Towards a Sensorimotor Approach

to L2 Phonological Acquisition

by

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A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved November 2015 by the
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ARIZONA STATE UNIVERSITY

December 2015
ABSTRACT

Studies in Second Language Acquisition and Neurolinguistics have argued that adult learners when dealing with certain phonological features of L2, such as segmental and suprasegmental ones, face problems of articulatory placement (Esling, 2006; Abercrombie, 1967) and somatosensory stimulation (Guenther, Ghosh, & Tourville, 2006; Waldron, 2010). These studies have argued that adult phonological acquisition is a complex matter that needs to be informed by a specialized sensorimotor theory of speech acquisition. They further suggested that traditional pronunciation pedagogy needs to be enhanced by an approach to learning offering learners fundamental and practical sensorimotor tools to advance the quality of L2 speech acquisition.

This foundational study designs a sensorimotor approach to pronunciation pedagogy and tests its effect on the L2 speech of five adult (late) learners of American English. Throughout an eight week classroom experiment, participants from different first language backgrounds received instruction on Articulatory Settings (Honickman, 1964) and the sensorimotor mechanism of speech acquisition (Waldron 2010; Guenther et al., 2006). In addition, they attended five adapted lessons of the Feldenkrais technique (Feldenkrais, 1972) designed to develop sensorimotor awareness of the vocal apparatus and improve the quality of L2 speech movement. I hypothesize that such sensorimotor learning triggers overall positive changes in the way L2 learners deal with speech articulators for L2 and that over time they develop better pronunciation.

After approximately eight hours of intervention, analysis of results shows participants’ improvement in speech rate, degree of accentedness, and speaking confidence with mixed changes in word intelligibility and vowel space area. Albeit not
statistically significant (p > .05), these results suggest that such a sensorimotor approach to L2 phonological acquisition warrants further consideration and investigation for use in the L2 classroom.
DEDICATION

I would like to dedicate this dissertation to my dear parents, Ana e Jose Lima, who have been constantly present in my thoughts and feelings, in love, despite living so far away; and to my dear friend, companion, support, and soul mate, Chris Martin, who teaches me to trust and believe. In part because of them, this work is being completed.
ACKNOWLEDGMENTS

I am truly appreciative of my Committee members. I have received excellent mentorship from Dr. Julie Liss, Dr. Mark James, Dr. Elly Van Gelderen, and Dr. Kathryn Pruitt. These wonderful people gave me instruction, motivation, guidance, and above all, love and respect, because these are actually characteristics of who they are. For that, I am very thankful. I also would like to specially think the mentorship of Dr. Van Gelderen with her sharp eye and practical approach to things and of Dr. Pruitt for her keen vision—seeing things I could not see and pointing to the light at the end of the tunnel. I thank you all for trusting in me as well as for dedicating your time and consideration to my work.

In addition, I would like to thank all the other persons who directly or indirectly contributed to the completion of this work, among them, Dr. Visar Berisha, Yishan Jiao and Ming Tu from the Department of Speech and Hearing Science, Lillie Essah and Lesley Poteet from the School of International Letters and Cultures, Ashley Barth from Graduate Statistics Support, Adrian Mandal, a Blackboard IT-Analyst, and all those who completed the online rating survey and, most importantly, the participants who volunteered their time to this dissertation’s experiment.
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CHAPTER 1

Introduction to the Work

This dissertation examines a multidisciplinary approach to enhance the process of phonological acquisition. It focuses on specific types of challenges adult (late) learners face when trying to advance their own development of the second language (L2) phonology and tests a unique methodology to help them overcome, or at least mitigate, those challenges. The challenges in question are of cognitive and articulatory natures and correlate with sensorial mechanisms in the brain and motor-articulatory mechanisms underlying the speech of L2. These two mechanisms when brought together can be viewed as a cohesive sensorimotor theoretical framework of speech learning (Waldron, 2010), which when taken pedagogically is hypothesized to help the learner acquire the phonology of L2 in an autonomous and holistic way.

This dissertation hypothesizes that a sensorimotor approach to L2 phonological acquisition (Waldron, 2010; Guenther, 2006), including an exploration of articulatory settings (Honikman, 1964) and the Feldenkrais technique (Feldenkrais, 1972), can lead to improvement of pronunciation quality by allowing the learner to become aware of articulatory constraints, gain some control of the neuromotor mechanism in the vocal apparatus, and develop self-efficacy.

The test developed by this dissertation consisted of a classroom experiment in which five adult (late) learners of Standard American English (SAE) underwent approximately 8 hours of instruction designed to target sensorimotor mechanisms of the brain affecting the production of articulatory settings (AS) of SAE phonology.
Participants (three males and two females aged 20 to 26) met once a week for approximately 50 minutes each time to learn about speech brain mechanisms, articulatory settings, and to experience practical sections of Awareness Through Movement (ATM – Feldenkrais, 1972). Data was collected using three pre and post-tests containing two readings tasks and one survey. Analysis of results showed participants’ improvement in speech rate, degree of accentedness, and speaking confidence on one hand, and varied degrees of intelligibility (Goggle automatic speech recognition) and vowel space area on the other. Albeit not statistically significant (p >.05), the results suggest that the sensorimotor approach to L2 phonological acquisition proposed in this dissertation warrants further investigation to advance the quality of pronunciation pedagogy in the L2 classroom.

In the following (Chapter 2), this dissertation examines traditional pronunciation methodology and discusses how that can benefit from incorporating a sensorimotor approach. It follows (Chapter 3) with an overview of the theory and principles of Articulatory Settings, a review of several neuroscientific studies shedding light on the sensorimotor mechanism of L2 acquisition, and an overview of the Feldenkrais technique. Chapter 4 presents a proposal containing the design and rationale of the methodological use of the sensorimotor approach to assist with phonological acquisition. Chapter 5 details the experiment developed in this dissertation, presents the results of the collected data, and discusses them, before presenting the limitations of the experiment. The dissertation concludes with a reflection for future directions in Chapter 6.
2.1. The Need for Pronunciation Research

As this dissertation focuses on L2 adult phonological acquisition, it is perhaps necessary to ask the question, “Why even discuss the issue of pronunciation pedagogy?” It might appear to some that pronunciation learning is an easy matter—possible of being managed (one way or another) by most language learners. It is true that, depending on the conditions of learning, some learners can easily deal with L2 pronunciation, but these learners are the exception. Phonological acquisition requires much effort and time and is normally very challenging because it involves several psychological and neurophysiological factors. Even when some learners have a high degree of aptitude to pronunciation learning, they are likely to need continuous pronunciation development as well. They may perceive and need to process new phonological features over time. As Katchen (1988) points out, “even at advanced levels, students have difficulty in pronouncing words in fluency at the sentence level and beyond” (p. 3). In fact, L2 pronunciation may be a lifelong learning process, which for a more careful learner can lead to a constant investigatory exercise.

To be clear, there are millions of English learners around the world in need of pronunciation instruction. Morley (1991) stresses that “in the last quarter century, we have witnessed an enormous ‘population explosion’ in student numbers the world over, and especially in adult and near-adult learner groups.” He cites Strevens (1988) reporting that “estimates of the number or people in the world who use English for some purpose
range between 750 million and a billion and a half” (p. 482). For such scholars, this large number of learners needs an increasingly efficient way to communicate and pronunciation competency is part of that.

There is also a need for further research in pronunciation pedagogy even though what is already available in language schools in the U.S. and abroad, seems to address the needs of the learners. In the following, I extend a review of the development of pronunciation pedagogy across time to explain why it is an important issue and still needs to be investigated. Despite having been considerably developed in the last few decades, pronunciation pedagogy still falls short of providing the adult learner with key tools to promote sound acquisition.

2.2. The Problem of Traditional Methodology

The quality of pronunciation pedagogy today is satisfactory and in retrospect, it has made significant strides in helping learners advance L2. Nonetheless, there are aspects of traditional instruction that contribute to some shortfalls, and a new approach is necessary to fill some gaps. Despite the importance of the subject, over the years language professionals have neglected the examination of pronunciation pedagogy in and outside of the U.S. This is not a result of pure ignorance, but stems from complicated issues regarding teaching and socio-cultural practices, causing the subject of pronunciation to be misunderstood and sidetracked.

Several scholars in the field of second language acquisition (SLA) agree that the issue of pronunciation in language teaching is complex and requires greater attention. Elliot (1997) for example mentions, “Studies on the acquisition of target language
pronunciation have lagged behind” (95). More recently, Lord (2005) points out that “the intrigue of this subject lies in the fact that, in spite of agreement on the importance of correct pronunciation, it is not an area that has been extensively investigated in second-language research” (p. 558).

One of the reasons for this scenario lies in the fact that over the decades, researchers, instructors, and institutionalized curricula of English, neglected approaches to pronunciation, teaching in favor of a more grammatical and vocabulary-based curriculum. As a result, language learners complete their coursework with great output of grammatical and vocabulary content but without satisfactory production of the target language (TL) sounds (Oliver, Rochecouste, & Haig, 2005).

It has been only recently that this antagonistic scenario has attracted increased concern from the scholarship and additional focus has been given to the problem in and out of the classroom. As Lord (2005) continues, “Although research on second-language phonological instruction is in its infancy, there is interest in determining whether we can effectively teach pronunciation, and if so, how” (p. 558). This discussion has just begun.

Oral language performance has not always been the general focus of regular education curriculum. Oliver, Rochecouste, & Haig (2005) indicate that in the curriculum of regular schools in Western countries (at least), the learning and practice of any oral language proficiency already lacks efficient attention. Although our current culture primes oral language performance, there is a neglect of attention when it comes to the training of elementary, middle, and higher level students in their curriculum. They note that in spite of the fact that the environment of a regular classroom can be 50 percent or more orally based (with lectures and oral activities, for example), students’ learning
objectives are focused on reading and writing skills (p. 215). While they are required to produce oral presentations, debates, and increasingly perform in front of an audience (usually their own classmates and teachers), they are not taught how to speak with linguistic effectiveness and rhetorical (discourse) efficiency. According to the authors, the result is a “lack of communicative competence” (p. 212).

Oliver et al. (2005) point out that most people understand the importance of oral language competence for the individual’s academic, professional, and even personal paths; nevertheless, there is a lack of will on the part of educational professionals to include oral-proficiency teaching and learning into classroom practices. This can be explained by the fact that “expedience and traditional teaching will override any possibility of a needs-based approach to oral language” (p. 220). This reality creates a gap between what the education system and society expects from students and what students are actually able to do when it comes to speaking performance. As a result, a great number of students are discouraged and even embarrassed to speak publicly or in new conversational situations.

This type of deficient approach to oral language learning extends to language courses such as those in curricula of English as a Second Language (ESL). Text-based teaching and lack of effective oral practices often cause oral proficiency of English language learners to fall below standards as compared to other skills such as reading and writing. Grammar and vocabulary features are the bulk of the pedagogical approach in the classrooms, and although oral activities may be a part of the classroom experience, little or almost no attention is given to the examination of important phonological features underlining the audio component of the target language.
A contradictory attitude toward pronunciation has its origins a few decades ago and at times reflected early scientific findings on behaviorism. Theoretical approaches to phonological acquisition during the first half of the last century related language (and especially sound) acquisition to a behaviorist theory of conditioning (Skinner 1930-50). By receiving “reward” or “punishment” (immediate feedback) in controlled situation, it was inferred that the learner would respond positively to instruction. Although this approach was not entirely faulty (to the extent that it related the idea of repetition to practice) it did not offer a comprehensive solution for pronunciation improvement in the L2 classroom as later research (below) shows that imitation and reward does not usually result in comprehensive pronunciation improvement.

In spite of its limitations, the theory of behaviorism reflected much of the pedagogy of the time; the field believed that it tackled the need for pronunciation correctness. However, contradictions pressed the issue of pronunciation to further discussion. Take Confoyannis (1944) for example. He asserts that “the sections on pronunciation in our high-school and college language texts are usually ignored in actual teaching practice in favor of the more direct and reliable method of mimicry” (p. 589). Confoyannis implies that although there were alternatives to teaching pronunciation, teachers depended more on a behaviorist method based on mimicry because it purported to be more direct and reliable. Most likely, teachers did not understand the need for a more detailed examination of the phonological features of English and resorted to the most immediate, albeit superficial means of pronunciation training: rote imitation.

This approach gave rise to a method of language learning called Audio-Lingual Method (ALM), which became very popular in the 1950s and 1960s. To this day, ALM
serves as a principle underlying the practice of speech mimicry in pronunciation courses, even when that theory is no longer recognized as paramount. This happens because the basic, overall technique for instruction in courses is still basic repetition followed by some kind of reward. Having taught and observed language courses in the U.S., I have seen pronunciation training based on simple repetition, not only inside the classroom, but also in computer labs. Much of the language learning software used in courses (as an enhancement) is based on listening and repeating a passage. Such methods ask the learner to listen to and repeat an isolated word, such as, “father”, or a sentence such as, “the father and mother love their children.” If the learner repeats the expressions acoustically right, s/he gets “a reward” in the form of a score in the computer, or a “Good job!” interjection from the instructor. If the learner misses the mark, s/he receives a negative score or interjection and is asked to try the expression repeatedly and in a rote manner. Until (and if) s/he can pronounce the sounds well enough, the learner moves to the next set of words or sentences.

There are several problems with this type of oral drilling. Repetition devoid of linguistic and physiological understanding tends to become rote and even cause fossilization, which is a non-desired output issuing from unclear Interlanguage (IL) \( \rightarrow \) TL sound correlation (Selinker, 1972), and from ‘assumed perceived similarity’ (Ringbom & Jarvin, 2009). According to Waldron (2010) rote practices of L2 features lead to recruitment of areas of the brain related to L1, rather than L2. Second, as Brown (2007) points out, “a reward-driven, conditioning theory of learning has some shortcomings that ultimately have a high impact on classroom instruction… lead[ing] learners to become dependent on short-term rewards” (p. 67).
Subsequent linguistic studies, most importantly by Chomsky (1957), challenged the behaviorist model, and corroborated with theories of Structuralism. One of the early followers of this linguistic movement is Parish. In his work, “A Practical Philosophy of Pronunciation” (1977), he proposes that teachers be able to understand the linguistic phonological features of the language they are teaching for better oral production from students. He asserts, “The teacher's professional inventory should clearly include a comfortable acquaintance with basic articulatory phonetics and with the phonological system of English” (p. 2). Parish’s proposal, like many others from this period, moves beyond the simple imitation approach of the previous trend, and introduces a more scientific (and less mimicry) attitude towards pronunciation. It has its values, because when put into practice, students are not only taught to repeat the sounds of English, but they also have a visual illustration and intellectual understanding as to how these sounds are featured and function in the target language. Still, in practice, teachers for the most part have not become aware of these phonological and anatomical features, and even when they have, rarely have they transferred this knowledge to learners, for reasons already mentioned above. Nonetheless, even when this kind of approach is put into practice, such practice is still based on rote repetition.

Morley (1991) points out that in the late 1960s and continuing through the 1970s until the beginning of the 1980s, “A lot of questions were raised about pronunciation in the ESL curriculum. There were questions about the importance of pronunciation as an instructional focus, questions about whether or not it could be taught directly at all, questions about the assumption it could be learned at all under direct instruction. The effect”, he follows, “was that more and more programs gave less and less time and
explicit attention to pronunciation; many programs dropped it entirely” (p. 485). This was a period of little improvement towards the development of pronunciation. It was also a time when the Critical Period Hypothesis (Lenneberg, 1967) influenced phonological theory hampering even further pronunciation pedagogy. As explained below, this theory hypothesized that native phonological acquisition after puberty was virtually impossible due to the development of the corpus callosum in the individual’s cortex assumed to prevent communication between both hemispheres of the brain.

Later pedagogical approaches to pronunciation made learning an increasingly contextualized and meaningful matter. Under this current, the sole examination and repetition of phonetic and phonological units of English were no longer sufficient to bring upon the development of the learners’ speaking potential. It was necessary to situate the material within the learners’ contexts and needs. In 1972, Bowen suggested “an effort to contextualize the pronunciation lesson” (p. 85) and to make lessons more interesting, he proposed the use of “credible visual images” (p. 88) and the practice of language materials that are “relevant to the experience and/or interest of the students” (p. 92). Stevick (1978) sees the learning of pronunciation as “a total process, social in nature, which involves the whole learner and not just the speech apparatus or cognitive faculties” (p. 148). Such comprehensive views of learning have somewhat contributed to make the experience more learner-centered.

Recent contextualizing approaches to pronunciation include both meta-linguistic and extra-linguistic components. Katchen (1988), for example, proposes the teaching of pronunciation using literature, famous speeches, music, tongue twisters and culture. She argues that “sentences in isolation lose their uniqueness after the point has been taught”
(p. 10). She advocates for a diversity of material that is at once authentic and meaningful to the learner.

Finally, Elliot (1997) suggests that “recent research examining phonological instruction indicates that improvement in pronunciation for adult foreign language learners is possible by employing a multimodal methodology for individual learning styles variation” (p. 95). He also suggests that practitioners take an in-depth analysis of the language sounds to indicate which phonological features challenge most a determined group of learners and proposes “incorporating pronunciation exercises designed to focus specifically on these TL sounds […] to enhance the quality of native and non-native speaker communication” (p. 103). This is an important point as it calls for an individual approach to phonological learning and at the same time, broadens the purpose of a pronunciation development as it shows what most learners want is to have an unimpeded communication with the interlocutor.

