech-language pathology graduate students to work with all populations that they may encounter in the workplace. Students who transcribed more speakers as part of their phonetics courses were better transcribers than students who transcribed fewer speakers. Educators should provide a number of speech sources for transcription practice, including: faculty, students, volunteers, and video recordings of individuals from varying age, racial, ethnic, and linguistic backgrounds. Additionally, 89% of study participants took one phonetics course during their undergraduate studies. With the knowledge that phonetic transcription is an essential skill for SLPs, the idea for including more than one phonetics course during undergraduate education can be pursued by individual universities and the American Speech-Language Hearing Association.

Policy

There is a growing population of multilingual speakers in the United States that will lead to a growing number of multilingual individuals who require speech and language services; many of these individuals will speak English with an accent. To better prepare SLPs to work with this growing population of individuals, there should be an increase in continuing education opportunities, educational resources, and outreach with diverse populations. The American Speech-Language Hearing Association (ASHA) requires providers to complete 30 hours of continuing education every three years. To increase cultural competence and skill when working with linguistically diverse

populations, ASHA should prepare modules, practice sessions, or handouts that focus on providing services to multilingual individuals that SLPs can participate in and review as part of their required continuing education. Additionally, the Council on Academic Accreditation can update phonetic coursework standards to ensure speech-language pathology students are receiving adequate and representative transcription experiences.

Research

This study provided a small amount of insight on SLP students' preparedness and competency for working with a linguistically diverse population. The participants in the study, who all attend graduate school in Farmville, Virginia, did not have adequate previous education, experience, or resources for working with this population. Future research should be completed at universities in more linguistically diverse areas, where there is a higher population of multilingual individuals who speak with accents, such as Florida, California, or Texas. Students attending graduate school in more linguistically diverse areas may receive more education and experience regarding transcription of accented English speech and distinguishing difference versus disorder. Additional, future research should also be completed using recorded speech from other populations that SLPs serve, such as individuals with: childhood apraxia of speech, articulation disorders, or dysarthria. With the knowledge that students are receiving limited diverse transcription experiences, it's possible that students are also not adequately prepared to transcribe individuals with various speech sound impairments or differences

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APPENDICES

Appendix A. Description of Research & Consent for Recorders

Acoustic Analysis of Graduate Student Transcription of Accented English Speech
Longwood University Communication Sciences and Disorders
IRB Approval: June 3, 2022

Description of Research:

For this voluntary research, a recording of ten English words will be obtained from speakers born outside of the United States whose first language was something other than English. The voice recording will contain no information identifying the speaker and the recording will be kept on a secure drive only accessible by the researchers. The recordings will be listened to in a closed classroom environment by speech-language pathology graduate students to assess their ability to transcribe speech from varying cultural backgrounds. Students will have no access to the recordings following participation in the study.

Participation in the research by creating a voice recording used for graduate student speech transcription is voluntary and consent can be withdrawn at any time. Additional information regarding the study can be obtained by contacting any of the following:
Lead Researcher - Emily Covington: emily.covington@live.longwood.edu
Longwood Faculty Supervisor - Dr. Alison King: kingar2@longwood.edu
Longwood Institutional Review Board (IRB): irb@longwood.edu

Consent for Voice Recording Usage:

I understand that the use of my voice recording in this research is voluntary, and that I am free to withdraw my consent at any time. I acknowledge that the general purpose of this study, including the use of my voice recording, has been explained to me. I acknowledge that I have the opportunity to obtain information regarding this research project, and that any questions I have will be answered to my full satisfaction. I understand that no information will be presented which will identify me as a voice recorder of this study unless I give my permission in writing. I acknowledge that I have read and fully understand this consent form.I agree to it freely and voluntarily.

- A. Yes, I consent.
- B. No, I do not consent.

Please list native language: _____

Appendix B. Survey and Transcription Test

Acoustic Analysis of Graduate Student Transcription of Accented English Speech
Longwood University Communication Sciences and Disorders
IRB Approval: June 3, 2022

Description of Research

For this voluntary research, speech-language pathology graduate students are asked to take a short survey examining phonetics education backgrounds and an assessment of transcription abilities completed by listening to a recording of 30 words. The assessment will contain no identifying information and will be stored securely, only to be accessed by the researchers. The assessment will take place in a closed classroom environment. Following transcription of the recording, participation in the study is complete. Participation in the research is voluntary and consent can be withdrawn at any time. Additional information regarding the study can be obtained by contacting any of the following:
Lead Researcher - Emily Covington: emily.covington@live.longwood.edu
Longwood Faculty Supervisor - Dr. Alison King: kingar2@longwood.edu
Longwood Institutional Review Board (IRB): irb@longwood.edu

