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Revisiting the language-music relationship : exploring pitch recognition and discourse intonation in adult ESL students

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REVISITING THE LANGUAGE-MUSIC RELATIONSHIP: EXPLORING PITCH RECOGNITION AND DISCOURSE INTONATION IN ADULT ESL STUDENTS

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CHAPTER I

INTRODUCTION

Statement of the Problem

For decades, there has been considerable speculation about a link between musical training and facility of second language acquisition (Dobrian, 1992; Mora, 2002; Stansell, 2002). For some people, gaining proficiency in music, typically through studying voice and/or a musical instrument, comes more easily than gaining proficiency in a second language. Others learn new languages easily but do not have the same capabilities for music. However, it seems that the link between music and language could be strong. Many who are multilingual have had musical training, while others endeavoring to learn a new language may wonder if their lack of musical training may have contributed to their struggles.

Much research has been conducted to investigate this possible link between musical training and language learning (Dobrian, 1992; Mora, 2002; Schueller, Bond, Fucci, Gunderson, & Vaz, 2004; Stansell, 2002; Wong, Skoe, Russo, Dees, & Kraus, 2007; Zatorre, 1997). In recent years, researchers have discovered that aural input is processed in different parts of the brain than had been previously thought (Klein et al., 2000; Levitin & Menin, 2003; Patel, 2003; Zatorre, 1997, 2002, & 2005). These researchers discovered that certain aspects of speech are processed in the brain's right hemisphere, and certain aspects of music are processed in the left hemisphere. Some studies showed that musical training seemed to influence language abilities (Borchgrevink, 1982; Peynircioğlu, Durgunoğlu, & Öney-Küsefoğlu, 2002; Wong et al., 2007; Schueller et al., 2004).

While aforementioned studies have been conducted to compare musical background and language proficiency, there have been no studies found comparing pitch recognition and discourse intonation in ESL students. Researchers in musical and linguistic fields alike (Gordon, 1999; Lehman, 1968; McCarthy, 1984) employ pitch recognition tests that provide a straightforward method of examining musical aptitude. Focusing on discourse intonation, or manner of using pitch in speech or a verbal exchange, has been of increasing importance to second language teachers over the last decade (Chun, 2002; Clennell, 1997; Welby 2003). This exemplifies a slight paradigm shift from the other aspects of second language learning on which researchers have previously focused, which were primarily grammar-based matters. Additionally, a discourse intonation test is a way of quantifying second language fluency, despite the fact that it only measures one component of second language fluency.

> It is very noticeable that, although some research has been devoted to (sentence) intonation, most work has hitherto concentrated on what traditionally have been lower level speech phenomena- the phoneme, the distinctive feature, the syllable, and so on. For a fuller understanding of L2 speech acquisition, this concentration will need in the future to be balanced by closer attention to higher level patterning in the discourse domain.
> (Leather & James, as cited in Chun, 2002, p.3)

Conducting a study that focuses on speech intonation at a higher level, such as the sentence or discourse level instead of the phoneme or word level, will fill in the dearth of such research. That is the objective of this study.

Another problem is that despite technological advances, it is not quite known what some recently collected neurological data prove. Activity measured in a certain area of the brain provides some information, but scientists are still discovering the best ways to interpret positron emission tomography (PET), functional magnetic resonance imaging (fMRI), and magnetoencephalography (MEG) scans into meaningful explanations. Both PET and fMRI procedures measure blood flow within the brain. The PET scan does so by measuring radioactive material that has been injected into the patient's bloodstream, while the newer and less invasive techniques of MEG and fMRI essentially involve using a large magnet to measure cerebral blood flow. As the magnetic field outside the patient's brain is changed, hydrogen atoms in the brain induce radio signals. These signals increase when the level of blood oxygen rises in the brain, which indicates a rise in brain activity. The fMRI produces higher quality images and is less invasive than the PET scan.

Zatorre (2005) points out that a problem with these techniques is that seeing certain cerebral activity highlighted in these brain scans is still essentially open to much interpretation: "…neuroimaging can be notoriously difficult to interpret: similar patterns of brain activity do not necessarily mean that similar substrates are involved, because many complexities of neural patterning are beyond our present technology's ability to measure" (p. 313). Zatorre is a researcher who has conducted many studies using methodology of both PET and fMRI scans. He currently runs McGill University's Auditory Cognitive Neuroscience Laboratory in Montréal. According to the lab's website: "In particular, our lab is most concerned with the two most complex and characteristically human uses of sound: speech and music" (Zatorre, 2006, p.1).

Besson and Schön (2001) agree with Zattore about the difficulty of using brain scans, but are optimistic about the future:

> …the task of the cognitive neuroscientist is to delineate the different comparisons performed within one level of processing, to understand the mechanisms that underlie these computations, and to localize where in the brain these mechanisms are implemented. This task is fraught with both philosophical and methodological problems, but science is advancing rapidly and new methods are now available to track these issues. (p. 238)

Purpose of the Study

The purpose of this qualitative, correlational study was to explore the relationship, if any, between three measures of musicality and discourse intonation. The three measures of musicality were musical training (MT), which in this study was measured by total hours an instrument was played or voice was trained, and pitch recognition (PR), which comprises two tests, PR-A, which is a pitch matching test, and PR-B, which is a pitch recognition test. Discourse intonation (DI) is defined as the manner of using pitch in speech at the discourse level; i.e., a verbal exchange or conversation. Whether or not students who speak tonal first languages have better discourse intonation was also examined. There was some demographic and background information collected, which focused on the students' linguistic and musical backgrounds.

> In the auditory domain, a great deal of effort has gone into understanding the way in which the human brain processes speech sounds. Given the importance of speech and spoken language to human communication and behavior, this is not surprising. It is interesting, however, to consider other aspects of auditory information processing that may help to round out the picture. Increasingly, music is being recognized as an important component of human activity that may help us to gain insight into the functional organization of the human brain. (Zatorre, 2001, p. 193)

Research Questions

The following questions were addressed in the study:

Main Question

What is the relationship, if any, between three different measures of musicality (two pitch recognition tests, and musical training) and discourse intonation?

Sub-Question

Is there a significant relationship between discourse intonation in students whose native languages are tonal and those whose native languages are atonal?

Theoretical Rationale

For years, the right hemisphere of the brain has been understood to be the locus for music and the left hemisphere the locus for language. "The currently held idea has been for a considerable time that speech perception and production are controlled by the so-called 'dominant' (usually the left) cerebral hemisphere, while musical functions are controlled by the 'non-dominant' (usually the right) hemisphere" (Borchgrevink, 1982, p. 151). While this generally seems true, the advent of technologies like brain scanning has enabled researchers to understand better the intricacies of how the brain processes sound signals. Three kinds of neuroimaging techniques that have recently captured the attention of many researchers, including Robert Zatorre (1997, 2001, 2002) are the previously mentioned PET, MEG, and fMRI.

More recent research has shown that both hemispheres may be engaged in language processing. "Zatorre (1992) claims that phonetic and pitch processing in speech perception are disconnected. The production and interpretation of pitch data in speech is handled by the musical intelligence..." (Stansell, 2002, p. 11). This will be discussed further in Chapter V.

Linguist Eric Lenneberg (1967) posits a critical period hypothesis for language learning, which suggests that language learning happens most effectively before the age of puberty. Many researchers stand by this hypothesis, and numerous studies have shown supporting evidence for it (Birdsong, 1999; Danesi, 2003); this will also be discussed further in Chapter II. Zatorre (2005) has recently been researching absolute pitch (AP), which is the ability to recognize a pitch without any reference point, and how there may indeed be a critical period hypothesis for acquiring AP. "It is now clear that absolute pitch cannot develop without some musical training, but critically, the exposure must happen during childhood: past the age of 12 to 15, it is essentially impossible to learn it. From this one can conclude that the brain must be particularly sensitive during a certain time in development" (p. 314).

There is also evidence that genetics play some role in AP (Zatorre, 2003.) In Zatorre's estimation, genetically mapping AP is easier to do than mapping relative pitch (RP), which is the ability to recognize a pitch after listening to a baseline pitch. While this study did not focus on AP, it focused on other aspects of pitch. Within the realms of language and music, the *nature versus nurture* debate still continues; it would be interesting to see whether or not genetics prove to be a strong indicator for AP and possibly other musical abilities.

In addition to starting to research genetics' potential involvement with musical abilities, researchers have been examining possible sex-linked differences as well (Brizendine, 2006; Knaus, Bollich, Corey, Lemen, & Foundas, 2004). "Under a microscope of an fMRI scan, the differences between male and female brains are revealed to be complex and widespread. In the brain centers for language and hearing, for example, women have 11 percent more neurons than men" (Brizendine, 2006, p. 5). The present study did not specifically control for gender, but if significant differences were to have arisen between males and females, they would have been noted in the findings.

Pitch is important in differentiating words in tonal languages. In the case of tonal languages, which do *not* include English, pitch or the pitch contour of one's speech distinguishes the meanings of the words that otherwise would be phonologically identical. Thai is a tonal language that has five tones, and

Mandarin, which is spoken by approximately 1/5 of the world's population, has four tones.

The most typical example of tones given in Mandarin is the word "ma". When said with a rising tone, it means mother; when said with a falling tone, it means hemp; when said with a falling then rising tone, it means horse; when said with a steady tone, it is a question marker. If someone speaking Mandarin says the word "ma" with the wrong pitch contour, the intended word would change into an unintended one. Much written poetry and prose in Mandarin (and assumedly other tonal languages) contains double and multiple entendres that cannot be fully grasped unless the reader is a native speaker or understands all possible meanings of each word. There is no way in Mandarin to differentiate tones simply by seeing a written character- one simply has to understand contextual cues. The same written character could mean hemp, horse, mother, or be a question marker. The number eight is an example of a double entendre in Mandarin- the same word (pronounced "ba") means *eight*; saying the word "ba" with a different tone means *wealth* or *prosperity*; thus, eight is thought to be a lucky number. Contrarily, *four* (pronounced "si" as in "sit") said with a different tone means *death*; the researcher's former Mandarin teacher told her that many superstitious, often elderly, Chinese try to schedule important events and major travel to happen on a date that does not contain the inauspicious number four.

Using pitch correctly is paramount in tonal languages; thus it was hypothesized that those who spoke tonal languages would score better on both the pitch matching and pitch recognition tests, regardless of any possible musical background. Another hypothesis was that scoring higher on the pitch matching and pitch recognition tests would mean scoring higher on the discourse intonation test. Thus, it could also be supposed that those who spoke tonal languages would score higher on the discourse intonation test.

Significance of the Study

Examining the possible link between musical training and second language facility is a large undertaking, but focusing on pitch recognition and discourse intonation of students at a local level could contribute to ongoing music-language research. Although previous studies have investigated this link, none has done so by focusing on pitch recognition in relation to discourse intonation of adult ESL students. If there had been a positive correlation between musical training and discourse intonation proven in this study, it may have further informed other researchers in musical and linguistic fields and possibly prompt more specific studies to be conducted, such as musical training's effect on second languages other than English.

The way the brain processes music and language has fascinated many for years. With the advancement of technologies related to brain scanning, neuroscientists and cognitive scientists are able to understand better how language and music are processed and slowly uncover realities that have been shrouded in mystery for ages.

If a positive correlation were to have been found between musical training and discourse intonation, the practical significance of this study would have been to propose and support music education and training. Ideally, such training would start before the age of nine, at which point Gordon (1986) posits that musical aptitude stabilizes.

Definition of Terms

The following definitions have been taken from musical and linguistic dictionaries, and other sources, and are appropriately cited. Those definitions without citations were taken from a variety of sources, all of which are listed in the bibliography, and are amalgamations created by the researcher.

Absolute Pitch (AP): The ability to recognize a pitch without any other pitch being given a reference point. Widely referred to as *perfect pitch*, some researchers believe AP is innate and passed on genetically. Musical training is necessary for full development of the auditory potential of a person with AP, unlike with relative pitch (RP).

Affective filter: "A block" (Krashen, 2003, p.6). An emotional block to learning; Krashen hypothesized that if students' affective filters are lowered, students are more capable of learning.

Amusia: "The inability to recognize musical tones or to reproduce them. Amusia can be congenital (present at birth) or be acquired sometime later in life (as from brain damage)" (Medterms online medical dictionary, 2002).

Aphasia: "Loss or impairment of the power to use or comprehend words usually resulting from brain damage" (Merriam-Webster, 1999, p. 54). Aphasia can be either congenital or acquired, which usually results from brain damage.

Atonal language: A language in which pitch or the pitch contour does not differentiate the meanings of words. English is among these atonal languages, which comprise the majority of languages.

Audiation: "Audiation takes place when one hears and feels music through recall or creativity, the sound not being physically present except when one is audiating while also aurally perceiving music that is being performed by others or that one is performing himself" (Gordon, 1986, p. 8). Musical meaning is derived through audiation and functions in both short- and long- term memory.

Broca's Area: "A cerebral area, usually in the left inferior frontal gyrus, associated with the movements necessary for speech production." (Dictionary.reference.com, 2007)

Discourse Intonation (DI): Manner of using pitch in speech, a verbal exchange or conversation (see intonation); "The ordering of pitched sounds made by a human voice" (Mora, 2002, p. 149).

First Language: "The language first acquired by a child (also called the mother tongue or native language) or preferred in a multilingual situation." (Crystal, 1999, p. 119)

Functional Magnetic Resonance Imaging (fMRI): A brain scan that uses magnetism to measure blood flow within the brain. This produces higher resolution images than PET scans and involves no radioactive injections.

Heschl's Gyrus: "A convolution of the temporal lobe that is the cortical center for hearing and runs obliquely outward and forward from the posterior part of the lateral sulcus… also called *transverse temporal gyrus.*" (Merriam-Webster's Medical Dictionary, 2007). Heschl's gyrus is responsible for organizing sounds according to their pitch.

IMMA: See *pitch recognition-B.*

Intonation: "The movements or variations in pitch to which we attach familiar labels describing levels (e.g. high/low) and tones (e.g. falling/rising), etc." (Ranalli, 2002, p.1).

L2 learning: Learning a second language, which may be a second, third, or any other language than one's first.

Language acquisition: "… a process similar, if not identical, to the way children develop ability in their first language. Language acquisition is a subconscious process; language acquirers are not usually aware of the fact that they are acquiring language, but are only aware of the fact that they are using the language for communication… In non-technical language, acquisition is 'picking up' a language." (Krashen, 1982, p. 10).

Language learning: "…conscious knowledge of a second language, knowing the rules, being aware of them, and being able to talk about them. In non-technical terms, learning is 'knowing about' a language, known to most people as 'grammar', or 'rules'. Some synonyms include formal knowledge of a language, or explicit learning" (Krashen, 1982, p. 10).

Magnetoencephalography (MEG): A brain scan that uses magnetism to measure blood flow within the brain. Images are not as high-resolution as those from an fMRI scan, but MEG is non-invasive, unlike PET.

Morphology: "The branch of grammar which studies the structure of its words" (Crystal, 1999, p. 223).

Multiple Regression Analysis (MRA): See *regression*.

Musical Training (MT): In this study, this will be represented by the measure of how many hours an instrument, including voice, was played by a participant.

Native Language: See *first language*.

Neuroplasticity: "The brain's natural ability to form new connections in order to compensate for injury or changes in one's environment." (Dictionary.reference.com, 2007)

Note: See *tone.*

Pitch: "The attribute of auditory sensation in terms of which a sound may be ordered on a scale from 'low' to 'high'. Pitch corresponds to some degree with the acoustic feature of fundamental frequency, which in the study of speech is based upon the number of complete cycles of vibration of the vocal folds. The linguistic use of pitch in words is called tone, and in sentences intonation" (Crystal, 1999,

p. 264).

Pitch perception: The process whereby a listener extracts a sequence of tonal units from the acoustic signal of music or speech.

Pitch recognition (PR): The initial stage of the decoding process in pitch perception.

Pitch recognition-A (PR-A): a pitch matching test designed by the researcher to measure pitch-matching capabilities using a piano keyboard.

Pitch recognition-B (PR-B): is a pitch recognition test called *IMMA*, or Intermediate Measures of Musical Aptitude used by the researcher but originally designed by Edwin Gordon.

Positron Emission Tomography (PET): A nuclear medicine imaging technique which produces a three-dimensional image or map of functional processes in the body. PET subjects are injected with radioactive material that illuminates the blood's path within the brain.

Pragmatics: "The study of factors influencing a person's choice of language" (Crystal, 1995, p. 457).

Prominence: Marked or noticeable stress on certain syllables when speaking; can be accomplished by pronouncing syllables louder and stronger, by assigning them a different pitch, or by articulating phonemes more distinctly.

Regression: "The prediction of scores on one variable by their scores on a second variable. The larger the correlation between the variables, the more accurate the prediction. We can undertake a multiple regression where the scores on one variable are predicted from the scores on a number of predictor variables" (Hinton, Brownlow, McMurray & Cozens, 2004, p. 372).

Relative pitch (RP): The ability to recognize a pitch after listening to a baseline pitch. RP can be learned by people of any age, whereas AP generally cannot.

Second language: A language other than one's native language. A second language, in this context, may in fact be a third or fourth language.

Semantics: "The study of meaning in language" (Crystal, 1999, p. 301).

Spectrogram: A two-dimensional, graphic representation of speech vibrations. The x-axis of a spectrogram measures time, while the y-axis measures frequency measured in Hertz (Hz). One Hz is a cycle of vibrations per second. Most spectrographs measure a range of 0 - 8,000 Hz.

Syntax: "The study of the rules governing the way words are combined to form sentences" (Crystal, 1999, p. 329).

Timbre: "Timbre is that which distinguishes one instrument from another- say, trumpet from piano- when both are playing the same written note" (Levitin, 2006, p. 85).

Tonal language: A language in which pitch or the pitch contour distinguishes the meanings of words that are otherwise phonologically identical. Some researchers believe the number of people speaking tonal languages outnumbers atonal ones: some examples of tonal languages are Mandarin, Thai, Vietnamese, Punjabi, and Somali. High concentrations of tonal languages are in South East Asia and throughout Africa.

Tone: “The linguistic functioning of pitch at word level” (Crystal, 1999, p. 341); vocal or musical sound of a specific quality; musical sound with respect to timbre and manner of expression. “…two terms, *tone* and *note*, refer to the same entity in the abstract, where the word *tone* refers to what you hear, and the word *note* refers to what you see written on a musical score” (Levitin, 2006, p. 85).