Nevertheless, attempts to enhance and make pronunciation pedagogy more effective, failed to provide the learner with additional knowledge and skill to understand further processing of L2 phonological acquisition. Despite the advances in pronunciation research, scholars still think that the field needs to be informed by further investigation (Ketabi, 2015; Ricketts, 2014). I argue that such thinking reflects the facts that pronunciation is a complex matter involving more than just a conglomerate of linguistic and psychological aspects; these have been extensively investigated by the field, and yet, there are still gaps to be filled. Celce-Murcia, Brinton, Goodwin, & Griner (2010) have proposed a communicative framework in which pronunciation tasks progresses from more controlled practice to freer production practice. Their purpose lies on developing
fluency. In controlled practice, the focus is on form whereas with freer practice the emphasis is on fluent production. I question, however, how can one develop fluency by just experiencing freer practice? Unless freer practice is supported by a deeper underlying theory of speech acquisition, that practice might turn out just like some other ineffective practices, because their underlying processing is based on mentation not sensorial development.

Perhaps, fluency is indeed the most important outcome one could aspire from learning pronunciation. The problem is that mainstream researchers and practitioners may not fully understanding how fluency can be developed. This creates a sense of frustration in the field. According to Ketabi (2015), pronunciation still “seems not to be receiving due attention from teachers and practitioners in many language programs compared to other language skills and subskills” (p. 186). There is a consensus that teachers and researchers do not communicate effectively, that teachers are not well trained and do not have access to the best materials (Wahid & Sulong, 2013), and that, consequently, they resort to the least effective form of pronunciation pedagogy, i.e., segmental instruction (Ketabi, 2015). I argue, however, that underlying this scenario is the fact that teachers feel somewhat impotent about the issue. They may disbelieve the research body informing them about linguistic and psychological issues, because they may not identify among the research, effective pedagogical tools to treat practical matters of pronunciation, such as fluency, for example. Moreover, consciously or not, they may realize that mainstream methodology currently printed in textbooks may not be effective enough to treat what is more important – to speak naturally and without impediment. If
that is the case, the research body has to catch up to the actual challenges teachers face in the pronunciation classroom.

A cynical attitude to pronunciation may be corroborated by a general assumption that fluency is something that cannot be achieved or even taught. This kind of assumption has unfortunately become widespread in the past few decades because of the Critical Period Hypothesis (CPH - Lenneberg, 1967). This theory relied on a mistaken assumption that full development of the corpus callosum occurred during puberty and blocked neuronal commissural pathways between right and left hemispheres that (supposedly) allowed for language development and that made language faculty increasingly lateralized (Birdsong, 1999, as cited by Selinker & Gass, 2008). Based on this limited view, it predicted poor L2 phonological acquisition by adult learners. Its impact on the field may have been negative enough to discourage practitioners and further interest in the field of neurolinguistics, for it seemed to have sealed the fate of the adult learner to poor performance, even after subsequent studies challenged it (e.g., Krashen, 1973, and the Sensitive Period by Long, 1990).

Neuroscience has since increasingly developed and revealed that the brain has the potential to deal with language in several other ways. It is indeed in the field of neuroscience that we can find most promising approaches to language pedagogy. Calabrese (2012), for example, offers a strong argument for increased involvement of neurolinguistic research pointing to a more comprehensive, and yet deeper, view of language acquisition:

Platonist approaches to language, which treat language only as pure mathematical computation and disregard the fact that language has a concrete bodily base, are quite common in linguistics. They lead to
abstract ideas that have only a remote relation with the actual reality of language as produced in real time through a complex interaction between body and brain...The linguist must therefore find ways to bridge the gap between mind and brain and to connect the abstract models of linguistic theory concerning the mental computation occurring in language to the study of the organization and functioning of the neural circuits performing such computations (pp. 356-57).

The learning of pronunciation is an articulatory activity, which depends on learners’ control of muscles and parts of the vocal apparatus. Simple repetition of an instructor’s (or recording’s) input does not necessarily result in learners’ optimal production of the target language. As said above, rote repetition and automatism of L2 production actually leads to learners’ tendency to turn to first language (L1) systems (Waldron, 2010), and negative transfer (Major, 2008) (This correlates to Abercrombie’s (1967) study into “problems of accommodation”, which explains why it is difficult for the learner to accommodate to L2 sounds due to habitual articulatory settings of L1, which will be discussed further in chapter 3).

Explicit phonetic and phonologic instruction (an additional approach to pronunciation practices) does not give the learner enough insight into the challenges of production either. It goes so far as to present the learner with a symbolic image of the sounds and a rationalization of structures. Furthermore, recent contextualized sociocultural approaches to phonological acquisition cannot provide the learner with an effective way to attain awareness and control of articulatory mechanisms.

The field of SLA phonology in general failed to explore the essence of the problem of pronunciation by not presenting the kind of methodology that this study proposes (below). Esling and Wong (1983) called for a ‘sensitization’ (p. 93) of the accent of a language, and proposed pedagogical strategies based on perception; yet, they
stopped short of discussing concrete ways one can become sensitive to new patterns of L2 input and production. Pedagogical approaches to pronunciation have attempted to add kinesthetic sensorial activities to classroom practices, but those have remained a mere accessory (e.g., Gilbert, 2005). And recent research on L2 phonological acquisition have distanced further away from a neuromuscular approach by mainly working on adding visual representation to sounds, and social, communicative, and contextual aspects of the L2 phonology (see Brown, 2007, Izumi & Izumi 2004; Katchen, 1988).

2.3. Overview of the Proposal

The recent scholarship foci to make pronunciation pedagogy more effective have led to important development in the field, but left out aspects of sensorimotor and articulatory natures that I argue are important to make pronunciation learning more effective. A sensorimotor approach to pronunciation, based on the examination of articulatory settings and the neuromotor mechanisms of production, needs to be followed. Concomitantly, there needs to be a shift of focus as to how we approach repetition, for as above discussed, rote repetition is of little use, if not detrimental to the learning of L2 sounds. Repetition only becomes meaningful when sensorial stimulation and development are encouraged and rightly processed in the brain (See Guenther, 2006). There is need to replace automatism with autonomous exploration.

Additionally, there also needs to be an expansion of focus as to which features of L2 phonology need to be targeted in the classroom. In traditional pronunciation pedagogy, instructors usually focus on segmental and supra-segmental features of L2. However, there is need to include features of articulatory settings of speech, as a way to
represent the underlying mechanism supporting the global phonology of L2. A more detailed explanation of the proposed approach can be found in Chapter 4 – Proposal. In the following, I examine the theory of articulatory settings, the research on neuroscience informing the importance of a sensorimotor approach, and the Feldenkrais technique.
CHAPTER 3

Conceptual Framework

3.1. Articulatory Settings (AS)

Throughout history, articulatory settings (AS) have also been referred to as “Organic Basis of Speech” (Sweet, 1890), “Basis of Articulation” (Arnold & Hansen, 1975), and “Voice Quality” (Esling, 1982; 2006; Laver, 1980). Despite the difference in nomenclature, there is a consensus among scholars that articulatory settings can be defined by a “long-term” or “quasi-permanent” characteristic of an individual or community speech gesture. One of the first linguists to deal with the topic of articulatory settings was Henry Sweet (1890); he described articulatory settings as the ‘long-term quality’ of the sounds of a language. He also associated it with the ‘voice quality settings’ of speech production (in Esling, 2006). Following Sweet, Beatrice Honikman (1964) coined the term Articulatory Settings focusing her study on articulatory phonetics. She observed that specific parts of the oral tract, such as the lips, tongue, and jaws, behave in specific ways depending on the language in question. She describes a particular setting of French as lip rounded (easily noticed by most French learners), blade-like tongue towards the front, with slightly open jaw setting.

David Abercrombie (1967) related articulatory settings to individuals’ speech gesture that can be characterized by some overall qualities that are “present almost all the time a person is talking […] running through all the sounds that issue from his mouth” (1967, p. 91). This definition contains a more holistic view of articulatory settings, and introduces the notion of the suprasegmental aspect of articulatory features, seemingly
because of carryover articulation. Following Abercrombie, Laver (1980) introduced a model to classify articulatory features based on the articulatory categories inside the oral tract, which, as Harmegnies, Delplancq, Esling, & Bruyninckx (1994) observe, made it “possible to refer to a given way of speaking in terms of the particular ‘palatal’, ‘faucal’, ‘bilabial’, etc. setting, which characterizes the speaker’s production” (p. 140). Esling (1982; 2006), Esling and Wong (1983), Jones & Evans (1995), and Pennington (1997), have associated articulatory settings with prosody, reinforcing the notion that articulatory settings have a broader implication in the speech gesture. Pennington (in Jones & Evans 1995) for example defines articulatory settings as “the ‘overall pattern’ of suprasegmental feature, that ‘results in the general auditory impression’ of the speaker’s voice” (p. 245).

John Esling’s (2006) Voice Quality, proposes a foremost definition and analysis of articulatory settings. He describes articulatory settings as “the subtle indices, or indicators, of physical or psychological [long-term] characteristics” of speech (p. 471). He also argues that from a phonetic point of view, articulatory settings can be seen “having a general, relatively nonfluctuating quasipermanent character, distinguishing it temporally from rapidly fluctuating segmental articulations and from slowly fluctuating dynamic or prosodic patterns” (p. 470). Additionally, he proposes labeling the “articulatory origins of the sounds in question” (p. 470) and includes a descriptive system of laryngeal and supra laryngeal features of articulatory settings and its correlation with the articulators. They reflect amongst other things, “the position of the mandible, the posture of the tongue, and the incidence of nasal resonance” (p. 470). The system is divided in three level: the laryngeal containing phonation types; the supra-laryngeal
containing more physically characterized features of vocal tract into six regions: lips, tongue, jaw, velic opening, laryngeal constrictor, and glottis and the laryngeal constrictor settings (Figure 1).

Another representative list of articulatory settings is from Ball, Esling, & Dickson’s (1995) study. This system adopts Laver’s (1980) use of brackets and numerals to measure the presence, time, and intensity of articulatory settings features during connected speech (Figure 2).
According to this system, there are 26 supra-laryngeal articulatory features, 14 laryngeal ones, and 2 airstream types, totaling 42 settings. While considerably exhaustive, this nomenclature should not be taken as conclusive. As Esling (2006) points out, these features are “defined according to auditory convention and [are] based on the phonetician’s experience of articulatory imitation and auditory comparison” (p. 470).
Such approach to nomenclature may therefore present problems. It is thus possible to assume that the nomenclature in articulatory settings at times is an estimation of what really happens during individual’s production of speech related to phonological and articulatory phenomena. For example, it is possible to consider the following settings as specific to SAE, but these settings are just an approximation.

1. Lips: neutral lip position and slight or vigorous lip rounding and spreading.
2. Tongue:
   a. active tongue tip moving towards the alveolar ridge (alveolar anchorage)
   b. tongue tethered laterally to the roof of the mouth
   c. tongue tapered (grown gradually lean towards the front of the mouth); upper surface of the tongue just behind the tip, lying concave to the roof of the mouth.
3. Teeth: not tensely held for comfortable lowering, retraction and advancing of the tongue.
4. Jaws: held loosely together, but not clenched. Occasional lowering of the jaw
5. Pharynx: generally relaxed
6. Velum: resonance of vowel sound towards the back of the vocal tract (velarization)
7. Larynx: neutral or slightly lowered larynx

Because this kind of description is inexact, it may come across as detrimental to the theory. Nevertheless, characterizing and describing an idiom based on articulatory settings (language specific articulatory settings) may be beneficial during an initial stage of acquisition to introduce to the learner the idea that articulators behave in specific ways
in L2. However, after that stage, exploration and identification of articulatory settings features for the purpose of acquisition must be an individual process. As I explain below, the anatomic and physiological conditions (e.g., length of the vocal tract, size of the tongue) and the articulatory habits of individuals (idiosyncrasies) must define the shape and manner of the settings in the learning process of L2.

Therefore, an objective look at the way articulators behave in L2 in relation to the learners’ performance must be the focus of investigation. It is therefore wise to use caution when dealing with the nomenclature issue and turn the focus to the acoustic-kinesthetic principle of the theory as it provides important insight into the phonology of languages and how they can be acquired.

3.1.1. The Pedagogic Potential of Articulatory Settings (AS)

One of the very first language features a learner notices about L2 is the particular sounding or articulatory settings emanating from the speakers of L2, whether it is Welsh, Japanese, Swahili or any other language or dialect, those speech sounds are what make L2 peculiar and even intriguing to the learner. Sometimes the learners’ observation lies only on one feature of the L2 articulatory settings, such as lip-rounding in French for example, but most times, it comprises an array of features that occur in concomitance (e.g., lip-rounding protrusion and nasalization) making thus difficult for the learner to understand the acoustic and articulatory features of L2. From the learners’ point of view, this is intriguing and questions such as, “Why do they sound like that?” and, “How can I speak like them?” become relevant.
Hypothetically, in learning Arabic for example, a student may ask why Arab
speakers, and especially male native speakers, convey a significant deal of harshness,
obstruction, and a certain degree of ingression as they speak, making their language
sound somewhat “cut and dry”. Despite the roughness of such impressionistic assessment
of Arabic, this illustration serves to show that the learner is attempting to understand and
apprehend, to the best of his or her ability, the sounds and sound patterns of Arabic. This
is a matter of L2 phonological acquisition and articulatory settings assessment.

The question then is whether the learner will actually understand why and how
the native speakers sound like they sound, and be able to reproduce the articulatory
movements that produce those sounds. In some cases, the learner will figure that out on
his or her own, but in most cases, an instructor’s intervention is necessary to bring the
matter to the learners’ attention and to speed up production.

The pronunciation instructor can examine the articulatory settings of Arabic, and
verify that a few features of that language can explain its characteristic sound. Some
Arabic segmental and prosodic features, for example, articulate in the pharynx and
larynx, including the characteristic pharyngealized stops and pharyngeal fricatives. In
articulatory settings terminology, these feature correlate to a laryngo-pharyngealized
setting that permeates Arabic. Drawing attention to these features and how they function
in the vocal apparatus helps the learner understand the phonology of Arabic.

Unfortunately, such an approach is not what most instructors adopt in the pronunciation
classroom and students end up forgoing their initial inquiries, or left on their own to
discover the complex mechanisms of articulatory settings organizing the speech quality
of L2. Traditional pronunciation instruction draws attention to compartmentalized
repetition of segments and suprasegmental components while forgoing the bigger picture allowed by an examination of articulatory settings.

Esling (2006) argues that since articulatory settings are indexical (as opposed to ‘linguistic’ with reference to phonemic distinctiveness), “auditory analysis of articulatory settings has been used in dialect and sociolinguistic research to identify and describe the indexical features found in pronunciation.” Furthermore, he adds, “it also has been used as a focal point to illustrate differences between languages and as a guide to the learning and teaching of pronunciation” (p. 472). Referring to articulatory settings as voice quality settings, Esling (1982) suggests being aware of them “can be a valuable asset to all language teachers […] and their students” (p. 1). Additionally, Jones & Evans (1995), Esling and Wong (1983), Esling (1982), and Honikman (1964), agree that it is important that the ESL instructor and the L2 learner become aware of a number of articulatory settings of languages other than their own.

It is even plausible to think that pronunciation instruction could begin with the teaching of articulatory settings prior to segmental and suprasegmental features. Jones & Evans (1995) is one of the handful of studies on phonological acquisition arguing that pronunciation teaching should begin with articulatory settings practices before the traditional segmental and suprasegmental approach is brought into play. They claim that as pronunciation pedagogy focuses on communicative function (a trend encouraged by contemporary research on second language methodology), an “atomistic, deductive, and rule-based” approach to learning is of no use to sensitize learners to the more global aspects of communication in connected speech. They suggest thus “presenting pronunciation in a truly communicative and holistic manner” (p. 244), and “a top-down
Esling and Wong (1983) reinforce the importance of the learner “to recognize the linguistic significance of the more general, higher-level setting features in the target language.” They add that an approach to repetition based on mimicry and segmental analysis may not be the best way to introduce L2 “since it focuses on the specific rather than first directing attention to the general characteristics of accent” (p. 90). In addition, they contend, “It follows that if the learner can be taught the relatively small number of higher-level features that constitute settings, then the pronunciation of a relatively large number of the lower-level segmental features captured within the generalized setting should improve as a result” (p. 93). An acquisition of SAE spread lips, for example, can help a near-native output of several segments, such as a nasal and yet fronted [ʌ] and an alveolar [t] in the word *continue*.

Kerr (2000) conducted a case study with a Vietnamese speaker, learner of English, focusing on articulatory settings related to tongue, jaw and lips placement. She asked the learner "to relax his tongue, to open his jaw to a greater degree, and to use lip rounding and lip spreading more effectively" (Derwing, 2007, p. 353). After 12 instructional sessions, judges were able to notice improvement in the subject's production of "longer sessions of utterances". This indicates that once the learner acquires a few articulatory settings features, the long-term quality of the learner's voice is improved. González (2003) has also tested an articulatory settings training program with seven Spanish speakers adult learners of English. After approximately 18 hours of training
within a month, learners were perceived as “having a more native-like accent, a better pronunciation, and a less strong Spanish accent” (p. 1605).

These studies illustrate the range of applications pertinent to use of articulatory settings features to the acquisition of L2 phonology. Most of the research on this subject advocate for an instruction of some of the features depending on the language in question. Moreover, they suggest that the feature be taught independently, that is, separated from segments or supra-segments, such when the learner apprehends the position of the tongue or lips before s/he relates it to a segment or syllable. In this work, I experiment teaching segments with the articulatory settings features with which they correlate. A detailed explanation of this approach is developed in chapter 5 – Experiment.