Consent to Voluntary Participation

I understand that my participation in this research is voluntary, and that I am free to withdraw my consent at any time and to discontinue participation in this project without any penalty. I acknowledge that the general purpose of this study, the procedures to be followed, and the expected duration of my participation has been explained to me. I acknowledge that I have the opportunity to obtain information regarding this research project, and that any questions I have will be answered to my full satisfaction. I understand that no information will be presented which will identify me as the subject of this study unless I give my permission in writing. I acknowledge that I have read and fully understand this consent form. I agree to it freely and voluntarily.
    A. Yes, I consent.
    B. No, I do not consent.

Demographics:

Are you currently enrolled in the Communication Sciences and Disorders Graduate Program for the Fall 2022 semester?
    A. Yes
    B. No

Is English your native language?
    A. Yes
    B. No

Do you speak Spanish, Italian, or Chinese?
    A. Yes
    B. No

Have you ever traveled to a Spanish, Italian, or Chinese speaking country?
    A. Yes
    B. No

<u>Phonetics Education:</u>
Please select your undergraduate degree field of study:
    A. Communication Sciences and Disorders (Speech-Language Pathology)
    B. Linguistics
    C. Phonetics
    D. Other

When was your most recent introductory phonetics course taken?
    A. Less than one year ago
    B. Between one and two years ago
    C. Greater than two years ago

Did you receive education regarding diacritics during your introductory phonetics course?
    A. Yes
    B. No

During your introductory phonetics course, how many speakers did you have experience transcribing?
    A. 1 (eg. only the professor)
    B. 2 (eg. professor + another student)
    C. 3 or more (eg. professor, other students, other recorded materials, etc.)

How many phonetics courses did you complete during your undergraduate program?
    A. 1 or less
    B. 2
    C. 3
    D. 4 or more

Have you ever transcribed speech from someone who is not a native English speaker?
    A. Yes
    B. No
    C. Unsure

How would you rate your overall comfortability with transcription?
1. Very Poor
2. Poor
3. Neutral
4. Good
5. Very Good

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

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30. _____
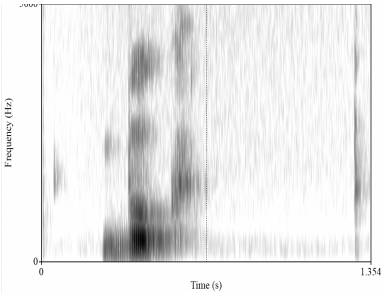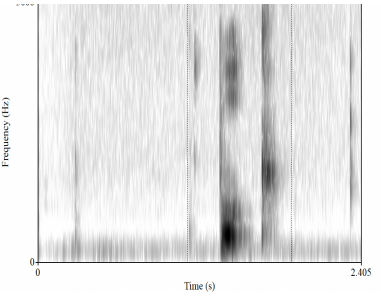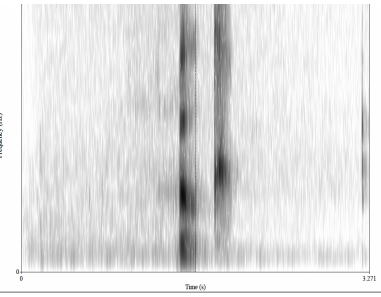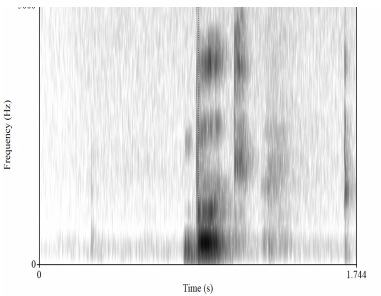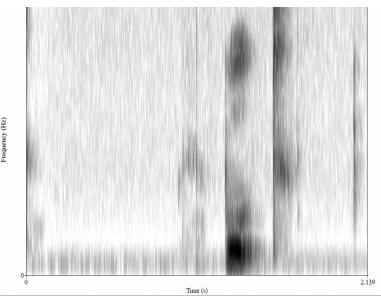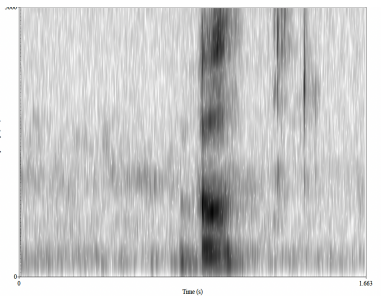
Appendix C. Test Word Spectrogram Comparison