Wernicke’s Area: “A portion of the left posterior temporal lobe of the brain, involved in the ability to understand words.” (Dictionary.reference.com, 2007) Named after German neurologist Karl Wernicke.

Williams Syndrome (WS): “A genetic disorder characterized by mild mental retardation, unique personality characteristics, unusual facial features, and cardiovascular disease…Williams Syndrome is inherited in an autosomal dominant manner and is due to a small chromosome deletion.” (Medterms online medical dictionary, 2002).

CHAPTER II

REVIEW OF LITERATURE

Introduction

The review of literature is designed to give an overview of language and music acquisition, including the theories relevant to the major research questions of the study. Also included in this chapter are an overview, results from studies of the cerebral processing of language and music, research on the role of music in first and/or second language acquisition, and a summary. The review of literature is intended both to introduce these topics and to delve into past and current research through the examination of specific studies.

Background of Language and Music Acquisition

"There is a broad acceptance of a correlation between musical aptitude and language learning ability. Among otherwise diverse individuals with fluency in speaking five or more languages, often a shared trait is a high musical ability" (Stansell, 2002, p. 24). The broad acceptance Stansell mentions has been endorsed by many over the years; only recently, however, have researchers begun to try to determine the strength of the correlation between music and language through neurological studies (Zatorre, 1997, 2000, 2001, 2003; Zatorre, Belin, & Penhune, 2003).

Crystal (1997) defines language learning as "the process of internalizing a language- either a mother tongue or a foreign language" (p. 189). Internalizing language and music is a long and complex process that depends on a number of faculties of the learner and the learner's environment. Learning a language, first or otherwise, and learning music are both commitments that often require years of study until proficiency can be attained.

English has been said by many to have the largest vocabulary (Aitchison, 2003, Crystal, 2006, Dabrowska, 2004), even if a majority of the words found in English dictionaries are archaic and/or infrequently used. "*The Oxford English Dictionary* (OED) had over 500,000 entries in its 1992 edition," cites Crystal (2006, p. 10). Crystal adds that he has many regional dictionaries from places like Jamaica and South Africa, and posits that the 500,000 figure must thus be much higher when such local words are accounted for worldwide. One such example that has made it into the *OED* (2007) is the word "prepone." This word is the opposite of *postpone* and thus means to move something to an earlier spot in time, as in "*prepone* a meeting from Thursday to Tuesday." When the researcher was in India, a friend had notified her of this word and said that people in India had coined the word; the *OED* recognizes this Indian origin. Despite the large number of extant words in English, the majority of these are not used often.

Aitchison (2003) believes that "the number of words which an educated adult native speaker of English knows, and can potentially use, is unlikely to be less than 50,000, and may be much higher" (p. 7). The knowledge of this number of vocabulary words requires years of study. Also needed to be learned in order to attain linguistic competency are semantics, or “the study of meaning in language” (Crystal, 1999, p. 301), pragmatics, or “the study of factors influencing a person’s choice of language” (Crystal, 1995, p. 457), morphology, or “the branch of grammar which studies the structure of its words” (Crystal, 1999, p. 223), and syntax, or “the study of the rules governing the way words are combined to form sentences” (Crystal, 1999, p. 329).

The speed at which we recognize and produce language, both in spoken and written form, is currently more easily done with humans than it is with computers, despite enormous differences in processing speed. According to Dabrowska (2004):

> …the enormously complex processing required to interpret an utterance is carried out extremely quickly… Neurons in the human brain typically fire about 200 times per second. The clock speed of most desktop computers is between 100 million and 1,000 million cycles per second- about a million times faster. Yet, while humans process ordinary conversation quickly and effortlessly, computers run into serious difficulties at just about every level of processing. (p. 17)

Processing simple sound signals, let alone input much more multifaceted like a conversation, involves a string of mechanical, chemical, and neural events. Similarly complex processes are involved with listening to, and certainly performing, music, and new evidence shows that we use some of the same cerebral regions in interpreting both language and music; this will be discussed further in subsequent sections.

Lily Wong-Fillmore (1976) coined the term *formulaic language* (also known as *formulaic speech*), which refers to formulas, or routines, learned by second language learners of all ages and can be one word, many words, songs, idioms, rhymes or even proverbs. It is usually achieved by simply repeating or mimicking. This engages the short-term memory and the reproduced segment does not initially need to be fully comprehended. Formulaic language has been associated with implicit linguistic knowledge which is analyzed, i.e. consisting of formulas of single words representing whole utterances (Bialystok, 1982).

The present study that was conducted, however, gathered phrases that were only heard up to two times before being repeated by the ESL speaker: the likelihood of such phrases (some of which are more than one sentence) being able to fall under the category of formulaic speech is possible, but not likely. Further studies involving fMRI and/or PET scans could be conducted to see where cerebral activation occurs when using formulaic speech. According to Danesi (2003), the right cerebral hemisphere handles “intonation and other prosodic systems” and the left hemisphere is in charge of “major speech subsystems (pronunciation, grammar, etc.)” (p. 35). It could be argued, therefore, that formulaic speech would be processed in the right hemisphere and material in this study, which involves more cognition, would be processed in the left hemisphere.

The researcher chose to focus on discourse intonation as a larger predictor of speech, which is an important component of second language acquisition and education.

> In some ways, speaking can be considered the most difficult skill to acquire since it requires command of both listening comprehension and speech production subskills (e.g. vocabulary retrieval, pronunciation, choice of a grammatical pattern, and so forth) in unpredictable, unplanned situations. (Celce-Murcia & Olshtain,2000, p. 165)

In the same vein, Celce-Murcia & Olshtain (2000) outline ten prerequisites for speaking in another language. Following are some of these that participants will need to have in order to successfully complete the interview process, part of which involves interactions like scheduling an interview appointment (sometimes by phone).

> B. ability to use discourse connectors such as *well; oh, I see;* okay… C. ability to use suitable 'opening phrases' and 'closing phrases' such as *Excuse me* or *Thank you for your help*… D. ability to comprehend and use reduced forms… F. ability to use the basic intonation – or tone – patterns of the language… G. ability to use proper rhythm and stress in the language and to make proper pauses… I. knowing how to use the interlocutor's reactions and input… J. awareness of the various conversational rules that facilitate the flow of talk" (p. 175).

The shift to focusing on spoken discourse in second language learning, as will be expanded upon in subsequent sections, is somewhat of a recent phenomenon, as noted here by Bygate (in Carter & Nunan, 2001).

> Speaking in L2 has occupied a peculiar position throughout much of the history of language teaching, and only in the last two decades has it begun to emerge as a branch of teaching, learning and testing in its own right, rarely focusing on the production of spoken discourse (p. 14).

Bygate lays out certain characteristics of speech: conceptualization, formulation, articulation and self-monitoring. All of these were employed by students in this study during the testing, notably articulation and self-monitoring in the discourse intonation test; "[articulation] involves the motor control of the articulatory organs; in English: the lips, tongue, teeth, alveolar palate, velum, glottis, mouth cavity and breath. Self-monitoring is concerned with language users being able to identify and self-correct mistakes" (p. 16). While discourse intonation is only a small indicator of second language acquisition as a whole and education is a more significant indicator, recent literature has illustrated the complexities involved and the need to continue studies centered around second language speech.

Theories of Second Language Acquisition

Speaking, specifically discourse intonation, is only one component of a second language, and some researchers (Celce-Murcia & Olshtain, 2000) argue it can be the most difficult to master. Providing a neutral overview of theories of second language acquisition not only connects the discourse intonation piece to second language learning as a whole, but also provides a background of relative, current theoretical models. The following theories and explanations are rarely agreed upon unanimously by linguists, psychologists, and educators.

Behaviorist theory describes second language learning by using imitation, practice, reinforcement (feedback), and habit formation as its core practices. Early behavioristic experiments were conducted on animals, and were not originally focused solely on second language acquisition.

Two methods of second language learning often associated with behaviorism are the audiolingual method and the contrastive analysis hypothesis (Lightbown & Spada, 2006, p. 34). The audiolingual method, sometimes referred to as *drill and kill*, uses extensive memorization exercises to help language learners master linguistic structures and forms; this method was most popular in the 1960s and 1970s. The contrastive analysis hypothesis posits that learners' second language should be easy to learn if its structure is closely related to that of their first language (Klein, 1986, p. 25). Similarly, it supposed that second language learning would be harder to learn if the learner's first language differed greatly in structure.

Universal Grammar (UG), a term coined by Noam Chomsky, is part of the innatist perspective of language learning and posits that grammar is essentially hardwired in the brain. Some researchers believe this is an acceptable explanation for first language acquisition, but not second, especially if the second language was learned after the critical period around puberty (cited in Lightbown & Spada, 2006, p. 35).

Krashen posited a model called the Monitor Model in the 1970s that was designed to explain second language learning and could be considered in the innatist school. The Monitor Model comprises five hypotheses: the acquisition-learning, monitor, natural order, input, and affective filter (Klein, 1986, pp. 28-29; Krashen, 1982, pp. 10-32).

The acquisition-learning hypothesis suggests that acquisition happens naturally and without conscious attention, whereas learning requires attention to structural forms. The monitor hypothesis posits that the system of the second language learned is a monitor for self-editing one's second language output, whether spoken or written. Second language acquisition occurs in a predictable order. This is the basis for the natural order hypothesis, and just as in a first language, the easiest forms are not necessarily learned first. Possibly the best known of Krashen's hypotheses is the input hypothesis, which posits that exposure to *i+1* level of instruction leads to optimal acquisition, where *i* is the learner's current language level and *+1* represents a level slightly above the present level. "We acquire… only when we understand language that contains structure that is 'a little beyond' where we are now" (Krashen, 1982. p. 21). Finally, the affective filter is a construct that represents a barrier that prevents learning from happening effectively. One's affective filter could be considered high if one were experiencing an usually high level of stress, for example.

The cognitive / developmental perspective that has developed since the 1990s states that there is no need to differentiate *acquisition* from *learning*, and that "general theories of learning can account for the gradual development of complex syntax and for learners' inability to spontaneously use everything they know about language at a given time" (Lightbown & Spada, 2006, p. 38). Within this perspective are three models: information processing, connectionism, which is also known as parallel distributed processing (Bialystok, 1991, p. 115), and the competition model.

The information processing model suggests that second language acquisition is a gradual increasing of knowledge that can be automatically tapped into for speaking and understanding. There is a limit to how much attention can be paid to information; at the earlier stages of language learning, basic information like key vocabulary words are focal points. As learning progresses, attention to form is better, and information becomes more easily accessible. Bialystok (1991) says "Using the perspective of information processing, the assumption is that language is assigned a mental representation, and using language involves the application of identifiable processes to those representations" (p. 116).

Connectionists like psychologists James McClelland and David Rumelhart (1986) argue that language knowledge is gradually built up via exposure to many instances of linguistic features. As language learners continue to hear these language features, they develop a stronger network of connections. If someone hears, for example, "he goes" and "they go" repeatedly, they will learn pronoun / verb agreement even if they do not intend to do so.

Similar to the connectionist model, the competition model suggests that language learning can happen whether or not it is intentional. Competition model proponents, such as psychologists Brian MacWhinney and Elizabeth Bates (1981), argue that through repeated exposure, learners pick up cues with which a language signals functions. "For example, the relationship between words in a sentence may be signaled by word order, grammatical markers, and the animacy of the nouns in the sentence" (Lightbown & Spada, 2006, p. 42). Word order within a sentence is one example of this— in English, we use Subject-Verb-

Object. If a learner understands the words “kicks the ball” in the phrase “Amy kicks the ball,” he or she can deduce that Amy would probably be the subject.

Theories of second language acquisition are, as previously mentioned, not often unanimously agreed upon by experts. There seem to be new schools of thought in learning theories in general every decade or two, and often a new perspective will counter an older one; this is the case in the field of second language acquisition and fields other than linguistics. The cognitive / developmental perspective is the most recent shift and has been quite influenced by the field of psychology. Theories from this section will be compared with the present study and further discussed in Chapter V.

Theories Relevant to the Major Research Questions

Georgi Lozanov (1968), a Bulgarian psychotherapist and physician, is most known for promoting Suggestopedia (also referred to as Suggestology), which is derived from the words *suggestion* and *pedagogy*. This technique, which was pioneered by Dr. Lozanov in the 1960s and 1970s, is a method of second language learning in which students use rhythm and music, among other tools such as art and poetry, to bolster their learning process.

“In suggestopedic teaching the trend is toward bringing about, through a purposefully elaborated program and making use of psychotherapeutic methods and artistic devices, the natural conditions necessary for the spontaneous analytical-synthetical activity of the brain in its receiving and processing information" (Lozanov & Gaveva, 1988, p. 101). Lozanov designed a program in which students are supposed to be put at ease, or to lower what Krashen would later come to call the *affective filter*, or "a block" (Krashen, 2003, p. 6). Lozanov created the environment that he deemed most relaxing by having the lights dimmed, encouraging quiet conversation, and at times by having Baroque music playing in the background of class and even occasionally encouraging meditation immediately following class sessions (Bancroft, 1999).

Suggestopedia, while it enjoyed some popularity, has also been scorned by researchers and language teachers, among others. "To a researcher accustomed to a rational, logical presentation of theoretical points, backed up by factual details or statistical evidence, the Lozanov thesis… appears, on more than one occasion, to be self-contradictory and disorganized" (Bancroft, 1999, p. 17). Despite its controversy, Suggestopedia is still used to teach second languages, and it is certainly discussed along with other second language learning techniques.

Another topic proven to be controversial has been attempting to define the term *musical aptitude*, and in the following paragraphs various definitions will be discussed. "The general lack of agreement as to what constitutes musical aptitude has been the source of much of the controversy surrounding its measurement" (Lehman, 1968, p. 7). There have been a wide variety of musical aptitude definitions: talent, ability, to name the most commonly used – and often interchangeable – words. From simply absorbing and reproducing a musical phrase to Seashore's classic structured list of *characteristic elements of the* *musical mind* (1919), the scope of musical aptitude definitions is spread over a broad spectrum. Lehman also laments the difficulties of consolidating definitions for musical terms:

> Other authors emphasize the importance of absolute pitch, ability to recognize intervals, feeling for tonality, love of music, or general intelligence. Some suggest that such matters as will power, socio-economic background, and self-confidence may be relevant… Because musical talent is such a complex phenomenon, it is perhaps inevitable that experimenters should disagree as to the number and relative importance of its constituent elements. (pp. 7-8)

Gordon (1986), who has researched the psychology of music for decades, has coined a word to try to sort out the arguments for and against *aptitude* and *achievement*. He posits that the words *talent* and *ability* include and mistake *aptitude* and *achievement.* "Aptitude is a measure of one's potential to learn, and achievement is a measure of what one has learned" (p. 3). He points out that the two are not mutually exclusive. He brings in the nature / nuture issue, which psychologists, sociologists, cognitive scientists, and linguists were – and still are – examining: are humans born with an unlimited aptitude for music (or language) or is our potential shaped through our environment? Gordon believes that, regardless of how much musical aptitude with which one is born, the highest level will not be met unless environmental influences are favorable. Conversely, he points out that the level of environmental influences cannot push one past the aptitude with which s/he was born. "Unfortunately, it seems that none of us has developed his music aptitude to its highest possible level" (p. 4). This statement may be controversial, but is a viewpoint by which Gordon stands.

Gordon (1986) would rather coin a new word than inaccurately use the word *aptitude*. "Although it can be said that the level of one's music aptitude is commensurate with how well one audiates, a satisfactory verbal description of music aptitude, that is, a definition of its elements, has not yet been found" (p. 3). He describes why he uses the word *audiation* in this work's title rather than *aptitude*.

> Need dictated the coining of the verb *to audiate*. Audiation takes place when one hears and feels music through recall or creativity, the sound not being physically present except when one is audiating while also aurally perceiving music that is being performed by others or that one is performing himself. Although what is recalled may or may not be exact, musical meaning is derived through audiation. In order to give meaning to music that is being aurally perceived, one must audiate exactly or in abbreviated form what has just been heard in that music, as well as music heard at a previous time for referential and comparative purposes. Audiation functions in short term and long term memory, and both types of memory, unlike recall, necessarily represent formal musical achievement. (Gordon, 1986, p. 8)

Gordon (1999), in a later article succinctly says "audiation is the basis of musical aptitude" (p. 41), which might have made the earlier explanation a touch easier to digest had he come to this revelation before his previous article's publication. The longer quotation, however, necessarily details what neural processes are involved with audiation. While Gordon's term has yet to make it into a wider musical parlance, he has been urging music educators for years to teach audiation as a foundation of musicianship (1999).

Left/Right Hemisphere Processing of Language and Music

Overview of Language and Music Processing

In the past, much research has been conducted on patients who had sustained injuries to either cerebral hemisphere as the result of a stroke, tumor, or other head trauma. It was common for patients who suffered from seizures, such as epileptics, to have areas of their brains removed; studying these patients before and after their surgeries, as well as studying others who suffered head injuries, gave scientists a foundation on which to base much of what is currently known about the brain. "When dozens or hundreds of cases show loss of a specific function associated with a particular brain region, we infer that this brain region is somehow involved in, or perhaps responsible for, that function" (Levitin, 2006, p. 82). Studying certain genetic disorders, such as Williams Syndrome, has also helped neuroscientists determine differences in the brain, both with respect to its physical shape and its circuitry. Specific studies will be reviewed in subsequent sections.

"Discourse intonation, the ordering of pitched sounds made by a human voice, is the first thing we learn when we are acquiring a language. Later on, it is through interaction that a child picks up not only the musicality of each language, but also the necessary communication skills" (Mora, 2002, p. 149). Mora asserts that both rhythm and musical contours of a language can be imitated by children well before they can actually speak the words of the language. This is an observation with which many parents and caregivers of one-year-olds would likely agree as well; the researcher has noticed this behavior infants around the age of one.

Stansell (2002) and Lowey (1985) share viewpoints with Mora (2002) on this. Mora purports using music and language together in the ESL classroom; she believes that foreign language sounds coupled with music are stored in the long-term memory better than sounds without the musical accompaniment. Indeed, other researchers have thought along the same lines. Lozanov's (1978) method of Suggestopedia, as previously discussed, involves both using rhythm and music in L2 learning.