3.1.2. The Challenges of Learning AS Features

Working with Articulatory Settings as a theoretical framework may seem controversial because the field of linguistic does not consider articulatory settings a linguistic matter in the strict sense of the term. This is so because of at least two reasons: one is that articulatory settings acoustic features do not seem to fit within any type of phonological analysis as other features such as segmental, suprasegmental, and distinctive features do. Articulatory settings features are not distinctive and therefore, pure linguists consider them extra-linguistic (See Esling, 2006). Second, although some features of articulatory settings can be easily perceived (e.g., palatalization; dentalization; nasalization), they cannot be measured in absolute terms, for there is no numeric threshold to indicate when palatalization, for example, becomes a feature or ceases to be. Concomitantly, articulatory settings features are not distinctive to the point
of indicating meaning. To make matters worse, contemporary analysis of articulatory settings (See Esling, 2006 below) includes three types of settings – *phonation*, *laryngeal restriction*, and *oral* – making it complicated to establish a unitary approach. As a result, the nomenclature of articulatory settings describe some features, which have different properties. For example, in the phonation setting of *creaky voice* and the oral setting of *open jaw*, whereas the former is described acoustically, the latter is described kinesthetically.

To be fair, articulatory settings researchers have developed a significant scholarship around the topic and have contributed meaningfully to the research in SLA. Yet, in order to avoid vagueness of reasoning and confusion, I must use articulatory settings theory with caution. For the purpose of this work, I limit articulatory settings to some of its oral features and take the bait of its kinesthetic concept by hypothesizing that an open-minded approach based on its articulatory principles, will arguably lead to important insights as to how one can further develop the acquisition of L2 phonology.

What the theory of articulatory settings has to inform the field of SLA is that it helps us understand that any language phonology is expressed in a cohesive system of sound qualities, which in turn develops into a motor correlate in the vocal apparatus. This system is different for each language, as it behaves uniquely as a reflection of the way its segments behave (under manners and processes) and the vocal apparatus moves respectively. Pedagogically speaking, this acoustic and kinesthetic information can assist the adult learner to understand better the phonology of L2. As language-specific articulatory settings can be easy to identify, it can be used as auditory and motor conduits towards the understanding of L2 and the production of it.
Because articulatory settings features are global and yet subtle, learning them requires a specialized approach that deals with subtle acoustic and kinesthetic properties. Such an approach must contain a sensorimotor component in form of explicit explanation and targeted subtle exercise. In the material on articulatory settings I have explored, little has been discussed regarding this matter. As pointed earlier, Esling and Wong (1983) calls for “a sensitization” (p. 94) to the accent of the target language, and propose some activities based on perception, but they stop short of discussing concrete ways one can become sensitive to new patterns of sound production. More recent studies, such as González (2003), use an array of teaching tools and techniques to stimulate senses, including videos, and manipulation of objects. González even includes breathing techniques and relaxation. These point to a more sensorial approach to learning; however, his study does not develop an essentially based sensorimotor method whose focus is to deal with the neuro-motor subtleties of L2 speech acquisition.

With focus on learners’ articulatory challenges of phonological acquisition, I turn my attention to matters of anatomy and physiology of speech learning and motor production. Linguistic studies on this subject have limited the analysis of sound production to muscular and skeletal positioning of the vocal apparatus (e.g., the position of the jaw, the spreading of the lips, the location of the tongue, the direction of the flow of air, etc.) This work, however, goes further than that, for it examines the roots of the muscular effort itself, i.e., the neurologic conduit leading to motor acquisition and output. This work thus proposes a neuroscientific approach to speech acquisition, including brain mechanisms responsible for the acquisition of differentiated features such as those of articulatory settings.
In the following section, I consider a careful examination of several neuroscience studies shedding light on the neuro-auditory-motor pathways and brain configurations leading to learning and producing L2 sounds. I suggest that neuro-anatomic-physiological knowledge can significantly help the field of SLA. In addition, as I inspect related neurolinguistic and neuroscientific findings, I point to approaches that stimulate determined areas of the brain, namely the sensorial ones.

3.2. The Importance of a Neuroscientific Approach

From a neurological standpoint, adult L2 phonological acquisition involves competing neuro-auditory-motor mechanisms of speech reflecting a physiological configuration that has developed over a significant period of time during the acquisition of L1. When L2 learning begins, change or re-accommodation of this neuro-auditory-muscular physiology entails a re-configuration or formation of a neuromotor system re-educating old or establishing new sensory and motor tracts (Doidge, 2007), leading to and from the vocal apparatus. This is a complex situation, which cannot be done rapidly or superficially, rather, from a pedagogical point of view, it requires a lengthy and dedicated process of learning that often demands a specialized learning setting, and a specific type of effort. It entails the working of the brain activating several areas, centers of organizations and associations related to input, processing, and production. As Dronkers & Ogar (2004) point out, the ability to produce accurate speech sounds in rapid succession is “an extremely involved process [in which] numerous brain areas are recruited” (p. 1461).

In the last thirty years, neuroscientific research in the field of speech and language
acquisition has increased significantly (albeit not as much as needed) and its findings appear to shed light on a number of aspects of late phonological acquisition, pointing to new and exciting discoveries. According to Simmonds, Wise, & Leech (2011), a neuroscientific approach to speech production and acquisition can reveal anatomical and physiological insights as to how the brain works in relation to speech. Dronkers et al. (2004) add that advanced imaging technology allows for an ‘in vivo’ investigation of speech production in the brain, informing us of the way the brain works. Danesi (1994) emphasizes that further understanding of how the brain can adapt to new linguistic situations gives us “an empirical basis to constrain cognitive and linguistic theories of second language acquisition” (p. 10). Clinical research has discovered an elaborated neurological system for language acquisition and production. Advanced imaging techniques and increased interest in the topic now demonstrate that those areas once thought to be localized and monolithic for language, are now seen as refracted and performing several different functions (Small & Burton, 2002; Poeppel & Hickok, 2004). Also, new areas, such as the insula, have been observed to have key participation in the production of language, whereas Broca’s area may not play any major role at all (Dronkers et al., 2004). Furthermore, subcortical areas, such as the striatum (in the basal ganglia) and the cerebellum, have been found to impact speech production through an indirect pathway controlling rate and coordination of speech (Guenther, 2006).

Additional examination of how these areas connect in the brain has revealed more complex pathways and patterns of association, such as the dorsal and ventral tracts (Hickok & Poeppel, 2000) and a Sylvian parieto-temporal area (Spa) participating in speech processing (Poeppel et al., 2004). Finally, research is now pointing to the likely
more important participation of the right hemisphere in speech acquisition and
production (Small et al., 2002; Poeppel et al., 2004). All this points to a dynamic scenario
of speech acquisition which opens doors to a sensorial approach.

3.2.1. The Sensorimotor Approach

Neuroscientific studies have brought to light discussion of a sensorial approach to
the articulatory component of phonological acquisition, which is particularly important to
the teaching and learning of pronunciation. As Simmonds et al. (2011) point out,
“Pronunciation is the only 'physical' part of language with complex neuromuscular
demands […] and correct pronunciation is strongly dependent on sensory feedback of
how and where the articulators are moving” (p. 4). The neuroscientific research
informing this dissertation argues that the acquisition of L2 phonology (and specifically
of articulatory features of L2) is a process that requires the involvement of sensorial areas
of the brain. This is significant because it is commonly assumed that the acquisition of
motor abilities, such as that of the vocal apparatus, is primarily governed by motor areas
of the brain, i.e., the motor cortex, and that adjacent areas, such as the sensorial cortex,
play an insignificant role. This kind of rationale may have its basis on older the
behaviorist theory of conditioning mentioned above (Skinner 1930-50), which permeates
the mainstream educational thinking to this day. It is for this reason that pronunciation
pedagogy still makes use of rote repetition of segmental and prosodic features,
mistakenly believing that it will lead to learners’ acquisition. It may, but not as well as it
should, because as studies (examined below) have shown, targeting primarily the motor
cortex without concomitantly stimulating the support functions of the sensorial cortex,
may over-tax the learner’s brain. Additionally, as Waldron (2010) has shown, this leads the learner to resort to areas of the brain that will compensate, rather than act as, the required learning function.

One of the first neuroscientific studies to inform the sensorimotor approach to phonological acquisition comes from Arndt and Stewart (1981). These neurolinguists had an early insight into the process of late L2 phonological acquisition as they examined the participation of multiple areas of the brain (instead of those of the cortex alone) to the acquisition of L2. They postulated that important phonological acquisition functions were to be found in the thalamus, the limbic system, and the brainstem. These parts are located one on top of the other in the middle of the brain mass, leading down towards the medulla, and up towards the corpus callosum and the cerebral cortex.

Arndt and Stewart based their arguments on contemporary neuroscientific experiments, which indicated that language processing occurred not only horizontally and trans-cortically (on top of the brain), but also vertically, between cortical and subcortical areas, i.e., in deeper areas mentioned above. As such, they cited earlier neurolinguistic studies by Myers (1967), which suggested that language functions happen because of collaboration between the cognitive thought-process-oriented cortex and the innate sensorial emotional mid-brain. They also cited experiments by neurosurgeons, such as Penfield & Roberts (1959) which demonstrated that sacrifice of cortical areas related to speech (Broca’s area) did not result in loss of normal speech in the adult individual as previously thought. This suggested that other parts of the brain were also responsible for speech, namely some subcortical areas mentioned above. Further, they cited studies using
surgical and stimulatory techniques of the brain, which attested brainstem involvement in language functions.

With this in mind, Arndt and Stewart then proposed, “a three-dimensional model of neurolinguistic processes comprising both transcortical associations and reciprocal cortico-subcortical projections” (Sic.; p. 329). They then discussed the sensory, emotive, and affective involvement of the brainstem and the limbic system on the learning process of phonological acquisition. Besides emotional and sensorial functions, those areas are also responsible for long-term memory, and reward-driven behavior. Additionally, the brainstem plays a part in motor action. All put together, it is possible to see that the three-dimensional modal for language acquisition and processing leads to a holistic approach to brain language functions.

By looking at studies about the general maturation of the central nervous system, and how infants acquire L1 phonology, Arndt & Stewart (1981) devised an approach to language phonology acquisition, which can be applicable to adults, except that it must function in reverse order from that of the infant. Neonates and infants acquire phonology when still in early stages of brain development. For that, they must use their limbic system and brainstem areas, which are most available to them (for cortical areas responsible for intellect and thought-processes are not yet developed). Gradually, as the brain develops, it sends phonological information from lower parts through the thalamus, up into the cortex. This process takes a few years, and reflects the development of the brain from within. Around puberty the phonological (and other linguistic) configurations are fully formed and set. The infant brain first connects phonological matter to affective, motivational, sensorial and reward-driven functions of the limbic system, and gradually,
as the brain develops, it accesses the conative functions of the thalamus, which send
the information to the cortex, where language can then be rationalized. It is a bottom-up
process of language phonological acquisition, which includes sensorial, emotional, and
motor information. As Arndt and Stewart point out, one of the advantages of this
developmental process of acquisition is that it begins where it can be fully anchored: in
the limbic system.

According to Arndt and Stewart, the adult learner must use the same pathway to
learning, except that in reverse order: the learner must activate the cortical mental
functions, stimulate relay functions of the thalamus, and reach deep down into functions
of the limbic system and brainstem, where all those sensorial, emotional, and further
motor mechanisms are located. It is only then that the adult learner can “anchor” the L2
phonology in their brain: “It is a post-hoc process inverse to that the infant went through
when acquiring L1” (p. 331).

The significance of these authors lies in the fact that with limited scientific
knowledge and little technology (brain imagery became fully accessible only in the 90s),
they were able to devise an approach to late L2 phonological acquisition that is
captivating and convincing. The fact that there must be feeling in the process of language
acquisition (or in any other human endeavor, as a matter of fact) to foster cognition and
motor control, and that we must look inwards for essential matters, is a sure welcome
thing, but to our knowledge, no one had described this process in neuroscientific ways so
well until then.

According to the authors, the adult learner needs to take such neurologic pathway
in order to successfully acquire the phonology of L2, because if not, phonological
acquisition stays at the level of mentation alone where it is processed superficially (thus the rote repetition of sounds mentioned above) and can be easily forgotten, even if it is dealt with many times. In addition, the physicality – the articulatory factor of phonological acquisition – cannot be fully treated unless we tap into deeper sensorial and motor areas.

Arndt and Stewart suggest that learners need to be assisted to turn their attention to deeper areas of the brain. They also must find motives (meaningful reasons) to do so. They suggest that social-cultural interaction and interpersonal needs can lead to learners’ interest in pursuing such path. Through this approach, culture, society, and communicative needs, play an important role, as the learners became increasingly aware of (and willing to explore) the importance pronunciation plays in language interactions among native and non-native speakers of L2 in varied situations. As for the motor aspect of pronunciation learning, stimulating sensorial and deeper brains areas also becomes necessary.

Arndt and Stewart conclude their discussion by stating, “We hazard the rather less fatalistic hypothesis that the difficulty of acquiring an accent-free L2 pronunciation increases continuously with age, but that this difficulty can at any age be offset by a favorable constellation of emotional, motivational and intellectual factors constituting a quasi-L1-learning situation” (p. 334). Their study did not specifically focus on sensorimotor mechanisms of the brain, but pointed to an early exploration of the sensorial areas and functions.

3.2.2. The DIVA Model
The evolving research has also developed several fronts of investigation. One of them is the devising of models of speech acquisition and production, such as Levelt (1989-1999), the PALPA model (Kay, Lesser & Coltheart, 1992, in Ahlsén 2006), and the DIVA model (Guenther, Ghosh, & Tourvilee, 2006). Of these, the Directions Into Velocity of Articulators (DIVA) model is of most importance, for it deals with speech acquisition and production from a sensorimotor perspective that is correlated with the neuromuscular and articulatory mechanisms of speech and with phonological analysis. As Guenther et al. (2006) posit, “whereas the Levelt, Roelofs, & Meyer (1999) model focuses on linguistic and phonological computations down to the syllable level, the DIVA model focuses on the sensorimotor transformations underlying the control of articulator movements. Thus, the DIVA model focuses on speech control at the syllable and lower motor levels” (p. 2).

Although the DIVA model primarily relates to mechanisms of L1 speech acquisition, there have been studies linking it to L2 speech as well (e.g., Terband, Maassen, Guenther, & Brumberg, 2009; Simmonds et al., 2011). This must be so, because in essence and in principle, putting aside matters of language competition (discussed below), what the DIVA model shows us in relation to brain mechanisms to speech seems to be applicable, at least primarily, to processes of activation of speech to L2 or even L3 (language/s acquired after L2).

The DIVA model (Guenther et al., 2006) is designed in reference to localized areas in the brain responsible for the hearing, processing and production of speech. It postulates that there are three main neuronal clusters activating the auditory, somatosensory, and motor map cells located respectively in the Heschl’s area in the
superior temporal cortex (STC), the post-central gyrus (PCG) in the inferior parietal cortex (IPC), and the inferior frontal gyrus (IFG) of the motor cortex. In the motor map cell, there is a speech sound map cell hypothesized to lie in the inferior and posterior portion of Broca’s area, sometimes called the frontal operculum (Guenther et al., 2006). In addition to all these areas, the cerebellum has been responsible for the fluent aspect of speech (Guenther et al., 2006).

Computationally reproduced interactions of these cortical areas allow for an analysis of the neurological data of feed-forward (motor) and feedback (auditory and somatosensory) controls to inform phonetic and phonological developments. The model “helps explain the articulatory learning process from a neural network framework and why some [learners] are unable to change their productions with traditional methods” Bullock (2011). This finding can inform adult late learners’ process of phonological acquisition, which is also characterized by difficulty in speech change/adaptation, requiring special attention.

The DIVA model assumes that a speech sound map in the left ventral premotor cortex, and a motor planning system in the IPC, are activated before production of any actual sound begins (Bullock, 2011). The speech sound map cells in the left frontal operculum project axonal branches to the higher level auditory cortical areas. This in turn embodies the auditory target region for the production of the speech sound (Tourville & Guenther, 2011). Additionally, the auditory and somatosensory targets equate to phonetic and motor planning (Terband et al., 2009). In reference to second language acquisition processes, this stage correlates to a ‘silent period’, which has been shown to be a natural
component of phonological learning (Simmond et al., 2011; Snow, 2002). In this stage, “the model” listens to input while planning and programming for the output.

As production comes into play, the acoustic signal (including self-hearing) is essential for acquisition of target sounds, and so are somatosensory and proprioceptive information. The FF control is updated with each attempt. Auditory feedback should arise when the speaker hears himself/herself producing the current sound. The system compares the incoming auditory information (the acoustic signal) with the auditory periphery. If the current auditory feedback is outside the target region, auditory error cells in the posterior superior temporal gyrus and planum temporale (traditionally, the Wernicke’s area) become active. Error cell activities are then transformed into corrective motor commands through projections from the auditory error cells to motor cortex and cerebellum (Guenther et al., 2011). In other words, during speech acquisition, the somatosensory target region for the sound is used for feedback (error) analysis, while encoding tactile and proprioceptive information that accompanies correct production of sounds. It then sends fine-tuned phonological information to the FF command subsystem (Terband, Maassen, Guenther, & Brumberg, 2009).

DIVA incrementally records feed-forward babbling output to inform the FB control subsystem and its future contributions. The motor commands for different speech sounds are stored in FF projections that specify articulatory trajectories. A final output is given out but also received for further fine-tuning. This cooperative construct is a cohesive cumulative phonological machine, in which “the learned sensory-motor transformations will be used for all speech sounds that will be learned later” (Guenther, 2006, p. 3). The system gives hint as to how humans acquire entire phonologies.
“Eventually, the feed-forward command is accurate enough for the model to produce the sound without generating auditory errors” (Terband et al., 2009, p. 1598) and output (speech) becomes increasingly automatic, natural, and fluent.

Figure 3: Schematic of the DIVA Model (“The DIVA Model”. (n.d.). Speech Lab, Boston University).