Word: "Annoy"		
Spanish	**Chinese**	**Italian**
/ənɔɪ/	/ʌnɔɪj/	/ʌnɔɪj/
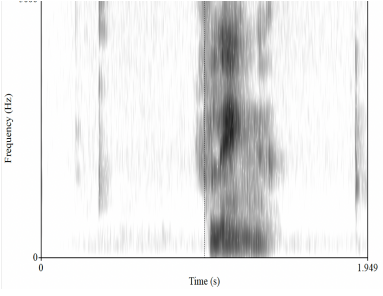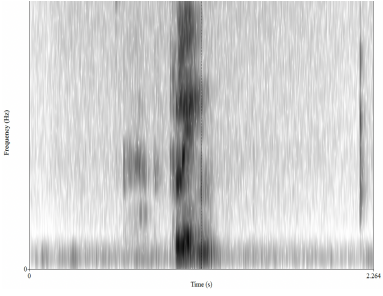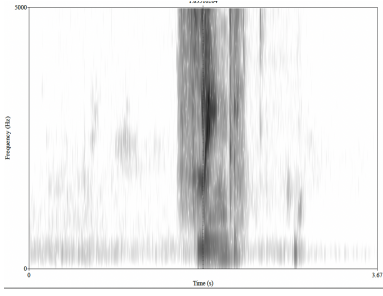
Word: "Batches"		
Spanish	**Chinese**	**Italian**
/mætʃɪz/	/pʰætʃɪz/	/bætʃɪz/
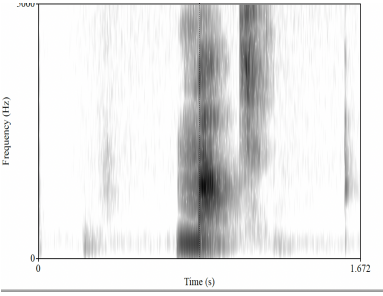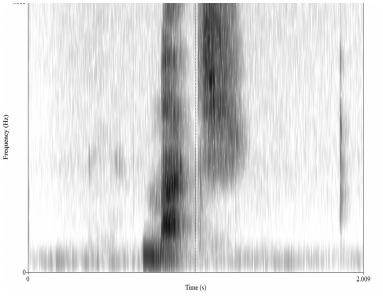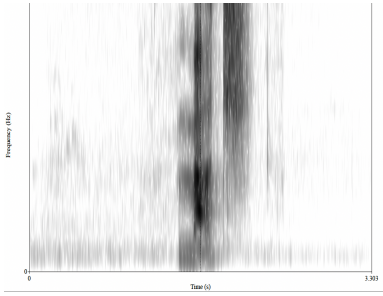
Word: "Book"

Spanish	Chinese	Italian
/buk/	/bʊk/	/buk/
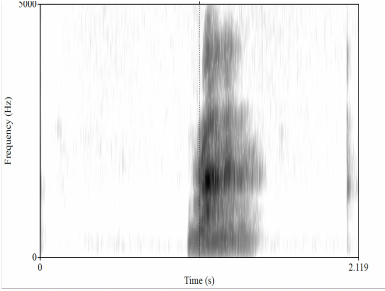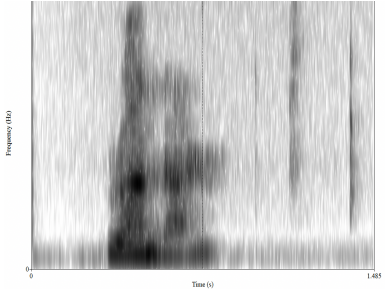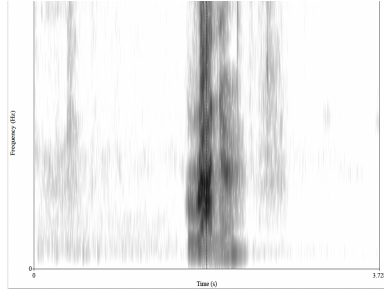
Word: "Boot"		
Spanish	**Chinese**	**Italian**
/but/	/but/	/bu/
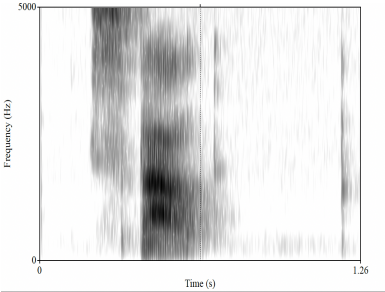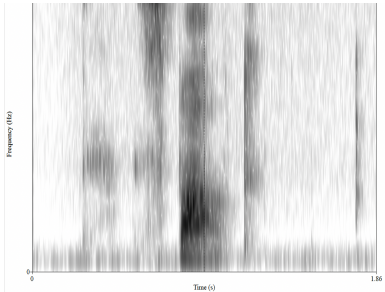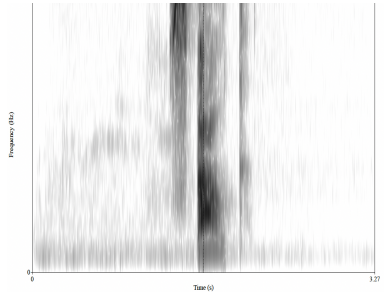
Word: "Fling"		
Spanish	**Chinese**	**Italian**