Definitions of language and music generally vary but contain very similar essences. Besson and Schön (2001) argue that definitions for the two often apply to one another:

> …it is clear that both language and music are conveyed by sounds, are ubiquitous elements in all cultures, are specific to humans, and are cultural artifacts that do not correspond to natural objects. They are rule-based systems composed of basic elements (phonemes, words, notes, and chords) that are combined into higher-order structures (musical phrases and sentences, themes and topics) through the rules of harmony and syntax. (p. 235)

In a review of author, musician, and composer Robert Jourdain's book *Music, the brain and ecstasy: How music captures our imagination*, Zatorre (2000) writes: "Asking whether music is a right brain or left brain function isn't really the right question. I have very little doubt that when you are listening to a real piece of music, it is engaging the entire brain" (p. 1). This last statement may encapsulate the entire body of cerebral research, past and present. Daniel Levitin

(2006), neuroscientist and McGill University colleague of Zatorre, agrees: "Musical activity involves nearly every region of the brain that we know about, and nearly every neural subsystem. Different aspects of the music are handled by different neural regions…" (pp. 83-84).

Studies of Language and Music Processing

The researcher felt it might be helpful to include in the appendix a map of the brain with highlighted areas that are discussed in this study. See Appendix L for this brain map, which also includes citations of some of the research described in this section.

The title of Borchgrevink's (1982) study is self-explanatory: Prosody and musical rhythm are controlled by the speech hemisphere. Despite this study being over two decades old, it still sheds valuable light on brain functioning. This study took place in Norway, in Norwegian, and Borchgrevink (1982) translated his study into English. Borchgrevink administered six young, epileptic participants (12-30 years old) with anesthesia in different hemispheres of the brain: first the right, then after recovery, the left. Before the first injection, he asked participants to sing a very common, 4-bar piece of Norwegian folk music- something akin to *Twinkle, Twinkle, Little Star*. All participants were familiar with and capable of singing this tune. He then asked them to sing the numbers 1-7 (two times) to fit the tune of the piece of music. Using *Twinkle, Twinkle, Little Star*, if one were to count out numbers rather than sing syllables, s/he would also sing up to the number seven twice. Patients were able to do this easily. He also asked them the names of common items like a book of matches or a set of keys, which they recognized and correctly verbalized.

Next, anesthesia was administered to the right hemispheres of participants' brains and a few minutes elapsed so the anesthesia would become most effective. When asked to count to seven (in place of lyrics), four right-handed patients immediately lost the ability to sing or maintain pitch; rather, they counted to seven with preserved rhythm but in a monotone voice. They were able to comprehend and produce normal speech while anesthetized. Once the anesthesia wore off on the patients, their pitch capabilities returned to pre-experimental levels.

After being injected in the left hemisphere of the brain and asked to sing in the previously mentioned manner, four right-handed patients experienced abrupt loss of speech comprehension, production, and the ability to sing. Shortly after this, while the left hemisphere was still anesthetized, some patients (Borchgrevink omits which ones) could not recall information like the date, nor could they vocalize the names for the matchbook and keys. The left hemisphere, incidentally, is the home of Wernicke's Area, which is responsible for comprehension of spoken language. This study illustrates that pitch in speech (which may be referred to as discourse intonation) is controlled by the brain's right hemisphere.

In his study about tonal processing, Zatorre (2000) describes another study that was conducted in his laboratory at McGill University with researchers

Johnsrude and Penhune. This is from Zatorre's concise review of the study (taken from another publication): "…left auditory regions are better suited for rapidly changing, broad-band stimuli, such as speech, whereas the right auditory cortex may be specialized for slower narrow-band stimuli, such as tonal patterns" (Zatorre, 2001, p. 193). This follows the findings of Borchgrevink (1982) that pitch, in music but also in speech, is controlled by the brain's right hemisphere.

The subjects of the Johnsrude, Penhune, and Zatorre (2000) study were 14 neurologically normal patients and 31 patients who underwent cerebral tissue removal to control their epilepsy, some of whom had damage to the Heschl's gyrus area located in both hemispheres. Two tasks were given to each participant, and each task contained a coupling of two musical tones played to the participant on headphones. The first task was to have patients indicate whether the two tones played were the same or different. (This task, incidentally, is almost identical to one of the pitch perception tests- PR-B- that was administered to Bay Area ESL students in this study.) Johnsrude, Penhune, and Zatorre's second task was to have patients indicate whether the first tone was higher or lower than the second tone.

The findings from this study were both confirmatory and novel. Patients with lesions in the left hemisphere, specifically in the left temporal lobe, were as unimpaired as the control participants were. Participants with lesions in the right hemisphere excluding Heschl's gyrus, the area responsible for organizing sounds according to their pitch, were unaffected. Participants with lesions on the right

Heschl's gyrus scored normally on the first (pitch discrimination) test, but for the second (pitch direction) test, they had significantly different results. The tones needed to be four times as far apart for this participant group to detect a difference. "…there exists a region of frequency difference within which they are able to say two tones are different, but are unable to determine which of the two is lower or higher in pitch" (Johnsrude, Penhune, & Zatorre, 2000, p. 160).

These results yield a confirmation of previous studies in which the right hemisphere of the brain has been claimed to be the exclusive locus for music. The results also dictate, on the novel side, that the right hemisphere, specifically the right primary auditory region which includes Heschl's gyrus, is responsible for organizing sounds according to their pitch. Decades earlier, Borchgrevink (1982) posited that pitch in speech was controlled by an area in the right hemisphere of the brain, and this work by Johnsrude, Penhune, and Zatorre confirms Borchgrevink's work and, further, points to a more specific region of the brain in which sounds are organized according to pitch.

Levitin and Menon (2003) conducted a study in which participants listened to selected movements of classical music pieces in their normal forms, and then in a scrambled forms. The scrambled versions "disrupted musical structure while holding low-level musical attributes constant, including the psychoacoustic features of the music such as pitch, loudness, and timbre" (p. 2142). This study is available online on Levitin's homepage, and MP3 forms of two pieces (of eight total) are available in unscrambled and scrambled versions at http://ego.psych.mcgill.ca/labs/levitin/research/musicsamples.html. The scrambled versions of the two pieces sounded similar to fast forwarding through a track while listening to a CD, but in a haphazard way. Instruments and tonality of each scrambled piece were discernable, but the order of the notes and the rhythm were unintelligible.

fMRI (functional Magnetic Resonance Imaging) was used on the participants while they were listening to the unscrambled and scrambled versions of classical music, and after switching from the standard music to the scrambled version, there was focal activation of a region in the left inferior frontal cortex (LIFC) of the brain called the pars orbitalis, which in the past has been associated with language processing of both spoken and sign language. "…The LIFC has been generally implicated in the comprehension of sentences, and specifically in the control of semantic retrieval, the selection of semantic information, and rehearsal and maintenance of linguistic as well as nonlinguistic verbal materials" (Levitin & Menon, 2003, pp. 2142-2143). This study's results illustrate that the LIFC can be used in processing signals from both linguistic and musical sources. This study also tells us that when we listen to something relatively predictable like classical music, our brain is less stimulated than it is when hearing something unpredictable like scrambled music. Novelty truly seems to excite the brain.

Additionally, Levitin and Menon (2003) discovered that the LIFC was also active in deaf people when they were using sign language (*signing*) with one another. The LIFC was therefore discovered to be a central area for syntax, or structure, in not just language, but also music and signing.

The results from this study are similar to those of an article written by Patel (2003) in which Patel hypothesized that syntax in both music and language share common neural substrates used for processing. After referencing his own study that supports this hypothesis, Patel describes another study that used magnetoencephalography (MEG) to determine its results: "Subsequent neuroimaging research has supported the case for syntactic overlap by showing that musical syntactic processing activates 'language areas' of the brain" (p. 675).

The study of patients with neurological disorders has also helped neuroscientists to figure out how music and language may be processed. Williams Syndrome (WS) is a neurogenetic, developmental disorder that affects about 1 in 20,000 people (Levitin *et al.*, 2003) and impairs cognitive abilities. WS people range in IQ from 40-100 but the mean score is around 60 (Lenhoff, Wang, Greenberg, & Bellugi, 1997, p. 70). Autopsies of WS people's brains have shown that the actual folds, or *sulci*, within the brain are far less wrinkled than those of a normal brain: the WS brain physically appears to be much smoother. (Levitin *et al.*, 2003). For WS people, motor skills, reasoning, and spatial abilities are usually compromised: tying one's shoes, knowing how many hours are in a day, and having normalized emotional reactions can be difficult to impossible for those born with WS. WS people, however, generally have remarkable musicianship, and can play instruments, sing, and remember song lyrics with a skill level unparalleled to completing other motor skill-related tasks.

> Most intriguing is that WS people present relatively *preserved* (sic) abilities in four domains: social drive, face processing, language, and music (Bellugi *et al*., 2000). Compared to normal people, most people with WS display greater musical creativity, spend more time listening to music and certain noises that they find appealing (Levitin & Bellugi, 1999), and show stronger emotional reactions to music (Don *et al*., 1999). (Levitin *et al*, 2003)

Just as WS people may draw pleasure and fascination from certain pieces of music, they may also have a similar fondness of other sounds like running water, a telephone’s dial tone, or a vacuum cleaner’s engine: caretakers of WS people have often reported them listening intently to these kinds of noises for hours on end (Lenhoff, Wang, Greenberg, & Bellugi, 1997). Levitin (2003) describes these sounds as broad band or filtered noise, and points out that WS people, while entranced by these types of stimuli, generally have an aversion to sudden, loud sounds.

Lenhoff, Wang, Greenberg, and Bellugi (1997) also describe WS people in their research. In addition to having a facility for music, WS people have a facility for language. When talking, many WS people are more descriptive and use a wider range of vocabulary than non-affected peers. They are also often more linguistically expressive and animated: “This animation was demonstrated amusingly when Williams children were asked to provide a story for a series of wordless pictures. As they told their tale, they often altered their pitch, volume, length of words or rhythm to enhance the emotional tone of the story” (p. 71).

Levitin and his colleagues (2003) conducted a study in which five WS adults (mean age 28.8) and five age-matched control subjects listened to both music and sound clips and were measured for neural activity using an fMRI scan. The sound files used consisted of the first 23 seconds of a number of popular pieces from, classical repertoire, including Beethoven's *Fifth Symphony,* Mozart's *Eine Kleine Nachtmusik*, and Tchaikovsky's *Nutcracker Suite*. They were also played 23 seconds from recordings of running water, noise from a construction site, noise from running motors, and a telephone dial tone. All ten participants listened to these sounds while simultaneously being fMRI scanned.

Results from this study, which was the first of its kind using fMRI on WS participants, showed vast differences in sound processing between WS and control groups. As expected, the control group showed consistent bilateral activation of regions typically associated with sound processing, which are the superior and the middle temporal gyrus. These areas were not activated in the WS participants. Rather, the activated regions were quite widespread in WS subjects, and included mostly the cerebellar vermis and the amygdala, the latter of which is generally considered to be the emotional center of the brain. Both groups also showed differences between cerebral areas activated by the musical pieces and the sound clips. "Both groups displayed significant bilateral temporal lobe activation for music compared to noise and rest, indicating that their music processing can be neuroanatomically distinguished from their noise processing" (Levitin *et al.*, 2003, p. 79).

This research, in true form to significant research, has prompted the asking of more questions. Levitin (2003) wonders whether or not WS people who are currently unable to do tasks like tie their shoes may be capable of tying their shoes if trained to do it to the beat of a familiar song, for example. Music may be able to help teach WS people non-musical things. This lies within the realm of possibility, especially given the fairly novel concept of neuroplasticity, which is "the brain's natural ability to form new connections in order to compensate for injury or changes in one's environment" (Dictionary.reference.com, 2007).

For years, researchers assumed the brain's capabilities slowed, or calcified, as people aged. Lenneberg's Critical Period Hypothesis is just one example of this dogma. Research in the past few years, however, has prompted questioning of these viewpoints (Begley, 2007a; Pascual-Lenoe, Amedi, Fregni & Merabet, 2005; Begley, 2007b; Taub, 1995). As researchers continue to conduct fRMI and MEG studies, some have noticed something extraordinary: the brain can essentially rewire itself (Begley, 2007:2).

This phenomenon is called neuroplasticity, and is being increasingly explored by researchers. "…we have discovered only recently that the brain has a capacity for reorganization that vastly exceeds what we thought before. This ability is called neuroplasticity…" (Levitin, 2006, p. 85). Studies are being done by researchers in different fields to explore this relatively new discovery about the brain's capabilities.

> Even when the brain suffers a trauma late in life, it can rezone itself like a city in a frenzy of urban renewal. If a stroke knocks out, say, the

> neighborhood of motor cortex that moves the right arm, a new technique called constraint-induced movement therapy can coax next-door regions to take over the function of the damaged area. The brain can be rewired. (Begley, 2007a, p. 74)

Neuroplasticity is starting to be not only taken more seriously by researchers, but is increasingly becoming more publicized. One study of neuroplasticity that was conducted in 1995 (Taub) was somewhat groundbreaking, but its results were slightly misinterpreted by reporters. Behavioral psychologist Edward Taub was curious to see if the cortical areas of the brain were bigger in those of violin players, as some neuroscientists had casually suggested but not formally researched (Begley, 2007b, p. 127). There are specific areas of the brain that correlate to each finger of both hands, so activation of these areas was sought in this study. Taub and colleagues recruited six violinists, two cellists, and one guitarist, as well as six nonmusicians, for their study (Elbert, Panatev, Wienbruch, Rochstroh & Taub, 1995). All participants held still while a device lightly applied pressure to each of their fingertips while an MEG recorded their neuronal activity.

There was no significant difference between musicians and nonmusicians in the right hand, but there were significantly larger areas activated in the left cortices of violin players specifically. (The left hand of violin players is the one which works to play notes with the fingers, while the right hand solely controls the bow movement.) The activated neural areas happened to be biggest in those violin players who started playing before the age of twelve. This starting age difference is what attracted the most media attention, and according to Begley

(2007b, p. 127), Taub said that "everyone knew" that the brain of the child is more plastic. The most fascinating aspect of this study, according to Taub, was that "even if you take up the violin at forty, you still get use-dependent cortical reorganization" (Taub as cited in Begley, 2007b, p. 127).

Another study that uses music to illustrate neuroplasticity was conducted at Harvard Medical School by Pascual-Leone, Amedi, Fregni & Merabet (2005) and has received considerable press. Pascuale-Leone and colleagues asked some of the participants, all of whom were nonmusicians, to learn a certain passage on the piano. The other participants (control group) did not learn anything on the piano. The goal was to be able to play the learned passage at a tempo of sixty beats per minute. Participants practiced the musical passage for two hours each day for five days; at the end of each two-hour practice session, they were tested while undergoing transcranial-magnetic stimulation (TMS), which is a type of brain scan. At the end of every day, the results were that those who practiced the piano passage used a bigger expanse of motor cortex that was devoted to the finger movements.

Pascual-Leone (2005) took this study one step farther, however, and performed TMS on the piano-playing volunteers when they were not physically playing the piano, but mentally rehearsing their pieces (which Gordon would term audiating). The results from this were groundbreaking:

> Remarkably, mental practice resulted in a similar reorganization of the motor outputs to the one observed in the group of subjects that physically practiced the movements. Mental simulation of movements activates some of the same central neural structures required for the performance of

> the actual movements (Roland et al. 1988, Decety & Ingvar, 1990). In doing so, mental practice alone may be sufficient to promote the plastic modulation of neural circuits placing the subjects at an advantage for faster skill learning with minimal physical practice, presumably by making the reinforcement of existing connections easier and perhaps speeding up the process of subsequent sprouting and consolidating of memories (Pascual-Leone, Amedi, Fregni & Merabet, 2005, p. 380).

This research reveals that we can simply change our brain structure by thinking about certain activities, not only by doing them.

The Role of Music in First and/or Second Language Acquisition

Controlling for a difference between tonal and *atonal* languages when gathering participants' background information is simple and potentially very valuable. Increasingly, researchers have been investigating possible differences in sound processing between speakers of tonal and atonal languages. "Linguistic background has been identified as important in the perception of pitch, particularly between tonal versus atonal languages. In addition, a link between native language and the perception of musical pitch has also been established" (Schueller, Bond, Fucci, Gunderson, & Vaz, 2004, p. 421).

In their pilot study, aforementioned researchers grouped participants into tonal-language-speaking (from China) and atonal-language-speaking (from India) categories. People from both groups had been living in the U.S. for an average of 20 months. One condition involved having participants from China listen to Chinese (pentatonic scale) music and having the participants from India listen to Indian (microtonal) music before completing certain tasks and the other condition involved listening to no music before completing tasks. The tasks were two pitch-matching tests, one involving matching the highest and lowest notes of a pre-recorded voice singing specific notes with notes on a piano keyboard, the other involving matching the highest and lowest notes of a pre-recorded voice reading a literature passage to the notes on the piano keyboard. The results: "There were no differences between the two linguistic groups. Methodological limitations preclude generalization but provide the basis for further research" (Schueller, Bond, Fucci, Gunderson, & Vaz, 2004, p. 421). The number of participants in this study was only 20 (10 per linguistic group), so in addition to other methodological issues, this may have contributed to the study's outcome. The following study that also had 20 participants, however, had more significant results.

Wong, Skoe, Russo, Dees, and Kraus (2007) also examined language tonality and music. Their research, however, showed that having musical background can help with second language abilities. Researchers asked twenty people who did not speak any tonal languages to watch a video. Half of the participants had at least 6 years of musical training (mean = 10.7 years of training starting at or before the age of 12) while the other, "non-musician" half had no more than 3 years of training (mean = 1.2 years). While participants were watching the video, they were hooked up to a brainscan machine called Scan 4.3 (manufactured by Compumedics) that uses scalp electrodes to measure brain activity. The Mandarin word "mi" was randomly played in the background of the video in three different tones, which altered the meaning of the word depending on the pitch that was used. Because none of the participants knew Mandarin, none knew the meaning of the words. Significant differences in sound processing arose between the non-musician and the musician groups; the musician group experienced "more robust and faithful encoding of linguistic pitch information" (p. 2). One of the most interesting results of this study was not just the activation of musicians' brains, but where researchers looked for the activation: in the brainstem, which is lower than the cerebral cortex where researchers have traditionally targeted. Participants with musical training showed more activity when hearing the Chinese sounds, and the study's authors hypothesize that, contrarily, native speakers of tonal languages could do better at learning instruments as well.