The model learns entire phonologies by first registering non-phonemic or syllable specific sounds (equivalent to infant babbling). Then, as it is presented with sample speech sounds, it translates them into discrete units or “time-varying acoustic signals corresponding to a phoneme, syllable, or word spoken by a human speaker” (Guenther et al., 2006, p. 352). Next, it establishes an auditory target for each sound unit. These targets
consist of “time-varying regions (or ranges) that encode the allowable variability of the acoustic signal throughout the syllable” (p. 352). As pointed by Guenther et al. (2006) the use of target regions, rather than point targets, explain speech phenomena such as motor equivalence, contextual variability, anticipatory coarticulation, carryover coarticulation, and speaking rate effects (p. 352). The result is that the system has the ability to store a specific phonological system.

The model provides SLA researchers with several insights as to how learners do and do not acquire L2 phonology. First, it presents a coherent and comprehensive model of speech acquisition, which precludes collaboration among its parts – the system is (or should be) optimal in itself. Second, it indicates areas in the brain for speech acquisition that are in accordance with the latest findings on anatomical and physiological research. This localized approach to brain functions, although considered dynamically (Ahlsén, 2006), makes it better to understand the parts of the speech mechanisms and how they interact. Additionally, since the model is computationally designed to consider incremental feedback and feed-forward relationships of input, processing, and output, it provides a hierarchical representation as to how sound acquisition builds up.

One other important aspect of DIVA is that, looking at how the ‘machine’ functions, we can infer what happens to speech learning when something malfunctions or does not function as desired (e.g., speech disorders, and delays in phonological acquisition). Terband et al. (2009), for example, examine the phenomena of degraded FF control in children with childhood apraxia of speech (CAS). They cite studies which suggest that poor oral production in these children is due to a weak somatosensory control caused by “a lowered oral sensitivity of the tongue and palate” (p. 1605). In
DIVA, such weak subsystem feeds the entire system with inconsistent information, overloading and ultimately crashing it. It activates underspecified synaptic projections from the somatosensory error map to the articulator velocity map in the motor cortex, which in turn sends unsound information back to the error map control during the imitation stage. Because there is cumulative effect involved, the error map is over-loaded sending intermittent error feedback to the system each time there is production. Over-reliance on FB control is followed by a degradation of the FF control leading to increasingly poor production. These hypotheses were tested by Tourville, Guenther, Ghosh, Reilly, Bohland, & Nieto-Castanon in an fMRI study conducted in 2005. The study involved real-time perturbation of the first formant frequency (F1) of the speaker’s acoustic signal (as mentioned by Guenther et al., 2006). As predicted by the model, “auditory error cell activation [was] evident in the posterior superior temporal gyrus and planum temporale” (p. 356).

In adult late SLA phonology, lowered sensitivity to parts of the vocal tract and speech apparatus may be an issue. It can happen because the articulatory settings of the primary language (or the L1) may require only certain parts of the vocal apparatus to activate, whereas others are left that have never been needed to be sensitized. Problem arises to the learner when un-sensitized areas are needed for the production of the L2. An extreme example of this is the use of the epiglottis in the Burkikhan dialect of Agul (Blevins, 2006). In this dialect an epiglottal fricative is contrastive and thus needs to be clearly produced. The epiglottis’ phonological importance is minimal or null in most languages around the world. Once a speaker of any of these languages is faced with such acquisition scenario, sensitization of the epiglottis and its articulators will be needed.
Activation or even development of neuromotor pathways responsible for the target movement of the epiglottis will have to be developed with the aid of special method.

Even when lowered sensitivity to parts of the vocal tract and speech apparatus are not an issue (for extreme cases such as above are rather rare), sensitivity towards specific ways to move certain parts of the vocal tract is. Examples range from how and how long to round the lips or place the tongue interdentally, to tense the root of the tongue or to resonate sound in the velar region among many other articulatory gestures. In this case the learner will need extra stimulation to learn how to move articulators in ways that have never been tried before.

The studies reviewed by Terband et al. (2009) also show that when there is an increased reliance on FB control subsystems, there is increased (carryover) coarticulation. However, this disappears when speech rate is slowed down. Carryover coarticulation in L2 learners may indicate fuzziness in the way speech is produced. It may also make production more anatomically effortful and less cognitively fluent, since the feedback error control keeps working harder in the background. The DIVA model predicts that sounds must be inputted in the form of phonemes and syllables so that acoustic input is clear and distinctive. Such effect can better be achieved if speech is slowed at some point. Studies on phonological acquisition (e.g., Kuhl, 2008) have reported on the direct relationship between slow paced input and learners’ capacity to discriminate and compute meaningful phonological information.

A third component of the DIVA model is in relation to phonemic and syllabic input. As said above, word input in the DIVA is processed via phonemic and syllabic discrimination. In Guenther’s (2006) words,
The model is presented with sample speech sounds to learn, much like an infant is exposed to the sounds of his/her native language. These sounds take the form of time-varying acoustic signals corresponding to a phoneme, syllable, or word spoken by a human speaker. Based on these samples, the model learns an auditory target for each sound (p. 352).

Incrementally, a phonological system is constructed. Additional to this process, the model “must undergo a training process analogous to infant babbling and early word imitation” (p. 352). This babbling stage has at least two important components: (1) it is phonemic, syllabic, and distinctive, i.e., it can be very comprehensible to the learner’s brain processing; (2), it can be slowed down and the phonemes, especially the vowels, can be lengthened during production. This also can result in better FB and FF fine-tuning.

DIVA’s emphasis on discrete features of sounds correlates to some researchers’ suggestions to respect syllabic emphasis and vowel lengthening in pedagogical practices. Kuhl (2008) for example, by observing how children acquire phonologies, discovered that they notice and process better the target sounds when these are presented in the ‘motherese’ form. In this type of speech input, syllables and phonemes, as well as pitch and intonation, seem to gain more importance than the words themselves (and what they mean), at least in initial stages of adult-children interaction. On the other hand, connected fast speech without pitch and rhythm contours seems to be uninteresting to children, for it lacks salient phonological features. She then concludes that the adult L2 leaner would benefit from a similar type of input, at least during initial stages of acquisition, because the adult’s brain mechanism for speech learning also needs distinctive input. Simmonds et al. (2011) go as far as to entertain the reader by asking whether late learners should be called “babbling adults” (p. 10). They add that adult learners would benefit from a
babbling stage not only for production, but especially during a ‘silent period’, in
which “accurate efferent copies of the motor commands required for the production of
the sounds” (p. 10) might be developed.

Some emphasis on phonemes and segments of the target language is not a new
approach to pronunciation practices. In fact, in the classrooms, it is not uncommon to see
the teacher asking the student to repeat words or sounds in isolation that have not been
acquired. And the student responds by repeating it slowly and carefully. However, in
order for this type of exercise to be effective, it needs to be systematic and informed by
the neurocognitive research discussed above. Both instructors and learners would benefit
from having a neuro-motor approach to babbling mechanisms involved in speech
learning. Otherwise, repeating sounds may remain just a mere and meaningless exercise
that may not speed up production. I suggest that a neuromuscular approach to babbling be
considered, taking into consideration subtle and fine (sensorimotor) sensitization of the
target areas of the vocal tract. This could be done by techniques of neuromuscular
awareness discussed below.

3.2.3. The Sensorimotor Hypothesis

A final review concerning the sensorimotor approach to L2 phonological
acquisition examines the way L2 learners recruit brain areas that are necessary for the
learning of the L2. A study examining this topic has been recently developed by Waldron
(2010) at the University of Houston, Texas. He compared fMRI images of English
monolinguals, early, and late Spanish-English bilinguals during a past-tense generation
paradigm, to examine patterns of neural modulation. The results supported an
“emergentist sensorimotor hypothesis of language development” (p. 6), which states that in early bilinguals, a competitive interplay between L1 and L2 results in functionally disparate representation of L2, whereas in late bilinguals, the L2 acts in “overlapping and parasitic” manner on the L1. The study revealed why this overlapping and parasitism occurred in the brain of late bilinguals: these learners recruit areas that “are to a much lesser degree sensorimotor in nature, but are rather regions that are thought to be involved in working memory (the right superior frontal gyrus), and visual image and episodic memory (precuneus)” (p. 25). Thus, when producing L2 they resort to L1 and other general learning mechanisms.

Waldron (2010) found out, conversely, that in monolinguals and early bilinguals, sensorimotor regions are recruited to a much higher degree and “both of these groups heavily utilize motor planning, initiation, sequencing, and articulatory regions, in addition to visual and auditory sensory regions” (p. 27) In other words, monolinguals and early bilinguals resort to more areas in the brain when processing language, and in special, to sensorimotor ones, whereas late learners limit themselves to areas of high order cognition such as executive functioning. Waldron attributed these two different types of neuronal modulation to age of acquisition (AoA) and brain “competitive plasticity” (Doidge, 2007). In early bilinguals, several linguistic representations can be developed and coexist without overlapping. In older learners, mapping configuration for language has already been established in the brain, and linguistic representation is set to L1. When they try to acquire a new linguistic representation, that of the second language, L1 (not L2) comes into play. It seems that there is a ‘hardening’ of the sensorimotor areas preventing ingestion of the new sound representations, thus, processing of the L2 is done solely at
the level of cognition where automatism for L1 is the norm. This results in a foreign accent which does not appear in early learners. This scenario may help explain “why the system rarely becomes so finely and accurately tuned that L2 can be spoken without accent” (Simmonds et al., 2011, p. 2).

Learning how to access and activate the sensorimotor subsystem would be beneficial to L2 late learners. It seems that, naturally, late learners are not aware of this mechanism, or do not know how to utilize it. Instead, as Simmonds et al. (2011) point out, in their learning period, there exist several factors hampering connection to sensorimotor learning: (1) interference and transfer from L1 to L2; (2) silent period and babbling stages are skipped; (3) word phonology is averted by semantic translation; and (4) as the L2 learner reads text in L2, L2 graphemes turn into L1 representations. Instructional practices to phonological acquisition would need to focus on helping the late learner become aware of sensorimotor areas and their associations to FF control to L2 production. As Simmonds et al. (2011) explain, “Persistent accent in late learners of a second language is likely to be the result of a failure to achieve the same proficiency in integrating the motor feedforward and sensory feedback control of articulation” (p. 7).

As it is commonly known, by age seven, most individuals will have established the system of L1 in their brain, and neural pathways for perception, conceptualization, processing, and production of L1 will have been formed and set as the sole way to process language. If by age seven the child has learned more than one language, the established neural pathways will reflect those languages as well, and will be able to respond to the demands of the early-learned phonologies without problems. However, after that period, learning new parameters becomes very challenging.
As studies suggest, the adult learner has to develop new neurological pathways that are responsible for the production of the new language, as the loci for L2 is different from that of the L1 (Doidge, 2007; Chee, Caplan, Soon, Sriram, Tan, Thiel, & Weekes, 1999; Kim, Relkin, Lee, & Hirsch, 1997). Creating new pathways to L2 learning, however, is not an easy task. The adult learner has no mental recollection of the early processes the brainstem and limbic system went through while acquiring the first language. Once the language pathways have been established in the brain by puberty, and there was no further (meaningful) stimulation of additional pathways to learn additional languages, that mechanism is taken over by the higher thought-processing cortical functions. The sensorial functions are thus de-stimulated, and somewhat considered unnecessary. Adult learners and instructors alike, are not commonly conscious of the importance of the sensorial and deep motor systems for language learning, and will think that learning a new language will be possible by using only motor cortical functions. Several problems will then arise as a result of this attitude towards language learning.

The problem is not that cortical functions will not help new phonological acquisition. In fact we need to use our rational cortex for basically every action we take in life. However, these areas alone, although successful for maintaining already acquired language processing, is not capable to deal with comprehensive acquisition of L2.

If it is possible to stimulate the cortical and sub-cortical areas leading to sensorial functions, we may indeed think about a new way to work with phonological learning. We can think of a method and its correlation with neuro-muscular physiology and brain plasticity leading to learners’ acquisition of motor control or organization of articulatory
functions. One example is the teaching movement lessons that may lead directly to articulatory movement exploration and awareness of the vocal apparatus used for pronunciation output. In fact, a movement theories of neuro-muscular awareness, called the Feldenkrais method (Feldenkrais, 1972; Strauch, 2008) is a promising tool for investigation, and in the following, I examine and put to test such technique.

3.3. The Feldenkrais Method

Although the idea of sensitization in the SLA field has been often suggested (as I mentioned above), little has been done to approach the issue with praxis in relation to neurological mechanisms of speech. Learning conditions for the learner to become sensitive to parts of the oral tract that impact the L2 production are not impossible to be created. There are techniques of neuromuscular awareness that offer tools to sensitize articulators and required muscles in isolation or in compound. The Feldenkrais method (named after its creator, Moshé Feldenkrais, 1904-1984) is one of them.

In An Overview of the Feldenkrais Method, Ralph Strauch (2008), a certified Feldenkrais practitioner, explains that the method is an educational system centered on movement aiming to expand and refine the use of the self through awareness. The method can be used simply by those who want to improve their general well-being and personal development, but further research on the method reveals several of its key characteristics dealing with specific articulatory learning. Focus is on the development and improvement of individuals’ movement repertoire among dancers, musicians, athletes, and those wishing to reduce pain or limitations in movement. Of great importance to this dissertation on L2 phonological acquisition is the method’s
applicability to problems that arise from articulatory settings acquisition, which issue from “problems of accommodation” (Esling & Wong, 1983, p. 93).

A problem of accommodation in speech setting is directly resulting from repetitive patterns of movement (those of L1) inside the vocal tract, which is the natural habituation of many years of neuro-muscular development that becomes difficult to change. Although the purpose of the Feldenkrais method has not originally been to treat constraints of phonological acquisition, and only recently, its community has begun researching neuroscientific correlates, I argue that such an approach can be used to improve practices of phonological acquisition and pronunciation in the classroom and to advance research in the field of SLA.

The Feldenkrais method is based on the building up of neuromotor awareness leading to freedom and control of articulatory movements. At the same time, it fosters the breaking up of fossilized movement caused by habitual settings. In his work Awareness through Movement, Moshe Feldenkrais (1972) writes about important ways to work through movements to help individuals be aware of their own movement constraints and abilities. Awareness leads to sensing of the articulatory mechanism, which in turn, leads to a higher degree of kinesthetic control. This method is totally against rote repetition of movements; instead, it favors (and stresses) spontaneity and sensitization of neuro-muscular mechanisms to discover new pathways to movement. In addition, the technique can allow the language learner to tap into the deep sensorimotor mechanism that assists in the pronunciation of subtle features of L2.

In neuroscientific terms, the method fosters a sensitization to L2 phonology by involving the working of articulators to awaken or stimulate underlying neuronal firings
and their synaptic projections (articulatory trajectories) leading to and from the sensorimotor regions in the brain, so that new sensory and sound motor maps are developed and feed-forwarded to production. As cited by Doidge (2015), one of the main objectives of Feldenkrais when developing this method was to re-differentiate undifferentiated (or unused) areas of the brain and their kinesthetic correlates. If this method deals with movement in such way, it must help the learner gain awareness of articulatory movements of the speech apparatus responsible for the perception, acquisition and production of the L2 sounds, especially in cases where phonological features prove to be more challenging and subtle to acquire.

During Awareness Through Movement (ATM) lessons, one of the two ways the method can be taught (The other way is Functional Integration – a hands-on, one-on-one interaction between the practitioner and the student that involving touch and pressure), the practitioner first help students relax and concentrate. Then, s/he verbally leads learners through motor sequences in paced and gentle manners. Lessons are often organized around a specific movement function. The goal is to increase learners’ awareness of the mechanical detail of the movement leading to sensorimotor feeling. ATM lessons can be given to groups of individuals, in a face-to-face manner or through pre-recorded audio. Instructions contain simple but unusual movement exercises and cues, which allied to introspection and self-exploration, lead to articulatory fine-tuning. This approach makes it possible to put in practice the proposed methodology suggested by the neurolinguistic research mentioned above.

A basic lesson activity could ask learners to make a quick list of body parts they know they have but which they cannot feel or move consciously in the vocal tract. Then
could ask them to compare that list with a second list containing parts they can feel. In a subsequent stage, this lesson could lead students to sense specific places of articulation, one at a time, and have them focus on the parts of the vocal tract that are relevant to specific sounds of the target language. For example, in the Burkikhan dialect of Agul mentioned above, the epiglottis is of distinctive relevance. Learners of Burkikhan could be asked to sense and move the epiglottis in specific ways and to reflect on parts of the vocal tract that are involved and on to what extent they relate to the overall articulatory setting of the vocal tract.

For the experiment developed by this dissertation (described below), Richard Goldsand, a certified Feldenkrais practitioner was hired to administer five ATM lessons. The lessons were designed by him with some input from me to target specific parts and articulators of the vocal apparatus. Focus was given on the tongue, lips, jaw, nose, teeth, cheek, and on breathing.

The breakdown and building up of the movement is done in simple and meaningful stages and further developed by experimenting with different axes and situations, such as laying down, standing up, walking, rolling, speaking, singing, and so on. As above discussed, in DIVA, with each and better new sensory and sound input, the system improves incrementally. This in turn, leads increasingly to fluency and automatism of output.

The task, however, becomes challenging as students have become used to a different type of learning method, which is based on automaticity (recruitment of non-sensory areas – Waldron, 2010) and fast results. However, the method has been devised to deal with this caveat. In fact, one of the first requirements during the practice of
exercises in the Feldenkrais lesson is that the student interrupt the flow of involuntary movement right before its realization (interrupting automaticity), and follow by ‘sensing’ and observing the muscular response to the initial movement impulse.

Although not being told (at least at first) that by following such instruction, the learner is actually becoming sensitive and increasingly aware of the neuro-muscular mechanisms pertinent to the production of movement, unconsciously, the learner is apprehending a novel way of activating new movement pattern through new neuronal recruiting and firing. I have never seen this kind of approach being employed for pronunciation practice before, but I propose that this approach can be applicable to the learning and long-term re-education of an individual’s speech articulatory ability towards L2 or L3.