/flɪŋ/	/flɪŋ/	/flɪŋ̃/
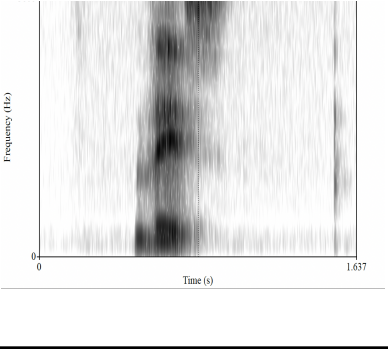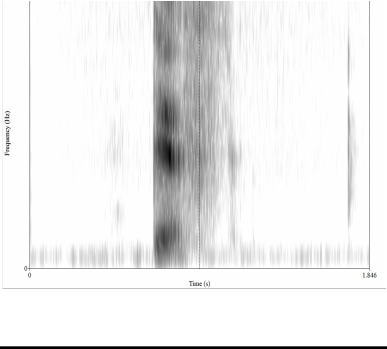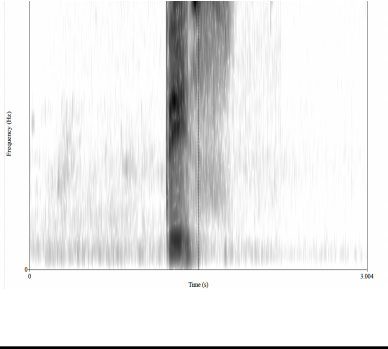
Word: "Much"		
Spanish	**Chinese**	**Italian**
/mɑtʃ/	/mʌtʃ/	/mætʃ/
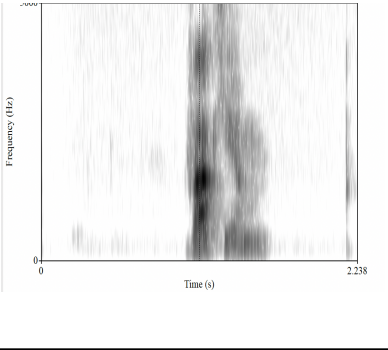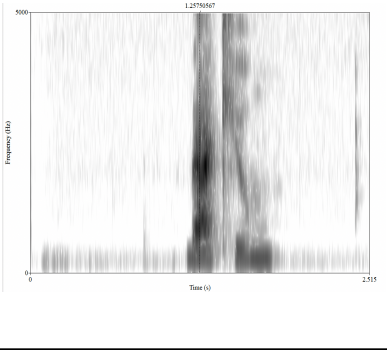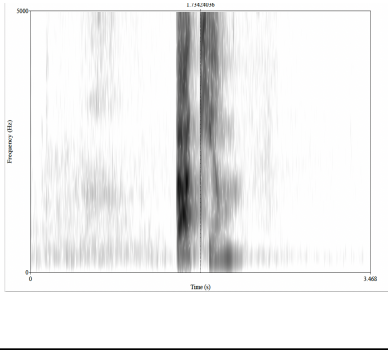
Word: "Runner"		
Spanish	**Chinese**	**Italian**

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/rʌnɜ^/	/rʌnɜ^/	/r:ʌnɜ^/

Word: "Spout"		
Spanish	**Chinese**	**Italian**
/spaʊt/	/spɑt/	/spaʊt/

Word: "This"		
Spanish	**Chinese**	**Italian**

/ðɪs:/	/dɪs/	/ðɪs/

Word: "Vacuum"		
Spanish	**Chinese**	**Italian**
/vækjum/	/bækjum/	/vækjuːm/