Summary

For decades, researchers have thought that the left hemisphere of the brain was devoted to language and the right was dedicated to music. We have learned that pitch, in speech, is controlled by the right hemisphere (Borchgrevink, 1986). Specifically, pitch in speech is processed in the primary auditory region which includes Heschl's gyrus (Johnsrude, Penhune, & Zatorre, 2000).

We have also learned that part of the left hemisphere, the left inferior frontal cortex (LIFC) may be responsible for processing signals from musical sources (Levitin & Menon, 2003). Syntactic processing of music can occur in the left hemisphere (Patel, 2003). The old *left = language, right = music* mantra is not necessarily false, but it is decidedly more complex than a simple dichotomy.

Studies of language and music processing through people with different genetic backgrounds, like Williams Syndrome, as well as studies using MEG, PET or fMRI scans are helping researchers continue to discover more about the structure and capabilities of our brains. While the present research did not involve brain scanning or genetic background testing, it incorporated such scientific breakthroughs that have already contributed to the corpus of literature regarding how music and language are processed. Research comparing discourse intonation and musical background in ESL students may now be added to this corpus of literature that will further inform researchers on areas for future investigation.

CHAPTER III

METHODOLOGY

Research Design

This quantitative, correlational study analyzed data collected from ESL students regarding their musical training and pitch recognition abilities and related these to their discourse intonation, which was also evaluated. "Correlational studies attempt to understand patterns of relationships among variables. Although such studies cannot prove causation, they are useful in predicting one variable from another or building a theory about a complex phenomenon" (Glatthorn, 1998, p. 74). If the ESL students who participated were found to have a high score on the pitch recognition tests, this would not necessarily mean that they would get a high score on the discourse intonation test. A positive correlation in a significant amount of participants between pitch recognition scores and discourse intonation scores, however, may have indicated a pattern from which we might be able to draw certain conclusions, such as early musical training possibly benefiting facility of second language speech.

The main research question asked was: What is the relationship, if any, between three different measures of musicality (two pitch recognition tests, and musical training) and discourse intonation? The sub-question asked was: Is there a significant relationship between discourse intonation in students whose native languages are tonal and those whose native languages are atonal? These relationships can be seen visually in Figure 1, where the black arrows represent those relationships asked by the main research question, and the red arrow represents the relationship asked by the sub-question.

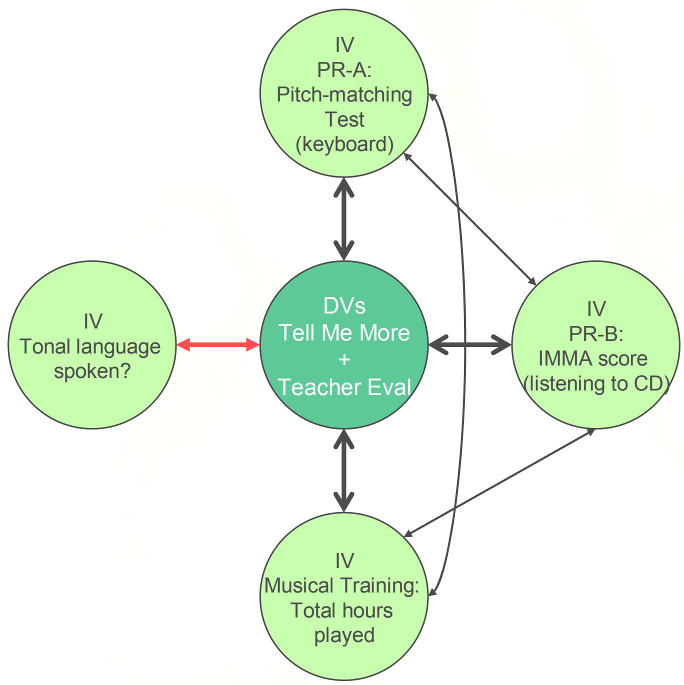


Figure 1: Relationships asked by the research questions.

Research Setting

Two Bay Area institutions were involved with this study: Intrax International Institute in downtown San Francisco, which is a private ESL school, and College of Marin in Kentfield, which is a community college. The facilities at Intrax include approximately twenty classrooms, two computer labs, and three student lounges. Approximately 30 nationalities (e.g., Japanese, Chilean, etc.) are represented within its student body; the students' age range in January 2007 was 18-67. Intrax students can choose among grammar, speaking, culture, Business English, TOEFL (Test of English as a Foreign Language) and TOEIC (Test of English for International Communication) classes. College of Marin has students from over 50 countries and enrolls approximately 500 students each semester in their ESL courses; the students' age range in the Fall 2006 semester was 18-85. The ESL department offers an intensive ESL program, credit classes from beginning to advanced levels, and non-credit classes from beginning to intermediate levels. The non-credit classes are offered at no cost to students. Many students in College of Marin's credit program pursue academic degrees, while others seek preparation for vocational careers.

Administrators at both Intrax and College of Marin graciously granted the researcher use of a private room at each facility in which she held student interviews. The researcher has taught various ESL classes at both institutions.

Population and Subjects

Demographics varied within each institution, but generally the student population was a bit younger at Intrax International Institute. Many Intrax students are between the ages of 18 and 30. The researcher asked students from intermediate, high-intermediate and/or low-advanced level ESL classes to participate in her study. These levels were chosen because participants needed to have some proficiency of English in order to understand the background questionnaire and test questions. The student background questionnaire was developed by the researcher with this high intermediate / low advanced level in mind, and the Tell Me More® software was designed for high intermediate ESL students.

At each school, the aim was to have a sample of at least 20 students, and in accordance with expected participant attrition, there was an aim to start the study with at least 25 students. Only 22 students completed interviews, however; this will be discussed further in Chapter IV. The researcher went to different intermediate- through low-advanced-level ESL classes and gave a brief description of the study to students and asked for participants. In addition to this, color copied flyers were placed near the ESL classrooms. Students were notified that food or a gift card for a major coffee retailer would be provided during the sessions when they met with the researcher.

Instrumentation

Four instruments were used with participants in this study: a student background questionnaire, two pitch recognition tests (PR-A and PR-B), and a discourse intonation test. The researcher developed and/or chose instruments both to gather personal information from the participants and to gather empirical data. Some instruments were computerized, whereas others were human-based; this design was intentional to add validity to the instruments and the study.

Student Background Questionnaire

The first instrument was a student background questionnaire, which posed questions such as age, native language, other languages known, and when they were learned / acquired (see Appendix A). This questionnaire also asked whether or not the student had played a musical instrument and, if so, hours per week it had been played and over how many years. The musical training (MT) component reported in the data was the total number of hours a musical instrument had been played by the participant.

The total number of hours that the main instrument had been played by the participant was calculated for a musical training (MT) score. For example, if a student estimated that she played the piano for two hours per week from the ages of ten to twelve, the MT would be 208. (2 hours x 52 weeks per year x 2 years = 208.)

Because this MT figure is based on a self-reported number, the two pitch recognition tests (PR-A and PR-B) were additionally administered. Results from all three were used in the multiple regression analysis.

Pitch Recognition-A: Pitch Matching Test

The second instrument was a simple pitch-matching test that is widely used in musical and linguistic studies alike (Gordon, 1999; Lehman, 1968; McCarthy, 1984). The researcher brought a small, 3-octave Casio SA-75 keyboard into the classroom where individual interviews were held. The students had the opportunity to familiarize themselves with the keyboard for approximately one to two minutes: the researcher showed each student that pressing a key produced a certain tone (in case a student was not familiar with the instrument).

The researcher showed the student three examples of pitch-matching to ensure comprehension before proceeding. The first example note was played with the researcher's hands visible, and the subsequent two example notes were played with the researcher's hands shielded from sight. The researcher informed participants of this procedure before playing the first example note. After this warm-up, the ten-question pitch-matching test proceeded. A note was played individually while the researcher's hands were shielded and each participant was asked to match the note by playing the same note as the researcher; this happened ten times. The three example notes and ten test notes used were identical for every participant, and each participant was told that s/he could take their time finding the note they thought was the correct one. That is, the first note they hit was not likely to be correct, which was expected. Participants had as much time as they needed to feel comfortable declaring which note they deemed to be correct.

There are 37 keys on this keyboard; the student's score on this pitch-matching test depended on how close to the original note s/he got. The student was striving to have zero *notes off*; that is, the student would try to match each note perfectly on all ten questions. If a middle C was played by the researcher, for example, and a student played the key just below that (B), the student scored one note off. This is better than if s/he were to play a key many notes off (like the F below middle C, which would be four notes off) (see Appendixes B and C for Instructions and Test Score Card). The number of notes by which a student was off for each note played was noted and calculated on the Test Score Card. This total number was the student's score for the pitch-matching test.

Pitch Recognition-B: Gordon's IMMA Test

The third instrument was a slight variation of Edwin Gordon's *Intermediate Measures of Music Audiation (IMMA).* Gordon (1969, 1970, 1979) has published a number of musical tests, and the IMMA battery is intended for students in kindergarten through fourth grade. The reason that this test was chosen, despite its original design for younger children, is because tests designed for older students included vocabulary and musical terms with which the researcher did not think the intermediate to low advanced ESL students would be comfortable and/or competent. Gordon's (1986) *Primary Measures of Music Audiation* (*PMMA*) is similar to the *IMMA*, but while the *PMMA* measures developmental music aptitude, the *IMMA* measures stabilized music aptitude, which occurs around the age of nine. Gordon (1986) stresses that the *IMMA* test is appropriate for older students as well:

> Although the content of a developmental music aptitude test designed for very young children must be different from the content of a stabilized music aptitude test designed for much older students, it has been found that it is possible to use the same test to measure both the developmental music aptitude of young children and the stabilized music aptitude of children whose music aptitude has recently stabilized… if the design and content of the test conform to research specifications. (p. 27)

Gordon (1986) illustrates such conformity of the test in his *IMMA* manual (pp.8-9). The researcher emailed Dr. Gordon detailing some of the methodologies she was planning on using (administering the pitch-matching test using the keyboard and possibly his *IMMA* tonal test) and he confirmed that the *IMMA* would be an acceptable assessment tool for adult ESL students.

The *IMMA* battery consists of two sets of tests: tonality and rhythm. The researcher did *not* use the rhythm portion of the test, as the goal of this research was to measure pitch recognition, not rhythmic perception. The tonality test consists of a CD that contains the audio recordings students listened to and judged, accompanying answer sheets for ESL students, a manual, and rating instructions. The students judged whether or not the two audio clips they heard were similar or different, and detailed instructions were reviewed with each participant. The students received their answer sheets (see Appendix D) and were explained slightly modified instructions from the *IMMA* Manual. The researcher modified the instructions to be appropriate for adult students rather than the younger students for whom they were originally designed, for example, by deleting Gordon's instructions for students to raise their hands to answer the practice questions before the test. Students had the opportunity to answer two practice questions before commencement of the official test (see Appendix E for the transcript of the modified version of the *IMMA* Tonal Test instructions).

Discourse Intonation Test

The fourth instrument of this research was the test of discourse intonation. In following suit with the other tests in which one was computerized (*IMMA* Tonal Test) and one part was human-based (pitch-matching test), the discourse intonation test also consisted of computer-based and human-based rating systems. The computerized component was the Tell Me More!® software program's automatic ratings of participants' speech samples, whereas the human-based component was ESL teachers' ratings of these speech samples.

Tell Me More®

The computerized section used a rating system embedded in a software program called Tell Me More® that the researcher and ESL students used. Tell Me More®, produced by its parent company Auralog, is a language-learning software program that has hours of content available either online or on CD-ROM. Auralog and Tell Me More® pride themselves on their software's speech recognition capabilities, which the researcher feels are superior to those of other computer-based language learning programs like Rosetta Stone. Auralog was the first company in the world to use speech recognition in its language learning software, and their speech recognition model is called S.E.T.S.®, which stands for Spoken Error Tracking System.

The researcher brought her laptop computer into each interview session and used the CD-ROM software with each student during the testing period. This specific program was designed for high-intermediate students who were using phrases from the oral workshop content area. (The software has many content areas, including reading, writing, culture, and oral workshops.) In this section, students were able to listen to certain phrases while they were displayed onscreen. The researcher's computer, however, was not facing the students. The researcher was sitting at a desk looking at her computer screen and the students were facing the researcher, and therefore the back of the computer screen.

The phrases that students said were numbered and printed individually on card stock in size 36 font. Nine phrases from the *sentence pronunciation* area of the software's oral workshop were used (see Appendix F for these phrases and their breakdown at the phonemic level). The researcher carefully selected nine passages that include 37 of the 39 phonemes in English. The two phonemes not represented are the post-alveolar fricative / ʒ / (as in *azure*) and the diphthong /ɔɪ/ (as in *boy*). The first of these phonemes was omitted because of its somewhat infrequent occurrence in English speech (Spencer, 1998, p. 25), whereas the latter was omitted because in order to have that sound represented, another phrase would need to be added to the battery of phrases, costing more time for the students and teachers. Also, the independent sounds /o/ (as in *bode*) and /i/ (as in *bead*) were already included in the battery.

The ESL students participating in this study were given detailed instructions on how the software program works before the battery of nine questions was posed. If there had there been any errant noise that might have affected the student's score such as loud background noise, a student coughing, etc., the recording would have been done again. Each student said each phrase two times, and the two scores were averaged and totaled for a computerized discourse intonation score. The scores were automatically calculated using Tell Me More®'s proprietary scoring procedures.

The researcher has noted that both a spectrogram, or a two-dimensional representation of speech vibrations, and a pitch contour line, which outlines the pitch of the speaker's voice, were both displayed on the screen. These two vocal representations were given for the target (native English) speaker, as well as the person who repeats them (in this case, the non-native English-speaking participants) (see Appendix G). When a speaker finished a phrase, the software briefly displayed a "calculating…" sign for about one second, and then a bar graph of zero to seven bars was displayed: this was the speaker's score for that phrase. While it is not known how the scores were automatically calculated, the researcher suspects that the spectrogram and pitch contours were compared between the target speaker and the person who repeated them and this may have been a large component of the scoring process.

Some target phrases in the Tell Me More® battery were said by women, and others by men. Participants were told that, while they should try to match the pitch contour of the target speaker's voice, they did not need to try to emulate the pitch of the target speaker's voice. For example, if the target speaker was a woman and the participant was a male, he did not need to raise his voice to sound like a woman's while repeating the phrase. Students had two to three opportunities to hear the phrases before producing their own. If a student was comfortable repeating the phrase after only two times, the test would then proceed; if a student wanted to hear it once more, then that was accommodated. Students were explained that they would hear a "beep" just before they were to repeat the phrase into the microphone. Between students' first and second recordings, the target speaker repeated the phrase once more. See Appendix G for a screenshot of what this software looks like just after the student has spoken his or her speech sample.

The scores from both the Tell Me More® program and from the teacher-student evaluation sheet (described below) were both on a scale of eight, where zero was the worst possible score and eight was the best possible score. Both scores made up the student's discourse intonation score. Both the Tell Me More® scores and the Teacher-Student Evaluation scores were dependent variables; two multiple regression analyses were run using each as a dependent variable.

Teacher-Student Evaluation Sheet

Each of the aforementioned sessions was digitally recorded in its entirety on an Olympus VN-2100PC audio recorder that was backed up on the researcher's computer. The recordings of the computerized discourse intonation test were presented to a panel of three ESL teachers at each institution. The teachers at Intrax International Institute listened to College of Marin students' recordings, and the College of Marin teachers listened to Intrax International Institute students' recordings to avoid any potential teacher bias. The ESL teachers, all together, heard each student's speech sample of *one* of the nine phrases. As each student said each sentence twice, the ESL teachers listened to both takes of the sample sentence, which was "*I never keep track of that kind of thing!*" (see Appendix H for the teacher-student evaluation sheet for Intrax teachers). The ESL teachers independently gave a rating to each student's recordings similar to that of the Tell Me More!® software. The teachers were provided monetary compensation for their time spent evaluating student speech samples, which lasted under one hour.

The researcher put index marks before each of the samples that the teachers rated, so teachers only heard the student speaking and not the target speaker's sample. This was done intentionally so that rather than rating how closely the student mimicked the target speaker, which the software did, students would simply be rated on comprehensibility.

While triangulation was not achieved, having both computer- and human-based evaluations of students made the results more valid than using only one of these components would have. Concurrent validity, also referred to as criterion-related validity, is a type of objective validity. "The correlation of test scores with teachers' ratings or school grades is the most common type of concurrent validity" (Gordon, 1986, p. 104). Concurrent validity was achieved by having the panels of ESL teachers rate students' recordings made using the Tell Me More!® software. "Congruent validity refers to the correlation of two tests which are designed to measure the same factor. If the correlation is high and if one test is known to be valid, the evidence suggests that both tests are valid for their `intended use" (Gordon, 1986, p. 109). Congruent validity would be determined by comparing student scores from Gordon's *IMMA* Tonal Test with the pitch-matching exercise.

Data Collection

The researcher recruited participants for her study from intermediate, high-intermediate, and low-advanced grammar and conversation classes at both Intrax International Institute in San Francisco and College of Marin in Kentfield. Class members were given a brief description of the study, and color copied handouts containing photographs that illustrated the interview process were circulated (see Appendix I). Flyers were also placed near such classes with information about the study including the researcher's contact information (see Appendix J for sample from College of Marin).

All students in the classes in which the researcher recruited were first given a consent form, a self-addressed, stamped envelope in which they could mail their background questionnaires, and the researcher's contact information. Students were told, as also detailed on the consent form, that they were to complete the background questionnaire before coming in for the interview and that they could either mail it or bring it to the interview session. A sign up sheet was circulated, and the researchers' business cards with contact information were distributed to all students in each classroom. The researcher tailored available appointment times so students would not have to skip any portion of class in order to be interviewed.

Procedures for each instrument of the study have been detailed in the Instrumentation section. The researcher brought the portable Casio SA-75 keyboard, the CD accompanying Gordon's *IMMA* Tonal Test (which was played on the CD drive of her computer that has built-in speakers), the *IMMA* Tonal Test worksheets, her computer (which includes the Tell Me More!® software) and an Olympus VN-2100PC digital audio recorder that recorded each session entirely.