A final note about this technique regards its contribution to create in the learners’ minds a sense of autonomy in relation to learning. During Feldenkrais lessons, the learner is never commanded to perform an action, neither is he required to attain a certain level of dexterity. Rather, the learner is given the condition to make learning a unique and individualized experiment. Exploration of kinesthetic and proprioceptive senses is at the core of Feldenkrais, and such type of practice can only dealt with if the individual in fact owns it. That makes learning autonomous and empowers the learner. Looking from the point of view of L2 phonological acquisition, this is very relevant, as it shifts the approach from automated (of traditional pronunciation pedagogy) to autonomous. Ultimately, the learner gains confidence as s/he becomes aware of what s/he needs to do to improve the quality of speech production.
What follows is the detailed description of a proposed methodological approach involving the use of Feldenkrais, articulatory settings, and sensorimotor learning towards the acquisition of L2 phonology.
Embedded in the rationale of this dissertation is an assumption that an adult learner of L2 experiences three stages of phonological acquisition. In the first stage, s/he perceives in impressionistic ways certain salient articulatory features of L2, such as for example, nasalization, retroflexion, and pharyngealization (respectively in French, English, and German, for example). This is the stage of perceived recognition of L2’s encompassing sound features and no other phonological detail is assessed. According to the DIVA model (Guenther, 2006), this type of phonological learning is “not phoneme- or syllable-specific; rather, the learned sensory–motor transformations will be used for all speech sounds that will be learned later” (p. 352).

In the second stage, if the learner receives traditional instruction, s/he will be taught about the segmental features of L2, that is, phonemes and their interactions. At this stage, focus is heavily given to visual representation of L2’s most challenging segments and phonological processes. In Guenther’s (2006) DIVA model, this subsequent stage of learning consists of “time-varying acoustic signals corresponding to a phoneme, syllable, or word spoken” (p. 352). These are called time-varying because they make up for “target regions” that accounts for “a wide range of speech production phenomena, including motor equivalence, contextual variability, anticipatory coarticulation, carryover coarticulation, and speaking rate effects” (p. 352). I argue that this kind of correlation between the phoneme, syllable, or word, and their target regions explains the nature of articulatory settings. The target regions make up for the settings as they are “radiations”
of segmental features. These radiations are resilient, but not rigid, and they interact
with one another. Unfortunately, during traditional learning, this aspect of L2 is not
addressed in the classroom. Also, at this stage, production is based on rote repetition of
the segmental features.

A third stage within this traditional pedagogy, includes the learning of supra-
segmental features such as, intonation, stress, and rhythm. At this stage, such features are
usually taught similarly to segmental features described above – through visual
representation and rote repetition – somewhat detached of an awareness of the overall
“musicality” of the language, as features are presented in small chunks (As I have
observed in mainstream pronunciation course and textbooks³). Production of segments
and prosody may now occur, as the learner may also be able to perform connected
speech. In its quality, however, the speech will likely be “disconnected” (thus, the foreign
accent) as it lacks a fourth component (described in the building mechanism below). At
this stage the learner could be taught further about the overall prosodic pattern of L2,
which could evolve the exploration of more global phonological features described
below; however, traditional pedagogy sticks with compartmentalized approaches to
phonology, as it misses the opportunity to explore encompassing features of L2, those of
articulatory settings. The learner is then left on his own to figure it out how to put
everything together.

Such description of learning stages can be compared to the construction of a
building. At a first stage, an idea of the building is assessed and some kind of mapping is
formed. In the phonology of the language, this can be compared to the initial assessment
of articulatory features, the basis of support. In the second stage, the pillars and bricks of
the building are laid out, on top of and around each other, in specific configurations. These pieces are the core of the structure, if not the structure itself (represented in phonology by the segments and their interactions). In the third stage, the building is given important resources – that is, running water, electricity, ventilation, even some decorative finishes. The third stage can also be described as the insertion of features that connect the parts of the structure, illustrated by cables, pipes, and air ducts, among other conducting things. Without these last features, the building could not function smoothly. In phonology, these can be compared to the supra-segmental features of intonation, stress, and rhythm.

Then, there is even a more subtle feature of this building, one that is invisible and has its origin inside its core structures. That is the center of gravity, which is made of the interactions among the bricks (segments) and their basis of support. It is interesting to note that the center of gravity depends on the segments, which build the center of gravity, and the segments depend on the center of gravity, which holds them up in consonance. Without such congruent stability, the building would fall. This center of gravity also contains energy that irradiates. Such is the analogy of a language phonological system. The energy containing the center of gravity is the articulatory settings of the language, the spectral, aural features built by and sustaining the building parts. The question is, how do you teach these features or this component of the system?

You can only acquire the gravitational feature of a language by sensing it; there can be no other way, as the learner can only try to feel it in sensorimotor ways. However, as an instructor, first you need to identify it and describe it to your learners. The initial impressionistic descriptions assessed by the learners help to begin with. Further
assessment, however, is necessary and the concept of articulatory settings examined above gives a theoretical foundation. This foundation is based upon the observation that languages have specific settings (or acoustic forces) roughly described as rudimentary features, such as, nasalization, palatalization, retroflexion, velarization, uvularization, and so on. This kind of assessment helps the learner identify perceived sound saliences or language specific characteristics. In addition, the theory has a proprioceptive component to it, as auditory features are somewhat correlated to motor production (Thus the name "articulatory settings").

Researchers have tried hard to establish an exact correlation between the articulatory performance and its target sound by saying for example, that to produce palatalization one needs to raise the tongue body, or that to produce retroflexion one needs to roll back the tongue tip, or even that to sound nasal one needs to lower the velum; however, the correlation between the sound of articulatory features and their projected articulation is not always a one-on-one (Mennen, Scobbie, de Leeuw, Schaeffler, & Schaeffler, 2010); also, how can one teach a student to lower the velum? In fact, things do get complicated. Most times the projected articulatory performance is a combination of underlying actions interacting in the vocal apparatus. And as Mennen et al. (2010) point out, “Our understanding of articulation and its relation to acoustics is still rudimentary” (p. 15). Therefore, teaching those basic instructions of articulatory settings or even more complex ones requires further strategies.

Some researchers, such as González (2003), Kerr (2000), Toscano & Audibert (n.d.), and Honikman (1964), have focused on the overall placement of the tongue, lips, jaw, and tension/laxity of pharynx, larynx or even vocal tract. But this approach also has
its drawbacks, as the tongue alone for example, has several parts imparting production, i.e., the root, the dorsum, the blade and its tip, and the root. How to analyze and reconcile all of that?

Other researchers, such as Wilson (2010) and Wilson & Gick (2014), have paid attention to the placements of the articulators during inter-speech pauses (ISP). They argue that such placements are more indicative of a language specific articulatory settings as they are filtered from all of the movements going on during speech. Also, they can be assessed by imaging and point-track technologies. Their results have presented some similarity with the findings of the earlier research above, as they found in American English, for example, the same results in relation to the spreading of the lips and the opening of the jaw. In addition, they found other settings, such as vertical movement of the lips. While this line of research presents significant insight into the subject, its scope is still limited by the small number of settings the authors were able to identify and pinpoint. Also, it has limited reach to pedagogy, as it does not answer the question of how one can teach vertical lip movement, for example.

There is where we get to the second aspect of this proposed methodology. The instructor has to point to the learners that the articulatory settings of L2 are only referential because true settings are to be found in the intersection where the auditory representation of segments become overall motor action. In this way for example, the segment /r/ contains the underlying motor information leading to articulatory performance of [r] in a global environment (a neuromotor speech mechanism explained with the DIVA model above). This happens with all the segments and their combinations in the language. Every segmental feature and phoneme of any language has in its acoustic
blueprint, articulatory projections towards the articulators, which results in a compound of motor actions, and not only one or two actions. Furthermore, this compound – a holistic action – translates into spectral, aural futures. This leads to the third aspect of this methodology: the sensorimotor approach to teaching pronunciation.

Teaching the point of sensation where the auditory representation meets its articulatory projections requires fine sensorimotor activity. To say more subtly, teaching the "radiation" of a language, that which the segment or their combinations (the blocks) creates and that which holds the system, is so subtle that requires sensing of the sensorimotor mechanism underlying the production of speech.

Pronunciation is an articulatory activity involving muscles and neurons. Learning L2 pronunciation means to develop new neuronal synapsis and connections leading to and from the muscular system contained in the vocal apparatus. That also means to develop new muscles responses. During acquisition, these responses lead to articulatory settings necessary to the wholesome, overall, and quasi-permanent production of L2 (that is, the target regions; not individual segments or their combinations alone).

The development of this type of phonological learning requires an approach to sensorimotor mechanisms, which stimulates the somatosensory cortex to give better and more complete feedback to the entire system (Guenther, 2006). Activation of somatosensation begins with stimulation of mechanoreceptors (tactile sensory receptors) in the skin, organ, or muscle. These receptors are nerve endings of the somatosensory system running to and from the brain stem, thalamus, and ultimately, the somatosensory cortex. In the vocal apparatus these receptors lie in all areas responsible for speech,
including the tongue, velum, lips, checks, pharynx, and even the palate, which does not move, but can provide sensorial information.

In an infant, this kind of stimulation must happen naturally, as the DIVA model and Arndt & Stewart (1981) predicted. During infancy, neurons discriminate the phonology of early language or languages being acquired (Kuhl, 2008). Once discrimination and neuronal pruning finalizes (around puberty), specialization takes place and the neurons that remain are set to the production of early acquired languages. The system is then “hardwired” (Doidge, 2007) and the somatosensory system lies dormant. The learning of L2 signifies re-activating the entire system, including the re-stimulation of the somatosensory subsystem.

Re-stimulating the system requires a specialized technique that reflects the need for sensing. Within traditional pedagogy, simple repetition of segmental features is of limited benefit, because the learners’ efforts, despite persistent, reach only the readily available, habitual and immediate matter. Waldron (2010) has explained this by showing that adult learners resort to frequently used areas of the brain (those automated for L1) instead of tapping into the needed sensorial and more subtle areas. As Arndt & Stewart (1981) pointed out, the sensorial areas are key for “anchoring” the phonology of L2; and as Guenther's (2006) DIVA model illustrates, feedback and feedforward information coming to and from sensorial areas of the brain enables and fine-tunes phonological acquisition. Therefore a technique that stimulates sensorial functions is what is needed in pedagogy. The Feldenkrais technique of movement awareness shares the same fundamental principles of learnability.
The Feldenkrais technique purports to re-differentiate neurons that are undifferentiated or hardwired (Doidge, 2015) to early-learned settings (Think of L1 settings). It attempts to re-educate the system so that neuronal firings produce new motor behavior. The technique uses movement to do that – thus, the names *Awareness Through Movement* and *Functional Integration*, the two possible ways to learn the technique. This premise of learning through movement correlate with the neuroscientific research, which says that mechanoreceptors are stimulated through movement and pressure. Therefore, the Feldenkrais technique can re-activate the somatosensory system.

The pronunciation classroom, therefore, needs to integrate techniques such as Feldenkrais and examine the radiated features of articulatory settings. I propose that sensorimotor activities based upon articulatory projections of phonemes be used to complement the other teaching techniques already in place (with due reservation to repeated drills). Activities need to be sensorimotor in nature. The Feldenkrais method seems to be the most attuned technique for this kind of approach to pronunciation and that is why I use this technique in the experiment that follows.

Another aspect of this proposed methodology is that the learning is individual – it is an individual somatosensory exploration – and can only be felt (or sensed) by the learner. The target regions with “time-varying” acoustic signals can only be sensed by the individual’s sensorimotor experience. This also relates to the fact that true characteristics of articulatory settings can only be sensed in relation to individual’s own physiology – the anatomy of the vocal tract -- habitual (previously learned) settings, and perceived L2. All this influence the way new settings are to be acquired. The learning, therefore, has to
be an autonomous exploratory activity. While this may make learning challenging, it is nevertheless, more effective. In this approach, autonomy replaces automaticity.

Finally, because the learning is autonomous, it gives the learner control of the process – it is intrinsically learner-centered. Also, the goal of learning is to improve the quality of the articulatory gesture rather than mimic the accuracy of the L2 input (although that can be the final result). From the learners’ point of view, this shift from automaticity to autonomy and from accuracy to quality, allows for the development of a independent attitude, which ultimately leads to confidence and self-efficacy.
CHAPTER 5

The Experiment

5.1. Method

This chapter describes a classroom experiment that takes five participants through an 8-week “course” designed to teach them how to identify and use the features of articulatory settings in tandem with the sensorimotor mechanism. The method integrates the application of articulatory settings and the Feldenkrais technique to the learning of American English pronunciation and contains exercises of mindful repetition to phonemes.

After being pre and post tested, respectively at the beginning and end of the experiment, participants’ production should show improvement in the degree of intelligibility and speech rate (fluency), and decrease in accent. In addition, participants should gain speaking confidence.

5.1.1. Participants

This dissertation recruited 15 participants over the age of 18. They were all English language learners of various first languages and cultural backgrounds. All participants were fluent in English and currently enrolled at or have recently attended a U.S. High School and/or College institution for at least one year. They were recruited from a community of students and employees of a major university in the Southwestern United States.
Only five participants completed the study by meeting the attendance requirement of being present at least 85% of the time throughout the entire experiment. The five participants were three males and two females aged 22 to 26 years old (mean = 24.4). Among them, the least amount of years one had been an English learner was seven and the most was seventeen (mean = 12.75). In addition, their time of living in the U.S. ranged from seven months to five years (mean = 2). All of them considered themselves to be bilingual and had achieved a level of English proficiency that was at least intermediate. In a seven point Likert type scale, 7 being the best, they indicated that their English speaking ability was 4.6 (mean). In a similar scale, this time 7 being the strongest, they indicated that their foreign accent was 5 (mean).

Participants were not paid in any way for participating in this study; however, upon completing the experiment, they each received a certification of participation and an unannounced $10 gift card from a coffee shop.

5.1.2. Procedures

The experiment designed for this dissertation took participants through a classroom laboratory, which met nine times throughout a period of approximately two months. Except for the first week, participants met once a week for eight weeks, for 50 minutes each time. In the first week, participants were introduced to the study and completed all assessment types before they began receiving instruction. The entire experiment is divided into four main stages described below.

The first part of the experiment lasted approximately two and a half hours spread along approximately three meetings. During this time, participants received explicit
instruction on the theoretical content of parts of the vocal apparatus (VA), Articulatory Settings, and some practical experience with the problem of articulating some English segments in relation to English articulatory settings. Within the instruction of the VA, I focused attention on main articulators of speech, such as the tongue, the lips, the jaw, and the velum. Pictures of the vocal apparatus and animations of the articulators were shown to help the learners understand the anatomic and physiologic scope of the VA.

Instruction on articulatory settings focused initially on the movement of jaw, tongue, and lips of the speech of several native speakers of different languages, i.e., SAE, Brazilian Portuguese (BP), and Continental French. Using video clips of TV newscasters of different nationalities, I showed to participants how different languages have different articulatory settings. I also encouraged them to identify the articulatory settings of some of those speakers, as they paid close attention to the lips, the jaw, and tongue. Most participants were quick to realize that compared to the BP newscasters, the speech of the SAE newscasters presented greater range of movement overall: the jaw opened more prominently, the lips showed greater horizontal movement, and the tongue had great deal of (in their own words) “flapping” and “back and forth” movement. One of the participants also observed that the SAE speaker’s tongue often positioned closer to the lower teeth.

Embedded in this part of the experiment was the introduction to an important aspect of this method, which deals with participants being encouraged to explore their own articulatory settings. To do that, I gave them a set of sentences from the Harvard list of phonetically balanced sentences (Rothauser, Chapman, Guttman, Silbiger, Hecker,
Urbanek, Nordby, & Weinstock, 1969) and asked them to read them aloud. After that, I asked them to identify which sounds they had difficulty with articulating. Some participants readily identified segments, such as [θ; ð; ɻ] from words such as both, these, rare. I then asked them to observe in their VA where the difficulty lay, in other words, which articulator or articulators participated in the pronunciation of such sounds and how they did so. In the case of [ɻ] some participants quickly pointed to the participation of tongue and its tip curling.

In a following stage, I encouraged participants to focus on the articulation of the tongue and actually feel what was limiting them to move it more native-like in order to produce a better L2 [ɹ]. This was intended to help them correlate segmental pronunciation with the necessary articulation of L2. I told them in order to pronounce certain English segments, they needed to move their articulators more like English speakers do, but not always, as the correlation learner’s articulatory settings towards L2 settings is idiosyncratic, that is, learners may come up with different anatomic referential to settings depending on their own VA anatomy and habitual settings.

I then asked the participants to look back at the observations they made about the tongue of the English speaker newscasters and compiled with them a more detailed list of articulatory settings of the tongue in English, containing descriptions of settings, such as having a more relaxed and ample articulation of the vocal apparatus overall. This included the flapping and spreading of the tongue, and its position closer to the lower teeth. While, some participants were able to realize that in order to speak a more native-like English they had to (in a broader scale) relax the movement of their tongue, further open their jaw, and move their lips with greater range, one of the participants indicated
his tongue should be tensed instead of relaxed. This participant’s native dialect (Mexican Spanish) may have had an impact on his assessment of English articulatory settings. This dialect is characterized by aspiration (Morris, 2000), which, besides being present in English as well, may play a role in relaxing the tongue or some of its parts (See discussion below).

This section of the experiment ended with me introducing to them the idea that in order to change the way one moves his/her VA, one needs to go through a sensorimotor approach to movement awareness and development. This led to the second section of the experiment.