The discourse intonation test using the Tell Me More!® software generally took about ten minutes, Gordon's *IMMA* Tonal Test lasted approximately four to five minutes, and the pitch-matching exercise usually took approximately three to five minutes to complete. Student interviews were scheduled with at least a ten minute break between tests to prevent late start times should any interviews extend beyond the allotted time.

Data Analysis

The student background questionnaires were examined and answers such as languages spoken (including tonal / atonal specification), instruments played if any, and hours per week such instruments were practiced were among the data that was extracted. Discourse intonation scores from Tell Me More!®, teachers' ratings of these discourse intonation samples, Gordon's *IMMA* Tonal Test scores, and the pitch matching scores were all gathered. These results were all recorded on worksheets and then inputted into the Student Version of SPSS 13.0 software, which provides various analyses appropriate to correlational research such as scatterplots and correlation matrixes, among many others.

The central analysis conducted in order to answer the main research question was a multiple regression analysis (MRA); in fact, two MRAs were conducted. The dependent variables in these MRAs were discourse intonation as measured by the Tell Me More® software, and as measured by the teachers' ratings of the Tell Me More® samples. The independent variables in the MRAs were PR-A (keyboard pitch-matching test), PR-B (Gordon's *IMMA*), musical training (presence of absence of it), whether or not the student spoke a tonal language.

To help answer the research sub-question of whether or not there was a significant relationship between discourse intonation in students whose native languages were tonal and atonal, the background questionnaire asked whether or not students speak tonal languages and the answers were included in the MRAs.

Human Subjects Protection

The rights of all students who participated in this study were protected by the researcher by adhering to the rules and regulations of the Institutional Review Board for the Protection of Human Subjects (IRBPHS) at the University of San Francisco. Required forms describing the study and how it might have affected participants were submitted and remain on file at the IRBPHS office, and the researcher did not commence interviews until full approval was granted. (See Appendix K for emailed approval letter.)

Because the consent form was written in academic English in accord with IRBPHS standards (see Appendix A), the researcher explained it carefully and simply to each class in which she told students about her study. She notified students that this form was for their protection, and that the study was voluntary and would not affect their grades or student status whatsoever. She assured students that teachers would not know their interview results, that their names would not be published, and that they would either get a free lunch or café gift card for participating.

Limitations of the Study

The limitation of this study was the small number of participants. As previously stated, the researcher hoped to have at least twenty participants from each institution. She gave her introductory speech and handed out flyers illustrating what to expect during the interview, and packets containing the background questionnaire, consent form, and contact information to over 120 students. Approximately one-third of the students who signed up never showed up for the interviews, despite the interviewer calling and/or emailing at least one day before the interview to remind them. A couple of students expressed interest in participating but said they simply had no time because of other commitments immediately following or before class.

When the researcher was conducting interviews at the second institution and realized she would not have close to the anticipated forty participants, she investigated interviewing ESL students at the University of San Francisco; however, the student enrollment was significantly low in the Spring 2007 semester and she was told the likelihood of getting more than a couple of students in the intermediate to low advanced range was slim.

The researcher also decided to raise the compensation from a $5 café card to a $10 café card in hopes that this would help attract more participants. Students at College of Marin, the first interview site, were brought in lunch (always including a vegetarian option) as compensation, whereas the students at Intrax in downtown were given a $5 or $10 card for a major coffee retailer. The researcher decided to offer café cards rather than lunch after many students did not show up for interviews at College of Marin and she was left with uneaten sandwiches on interview days. The total number of participants that were interviewed is 22; a total of 24 student background questionnaires were gathered, but two students failed to appear for interviews so their background information was not compiled.

CHAPTER IV

RESULTS

Introduction

This section will present the findings of the study. Descriptive statistics including case summaries of participants will first be given, then both the findings that answer the research questions and other findings will be discussed. Finally, limitations of the study will be explained.

The purpose of this study was to explore the relationship, if any, between three measures of musicality and discourse intonation. The three measures of musicality were musical training (MT), which in this study was measured by total number of hours an instrument was played, and pitch recognition (PR), which comprised two tests, PR-A, which was a pitch matching test, and PR-B, which was a pitch recognition test. Whether or not students who speak tonal languages have better discourse intonation was also examined.

Descriptive Statistics: Case Summaries of Participants

The age range for the twenty-two participants was nineteen to forty years old, and the mean age was 28.95. The participants were 32% male and 68% female. The participants had a mean education level between "some university" and "university degree." The most common first languages were Spanish and Japanese, each with five cases (see Table 1). The average number of languages spoken by participants was 2.32. The average age when a second language was acquired was 10.81, and 36% of the participants speak at least one tonal language.

Table 1

Case Summaries for Background Information

ID	A-ge	Gen-der	Highest Education Level	First language	Second language	Age when learn-ed L2	# of lang-uages spoken	Speak tonal langu-age?
1	40	F	Some univ.	Farsi	English	13	3	No
2	40	F	High school	Spanish	English	10	2	No
3	25	F	Univ. degree	Portugese	English	23	2	No
4	40	F	High school	Cantonese	English	9	2	Yes
5	20	F	High school	Spanish	English	4	2	No
6	23	F	Univ. degree	Spanish	English	11	3	No
7	36	F	Middle school	Spanish	English	32	2	No
8	24	F	Univ. degree	Spanish	English	10	2	No
9	26	M	Univ. degree	Turkish	English	11	2	No
10	24	F	Univ. degree	Japanese	English	11	2	No
11	24	M	Univ. degree	Turkish	English	10	2	No
12	35	M	Univ. degree	Japanese	English	12	2	No
13	22	F	Some univ.	Japanese	English	13	2	No
14	23	F	Grad. degree	Japanese	English	7	2	No
15	30	M	Univ. degree	Taiwanese	Mandarin	5	3	No
16	30	F	Some univ.	Mandarin	Taiwanese	2	3	Yes
17	30	F	Some univ.	Japanese	English	12	2	No
18	19	F	Some univ.	Taiwanese	Japanese	1	3	Yes
19	27	M	Univ. degree	Mandarin	Taiwanese	1	3	Yes
20	28	M	Univ. degree	Taiwanese	English	27	2	Yes
21	37	M	Univ. degree	Taiwanese	Mandarin	1	3	Yes
22	34	F	Univ. degree	Mandarin	English	13	2	Yes

Fifty-nine percent of participants grew up playing a musical instrument; the most common instrument played was the piano, with five cases (see Table 2). The number of hours per week the instruments were played were obtained from answers on students' background questionnaires and totaled for a "total hours played" score, which comprised the musical training (MT) score. The mean total hours played was 1653. The (separately calculated) median, however, was merely 104.

Table 2

Case Summaries for Musical Background

ID #	Grew up playing an instrument?	Which instrument?	Total years played	Total hours played
1	No			.00
2	No			.00
3	Yes	Guitar	2.00	416.00
4	No			.00
5	Yes	Guitar	1.50	78.00
6	No			.00
7	No			.00
8	Yes	Recorder	4.00	208.00
9	Yes	Saz (like guitar)	10.00	8320.00
10	Yes	Piano	2.00	416.00
11	Yes	Flute	6.00	2496.00
12	Yes	Piano	12.00	12480.00
13	No			.00
14	Yes	Violin	9.00	5148.00
15	Yes	Guitar	2.00	104.00

ID #	Grew up playing an instrument?	Which instrument?	Total years played	Total hours played
16	Yes	Piano	10.00	6240.00
17	Yes	Piano	2.00	104.00
18	Yes	Piano	1.00	104.00
19	No			.00
20	No			.00
21	No			.00
22	Yes	San Xuen	5.00	260.00
Mean	.59	4.46	5.12	1653.36

The means, standard deviations, (which show the spread of scores for each variable) and number of cases are reported in Tables 3 and 4 in the descriptive statistics using both dependent variables.

Table 3

MRA- Descriptive Statistics with Dependent Variable 1 (Tell Me More®) (N=22)

Variables	Mean	Std. Deviation
DV1: TMM! Average out of 8	5.04	.64
Speak a Tonal Language?	.36	.49
PR-A: PMT- Total Notes off (0-best)	6.32	7.51
PR-B: IMMA- Correct Matches of 10	9.59	.73
MT- Total Hours Played	1653.36	3359.41

The variables other than the dependent variable and their mean and standard deviation scores listed in Table 3 are the same, regardless of which dependent variable is used; therefore they were not included in Table 4.

Table 4

MRA- Descriptive Statistics with Dependent Variable 2 (Teachers' Ratings) (N=22)

	Mean	Std. Deviation
DV2: Teacher Rating out of 8	5.15	1.08

Findings

Figure 2 on the following page is a scatterplot illustrating how the scores that were automatically generated from the Tell Me More® software compare with the teachers' ratings of students' speech samples. The line, called a fit line, was automatically calculated by the SPSS software, and represents the trend of the data. This illustrates a relatively visible correlation between the computer-based scores and the human-based ones, and congruent validity was achieved. The mean score for Tell Me More® is 5.04, whereas the mean score for the teachers' ratings is 5.15 (see Table 5). Both are scores out of eight.

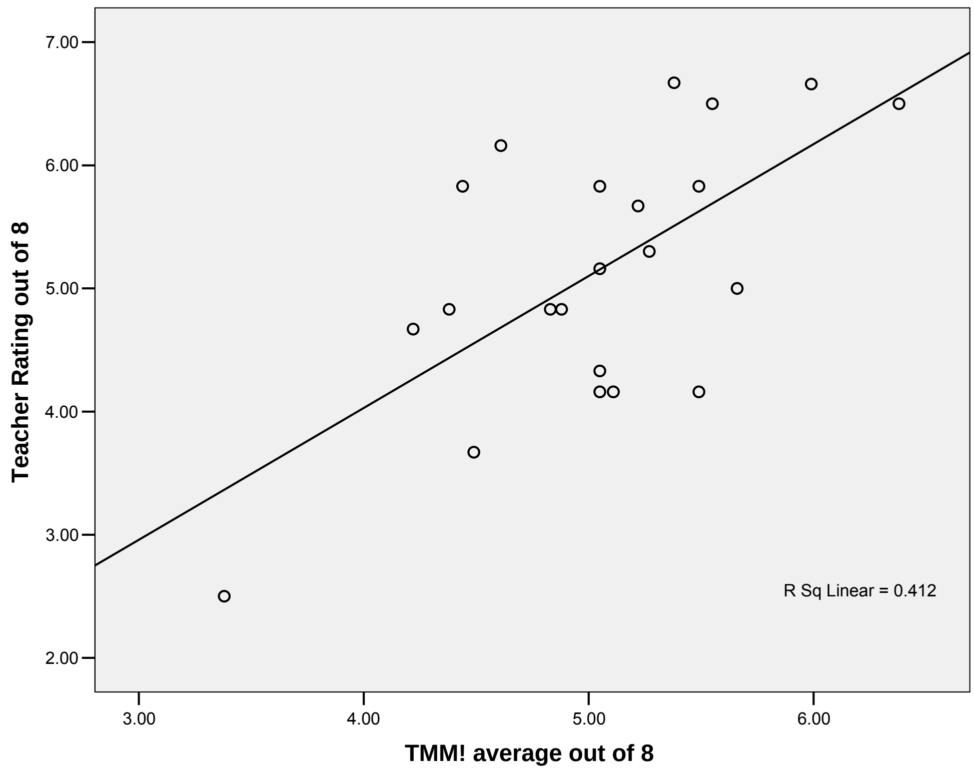


Figure 2. Tell Me More® scores against teachers' ratings with fit line.

The researcher had originally planned to have the teachers use a four-point scale, rather than the eight-point scale the Tell Me More® program uses; this was thought to be simpler. As listed in Appendix H, the following were to be the ratings: 1 = incomprehensible speech, 2 = somewhat comprehensible speech, 3 = acceptable speech, and 4 = perfectly comprehensible speech. However, the ESL teachers at College of Marin, which was the first site in which teachers' ratings were gathered, were not comfortable with this rating system. After having listened to a few speech samples, they all expressed that they were giving students the same or very similar ratings and asked if they could employ a "plus" system, which would let them have four extra points added to the range (1, 1+, 2, 2+, 3, 3+, 4, 4+) and essentially transform it to an 8–point scale. The researcher said this was acceptable. When the researcher went to Intrax to gather teacher ratings there, she explained to teachers that teachers from College of Marin had changed the original 4-point scale into an 8-point one by adding plusses, so an 8-point scale was also employed by Intrax teachers.

There were three ESL teachers at both institutions, and the scores from all three teachers were averaged for each student. The scores were similar between teachers and there were only 3 total cases in which the variance was as much as 2 points; that is, if one teacher gave student X a rating of 4.5 of 8, another would have given a rating of 6.5.

Table 5 below numerically illustrates the same figures from the scatterplot, and additionally shows students' scores from the pitch-matching test (PR-A), the pitch recognition test (PR-B), total hours of musical training, and whether or not they spoke a tonal language. There was no significant correlation between the scores in the two measures of musical training alone, PR-A and PR-B ($R = .64$). In the context of the MRA, however, this is a positive result because multicollinearity, or having two independent predictors being highly correlated with one another, was avoided. One of the aims of an MRA is to ensure that each element measured be independent of one another so they do not measure the same thing.

Table 5

Case Summaries for Dependent and Independent Variables

ID#	PR-A: PMT-Total Notes off (0- best)	PR-B: IMMA-Correct Matches of 10	Speak a Tonal Language?	MT- Total Hours Played	DV1: TMM! Average out of 8	DV2: Teacher Rating out of 8
1	12	10	No	0	5.05	5.83
2	3	9	No	0	4.88	4.83
3	17.5	7	No	416	5.99	6.66
4	24	9	Yes	0	5.05	5.16
5	2	10	No	78	5.55	6.5
6	15	9	No	0	5.49	5.83
7	19	10	No	0	5.49	4.16
8	8.5	10	No	208	4.61	6.16
9	0	10	No	8320	5.27	5.3
10	0	10	No	416	4.38	4.83
11	3.5	9	No	2496	5.11	4.16
12	0	10	No	12480	4.44	5.83
13	0	10	No	0	6.38	6.5
14	4	10	No	5148	5.22	5.67
15	1	10	Yes	104	4.49	3.67
16	0	10	Yes	6240	5.05	4.16
17	0	10	No	104	5.38	6.67
18	4.5	9	Yes	0	3.38	2.5

ID#	PR-A: PMT- Total Notes off (0- best)	PR-B: IMMA- Correct Matches of 10	Speak a Tonal Language?	MT- Total Hours Played	DV1: TMM! Average out of 8	DV2: Teacher Rating out of 8
19	11	10	Yes	0	4.22	4.67
20	0	10	Yes	0	5.66	5.00
21	14	9	Yes	0	5.05	4.33
22	0	10	Yes	260	4.83	4.83

The main analysis completed for this study was an MRA. The stepwise method, which calculates only the predictor (independent) variables that significantly contribute to the prediction, was first attempted. The MRA, however, was not able to be completed by SPSS because the data were not significant enough due to the fact that there were only 22 participants. There was therefore a practical justification to use the enter method, also known as direct or simultaneous regression, where all the predictor variables were tested at once.

The following, Table 6, is a correlation matrix of the variables. The variables in bold print illustrate a significant correlation. No significant correlations were found using dependent variable 1, the Tell Me More® software, and were therefore not included in the table. However, a significant correlation was found between dependent variable 2, the teachers' ratings, and language tonality, as seen in Table 6.

Table 6

MRA- Correlations Using DV2

		DV2: Teacher Rating out of 8
R = Pearson Correlation p = Sig. (1-tailed)	DV2: Teacher Rating out of 8	1.00
	Speak a Tonal Language?	**-.62 (R) .00 (p)**
	PR-A: PMT- Total notes off (0- best)	.03 (R) .45 (p)
	PR-B: IMMA- Correct matches of 10	-.03 (R) .45 (p)
	MT- Total Hours played	.06 (R) .40 (p)

No significant correlations were found using the enter method with both dependent variables. However, using the stepwise method after the enter method produced a significant correlation (where $p < 0.05$) between the independent variable of speaking a tonal language and dependent variable 2, teachers' ratings of discourse intonation samples (see Table 7).

Table 7

MRA- Model Summary Using Stepwise Method

Model	R	R Square	F Change	df1	df2	Sig. F. Change
1	.62[a]	.38	12.27	1	20	.00

Table 8 shows the analysis of variance, or ANOVA, which tests the significance of the regression model. The value listed under "Sig.", which is the *p* value, is significantly better than would be expected purely by chance.

F (1,20) = 12.27; p < 0.05.

Table 8

MRA- ANOVA[a] Using Stepwise Method

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.25	1	9.25	12.27	.00(a)
	Residual	15.07	20	.75		
	Total	24.32	21			

a Predictors: (Constant), Speak a Tonal Language?
b Dependent Variable: DV2: Teacher Rating out of 8

Research Questions

The main research question is what is the relationship, if any, between three different measures of musicality (two pitch recognition tests, and musical training) and discourse intonation? The sub-question is: is there a significant relationship between discourse intonation in students whose native languages are tonal and those whose native languages are atonal? To answer these two questions, the MRAs were used.

There were no statistically significant relationships between variables listed in the main research question. There was, however, a significant relationship found in the sub-question, where $p = 0.00$, between the second dependent variable (teachers' ratings) and whether or not a tonal language was spoken. As shown in Table 7, the R-squared figure of .38 was reached by the model summary using the stepwise method. R-square value in any model summary shows the amount of variance in the dependent variable (in this case, teachers' ratings) that can be explained by the independent variable (in this case, language tonality). In this example, language tonality accounts for 38 percent of the variance in the teachers' ratings scores. When the ANOVA was conducted after this model summary, the significance level achieved (p) of 0.00 is considered high; this means the language tonality predictor is significantly better than would be expected by chance. Results from the first and second MRAs can be seen below in Figures 3 and 4. The calculations listed are *p* values.

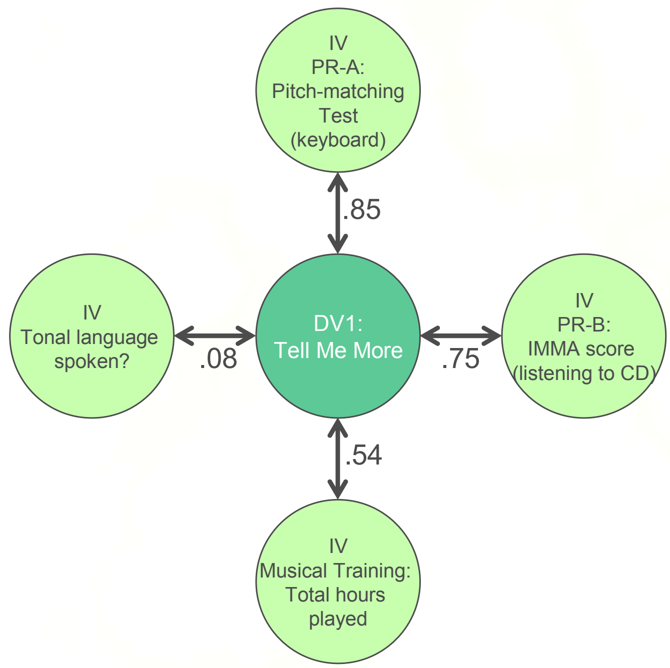


Figure 3: First MRA, where DV1 is ratings from Tell Me More® software.

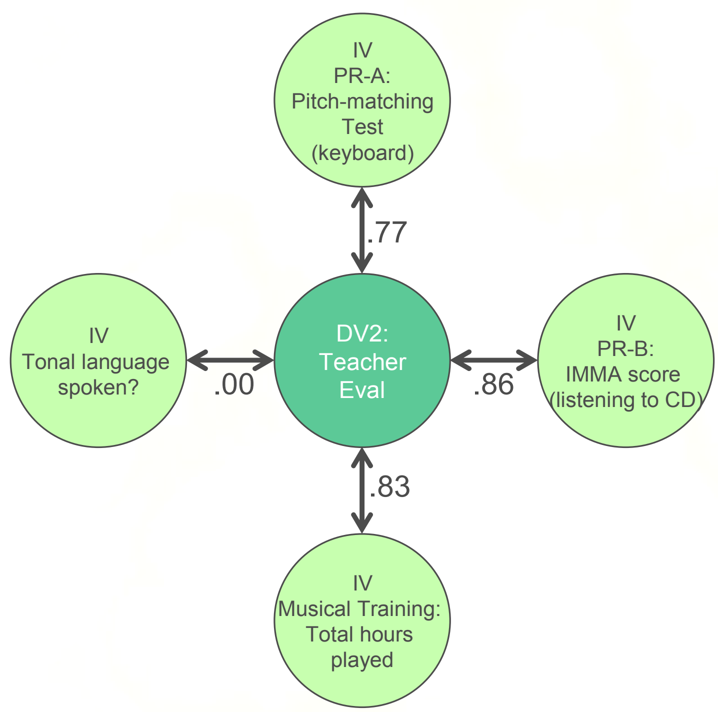


Figure 4: Second MRA, where DV2 is ratings of student samples by teachers.

Other Findings

There are two cases that fall in line with neuroplasticity, rather than Lenneberg's (1967) critical period hypothesis. One is student number three, a female student who speaks no tonal languages but played guitar four hours a week for two years. She was 25 years old when tested and only started learning English, her second language, at the age of 23. She received the second highest of the teacher ratings (6.66).

The second case is a 28-year-old male whose first language is a tonal one; he did not report any musical training. English was the second language he learned, and he only started learning it when he was 27. His Tell Me More® score of 5.66 was the third highest (of 22 cases). These two cases are not statistical outliers, and illustrate that perfectly comprehensible L2 speech is capable of being produced even if one learns the L2 as an adult, and over a relatively short period of time (under two years for both students).

Do these cases disprove Lenneberg's critical period hypothesis period or Chomsky's universal grammar? Not necessarily, although the concept of neuroplasticity could be considered to be at the nurture end of the spectrum, whereas universal grammar and the critical period hypothesis could be considered to be at the nature end. This will be elaborated upon in Chapter V.

CHAPTER V

SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

Summary and Conclusions

The aim of this study was to examine the relationships between measurements of musicality, language tonality, and discourse intonation. It was hypothesized that those adult, ESL students with more hours of musical training and better pitch recognition scores would have better discourse intonation. Using tones correctly when speaking a tonal language is paramount and what often distinguishes words; therefore it was also hypothesized that those who spoke tonal languages like Mandarin, Cantonese, or Thai, for example, would have both better pitch recognition scores and better discourse intonation.

Adult, ESL students were recruited from College of Marin in Kentfield and Intrax International Institute in San Francisco and completed various assessments to help answer the study's research questions. A student background questionnaire asked questions about first and second languages, musical instruments they may have studied, and the ages at which all of these were learned. The researcher tested participants' pitch recognition with two tests, one a pitch-matching test on a piano keyboard (PR-A), and one a pitch recognition test based on Edwin Gordon's (1986) *Intermediate Measures of Musical Aptitude* (PR-B). Participants' discourse intonation was measured using two tests, which were the study's dependent variables. The first test used the software program

Tell Me More®'s instant rating system to rate participants' repetitions of nine, pre-selected phrases containing 37 of all 39 English phonemes. These responses were audio recorded and played for a panel of professional ESL teachers (from the aforementioned institutions) who rated the samples; this rating was the score for the second test of discourse intonation. Two multiple regression analyses addressed all of the research questions. There was not a statistically significant outcome between variables with the exception of the strong correlation between the second dependent variable of teachers' ratings and whether or not a tonal language was spoken (R Square = .38; p = .00).

Discussion

Simply because a strong correlation between the measures of musicality and discourse intonation was not proven, does not necessarily mean that one does not exist. A certain conclusion is thus difficult to state: had there been more participants, would the correlation between musical training and discourse intonation have been positive or negative?

What about the two cases of neuroplasticity, where participants who received the second and third highest scores (of twenty-two cases) on discourse intonation tests had only started to learn English within the last two years? Krashen discusses how some linguistic theorists assume that children acquire language, whereas adults can only learn (1982). He then posits:

> The acquisition-learning hypothesis claims, however, that adults also acquire, that the ability to "pick-up" languages does not disappear at

> puberty. This does not mean that adults will always be able to achieve native-like levels in a second language. It does mean that adults can access the same natural "language acquisition device" that children use. (p. 10)

Krashen and Chomsky certainly seem to be in the naturist camp, where biology plays a bigger role in determining language capabilities and abilities than nurture or one's environment does, as it does in the concept of neuroplasticity. Lenneberg and his critical period hypothesis also seem to be on the nature side of the spectrum.

Some adults will learn second languages better than other adults, just as some children will learn second languages better than their peers. Learning to perceive speech contrasts in a second language that are not present in one's first language can be problematic. McClelland, Conway, McCandliss, Fiez, and Protopapas (2002) studied Japanese adults learning the [r] – [l] contrast in English using a Hebbian model, which, initially, grossly exaggerates the sound difference between phonemes. Over time, the difference becomes increasingly less exaggerated until the phonemes are spoken in their native-like, non-exaggerated manner. The results from their study showed that the Hebbian model was more successful than native-like, unexaggerated phonemic training in teaching the [r] – [l] sound contrast to the native Japanese speakers. "There is, however, a growing body of evidence that some ability to learn nonnative contrasts remains into adulthood. Several groups have shown that training can lead improvement in identification and discrimination of nonnative contrasts…" (p. 89). Learning sound contrasts is merely one aspect of second language learning, albeit an important one. The fact that this has been proven to be successful in people after the critical period has supposedly passed, however, is important.

To say that theories posited by Lenneberg, Krashen, and Chomsky are outdated or erroneous would be brash. It may be more accurate to say that the pendulum is starting to swing from the naturist to the nurturist perspective. The adages *use it or lose it* with reference to second language maintenance and *practice makes perfect* with reference to musical maintenance are now able to be proven neurologically. More, “mental practice alone may be sufficient to promote the plastic modulation of neural circuits” (Pascual-Leone in Begley, 2007, p. 152). Just thinking about it is valuable.

Recommendations

For Educators

The researcher would still suggest for educators to continue early music training with the thought that this would certainly not hinder second language acquisition and discourse intonation, but ideally help it. Conversely, second language speech may help with musical abilities. The fact that this recommendation is similar to one posited by researchers Wong, Skoe, Russo, Dees, and Kraus (2007) is reassuring.

The following is from a *New York Times* article describing the previously mentioned study (Wong, Skoe, Russo, Dees, & Kraus, 2007) that examined differences between musicians' and non-musicians' brains after they heard different Mandarin tones:

> One of the study's authors, Nina Kraus, said the findings suggested that studying music "actually tunes our sensory system." This means that schools that want children to do well in languages should hesitate before cutting music programs, Dr. Kraus said. ((Nagourney, 2007, p. F2)

In addition to urging early music training, the researcher would also recommend that second language instructors bring in music from the target language into the classroom. Incorporating music into language courses is important for a number of reasons. Listening to music in which there are sung or spoken lyrics is a different way to get input in the target language, which can be useful, and is certainly something most are exposed to when acquiring a first language. Also, music can give us an intangible insight into a culture, just as other art forms such as dance, visual art, or even storytelling can. Personal examples of bringing music into the second language classroom are mentioned in the Researcher's Reflections section.

Finally, the researcher would recommend that teachers try different teaching techniques in each classroom. As educators know, students learn in different ways. Some students are more effective at learning visually through activities like reading and writing, whereas others are more effective at learning aurally through activities like listening comprehension tasks and conversation. By incorporating visual, aural, and oral activities, educators can give different types of learners equal opportunities to learn in a way that is best for them. Listening to, repeating, and analyzing (in written form) song lyrics from a target language would be an example of an activity that incorporates aural, oral, and visual styles of learning.

For Future Research

While this study did not find statistical significance between musical training and discourse intonation, this does not necessarily mean there is not a significant correlation between them. Had more students been tested, this link may have been found statistically significant; having this study replicated in the future with more participants would be recommended.

Testing the influence of musical training on second language speech is one way to examine the language-music relationship, but testing second language speech's influence on musical training may also prove fruitful. Also recommended, therefore, would be a study to determine whether or not the ability to speak a second language could help with learning a musical instrument.

Studying musical training as predictive of being able to learn a tonal language among people whose native language is atonal would also be suggested. Recommended relevant research by others (Wong, Skoe, Russo, Dees, & Kraus, 2007) involves "more comprehensive and systematic investigations of musicians' and non-musicians' responses to different simple and complex sounds" (p. 3).

Another way to have measured discourse intonation and pitch recognition could have been to conduct a qualitative study. Choosing participants with different linguistic and musical histories, asking them a number of in-depth questions about these histories, including their own thoughts on how and why they learned music and/or language the way they did, and then evaluating generative themes would be another idea for future research. This could be turned into a mixed-methods study if both qualitative and quantitative measures would be used in quantifying linguistic and musical histories.

Researcher's Reflections

This study was prompted in part by my own love of music and languages. I grew up listening to my mother play the piano and recordings of classical music, and remember often falling asleep to classical music on the radio. Studying other languages has also been of interest to me, and trying to speak something other than English, whether at home or abroad, has been something I have sought for years. Listening to and playing music have also been important throughout my life. Having played the violin and viola and singing since the age of five and acquiring perfect pitch shaped my musical knowledge. People have always wondered if my facility for speaking foreign languages, which I started learning in high school, may have stemmed from my musical training. There is something to be said for mental discipline in learning both a new piece of music or instrument and a new language. Some people naturally "get" a new piece or language effortlessly and quickly (I believe I could be among this lucky group), whereas some need to consistently study to attain the same level of proficiency. Like any journey in life, two people may arrive at the same destination having gone through vastly different routes.

I was hopeful that there would have been a stronger relationship between musical background and discourse intonation. By conducting background research for this study, I learned that there are neural correlations between linguistic and musical processing, and that music and language are not distinctly processed in different hemispheres. Having to learn about the brain has been difficult but fascinating, and I believe the recent transfer of information about the brain from the domain of researchers to the public will continue to increase. We are in exciting, new land of discovery of the brain, not solely in regards to language and music. The more studies that are conducted, the more we can understand why we do what we do as humans. While the study I conducted did not find great significance between the variables I chose, I feel that perhaps if the study were to be replicated on a larger scale there may be significance in some direction. I do feel that it is important to have more published literature and/or research studies about the brain and how we process sound, specifically sound processing in language and music. I hope that this study has again presented the need for more research, and posed an interesting question.

Teaching ESL has been very rewarding to me, and I feel fortunate to be in a situation where work is quite pleasurable. Having interviewed ESL students for my study was interesting, and I enjoyed being able to speak with students individually and understand their own linguistic and musical histories. My professional practice has always involved trying to incorporate music in the classroom on some level, even if it is something less involved than singing or playing music; last summer, for example, I had a group of Italian ESL students decipher lyrics to popular songs by Madonna and the rock band Maroon 5. I received positive feedback from the students about this exercise, and will continue to do similar activities. Some ESL activities that bring music to the classroom, like Carolyn Graham's *Jazz Chants*, seem quite outdated, and using more relevant music has proven to be more engaging for students. While I do not think it would be appropriate for me to urge students to play a musical instrument with the specific intent of possibly helping their English discourse intonation, I will certainly continue to use music in the ESL classroom. I will also suggest that other teachers, ESL and otherwise, do the same. Music is an international language that everyone can enjoy.

BIBLIOGRAPHY

Aitchison, J. (2003). *Words in the mind: An introduction to the mental lexicon (3rd Ed.)*. Malden, MA: Blackwell Publishing.

Bancroft, W.J. (1999). *Suggestopedia and language acquisition: Variations on a theme.* Amsterdam: Overseas Publishers Association.

Bates, E.A. & MacWhinney, B. (1981). Second language acquisition from a functional perspective: Pragmatic, semantic, and perceptual strategies. *Native Language and Foreign Language Acquisition, Annals of the New York Academy of Science, 379:* 190-214.

Begley, S. (2007a, January 29). How the brain rewires itself. *Time, 169* (5), 72-79.

Begley, S. (2007b). *Train your mind, change your brain: How a new science reveals our extraordinary potential to transform ourselves.* New York: Balentine Books.

Besson, M., & Schön, D. (2001). Comparison between language and music. In R. J. Zatorre & I. Peretz (Eds.), *The biological foundations of music: Annals of the New York Academy of Sciences*, V. 930.

Bialystok, E. (1982). On the relationship between knowing and using forms. *Applied Linguistics*, *3*, 181-206.

Bialystok, E. (Ed.) (1991). *Language processing in bilingual children*. Cambridge, UK: Cambridge University Press.

Birdsong, D. (Ed.) (1999). *Second language acquisition and the critical period hypothesis.* Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Borchgrevink, H.M. (1982). Prosody and musical rhythm are controlled by the speech hemisphere. In M. Clynes (Ed.) *Music, mind and brain: The neuropsychology of music* (pp. 151-158). New York: Plenium Press.

Brizendine, L. (2006). *The female brain*. New York: Morgan Road Books.

Brown, H.D., & Gonzo, S. (1995). *Readings on second language acquisition.* Upper Saddle River, NJ: Prentice Hall Regents.

Bygate, M. (2001). Speech. In R. Carter & D. Nunan (Eds.), *The Cambridge* *guide to teaching English to speakers of other languages* (pp. 14-20). Cambridge, UK: Cambridge University Press.

Celce-Murcia, M. & Olshtain, E. (2000). *Discourse and context in language teaching: A guide for language teachers*. Cambridge, UK: Cambridge University Press.

Chun, D.M. (2002). *Discourse intonation in L2: From theory and research to practice*. Philadelphia: John Benjamins Publishing Company.

Clennel, C. (1997). Raising the pedagogic status of discourse intonation teaching. *ELT Journal, 51* (2), 117-119.

Crystal, D. (1995). *The Cambridge enclycopedia of the English language*. Cambridge, UK: Cambridge University Press.

Crystal, D. (1997). *The Cambridge encyclopedia of language (2nd ed.).* Cambridge, UK: Cambridge University Press.

Crystal, D. (1999). *A dictionary of language (2nd ed.).* Chicago: University of Chicago Press.

Crystal, D. (2006). *Words, words, words*. Oxford, UK: Oxford University Press.

Dąbrowska, E. (2004). *Language, mind and brain: Some psychological and neurological constraints on theories of grammar.* Washington, DC: Georgetown University Press.

Danesi, M. (2003). *Second language teaching: A view from the right side of the brain.* Norwell, MA: Kluwer Academic Publishers.

Deutsch, D., Henthorn, T., & Dolson, M. (1999). Absolute pitch is demonstrated in speakers of tone languages. *Journal of the Acoustical Society of America*, *106,* 2267.

Deutsch, D., Henthorn, T., Marvin, E., & Xu, H-S. (2004). Tone language and absolute pitch: Prevalence among American and Chinese conservatory students. *Journal of the Acoustical Society of America, 116*, 2580.

Dictionary.com Unabridged (v 1.1). Retrieved February 7, 2007 from *http://dictionary.reference.com/browse/wernicke's%20area*, *http://dictionary.reference.com/browse/Broca's%20area*, and *http://dictionary.reference.com/browse/neuroplasticity*.

Dobrian, C. (1992). *Music and language*. Retrieved March 3, 2005, from http://www.music.arts.uci.edu/dobrian/CD.music.lang.htm.

Elbert, T., Panatev, C., Wienbruch, B., Rockstroh, B., & Taub, E. (1995). Increased cortical representation of the fingers of the left hand in string players. *Science, 270*: 305-307.

Ellis, R. (1997). *Second language acquisition*. Oxford: Oxford University Press.

Glatthorn, A. A. (1998). *Writing the winning dissertation: A step-by-step guide*. Thousand Oaks, CA: Corwin Press, Inc.

Goldsmith, J. A. (1999). Dealing with prosody in a text to speech system. *International Journal of Speech Technology, 3*, 51-63.

Gordon, E. E. (1999). All about audiation and music aptitudes. *Music Educators Journal*, *86* (2) 41-44.

Gordon, E. E. (1969). An investigation of the intercorrelation among musical aptitude profile subtests and seashore measures of musical talents subtests. *Journal of Research in Music Education*, *17,* 263-271.

Gordon, E. E. (1979). Developmental music aptitude as measured by the primary measures of music audiation. *Psychology of Music*, *7,* 42-49.

Gordon, E. E. (1970). *Iowa tests of music literacy*. Iowa City: The University of Iowa Bureau of Educational Research and Service.