The second part of the experiment lasted approximately one hour spread over two meetings. During this time, participants were presented with theoretical and practical content on the subject of sensorimotor mechanism of speech acquisition. I developed an explanation of the speech mechanism based on neuroscientific studies I presented earlier in this dissertation (Waldron, 2010; Guenther, 2006) I showed the participants pictures of the brain and nerve pathways responsible for speech. In the brain, I showed them the motor cortex and its adjacent sensorial one. I also explained the role played by these cortical areas, specifically the (possible) contribution of the sensorial cortex to the functioning of the motor one. I told them that the motor cortex sends motor impulses to the vocal apparatus to produce speech but that mechanism occurred automatically when someone spoke his or her L1. When learning an L2, however, the learner could no longer rely on that automaticity for the motor cortex needed to learn a new set of movements with updated or newly created neuronal firings and connections. As Guenther (2006) and Waldron (2010) point out, this development process depends on the stimulation of
sensorial feedback and processing. Finally, I told participants that in order to test the hypothesis of this dissertation, which proposes that such sensorimotor approach benefits L2 pronunciation, we needed to stimulate the sensorial cortex so that it could help the motor cortex to produce better articulation towards speaking English. The question now was how to stimulate the sensorial cortex. That led to the third part of this experiment, which had to do with using the Feldenkrais technique of movement awareness.

The third part of the experiment lasted approximately four hours and 20 minutes distributed in five weekly lessons of approximately 50 minutes each. During each of these lessons, participants received approximately 30 minutes of Awareness Through Movement (ATM) instruction, had a short 5 minutes break, and were led through an informal 15 minutes conversations about the method and its possible impact on their L2 development. The ATM lessons were delivered by Richard Goldsand, a certified Feldenkrais practitioner with over twenty years of experience with the technique. To our knowledge, this was the first time the technique had been used to treat matters of articulatory and phonological acquisition. The lessons thus had to be slightly customized to target specific English articulators within 20-30 minutes of instruction (Usually, an ATM lesson lasts 50 minutes).

During these lessons, focus was given to developing an overall mind and body state of relaxation and concentration – mindfulness (Pickert, 2014; Siegel, 2010), awareness of articulators and their potential mobility, and application of that mobility towards pronouncing L2. Participants were asked to come to practice wearing loose clothing. At the beginning of the lesson, they were instructed to lay on the floor, then the practitioner began giving participants verbal instructions as to which parts of the vocal
apparatus to move and how. The ATM lessons and discussions progressed as follows (See transcripts in Appendix C).

Lesson 1: Connecting breathing with the movement of the jaw, lips, and tongue.
Lesson 2: Connecting the movement of the head and jaw with that of the pelvis.
Lesson 3: Exploring the range of motion of the tongue.
Lesson 4: Exploring the movement of the lips.
Lesson 5: Exploring making sounds through the nose as well as through the mouth.

The last part of this experiment happened in the last 50 minute long meeting. During this meeting, I developed for participants a practical experiment, which targeted what they had learned about articulatory settings, L2 segments, and the sensorimotor approach of Feldenkrais. I asked them to repeat a list of words we developed, which contained the segments they had said earlier they had difficulty with pronouncing. Before they began repeating, however, I asked them to take a deep breath, relax, and focus their attention on what their articulators were going to do. The repetition, thus, was to be sensorimotor in essence. In addition, it was to be smooth and paced, to allow time and attention for sensorial information to be processed.

Attention (mindfulness) was to focus on what did not work in their articulatory production, instead of on what should work. That meant, instruction was given not to worry about “doing it right” but on sensing what was not doing right so that the brain could process feedforward and feedback information leading towards fine-tuning of articulatory and acoustic features. At this stage of learning, I did not expect participants to produce significantly better pronunciation of L2, but I did expect that they developed a sensorial “intelligence” to put forward an acquisition mechanism that was based on the
neuroscientific research informing this dissertation (illustrated by the DIVA model).

That initial sensorial development in its own should effect positive change in the fluency (rate of speech), degree of intelligibility, and speaking confidence of the participants.

Such data was collected on that same day as participants completed the post-tests.

The table below details the time spent during all the parts of this experiment.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Content</th>
<th>Approx. time spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Articulatory Settings</td>
<td>2 hours</td>
</tr>
<tr>
<td>2)</td>
<td>The Sensorimotor Mechanism</td>
<td>1 hour</td>
</tr>
<tr>
<td>3.a)</td>
<td>Feldenkrais ATM Conversations</td>
<td>2 and a half hours</td>
</tr>
<tr>
<td>3.b)</td>
<td></td>
<td>1 hour</td>
</tr>
<tr>
<td>4)</td>
<td>Sensing the AS of specific phonemes</td>
<td>Half an hour</td>
</tr>
<tr>
<td></td>
<td><strong>Total Time</strong></td>
<td><strong>7 hours in 8 weeks</strong></td>
</tr>
</tbody>
</table>

Table 4) Time spent in each stage of experiment

5.1.3. Assessments

This experiment assessed participants in three different ways. The first two assessments were two pre and post-tests, each containing a reading aloud task (Appendix B). The first reading task asked participants to read the text *The North Wind and the Sun*, which is a phonetically balanced text that has been used by the International Phonetic Association for over 100 years (Jesus, Valente, & Hall, 2015). The second reading task asked students to read a dialogue from a traditional textbook in ESL pronunciation[^4]. This was a slightly longer and more colloquial text, providing informal and familiar speech as well. In the textbook, the authors also use this dialogue as a pre and post-test. In addition to these two reading tasks, there was a third assessment in the form of a brief survey
focusing on speaking confidence. In this assessment, the participants rated their
degree of speaking and listening confidence of English at the beginning and at the end of
the experiment (Appendix B).

In addition to these three assessment types, participants completed a Language
History Questionnaire (Li, Zhang, Tsai, & Puls, 2013) generating language background
information and self-reported proficiency information, which were used to assist in the
description of profile of participants. All these assessments together offered a
“triangulating data” (Gass & Mackey, 2007) that served for a cross-examination leading
to a more substantial and valid analysis (below).

5.2. Results

The Analysis of the Data is divided in two modules. The first module is related to
the pre and posttests containing the reading tasks and is developed using four different
kinds of measurements (items 6.2 to 6.5): Vowel Space Area (VAS); Google Automated
Speech Intelligibility Engine; Speech Rate (SR); and Degree of Accentedness. The
second module of the analysis is based on the survey on speaking and listening
confidence survey (item 6.6 and 6.7). At the end of the analysis, a final table is presented
showing the results of all five kinds of measurements for each participant (Omnibus
Analysis – item 6.8).

5.2.1. Vowel Space Area (VSA)
Vowel Space Area (VSA) is the area formed within the points of intersection of the formants F1 and F2 of the peripheral vowels [i, e, æ, a, ɔ, ɔ, o, u] in a formant chart. The area is found by plotting F2 as an analog of the front/back dimension and F1 as an analog of the low/high dimension. VSA has been helpful in the analysis of speech intelligibility and performance (Luan, Wright, Ostendorf, & Levow, 2014; Chen, Evanini, & Sun, 2010) and in SLA studies (Khalil, 2014; Packer, Brakel, & Lorincz, 2013) by showing, for example, how much distinguished (far apart) or centralized (closed together) the speaker’s vowels are. In addition, VSA have an articulatory correlate in that higher F1 indicates less pharyngeal space, lowering of the tongue, and opening of the jaw, whereas lower F2 indicates tongue root retraction (RTR) and lowering as well. Finally, lower F2 can also indicate lip rounding for back vowels. In a VSA analysis the subject’s production can be compared with standard models and/or cross linguistically.

In this analysis, I use an “automated assessment of vowel space area” developed by Berisha, Utianski, & Liss’s (2013). This method purports to provide a more sensitive and accurate assessment of the speaker’s speech production (pp. 477-78). It takes into consideration all voiced sounds in connected speech. This method contrasts with traditional assessments of VSA as they consider only peripheral vowels taken from isolated words. A more comprehensive assessment of VSA as designed by the authors above, reflects the approach taken by this dissertation, which examines the acquisition of all-encompassing phonological features, such as those of articulatory settings. In the automatic assessment of VSA, the gray space indicates the tokens of all the voiced phonemes and the dots are the center of the clusters of the most prominent sounds, which contain the vowels.
In addition, in this dissertation, the analysis of Vowel Space Area (VSA) is done cross linguistically, as I compare the VSA of the participant’s Interlanguage (IL – Selinker, 1972) from the pre and posttest, with that of the participant’s first language (L1), and with that of SAE (L2). Posttest production can indicate any of the following outcomes: (1) the VSA remains equal to the original IL (pretest = posttest); (2) change of the VSA in the direction of the L1 VSA; and/or (3) change of the VSA in the direction of L2 VSA. The VSA of L1 and L2 are determined by the average VSA of native speaker’s (male or female) of each language.

In this assessment, the data used was the speech samples of all participants in test A (“The North Wind and the Sun”) from pre and posttest.

![Figure 4a] VSA of participant AA - native speaker of Mexican Spanish.

In Figure 4a, the posttest shows that the participant’s VSA increased more than two fold. It also shows that the vowels moved further apart from each other, and that overall, both F1 and F2 decreased.
Figure 4b) VSA of participant EI - native speaker of Japanese.

In Figure 4b, the posttest shows that the participant’s VSA decreased approximately three times. It also shows that the vowels moved closer to each other, and that overall, both F1 and F2 decreased.

Figure 4c) VSA of participant LU - native speaker of Mandarin Chinese.
In Figure 4c, the posttest shows that the participant’s VSA remained approximately the same. It also shows that the vowels moved closer to each other, and that overall, F1 decreased.

Figure 4d) VSA of participant MR - native speaker of Chewa (or Chichewa), a dialect from Malawi and Zimbabwe.

In Figure 4d, the posttest shows that the participant’s VSA increased almost three times as much. It also shows that the vowels moved far apart from each other, and that overall, F1 increased and F2 decreased.
In Figure 4e, the posttest shows that the participant’s VSA increased approximately twice as much. It also shows that the vowels moved far apart from each other, and that overall, F1 decreased.

5.2.2. Google Automated Speech Recognition

Speech recognition software have become increasingly popular as their accuracy and reliability seem to be useful in many different situations. Google automatic speech recognition engine uses Zhang’s (2015) Speech Recognition (Version 3.1) software. According to McMillan (2013), this kind of software works somewhat like the brain when it processes speech. First, it acoustically analyzes the speech sample in a spectrogram and then sends it to eight different computers in a network of servers in the cloud. This “neural network” is capable of processing the speech sample beginning with differentiating phonemes and then predicting the ensuing words and their syntactic organization, based on stored data and neural network algorithms.
In the field of SLA, automated speech recognition system (ASR) has been used for quite some time. Language learning software by Berlitz and Rosetta Stone, for example, has incorporated such technology to their assessment of intelligibility of learners’ production and to help the learner improve production. The technology has also been proposed as an alternative method to scoring L2 learners’ output (Neumeyer, Franco, Weintraub, & Price, 1996). While there have been some arguments that ASR has limitations to detect the large amount of variability in connected speech (Finke & Waibel, 1997), further research has shown that improved speech recognition technology can emulate human’s ability to estimate pronunciation quality (Franco, Abrash, Precoda, Bratt, Rao, Butzberger, ... & Cesari, 2000). In this dissertation, I consider the use of Google automatic speech recognition engine as a complementary tool to assess the data and to support a more robust and comprehensive analysis.

In this assessment, split speech samples of all participants containing 10 sentences of similar length from each test (test A – “The North Wind and the Sun” and test B – “Two Students Meet”) were run on Google automated speech recognition engine for word intelligibility. The assessment chart contains a scale 0 to 1.2 on the left vertical line. In theory, the greater the word error rate the lesser the degree of intelligibility. Results for pre and posttest A shows decline in intelligibility in the speech samples of participants MR and EI (yellow and orange bars), and gain in intelligibility in the speech sample of participants AA, LU, and MT, although with less degree change (Table 5a). Results for pre and posttest B shows minor change for all participants’ speech samples, except for AA, whose speech sample presented a larger gain (Table 5b).
The computed average of both tests show improvement of intelligibility in the speech of participants AA, LU, and MT, and decrease of intelligibility in the speech samples of participants MR and EI (Table 5c).

Table 5a) Pre and Posttest (A) - “The North Wind and the Sun”

Table 5b) Pre and Posttest (B) - “Two Students Meet”
Table 5c) Average of pre and posttests A and B.

5.2.3. Speech Rate (Fluency)

Recent studies have argued that fluency can be a better predictor of L2 speech development than pronunciation accuracy. Lin & Francis (2014), for example, suggest that fluency factors of speaking rate have, among other things, great impact on speech intelligibility and listening effort. Fluency has also been considered a goal to be achieved by learners as an indicator of L2 development (Razagifard, P. 2013; Rasinski, Blachowicz, Lems, & MyiLibrary, 2012; Perfetti & Jong, 2011; Wood & ebrary, 2010).

Freed, Segalowitz, & Dewey (2004) believe fluency is associated not only with rate and quantity, but with smoothness of speech as well (p. 298). The concept of fluency for this dissertation may help the analysis of the experiment data because this dissertation hypothesizes that a learner that develop global articulatory ease of producing L2, must somehow produce more fluent speech. As explained above, the acquisition of articulatory settings encompass features of L2 phonology that are related to target areas that help develop subtle features of L2. These areas also work as connectors of the entire
phonological system and can only be developed by ensuing neuromotor mechanisms in the vocal apparatus. Once overall articulatory movement is improved, the production of L2 phonology must become more fluid and less strenuous. Fluid speech, may and should result in the speaker producing more connected speech, which in turn can have faster rate.

In using fluency to analyze improved speech, however, one must proceed with caution. In their review of the literature in the topic, Freed et al. (2004) reveal that fluency have varied definitions and can be approached from three points of view: psychological, physical, and sociolinguistic (p. 278). This dissertation uses fluency as a physical (articulatory production and temporal) phenomenon that can help indicate development of speech when associated with other assessment types. I then consider speech rate as defined by Freed et al. (2004): The measure of fluency reflecting the number of spoken words per minute, excluding “all false starts, repetitions, partial repetitions and items contained in repairs” (p. 285).

While it seems easy to just choose one approach and develop a coherent speech analysis, however, there are still considerations to be made as no fluency analysis may render clear conclusions. This is so, because an individual speech performance can bring with it a number of temporal and situational variables, such as personalities, speaking styles, and pedagogical influence, which can impact the measurement of speech rate, for example (Hulstijn, Schoonen, Groenhout, & Jong, 2013;2015; García-Amaya, 2009).

With such considerations in mind, in this assessment, the speech samples of all participants reading the entire text of both tests A and B were computed for speech rate (SR). For each participant’s speech samples, I counted all the spoken words and the
elapsed time of production in seconds. Then I multiplied the number of spoken
words by 60 and divided that by the elapsed time in seconds to find the calculation of
words per minute. In test A, the speech samples of participants AA, EI, and MR, showed
improvement of speech rate (or fluency). The speech samples of participant LU presented
no notable change, and of participant MT presented sharp change towards slowing speech
rate by 21% (Table 6a). For test B results showed faster speech rate for all participants’
speech samples, except for participant MT, whose speech sample slowed by 6.2% (Table
6b).

<table>
<thead>
<tr>
<th>W (word)</th>
<th>m (minute)</th>
<th>w/m (words per minute)</th>
<th>/ (per)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant’s ID</td>
<td>Pre-test</td>
<td>Post-test</td>
<td>Absolute gain (w/m)</td>
</tr>
<tr>
<td>AA</td>
<td>168.88 w/m</td>
<td>176.28 w/m</td>
<td>7.4</td>
</tr>
<tr>
<td>EI</td>
<td>178.13 w/m</td>
<td>198.65 w/m</td>
<td>20.52</td>
</tr>
<tr>
<td>LU</td>
<td>85.04 w/m</td>
<td>84.12 w/m</td>
<td>-0.92</td>
</tr>
<tr>
<td>MR</td>
<td>163.98 w/m</td>
<td>197.49 w/m</td>
<td>33.51</td>
</tr>
<tr>
<td>MT</td>
<td>146.94 w/m</td>
<td>115.07 w/m</td>
<td>-31.87</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>28.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(mean: 5.73)</td>
</tr>
</tbody>
</table>

Table 6a) Reading task A - Pre and Posttest A

| Participant’s ID | Pre-test | Post-test | Absolute gain (w/m) | Gain in % (w/m) |
| AA | 163.73 w/m | 169.56 w/m | 5.83 | 3.56 |
| EI | 145.46 w/m | 163.25 w/m | 17.79 | 12.23 |
| LU | 75.48 w/m | 80.07 w/m | 4.59 | 6.08 |
| MR | 132.89 w/m | 149.02 w/m | 16.13 | 12.13 |
| MT | 124.69 w/m | 116.95 w/m | -7.74 | -6.20 |
| Total | | | 36.60 | 27.80 |
| | | | (mean 7.32) | (mean 5.56) |

Table 6b) Reading Task B - Pre and Posttest B

Considering results from both tasks A and B (comparing pre and post-tests of both
tasks), the mean number of gain in words per minute was 6.525, and the mean percentage
gain was 4.21%. A t-Test assuming unequal variances of the two variants (pre and posttest) of both tasks, presents a two-tail P value of 0.7 (Table 6c).

<table>
<thead>
<tr>
<th>Hypothesized Mean</th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>138.522</td>
<td>145.046</td>
</tr>
<tr>
<td>df</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>t Stat</td>
<td>-0.36909</td>
<td></td>
</tr>
<tr>
<td>P((T&lt;=t)) one-tail</td>
<td>0.35831</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.739607</td>
<td></td>
</tr>
<tr>
<td>P((T&lt;=t)) two-tail</td>
<td>0.71662</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.109816</td>
<td></td>
</tr>
</tbody>
</table>

Table 6c) t-Test

5.2.4. Degree of Accentedness

Foreign accent is a common phenomenon among learners of L2. Pedagogically speaking, foreign accent must be reduced in order for the learner to produce better L2 speech. This is supported by a number of studies relating foreign accent with L2 speech development (Simmonds et al., 2011; Derwing, & Munro, 2005; Major, 2001) and proposing methodology to accent reduction (Sikorski, 2005; Jokisch, Hirschfeld, & Hoffmann, 2005; Pannacheeto, 2003). In addition, Derwing et al. (2005) have suggested that foreign accent has a strong correlation with prosodic features and cited Esling and Wong’s (1983) call for the inclusion of articulatory settings to the teaching of pronunciation to reduce accent (p.383).
Several studies have attested the usefulness and relative accuracy of accentedness rating by judges. According to Derwing et al. (2005), “rating-judgment studies (e.g., Derwing & Munro, 1997; Derwing, Munro, & Wiebe, 1997, 1998; Munro & Derwing, 1995, 1999, 2001) have shown a high degree of reliability across groups of listeners. In this assessment, speech samples of participants and two extra native speakers of English were posted on an online shell (Blackboard) in the form of a survey. Speech samples were 10 sentences of similar length from each test (test A – “The North Wind and the Sun” and test B – “Two Students Meet”) taken from both pre and posttest (except for the native speakers of English whose speech samples were taken from reading the texts only once). A total of 120 speech samples were collected for this assessment.

The samples were rated by independent judges based on the degree of accentedness. All the judges were native speakers of English and affiliated as a student or staff members with the university where this study took place. The judges were not paid to complete the survey, but each received a $5 gift card from a popular coffee shop. At the time of this analysis, twelve judges had completed the survey. They had to indicate on a seven point Likert type scale, one being the least and seven the most, the degree of accentedness of the speech sample. Just to be clear, they were told that the degree of accentedness meant how much the speech sample differed from the native speaker norm – in this case, the Standard American English (SAE).

To calculate the results of the survey, the lowest and highest rating of each speech sample were eliminated to avoid any biased rating and account for rating fairness. The tables below are the data analysis indicating the results of a t-Test: Two-Sample
Assuming Unequal Variances of the pre and posttests for each participant (Tables 7a-7e) and for all participants (Table 7f). The results are not statistically significant (p>0.05).

Participant AA

AA - t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th></th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.505544</td>
<td>4.357754</td>
</tr>
<tr>
<td>Variance</td>
<td>0.209183</td>
<td>0.166346</td>
</tr>
<tr>
<td>Observations</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>0.762642</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.227778</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.734064</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.455556</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.100922</td>
<td></td>
</tr>
</tbody>
</table>

Table 7a: Participant AA’s degree of accentedness t-Test.

Participant EI

EI - t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th></th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.099991</td>
<td>4.182211</td>
</tr>
<tr>
<td>Variance</td>
<td>0.242151</td>
<td>0.450014</td>
</tr>
<tr>
<td>Observations</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>-0.31252</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.379225</td>
<td></td>
</tr>
</tbody>
</table>

Table 7f: Participant EI’s degree of accentedness t-Test.
Participant LU

LU - t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th></th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.976649</td>
<td>4.826644</td>
</tr>
<tr>
<td>Variance</td>
<td>0.344529</td>
<td>0.167853</td>
</tr>
<tr>
<td>Observations</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hypothesized Mean</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>0.66269</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.258481</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.745884</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.516962</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.119905</td>
<td></td>
</tr>
</tbody>
</table>

Table 7c: Participant LU’s degree of accentedness t-Test.

Participant MR

MR - t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th></th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.287757</td>
<td>3.85554</td>
</tr>
<tr>
<td>Variance</td>
<td>0.427608</td>
<td>0.422647</td>
</tr>
<tr>
<td>Observations</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hypothesized Mean</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>1.482271</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.077782</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.734064</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.155564</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.100922</td>
<td></td>
</tr>
</tbody>
</table>
Table 7d: Participant MR’s degree of accentedness t-Test.

Participant MT:

MT - t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th></th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.475535</td>
<td>4.654419</td>
</tr>
<tr>
<td>Variance</td>
<td>0.232418</td>
<td>0.289094</td>
</tr>
<tr>
<td>Observations</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>-0.78332</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.221813</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.734064</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.443625</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.100922</td>
<td></td>
</tr>
</tbody>
</table>

Table 7e: Participant MT’s degree of accentedness t-Test.

All Participants:

t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th></th>
<th>Pretests</th>
<th>Posttests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>4.469095</td>
<td>4.375314</td>
</tr>
<tr>
<td>Variance</td>
<td>0.354776</td>
<td>0.395045</td>
</tr>
<tr>
<td>Observations</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>98</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>0.765816</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.222813</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.660551</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.445626</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>1.984467</td>
<td></td>
</tr>
</tbody>
</table>

Table 7f: All participants’ degree of accentedness t-Test.

5.2.5. Speaking Confidence
Speaking and listening confidence are relevant for this dissertation because the kind of approach tried during the experiment is hypothesized to develop learners’ self-efficacy – an alternative, more technical term for confidence. Several studies have positively correlated the development of self-efficacy beliefs to overall success in life endeavors (Bandura, 2006), language learning strategies (Magogwe & Oliver, 2007; Wong, 2005), and pronunciation improvement (Sardegna, 2012). Brown, Malouff, & Schutte, (2013) theorize that the perception of self-efficacy is also influenced by somatic state (p. 20).

A sensorimotor approach to learning pronunciation is an individual experience of somatosensory and articulatory exploration. The Feldenkrais technique used in this dissertation helps learners develop kinesthetic awareness by a very personal exercise of discovery, which includes development of control and excludes psychological or physical imposition from the part of the instructor. This results in the learner developing his/her own sense of autonomy and confidence (self-efficacy) in a process where autonomy replaces automaticity.

The gain in confidence may not reflect immediate development of pronunciation, but learners may feel empowered to improve pronunciation due to the fact that they might have acquired enough knowledge and sensorimotor awareness to continue development of L2 speech on their own.

In this test, participants were asked on a five point Likert type scale, respectively: (1) – very confident; (2) – somewhat confident; (3) – neutral; (4) – not very confident; (5) – not at all confident) to answer the question, “How confident are you about speaking (pronouncing) English?” Results comparing pretest and posttest, show positive change on
all participants answers with the exception of one participant whose answer remained unchanged. Overall, there was a 2-point gain (mean) in speaking confidence (Table 8a).

![Graph showing speaking (pronouncing) confidence](image)

Table 8a) Speaking (pronouncing) confidence

### 5.2.6. Listening Confidence

In this test, participants were asked in a five point Likert type scale, respectively:

1. very confident;
2. somewhat confident;
3. neutral;
4. not very confident;
5. not at all confident

to answer the question, “How confident are you about listening (understanding) English?” Results comparing pretest and posttest, show positive change on two of the participants’ answers with the remaining participants’ answers unchanged. Overall, there was a half-point gain (mean) in understanding confidence (Table 8b).
5.2.7. Omnibus Results

<table>
<thead>
<tr>
<th>Analysis criteria / Participant</th>
<th>Vowel Space Area</th>
<th>Google Intelligibility</th>
<th>Speech Rate (n.s.)</th>
<th>Speaking Confidence</th>
<th>Degree of Accentedness (n.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Approximately double increase</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small reduction</td>
</tr>
<tr>
<td>EI</td>
<td>Larger reduction</td>
<td>small reduction</td>
<td>Larger increase</td>
<td>Small increase</td>
<td>Almost no change</td>
</tr>
<tr>
<td>LU</td>
<td>Small reduction</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small reduction</td>
</tr>
<tr>
<td>MR</td>
<td>Approximately triple increase</td>
<td>Small reduction</td>
<td>Larger increase</td>
<td>larger increase</td>
<td>Small reduction</td>
</tr>
<tr>
<td>MT</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Larger reduction</td>
<td>No change</td>
<td>Small increase</td>
</tr>
</tbody>
</table>

This table shows the results of all of the analysis criteria for all participants. In average, the VSA, the speech rate, and the speaking confidence, increased for all participants, while the degree of accentedness decreased. The Google intelligibility, on the other hand, presented no notable change. Looking at individual results, participant AA and MR achieved positive results indicating improvement of pronunciation in almost
all criteria. Participant LU achieved positive results as well, but to a lesser degree. Participants EI and MT, however, presented inconsistent results overall.

5.3. Discussion

This dissertation discusses the results of each participant in separate. Such decision stems from the fact that only five participants does not give enough data to build a statistically significant analysis as a group. In addition, looking at each participant in separate may allow for a more individual detailed analysis revealing aspects of the dissertation that might not be possible to consider if a group analysis took place instead. The analysis of each individual follows the order of assessment types detailed in the previous section (Results): VSA; Google automatic speech recognition engine; SR; degree of accentedness; and speaking/listening confidence.

5.3.1. Participant AA

Participant AA is a 22 year old male Spanish speaker with approximately five years of English language learning and use with friends, family, and classmates. On a seven point Likert type scale, one being the least and seven the most, he indicated that his current ability on speaking and listening English was five, and the strength of his foreign accent was four.

Figure (4a) shows participant’s results of VSA during pre and posttest. The posttest shows a large increase in area (more than double.) This indicates that the participant’s voiced sounds became more distinctive during the posttest, as a result of a
greater effort to articulate the sounds of L2. In addition, the vowels appear more far apart, also indicating increased awareness of articulation. In terms of F1/F2 change, posttest show a slightly lower F1, indicating a minor raising of the tongue and closing of the jaw, and a slightly lower F2, indicating RTR or laxness. The combination of these F1/F2 changes with increased VSA points to some relaxation of articulation by the participant, as he is able to produce greater articulatory movement (and distinction) within a smaller cavity. A cross linguistic comparison between the VSA of L1 (Mexican Spanish) and the VSA of the general American English (GAE) would be meaningful; however, an average VSA for L1 was not found. Still, looking at an average VSA of Iberian Spanish (Elvin, Escudero & Vasiliev, 2014) and of GAE (Khalil, 2014), the increased distancing between vowels shown in the posttest indicates change in the direction of L2.

This participant’s results from the Google automatic speech recognition engine for both tests A and B shows slight decrease in the amount of word error rate during posttest A (Table 5a), and large decrease during posttest B (Table 5b). A mean calculation shows his word error rate decreasing from approximate 0.7 to 0.6 on a scale from 0 to 1.2. This shows that his speech became more intelligible overall. An analysis of speech rate shows a small average gain of 6.6 words per minute (Tables 6a & 6b). As for the degree of accentedness, this participant’s results show a decrease of 0.14 points in a seven point Likert type scale (Table 7a). Finally, the participant’s speaking and listening confidence increased one point on a five point Likert type scale (Tables 8a & 8b).
Overall, this participant’s results indicate positive change in the direction of L2 as all measurements represent better outcomes, especially in what concerns the VSA. The table below shows all results for this participants (n.s. = not statistically significant).

<table>
<thead>
<tr>
<th>Analysis Type / Participant</th>
<th>Vowel Space Area</th>
<th>Google Intelligibility</th>
<th>Speech Rate (n.s.)</th>
<th>Speaking Confidence</th>
<th>Degree of Accentedness (n.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Approximately double increase</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small reduction</td>
</tr>
</tbody>
</table>

Table 9a: Participant AA’s overall results

5.3.2. Participant EI

Participant EI is a 26 year old female Japanese speaker and graduate student at the university where this study took place. Because she did not fully answer the language history questionnaire, this is all that is known about her. Her VSA result shows a space decrease of approximate one third the original size during posttest (Figure 4b). The reduction in space can indicate reduction in vowel production and can be interpreted as the participant trying to output SAE’s central and mid vowels. This could be a change in the direction of L2, for in terms of vowel inventory, SAE presents more central vowels than Japanese (Tsujimura, 2014, p. 23). In addition, a general lower F1 in the posttest indicates the participant opening less the jaw and creating smaller cavity for speech. This can reflect the reduction of the vowel space toward production of central and mid-vowels. It can also indicate that the participant is making less effort (and thus having a more relaxed articulatory movement) to speak L2. In terms of F2, there appears to be no meaningful change. In general, this participant’s VSA result could indicate improvement in the direction of L2, but could also represent that the participant is not producing
distinctive L2 vowels, which could result in greater degree of accent and/or unintelligibility.

The average results of the Google speech recognition for this participant shows a 0.1 increase of word error rate on a scale from 0 to 1.2 during posttest (Table 5c). This can represent a meaningful decrease in speech intelligibility. However, technical issues, such as the distance of the microphone from the mouth or external noise, could have influenced the results. The analysis of speech rate shows a gain of 19.15 words per minute, indicating increased fluency (Table 6a & 6b). As for the degree of accentedness, there was an insignificant increase of 0.08 point on a seven point Likert type scale (Table 7b). Finally, there was a one point increase of speaking confidence on a five point Likert type scale (Table 8a).

Overall, this participant’s results appear to be inconsistent, as there are positive outcome from some assessments, such as speech rate and confidence, but not from Google speech intelligibility. In addition, result from VSA appears contradictory, and from degree of accentedness close to zero. It is therefore difficult to develop an objective overall assessment of this participant’s results. The table below shows all results for this participants (n.s. = not statistically significant).

<table>
<thead>
<tr>
<th>Analysis Type / Participant</th>
<th>Vowel Space Area</th>
<th>Google Intelligibility</th>
<th>Speech Rate (n.s.)</th>
<th>Speaking Confidence</th>
<th>Degree of Accentedness (n.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EI</td>
<td>Larger reduction</td>
<td>small reduction</td>
<td>Larger increase</td>
<td>Small increase</td>
<td>Almost no change</td>
</tr>
</tbody>
</table>

Table 9b: Participant EI’s overall results

5.3.3. Participant LU
Participant LU is a 25 year old female Chinese speaker of Mandarin with approximately seven years of English language learning and use with friends, family, and classmates. She also indicated that she is a graduate student at the university this study took place, and has been living in the U.S. for three years. On a seven point Likert type scale, one being the least and seven the most, she indicated that his current ability on speaking and listening English was five and six respectively, and the strength of her foreign accent was four.

Figure (4c) shows participant’s results for VSA during pre and posttest. The posttest shows slight decrease in area. As with participant EI, but to a much lesser degree, the reduction in space can indicate reduction in vowel processing and can be interpreted as the participant trying to output SAE’s central and mid vowels. This could be a change in the direction of L2. A cross linguistic comparison supports such hypothesis taking into consideration Yi Tso-Lin’s (1920) study, which shows that Mandarin lacks the lax vowels of English and has only one central vowel /ɜ/ (as cited in “Comparison of English and Mandarin.”) In contrast and according to Khalil (2014), General American English (GAE) has three central vowels /o, ʌ, ə/. In addition, a general lower F1 in the posttest indicates the participant opening less the jaw and creating smaller cavity for speech. This can also reflect the reduction of the vowel space toward production of central and mid-vowels. It can also indicate that the participant is making less effort (and thus having a more relaxed articulatory movement) to speak L2. In addition, the high vowels appear more far apart from each other, but closer to lower vowels, indicating increased awareness of articulation as it relates to F1/F2 change. The posttest show a slightly lower F1, indicating a minor raising of the tongue and closing of the jaw, and a lower F2,
indicating RTR or laxness. The combination of these F1/F2 changes with decreased VSA points to some relaxation of articulation and centralization of vowel production by the participant.

This participant’s results from the Google automatic speech recognition engine for both tests A and B shows slight decrease in the amount of word error rate of approximate 0.1 point (mean) on a scale from 0 to 1.2 (Table 5c). This shows that his speech became more intelligible overall. An analysis of speech rate shows a small average gain of 3.6 words per minute (Tables 6a & 6b). As for the degree of accentedness, this participant’s results show a decrease of 0.15 points on a seven point Likert type scale (Table 7c). Finally, the participant’s speaking confidence increased one point on a five point Likert type scale (Table 8a).

Overall, this participant’s results indicate positive change in the direction of L2 as all measurements represent better outcomes, with caution to how to look at the change of VSA. The table below shows all results for this participants (n.s. = not statistically significant).

<table>
<thead>
<tr>
<th>Analysis Type / Participant</th>
<th>Vowel Space Area</th>
<th>Google Intelligibility</th>
<th>Speech Rate (n.s.)</th>
<th>Speaking Confidence</th>
<th>Degree of Accentedness (n.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LU</td>
<td>Small reduction</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small increase</td>
<td>Small reduction</td>
</tr>
</tbody>
</table>

Table 9c: Participant LU’s overall results

5.3.4. Participant MR

Participant MR is a 26 year old male Chewa speaker from Malawi with approximately fifteen years of English language learning and use with friends, family,
and classmates. On a seven point Likert type scale, one being the least and seven the most, he indicated that his current ability on speaking and listening English was four and six respectively, and the strength of his foreign accent was five.

Figure (4d) shows participant’s results of VSA during pre and posttest. The posttest shows a large increase in area (almost triple). This indicates that the participant’s voiced sounds became more distinctive during the posttest, as a result of a greater effort to articulate the sounds of L2. In addition, the vowels appear more far apart from each other, also indicating increased awareness of articulation. In terms of F1/F2 change, posttest shows higher F1 reach, indicating lowering of the tongue and opening of the jaw. This can represent an articulatory movement in the direction of SAE’s articulatory settings of open jaw (Esling, 2006) and anchoring of the tongue (Honikman, 1964). In addition, posttest shows lower F2, indicating RTR or laxness. The combination of these F1/F2 changes with increased VSA points to greater articulatory awareness by the participant, as he is able to produce clearer vowels and increase buccal cavity. A cross-linguistic comparison between the VSA of L1 (Chewa) and the VSA of the general American English (GAE) also reflects change in the direction of L2. Chewa has five vowels (Cibelli, 2012) whereas GAE has eleven vowels (Khalil, 2014; Packer et al., 2013). Since the participant’s VSA from posttest shows more point vowels and much greater voiced area, the change is notably in the direction of L2. Finally, the increased distancing among vowels shown in the posttest indicates change in the direction of L2 as well.