Gordon, E. E. (1986). *Manual for the primary measures of music audiation and the intermediate measures of music audiation*. Chicago: G.I.A. Publications.

Grimes, B. (Ed.). (2000 a). *Ethnologue: Languages of the world* (14th ed., Vol. 1). Dallas, TX: SIL International.

Grimes, B. (Ed.). (2000 b). *Ethnologue: Maps and indexes* (14th ed., Vol. 2). Dallas, TX: SIL International.

Hargreaves, D. J., & North, A.C. (Eds.). (1997). *The social psychology of music.* New York: Oxford University Press.

Hinton, P.R., Brownlow, C., McMurray, I., & Cozens, B. (2004). *SPSS explained*. New York: Routeledge.

Ingram, D. (1989). *First language acquisition: Method, description and explanation.* Cambridge: Cambridge University Press.

International Phonetic Association. (1999). *Handbook of the International Phonetic Association: A guide to the use of the International Phonetic Alphabet*. Cambridge: Cambridge University Press.

Johnsrude, I.J., Penhune, V.B., & Zatorre, R.J. (2000) Functional specificity in right human auditory cortex for perceiving pitch direction. *Brain*, *123,* 155-163.

Jourdain, R. (1997). *Music, the brain and ecstasy: How music captures our imagination*. New York: William Morrow & Co., Inc.

Kivy, P. (2002). *Introduction to a philosophy of music*. New York: Oxford University Press.

Klein, D., Zatorre, R., Milner, B., & Zhao, V. (2000). A cross-linguistic PET study of tone perception in Mandarin Chinese and English speakers. *NeuroImage*, *13,* 646-653.

Klein, W. (1986). *Second language acquisition*. New York: Cambridge University Press.

Knaus, T., Bollich, A., Corey, D., Lemen, L., & Foundas, A. (2004). Sex-linked differences in the anatomy of the perisylvian language cortex: A volumetric MRI study of grey matter volumes. *Neuropsychology, 18*(4), 738-747.

Krashen, S.D. (2003). *Explorations in language acquisition and use*. Portsmouth, NH: Heinemann.

Krashen, S.D. (1982). *Principles and practice in second language acquisition*. New York: Pergamon Press.

Krashen, S.D. (1981). *Second language acquisition and second language learning*. New York: Pergamon Press.

Ladefoged, P. (2003). *Phonetic data analysis: An introduction to fieldwork and instrumental techniques.* Malden, MA: Blackwell Publishing.

Larsen-Freeman, D., & Long, M.H. (1991). *An introduction to second language acquisition and research.* Essex: Longman.

Lě, M.H. (1999). *The role of music in second language learning: A Vietnamese perspective.* Retrieved February 18, 2005, from http://www.aare.edu/au/99pap/le99034.htm.

Leather, J., & James, A. (1991). The acquisition of second language speech. *Studies in Second Language Acquisition*, *13*, 305– 341.

Lehman, P.R. (1968). *Tests and measurements in music*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Lenhoff, H.M., Wang, P. P., Greenberg, F., & Bellugi, U. (1997). Williams syndrome and the brain. *Scientific American, 227*, 68-73.

Levitin, D.J. (2006). *This is your brain on music: The science of a human obsession*. New York: Dutton.

Levitin, D.J., & Menon, V. (2003). Musical structure is processed in "language" areas of the brain: A possible role for Brodmann Area 47 in temporal coherence. *NeuroImage*, *20,* 2142-2152.

Levitin, D.J., Menon, V., Schmitt, J.E., Eliez, S., White, C., Glover, G., Korenberg, J.R., Bellugi, U., & Reiss, A.L. (2003). Neural correlates of auditory perception in Williams syndrome: An fMRI study. *NeuroImage, 18*, 74-82.

Lightbown, P.M., & Spada, N. (2006). *How languages are learned (3rd ed.).* Oxford: Oxford University Press.

Loewy, J.V. (1995). The musical stages of speech: A developmental model of pre-verbal sound making. *Music Therapy, 13*(1), 47-73.

Lozanov, G., & Gateva, E. (1988). *The foreign language teacher's Suggestopedic manual.* Montreux, Switzerland: Gordon and Breach Science Publishers, S.A.

Lozanov, G. (1978). *Suggestology and outlines of suggestopedy*. New York: Gordon & Breach.

Medterms online medical dictionary. (1996-2006). Retrieved on May 30, 2006, from: *http://www.medterms.com/script/main/art.asp?articlekey=19458*.

Merriam-Webster's collegiate dictionary (10th Ed.). (1999). Springfield, MA: Merriam-Webster.

Merriam-Webster's Medical Dictionary. Retrieved February 07, 2007, from http://dictionary.reference.com/browse/Heschl's gyrus.

McCarthy, J.F. (1984). The pitch test: Program to test pitch perception. *Creative Computing 10*, 211-214.

McClelland, J.L., Rumelhart, D. E., PDP research group. (1986). *Parallel distributed processing: Explorations in the microstructure of cognition. Volume I.* Cambridge, MA: MIT Press.

McClelland, J.L., Conway, M., McCandliss B.D., Fiez, J.A., & Protopapas, A. (2002). Success and failure in teaching the [r]-[l] contrast to Japanese adults: Tests of a Hebbian model of plasticity and stabilization in spoken language perception. *Cognitive, Affective & Behavioral Neuroscience, 2*(2), 89-108.

Mora, C. F. (2000). Foreign language acquisition and melody singing. *ELT Journal, 54* (2), 146-52.

Nagourney, E. (2007, March 20). Skilled ear for music may help language. *The New York Times,* F 2.

Neubauer, J. (1986). *The emancipation of music from language.* New Haven, CT: Yale University Press.

Oxford English Dictionary Online. Retrieved April 7, 2007, from http://www.oed.com/help/updates/latest-additions.html

Pantev, C., Oostenveld, R., Engelien, A., Ross, B., Roberts, L.E., & Hoke, M. (1998). Increased auditory cortical representations in musicians. *Nature, 392*, 811-814.

Pascual-Leone, A., Amedi, A., Fregni, F., & Merabet, L.B. (2005). The plastic human brain cortex. *Annual Review of Neuroscience, 28*, 377-401.

Patel, A.D., Gibson, E., Ratner, J., Besson, M., & Holcomb, P.J. (1998). Processing syntactic relations in language and music: An event-related potential study. *Journal of Cognitive Neuroscience 6*(10), 717-733.

Patel, A.D. (2003). Language, music, syntax and the brain. *Nature Neuroscience, 6,* 674-681.

Peynircioğlu, Z.F., Durgunoğlu, A.Y., & Öney-Küsefoğlu, B. (2002).

Phonological awareness and musical aptitude. *Journal of Research in Reading*, *25* (1), 68-80.

Pierce, J. (1999). Introduction to pitch perception. In P. Cook (Ed.), *Music, cognition and computerized sound: An introduction to psychoacoustics* (pp. 57-70). Cambridge, MA: MIT Press.

Rothstein, E. (1995). *Emblems of mind: The inner life of music and mathematics*. New York: Times Books.

Schueller, M., Bond, Z.S., Fucci, D., Gunderson, G., & Vaz, P. (2004). Possible influence of linguistic musical background on a perceptual pitch-matching tasks: A pilot study. *Perceptual and Motor Skills, 99*(2), 421-428.

Schneider, P., Scherg, M., Dosch, G., Specht, H.J., Gutschalk, A., & Rupp, A. (2002). Morphology of Heschl's gyrus reflects enhanced activation in the auditory cortex of musicians. *Nature Neuroscience*, *5*(7), 688-694.

Seashore, C.E. (1919). *Psychology of musical talent*. Morristown, NJ: Silver Burdett Company.

Spencer, K. (1998). Predictive models of spelling behaviour [sic] in 7- & 11-year-olds. *Journal of the Simplified Spelling Society, J24*, 23-27.

Stansell, J.W. (2002, summer). *The use of music in learning languages: A review.* Retrieved February 18, 2005, from *http://www.mste.uiuc.edu/courses/ci407su02/students/stansell/Literature%20Review%201.htm.*

Stephens, L.J. (2004). *Advanced statistics demystified: A self-teaching guide*. New York: McGraw Hill.

Swain, J.P. (1997). *Musical languages*. New York: Norton.

The biology of music. (2000, Feb 12-18). *The Economist*.

Weinberger, N.M. (2004). Music and the brain. *Scientific American*, *291*(5), 88–95.

Welby, P. (2003). Effects of pitch accent position, type, and status on focus projection. *Language and Speech*, *46*(1), 53-81.

Wong, C.M., Skoe, E., Russo, N.M., Dees, T., & Kraus, N. (2007). Musical experience shapes human brainstem encoding of linguistic pitch patterns. *Nature Neuroscience Brief Communications.* Retrived March 21, 2007 from *http://www.nature.com/neuro/journal/vaop/ncurrent/abs/nn1872.html*

Wong-Fillmore, L. (1976). *The second time around: Cognitive and social strategies in second language acquisition.* Unpublished doctoral dissertation, Stanford University.

Zatorre, R.J. (1997). When that tune runs through your head: A PET investigation of auditory imagery for familiar melodies. *Cerebral Cortex, 9*(7), 697-704.

Zatorre, R.J. (2000). Sound work. [Review of the book *Music, the brain, and ecstasy: How music captures our imagination]*. Retrieved September 17, 2005 from *http://cogweb.ucla.edu/Abstracts/Zatorre_on_Jourdain_97.html*.

Zatorre, R.J. (2001) Preface. In R. J. Zatorre & I. Peretz (Eds.), *The biological foundations of music: Annals of the New York academy of sciences*, V. 930.

Zatorre, R.J. (2003) Absolute pitch: A model for understanding the influence of genes and development on neural and cognitive function. *Nature Neuroscience*, *6,* 692-695.

Zatorre, R.J. (2005) Music, the food of neuroscience? *Nature*, *434*, 312-315.

Zatorre, R.J. (2006) *The Auditory Cognitive Neuroscience Laboratory*. Retrieved September 20, 2006, from http://www.zlab.mcgill.ca/home.html.

Zatorre, R.J., Belin, P., & Penhune, V.B. (2002) Structure and function of auditory cortex: Music and speech. *Trends in Cognitive Sciences*, *6,* 37- 46.

APPENDIXES

APPENDIX A: STUDENT BACKGROUND QUESTIONNAIRE & CONSENT FORM (COLLEGE OF MARIN)

Directions: Please answer the following questions with as much information as possible. Please let Kate know if you do not understand something. If you run out of space, please turn the paper over and continue your answer on the back. Thanks!

1. Name ____

2. Age ____

3. Teacher / Class ______________________________________

4. Please check (√) a box for each education level you have so far:

Elementary school	1
Middle school	2
High school	3
Some university classes	4
University graduate	5
Some gradate school classes	6
Graduate degree	7

5. Please list the languages you speak in the order in which you learned them:

1. ____________ 2. _____________ 3. _____________ 4. _____________

What year did you start learning them? 1. ______ 2. ______ 3. ______ 4. ______

6. Did you grow up playing a musical instrument or singing? Yes / No

If you answered no, please skip down to question # 14.

7. If you answered yes, what instrument(s)?

____

If you played more than one instrument, please answer questions 8 – 13 thinking about the instrument you played the most.

8. Did you play this instrument because of a requirement, for pleasure, or both?

____

9. For how many years did you play this instrument? ________

10. How many hours per week did you play this instrument when you were:

5-10 years old? ______ 11-15 years old? ______ 16-20 years old? ______

21-25 years old? ______ 26-30 years old? ______ Over 30 years old? ______

11. Do you still play your instrument? Yes / No

12. Have you performed publicly with your instrument? Yes / No

13. If yes, how many times per year, on average? _____

____

14. Will you be available over the next month to participate in this study? Yes / No

15. Have you ever had a hearing problem? Yes / No

It will take about 20 minutes for you to participate in this study. We can schedule the test so it happens before or after class, or during a class break. You will not need to bring anything to the test, and some food will be provided for you (you can eat it after the test). There are three parts to this test, and you do NOT need to have any musical background to take the test. In the first part, we'll use a piano keyboard- we'll make sure you're comfortable with the way it works before you take this part of the test. In the second part, you will be listening to a CD and answering some simple questions by circling an answer. The last part involves computer software- you'll be listening to and repeating a few sentences in English. Kate will review the instructions when you meet with her and make sure you understand everything. The results of your test will NOT have anything to do with your school grade, and your teachers will not know your individual results. Thank you so much for your interest in this study!

Dear College of Marin Student:

My name is Kate Knickerbocker and I am a graduate student in the International and Multicultural Education department at the University of San Francisco. I am conducting a study to try to see if musical background has an effect on ESL speech. Dean David Snyder at College of Marin has given me permission to interview ESL students for my study.

You are being asked to participate in this study because you are an ESL student at College of Marin. If you agree to be in this study, you will complete the attached background questionnaire that asks about your educational and musical background. Return the survey to me directly, or in the enclosed pre-addressed, pre-stamped envelope.

It is possible that some of the questions on the questionnaire may make you feel uncomfortable, but you are free to decline to answer any questions you do not wish to answer, or to stop participation at any time. Although you will not be asked to put your name on the survey, I will know that you were asked to participate in the research because I asked you personally. Participation in research may mean a loss of confidentiality. Study records will be kept as confidential as is possible. No individual identities will be used in any reports or publications resulting from the study. Study information will be coded and kept in locked files at all times. Only I will have access to the files.

While there will be no direct benefit to you from participation, the anticipated benefit of this study is a better understanding of the possible link between musical background and ESL speech.

There will be no costs to you as a result of taking part in this study, nor will you be compensated monetarily for your participation. You will, however, receive one meal as compensation for your participation; you will receive this meal at the end of our interview.

If you have questions about the research, you may contact me at 415-254-8010. If you have further questions about the study, you may contact the IRBPHS at the University of San Francisco, which is concerned with protection of volunteers in research projects. You may reach the IRBPHS office by calling (415) 422-6091 and leaving a voicemail message, by e-mailing IRBPHS@usfca.edu, or by writing to the IRBPHS, Department of Psychology, University of San Francisco, 2130 Fulton Street, San Francisco, CA 94117-1080.

PARTICIPATION IN RESEARCH IS VOLUNTARY. You are free to decline to be in this study, or to withdraw from it at any point. College of Marin is aware of this study but does not require that you participate in this research and your decision as to whether or not to participate will have no influence on your grades or other status. Your teacher(s) will not know the results of your testing.

Thank you for your attention. If you agree to participate, please complete the attached survey and return it to me directly or in the enclosed pre-addressed, pre-stamped envelope.

Sincerely,

Kate Knickerbocker
Graduate Student, University of San Francisco

APPENDIX B: PITCH-MATCHING TEST INSTRUCTIONS

The researcher will let each student know that she will play all of the notes in the example and test questions three times each, with shielded hands, before soliciting a response. If the student feels comfortable responding after hearing the note only once or twice, he or she will be allowed to respond then. The researcher will let each student know that she cannot reveal the answers to any of the notes until the completion of the test: doing so would adversely affect test results.

Example notes to be played before test:

Middle C (hands visible to student and researcher)

Middle G (hands shielded from student)

High E (hands shielded from student)

Pitch-matching test notes to be played:

Middle D

Low E

Middle A

High G

Low B

High E

Middle C

High F

Low G

Middle D

APPENDIX C: PITCH-MATCHING TEST SCORE CARD

STUDENT'S NAME____

TODAY'S DATE: ______________________ TIME: ___________________

Example notes to be played before test:

Middle C (hands visible to student and researcher)

Middle G (hands shielded from student)

High E (hands shielded from student)

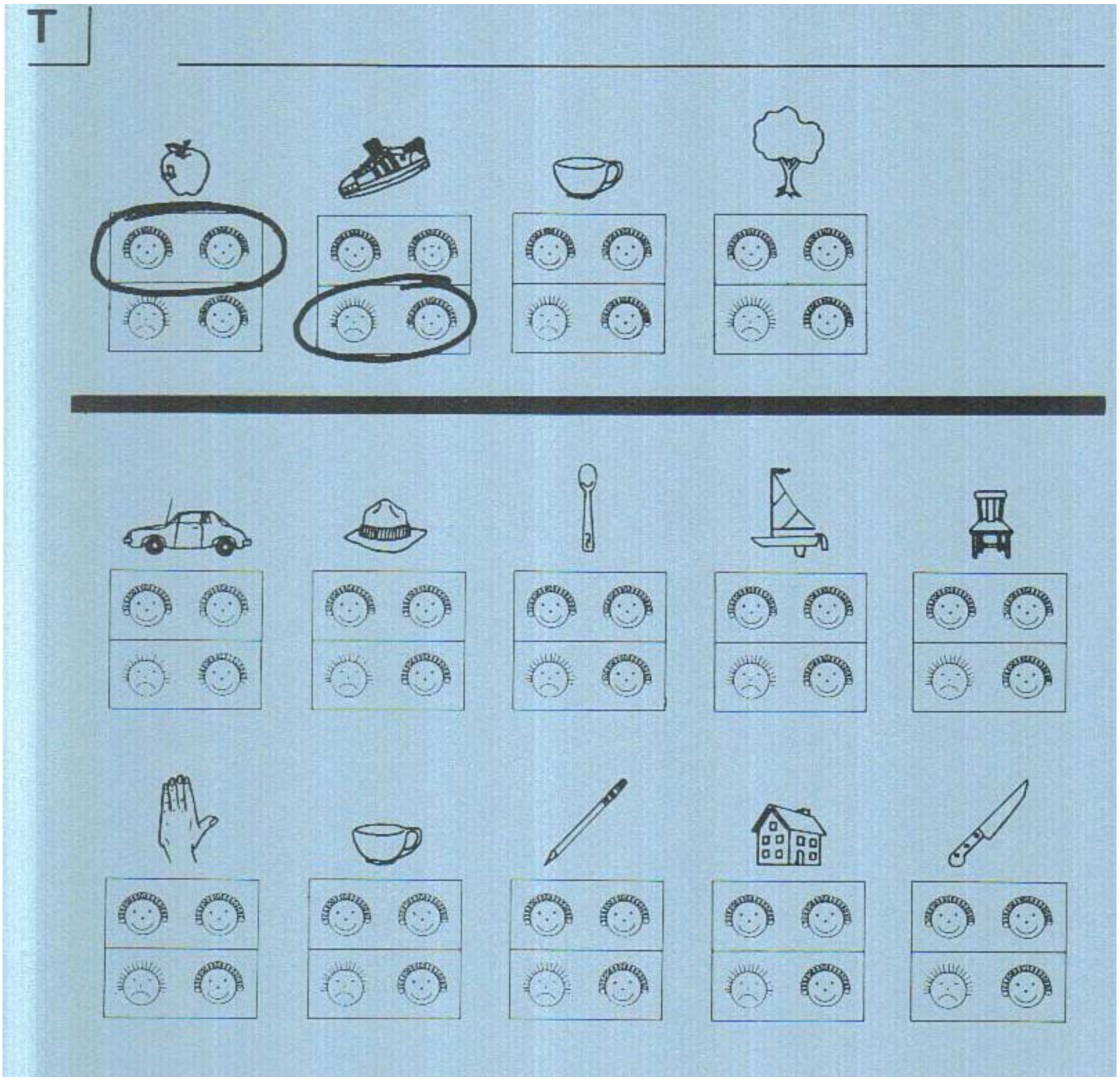
Pitch-matching test notes to be played:

Middle D	Student played: ______________	Notes off: _________
Low E	Student played: ______________	Notes off: _________
Middle A	Student played: ______________	Notes off: _________
High G	Student played: ______________	Notes off: _________
Low B	Student played: ______________	Notes off: _________
High E	Student played: ______________	Notes off: _________
Middle C	Student played: ______________	Notes off: _________
High F	Student played: ______________	Notes off: _________
Low G	Student played: ______________	Notes off: _________
Middle D	Student played: ______________	Notes off: _________

TIME WHEN TEST COMPLETED: __________ ELAPSED TIME: _________

Total number of notes off: ____________

APPENDIX D: GORDON'S *IMMA* TONAL TEST ANSWER SHEET



APPENDIX E: GORDON'S *IMMA* MODIFIED TONAL TEST INSTRUCTIONS

Print in black is taken directly from the "Specific Directions for Administering the *IMMA* Tonal Test," (Gordon, 1986, p. 45). Print in red denotes the researcher's modifications. Print in CAPS, per the *IMMA* Manual's directions, specify words the administrator is to tell students.

"'LISTEN TO THE TWO PARTS OF THIS SONG AND THEN I WILL ASK YOU IF THE TWO PARTS SOUND THE SAME OR DIFFERENT.'

'LOOK AT YOUR PAPER AND FIND THE APPLE AT THE TOP. THERE ARE TWO BOXES UNDER THE APPLE. THE BOX ON TOP HAS TWO FACES THAT LOOK THE SAME. THE BOX ON THE BOTTOM HAS TWO FACES THAT LOOK DIFFERENT. WHEN THE TWO SONGS SOUND THE SAME, YOU WILL DRAW A CIRCLE AROUND THE BOX ON TOP BECAUSE THE TWO FACES LOOK THE SAME (LIKE IN THE APPLE PICTURE HERE [POINT].) WHEN THE TWO SONGS SOUND DIFFERENT, YOU WILL DRAW A CIRCLE AROUND THE BOX ON THE BOTTOM BECAUSE THE TWO FACES LOOK DIFFERENT (LIKE IN THE SHOE PICTURE HERE [POINT.)

'NOW YOU MAY BEGIN TO DRAW THE CIRCLES. PICK UP YOUR PENCIL. FIND THE CUP AND THE BOXES THAT GO WITH THE CUP SONG. LISTEN TO THE CUP SONG AND DRAW YOUR CIRCLE.'

(Start the [CD], listen for the words and parts, and stop the [CD]. Allow five seconds for the [students] to draw the circle.)

'YOU SHOULD HAVE DRAWN A CIRCLE AROUND THE BOX ON THE BOTTOM WITH THE TWO FACES THAT LOOK DIFFERENT BECAUSE THE TWO SONGS SOUND DIFFERENT… LET'S PRACTICE ONCE MORE. FIND THE BOXES THAT GO WITH THE TREE SONG. NOW LISTEN TO THE TREE SONG AND DRAW YOUR CIRCLE.'

(Start the [CD], listen for the words and parts, and stop the [CD]. Allow five seconds for the [students] to draw the circle.)

'YOU SHOULD HAVE DRAWN A CIRCLE AROUND THE BOX ON TOP WITH THE TWO FACES THAT LOOK THE SAME BECAUSE THE TWO SONGS SOUND THE SAME… SEE THE BIG LINE ON YOUR PAPER. UNDER THE LINE IS A CAR. FIND THE CAR AND THE BOXES THAT GO WITH THE CAR SONG. WE ARE ALL DONE PRACTICING AND READY TO BEGIN. LISTEN TO THE CAR SONG AND DRAW YOUR CIRCLE.'

(Start the [CD] and the test has begun. Let the [CD] run continuously until the end. There are forty questions on the *Tonal* test. The [CD] is timed to allow the [students] five seconds to draw each circle… When the test is completed, check to see that the name is legible on each paper as the papers are collected." (Gordon, 1986, pp. 46-47).

APPENDIX F: TELL ME MORE® PHRASE SELECTION

Section location	Phrase
Breakfast Menus	Could I have some whole wheat toast?
Window-shopping	Actually, I need a new pair of pants.
At the Post Office	I’ve already been here for half an hour!
At the Post Office	How much will it cost to send this package?
Banks and ATMs	I never keep track of that kind of thing!
Banks and ATMs	Great. I’ll try that.
Banks and ATMs	Your machine won’t accept my card!
The Fitting Room	I’m just looking.
The Fitting Room	Navy blue sounds nice.

These phrases have been color-coded for illustrative purposes: each phoneme in English is represented except for the diphthong /ɔɪ/ (as in *boy*) and / ʒ / (as in *azure*). The phoneme / ʒ / was omitted because of its very infrequent occurrence in English speech (Spencer, 1998, p. 25), whereas /ɔɪ/ was omitted because in order to have that sound represented, another entire phrase would have needed to be added to the battery of phrases, costing more time on the behalf of students and teachers. Also, the independent sounds /o/ (as in *bode*) and /i/ (as in *bead*) are already included in the battery.

Could I have some whole wheat toast?

Actually, I need a new pair of pants.

I've already been here for half an hour!

How much will it cost to send this package?

I never keep track of that kind of thing!

Great. I'll try that.

Your machine won't accept my card!

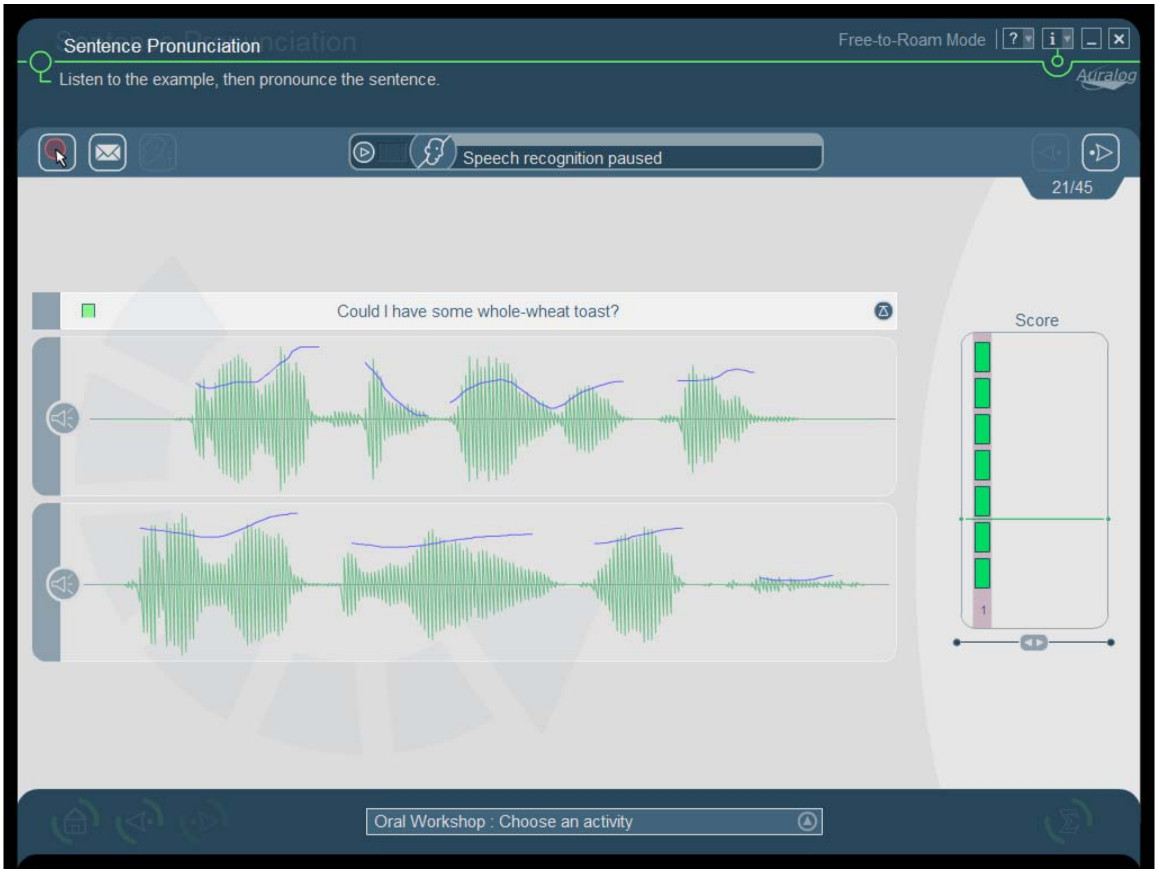
I'm just looking.

Navy blue sounds nice.

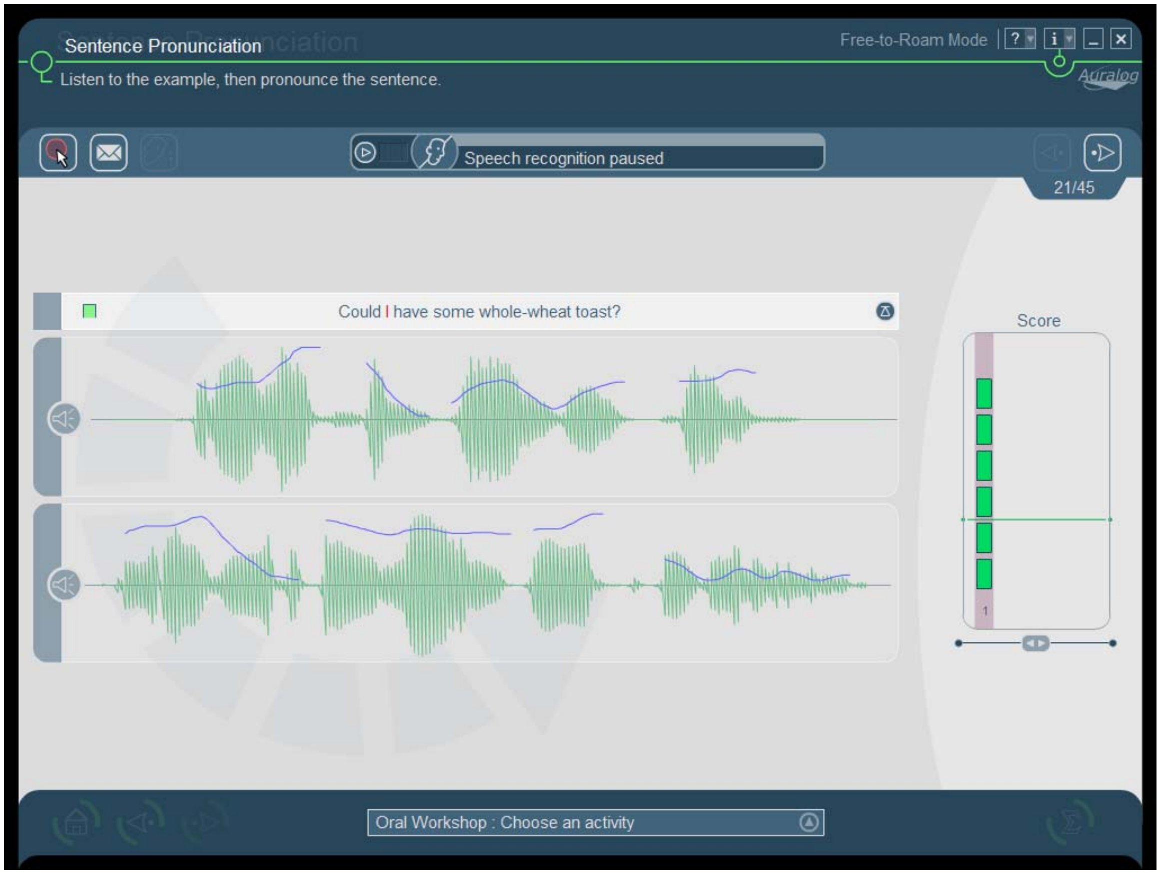
In the first column is the phoneme; in the second, the APA's example of each phoneme (International Phonetic Association, 1999, pp. 41-43).

p	*pie*	pair	pants	package	keep										
b	*buy*	been	blue												
m	*my*	some	much	machine	my	I'm									
f	*fie*	for													
v	*vie*	have	of	I've	of										
w	*why*	wheat	new	how	will										
t	*tie*	wheat	toast	pants	it	cost	to	track	that	great	try	that	won't	accept	just
d	*die*	could	need												
n	*nigh*	need	new	pants	been	an	send	never	won't	navy	sounds	nice			
θ	*thigh*	thing													
ð	*thy*	this	that	that											
s	*sigh*	some	toast	pants	cost	send	this	accept	just	sounds	nice				
z	*zoo*	sounds													
r	*rye*	pair	already	here	for	hour	never	great	try	your	card				
l	*lie*	actually	already	I'll	looking										
k	*kite*	could	cost	keep	kind	accept	looking								
g	*guy*	great													
ŋ	*hang*	thing	looking												
h	*high*	have	whole	here	half	how									
tʃ	*chin*	much													
dʒ	*gin*	package	just												
ʃ	*shy*	actually	machine												
j	*you*	your													
i	*bead*	wheat	actually	need	already	keep	machine	navy							
ɪ	*bid*	been	will	it	package	thing	looking								
e	*bayed*	pair	great												
ɛ	*bed*	already	been	send	never	accept									
æ	*bad*	actually	pants	half	package	track	that	that							
ɑ	*pod*	already	cost												
o	*bode*	whole	toast	won't											
ʊ	*good*	could	looking												
u	*booed*	new	blue												
ʌ	*bud*	some	of	an	of	of									
ɔ:	*bird*	hour													
aɪ	*buy*	I	I	I've	I	I'll	try	my	I'm						
aʊ	*bough*	hour	how	sounds											
ə	*above*	accept													

APPENDIX G: TELL ME MORE® SOFTWARE SCREENSHOTS



This is an example of the highest rating: on the right side you can see seven green bars (of a possible eight, as zero is the lowest score). The volume spectrograph is illustrated in green, and the speech contour waveform is illustrated with the blue line.



This is an example of good rating- the score is six bars. Any word noted in red needs correction: from both the red "I" and the dip in the pitch waveform (blue line), we can see that this speaker needs to work on pronouncing "I" better; the researcher will see this during testing, however participants will not. Participants will be looking at printouts of each phrase on card stock in large font.

APPENDIX H: TEACHER-STUDENT RATING SHEET FOR INTRAX

ESL students at another institution have taken a test using a software program that instantly rates the student's speech. Students were asked to repeat certain phrases into a microphone and the scores that were instantly generated by the software have been saved. Having ESL teachers rate the students' speech samples is helpful, as the study results will not be based solely on the computerized grades. Because it would take a very long time to have you listen to each of the phrases twice, you will only be asked to listen to one phrase.

Directions: Please rate the students' speech using 1-4, where

1 = incomprehensible speech, 2 = somewhat comprehensible speech,

3 = acceptable speech, and 4 = perfectly comprehensible speech.

You will hear each student two times, so please give each student two ratings.

Here is the phrase the students will be saying:

I never keep track of that kind of thing!

APPENDIX H: TEACHER-STUDENT RATING SHEET FOR INTRAX

Student	**Rating**
1 (first take)	___
1 (second take)	___
2	___
2	___
3	___
3	___
4	___
4	___
5	___
5	___
6	___
6	___
7	___
7	___
8	___
8	___
9	___
9	___
10	___
10	___
11	___
11	___
12	___
12	___
13	___
13	___

(etc.)

APPENDIX I: RECRUITMENT HANDOUT TO DESCRIBING STUDY

The researcher circulated this flyer when talking about her study to ESL classes. She also gave a packet of information to every student in the class containing the Student Background Questionnaire & Consent Form (see Appendix A), a self-addressed, stamped envelope, and her business card with contact information.

APPENDIX J: RECRUITMENT FLYER POSTED AT COLLEGE OF MARIN

APPENDIX K: IRBPHS APPROVAL LETTER

October 18, 2006

Dear Ms. Knickerbocker:

The Institutional Review Board for the Protection of Human Subjects (IRBPHS) at the University of San Francisco (USF) has reviewed your request for human subjects approval regarding your study.

Your application has been approved by the committee (IRBPHS #06-069). Please note the following:

1. Approval expires twelve (12) months from the dated noted above. At that time, if you are still in collecting data from human subjects, you must file a renewal application.

2. Any modifications to the research protocol or changes in instrumentation (including wording of items) must be communicated to the IRBPHS. Re-submission of an application may be required at that time.

3. Any adverse reactions or complications on the part of participants must be reported (in writing) to the IRBPHS within ten (10) working days.

If you have any questions, please contact the IRBPHS at (415) 422-6091.

On behalf of the IRBPHS committee, I wish you much success in your research.

Sincerely,

Terence Patterson, EdD, ABPP
Chair, Institutional Review Board for the Protection of Human Subjects
----
IRBPHS – University of San Francisco
Counseling Psychology Department
Education Building - 017
2130 Fulton Street
San Francisco, CA 94117-1080
(415) 422-6091 (Message)
(415) 422-5528 (Fax)
irbphs@usfca.edu

APPENDIX L: BRAIN MAP WITH PERTINENT REGIONS HIGHLIGHTED AND WORKS CITED

This is a superior view of the brain, or the view you would have if you were standing up and looking down into the top of the head of someone sitting face forward on a chair in front of you.