This participant’s results from the Google automatic speech recognition engine for both tests A and B, however, shows 6 on a scale from 0 to 1.2, an approximate 0.18 point
(mean) increase in the amount of word error rate during posttest (Table 5c). As with participant EI, this can represent a meaningful decrease in speech intelligibility. However, technical issues, such as the distance of the microphone from the mouth or external noise, could have influenced the results. An analysis of speech rate shows a large average gain of 24.8 words per minute (Tables 6a & 6b). As for the degree of accentedness, this participant’s results show a decrease of 0.43 point on a seven point Likert type scale (Table 7a). While this result cannot be considered statistically significant, a t-Test assuming unequal variances between pre and posttests produced a two-tail P value of 0.15 (p >.05). Among all participants, this result came closer to be statistically significant. Finally, the participant’s speaking confidence increased two points and listening confidence increased one point on a five point Likert type scale (Tables 8a & 8b).

Overall, this participant's results indicate the most positive change in the direction of L2 as all measurements represent better and larger outcomes, especially in what concerns the VSA and fluency. The sole exception is the Google speech recognition result, which can be interpreted as being interfered by external variables, such as technical issues with microphone or external noises. The table below shows all results for this participants (n.s. = not statistically significant).

<table>
<thead>
<tr>
<th>Analysis Type / Participant</th>
<th>Vowel Space Area</th>
<th>Google Intelligibility</th>
<th>Speech Rate (n.s.)</th>
<th>Speaking Confidence</th>
<th>Degree of Accentedness (n.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td>Approximately triple increase</td>
<td>Small reduction</td>
<td>Larger increase</td>
<td>larger increase</td>
<td>Small reduction</td>
</tr>
</tbody>
</table>

Table 9d: Participant MR’s overall results
5.3.5. Participant MT

Participant MT is a 23 year old male speaker of Mano, a dialect from Liberia. He has spent approximately sixteen years learning English and ten months living in the U.S. On a seven point Likert type scale, one being the least and seven the most, he indicated that his current ability on speaking and listening English was four and six respectively, and the strength of his foreign accent was six.

Participant MT’s VSA enlarged almost twice as much from pre to posttest (Figure 4e). As with participants AA and MR, an increase VSA indicates more voiced sounds being produced, which indicates movement in the direction of L2. Mano has seven vowels (Anyanwu, 2008), whereas GAE has eleven (Khalil, 2014). In addition, vowels appear more far apart from each other, reflecting a more distinguished pronunciation. However, there appears to be no change in the scale of F1 or F2. In terms of Google speech recognition, this participant’s results indicate a minimal improvement in intelligibility overall – approximately 0.01 point (mean) decrease in word error rate on a scale from 0 to 1.2 (Table 5c).

It is in the analysis of speech rate (fluency), however, that this participant’s posttest production presents a sharper change in the negative direction. His speech rate decreased by an average of 19.8 words per minute overall (Tables 6a & 6b). It is more likely that this participant slowed down the speech for reasons other than fluency development itself. Perhaps he focused on articulatory sensation, breathing, and accuracy. The intervention in this dissertation experiment included exercise on breathing, relaxation, and concentration. As a result, this participant may have decided to pace speech to reflect those aspects. Just to be clear, the participants were never informed that
their productions were going to be evaluated on the basis of fluency, and neither were the tasks of the pre and posttests designed to target fluency (they were just simple reading tasks).

As studies above have suggested, indeed, fluency measurements can be controversial due to several variables. This participant might have thought that in order to produce better L2 speech he ought to slow speech rate. Indeed, the VSA analysis indicates greater distinctiveness of vowel sounds, and Google speech recognition, indicates slight gain in intelligibility. Therefore, the slowing of speech rate must not be interpreted as an issue of speech quality.

His results for degree of accentedness also indicate negative outcome, but very slightly. Overall, his speech samples were rated 0.17 points (average) more accented on a Likert scale from 0 to 7 (Table 7e). This result may be the reflection of a notably slower speech during posttest, as judges might correlate decreased fluency with increased accent.

Finally, on the speaking and listening confidence results, this participant indicated no change during posttests (Tables 8a & 8b). Overall, in light of the results of this participant, of which, only the VSA shows meaningful change towards the development of L2 phonology, it is possible to hypothesize that for this participant, the approach used during the experiment did not have the expected impact by the time of the posttests.

<table>
<thead>
<tr>
<th>Analysis Type / Participant</th>
<th>Vowel Space Area</th>
<th>Google Intelligibility</th>
<th>Speech Rate (n.s.)</th>
<th>Speaking Confidence</th>
<th>Degree of Accentedness (n.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT</td>
<td>Large increase</td>
<td>Small increase</td>
<td>Larger reduction</td>
<td>No change</td>
<td>Small increase</td>
</tr>
</tbody>
</table>

Table 9e: Participant MT’s overall results
5.4. Limitations of the Experiment

The experiment developed in this dissertation is unprecedented since it appears this is the first time a study incorporates the Feldenkrais technique and the sensorimotor approach to pronunciation pedagogy. One of the challenges of this experiment was that almost all of ATM lessons had to be adapted to correlate the needs of a pedagogical setting that fostered sensorimotor awareness of the vocal apparatus towards L2 phonology. The attempt was thus approximate, as I must admit, and I wish the exercises were better designed to target specific articulatory settings of L2 development, such as the setting of moving the tongue in RTR. When dealing the first time with such a novelty approach there is always the risk of erroring and improvising with the experiment becomes a trial in itself. On the other hand, the trial leads to experience and experience leads to better knowledge of how it can be improved next time.

In terms of sensorimotor practice, participants might have benefitted further if the experiment had spent more time on actual exercising of articulatory settings features through the use of the Feldenkrais principle of movement awareness. In total, approximately three hours were spent with actual sensorimotor exploration of speech mechanism, and as I previously stated, within that time, some exercises were not ideally targeted. The overall time spent applying the technique was limiting. Moreover, the first two stages of the experiment were spent with theoretical explanations of articulatory settings and the sensorimotor mechanism of speech acquisition. The intention in doing that was to help participants understand the concepts and identify their own natural constraints of articulatory settings, before putting them into practice. In reality, however, that pedagogical choice might have confused some of the participants and taken them out
of focus. And because the theoretical explanations might not have been interesting to participants eager to start practicing pronunciation, that could be the reason why some of them left the experiment in the first few weeks. Therefore, an experiment more composed of sensorial stimulation and ATM-based lessons targeting articulatory settings might have been more effective in terms of testing the impact of the methodology proposed by this dissertation. If the core of the methodology was to develop the somatosensory mechanism of speech, it should be more relevant to give further focus to activities allowing participants to explore and experience the same.

Another limitation of this study is that the experiment was done without any connection to a regular pronunciation course. In retrospect, the approach tried in this dissertation was proposed as a complement to a customary pronunciation course to enhance the same and improve overall learning experience. Being disconnected from a regular pronunciation course, the classroom experiment developed in this study might have felt strange and disengaged to the students because of the way it differed from an otherwise more familiar learning experience. A sensorimotor approach to L2 pronunciation must not happen without, for example, approaches to auditory perception containing L2 input. As predicted by the DIVA model (Guenther, 2006), the auditory loci of the brain must receive input from the native form to build an auditory map before it can serve as reference for further phonological tuning through the feedback subsystem. In this experiment, only visual and kinesthetic inputs were presented to participants; auditory inputs were coming only from self-production and self-hearing production, not from external L1 input.
The final limitation of this study has to do with the number of participants who completed the experiment. Five participants can lead to significant qualitative data analysis, but limited (if not insignificant) quantitative analysis. This study has been designed to yield quantitative data and ideally, it should have happened with twenty or more participants to yield statistically significant results.

5.5. Other Considerations

In spite of the above limitations, this study has provided several indications as to how and how effectively one can advance pronunciation pedagogy by using the sensorimotor approach. For example, in order to acquire L2 phonology more comprehensively, learners require a special setting for learning, which is characterized by mindfulness – a condition to learning in which the learner is invited to pay attention to kinesthetic and proprioceptive sensation. This suggest that in a pronunciation class, there needs to be an environment in which learners should sometimes engage in silent moments of exercise to explore the neuro-muscular connections of the articulatory settings of the vocal apparatus towards L2 speech. In this study, participants were asked to fully focus on exercises and activities involving relaxation, concentration, and sensation. Based on one participant’s comments (Appendix C), this kind of learning helped him relax the parts of the vocal apparatus, especially the tongue, and engage them to better pronounce L2.

Another aspect to contemplate from this study relates to the teaching of the contents on brain mechanisms and articulatory settings. Although it was said above that these subjects, when taught to the participants, can confuse and sidetrack some of them, it
is important to keep in mind that if used in balance with the rest of the methodology, these contents might assist the learner better understand the entire theory. Particularly in regards to articulatory settings, it appears that explaining and showing this phonological feature to participants helps to open their minds to a deeper level of experiencing pronunciation. According to one of the participants, the learning of articulatory settings was a novelty concept that helped him think through his own learning of pronunciation. It was illuminating for him to see and realize how, kinesthetically, the native speakers produced L1 in their vocal apparatus, which in turn helped him develop his own articulatory settings towards L2 (in conference).

Still in relation to the pedagogy of articulatory settings (AS), previous works have suggested that AS should be taught separately from other features of phonology, such as the segmental ones. For instance, Esling & Wong (1983) proposed that AS be taught before a segmental approach to learning could take place. Likewise, Jones & Evans (1995) suggested a “top-down approach to pronunciation” (p. 245) that would begin with the teaching of articulatory settings, a more comprehensive feature. This study, however, suggests that working simultaneously with AS and segmental features can be productive. In this study, after introducing the concept of AS to participants, I asked them to identify specific phonemes (three to be exact) which made it more difficult for them to pronounce L2. I also asked them to identify the parts of the vocal apparatus that were involved in the production of those three segments (the articulatory reference). At the end of the experiment, I asked them to experience the same correlation: I developed an activity focused on the sensorial production of those three segments, which focused on the
understanding of articulators. The phonemes were therefore treated in conjunction with (and related to) their respective articulatory settings.

Additionally, this study predicts that it's important to focus on what is limiting the articulation of the target sound. Sensorial awareness of this limiting kinesthetic point is key to advance. As the sensorial brain is informed by what is not working (DIVA’s feedback subsystem), it can send feed-forward information to the motor cortex as to what can work (Guenther et al, 2011). It is therefore important that the teaching of pronunciation focuses on the articulatory point of difficulty where the attempt to rightly produce a sound needs to be assessed in order for the brain to be able to transpose the limiting barrier. Just to make sure, this approach needs to be sensorial and exploratory in nature as opposed to being conditioned or judgmental. In a traditional pronunciation course, conversely, the focus is on the right production of the L2 sounds through repetition, targeting what might still not exist in the repertoire of the learner, skipping the developmental learning. In the method proposed in this study, conversely, the focus starts on the sensation of the sound that the participant can actually produce – no matter limiting that is.

Furthermore, this study suggests that less effort and more sensitivity leads to more learning; whereas more effort and less sensitivity interferes with learning. According to Richard Goldsand (in conference), the Feldenkrais practitioner who designed and applied the ATM lessons to this study, this is a tenet that is also shared by the Feldenkrais method. Indeed, for the learners to be sensitive to their limiting productions, they need to relax and let the movement occur without tension. Once this kind of approach to movement is implicit, condition is given to the brain to process information without
interference or judgment. Indeed, if I had just asked the participants to mimic L1’s articulatory settings and judged them on their productions, I would have just repeated traditional methods of pronunciation learning. According to Arndt and Stuart’s (1986) study, traditional approaches to pronunciation, where effortful (and rote) repetition is a norm, can overtax the brain of the learners in detriment of fine phonological acquisition.
CHAPTER 6  
Conclusion and Future Directions

Without rejecting most of the practices and material presently available in ESL pronunciation classrooms, this dissertation tested a specialized approach to production (including repetition) by introducing the notion of articulatory settings as a sensorial material to be acquired through sensorimotor learning. Upon completion of the study experiment, while the analysis of the data and the data itself presented significant challenges, results indicated overall positive change towards the direction of L2. Whereas the results are not statistically significant (p>0.05), the principled idea of the hypothesis developed in this dissertation should still be considered.

One of the objectives of this dissertation was to build a strong theoretical support for a sensorimotor approach to L2 phonological acquisition, and I hope this objective was met. As for the other objective which purported to test whether a pertinent methodology would lead to participants advancing the quality of pronunciation; it suffices to say, further examination is necessary.

In fairness, this dissertation can be considered a foundational study leading to further investigation. It contains substantial material informing the acquisition of L2 pronunciation and if further developed in the future, this could lead to significant results. In an ensuing study, however, I recommend that the following points be considered: (1) that the number of participants be higher, so that a statistically significant amount of data can be collected, calculated, and analyzed; (2) that the teaching activities and practices of the experiment be focused on actual sensorimotor techniques of speech and not on theory
as they were during part of the experiment; (3) that the experiment last longer than approximately eight hours within a period of two months. Perhaps, the new study needs to be done during double the amount of hours and over a period of approximately a semester. This is because participants need time to process and develop the sensorimotor information that is taught. In this sense, this dissertation could become a longitudinal study; (4) that the experiment be conducted in tandem with and as a complement of a regular pronunciation course so that there is supportive methodology underlying the entire experiment and participants do not feel so strange to novel methodology; and finally, (5) that the ATM lessons of Feldenkrais be better adapted to reflect the specific demands of the target language articulatory settings. With that in mind, I suggest that in future trials, the ATM exercises should serve only as a principled model for developing similar but more targeted exercises for L2 speech development.

This study can be adapted to investigate the acquisition of other languages by other types of learners as well. This is because the theoretical and methodological matters tried in this dissertation focus on articulatory performance underpinned by neurological mechanisms, which in essence, is part of any idiom.

If an advanced L2 learner still struggles to produce L2 pronunciation even after prolonged L2 practice, there must be something in the phonology of L2, which challenges acquisition beyond what we commonly know. This seems to be especially true with phenomena of L1 - L2 similarity-equivalence, in which subtle features make the acquisition process further challenging (Ringbom et al., 2009). It must also be true to segmental phenomena that emanate articulatory settings that are competitive, sometimes even rival, to the learner’s own articulatory settings (those acquired with L1). The
acquisition of a second language, thus, seems to require more than traditional
approaches to segmental and prosodic features. It is thus important that pronunciation
researchers and practitioners take a closer look at this type of approach to advance the
quality of L2 pronunciation pedagogy.
NOTES

1. As a language student and instructor I have experimented with language learning software in French, Portuguese, English, and Italian. Recent software available on the market usually has a section on pronunciation, which is based on repetition of passages. Some of the companies selling this kind of software include Transparent Language and Berlitz.

2. However, I have found that many articulatory settings features are a reflection of (and effect) several phonological processes if not all of them. In an earlier study, “Perspectives on Voice Quality” (2010) I discussed in detail how some articulatory settings features correlate with a number of phonological processes, such as palatalization of /s, t, d, l/, light and dark /l, ł/, laxness of some English vowels, such as [ı, æ], velarization, and nasalization. Also it appears that they can interact with each other in a process similar to assimilation. The difficulty with assessing articulatory settings features and how they interact in this way lies in the fact that the technology currently available in the field does not provide an objective measurement (Mennen et al., 201).

3. During an academic semester, I observed an ESL pronunciation course at a local community college. Some textbooks include Lujan (2008) and Gilbert (2005).

WORKS CITED


Packer, Claire Brakel and Lorincz, Kristen (2013) "Acoustic Vowel Space Analysis of an English Language Learner," Linguistic Portfolios: Vol. 2, Article 3. Available at: http://repository.stcloudstate.edu/stcloud_ling/vol2/iss1/3


L2 Language History Questionnaire (Version 2.0)

Contact Information:
Name: _____________________ Email: _____________________
Telephone: ___________________ Today’s Date: ___________________

Please answer the following questions to the best of your knowledge.

PART A

1. Age (in years):

2. Sex (circle one): Male / Female

3. Education (degree obtained or school level attended):

4(a). Country of origin:

4(b). Country of Residence:

5. If 4(a) and 4(b) are the same, how long have you lived in a foreign country where your second language is spoken? If 4(a) and 4(b) are different, how long have you been in the country of your current residence? (in years)

6. What is your native language? (If you grew up with more than one language, please specify)

7. Do you speak a second language?

__YES my second language is ____________________.
__NO (If you answered NO, you need not to continue this form)
8. If you answered YES to question 7, please specify the age at which you started to learn your second language in the following situations (write age next to any situation that applies).

At home: ________
In school: ________
After arriving in the second language speaking country ________

9. How did you learn your second language up to this point? (check all that apply)

(Mainly) Mostly Occasionally) through formal classroom instruction.
(Mainly) Mostly Occasionally) through interacting with people.
A mixture of both, but (More classroom More interaction Equally both).
Other (specify: ____________________________).

10. List all foreign languages you know in order of most proficient to least proficient. Rate your ability on the following aspects in each language. Please rate according to the following scale (write down the number in the table):

<table>
<thead>
<tr>
<th>Very poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Functional</th>
<th>Good</th>
<th>Very good</th>
<th>Native-like</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Reading proficiency</th>
<th>Writing proficiency</th>
<th>Speaking fluency</th>
<th>Listening ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11. Provide the age at which you were first exposed to each foreign language in terms of speaking, reading, and writing, and the number of years you have spent on learning each language.

<table>
<thead>
<tr>
<th>Language</th>
<th>Age first exposed to the language</th>
<th>Number of years learning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speaking</td>
<td>Reading</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Do you have a foreign accent in the languages you speak? If so, please rate the strength of your accent according to the following scale (write down the number in the table):

<table>
<thead>
<tr>
<th>No Accent</th>
<th>Very Weak</th>
<th>Weak</th>
<th>Intermediate</th>
<th>Strong</th>
<th>Very Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language</th>
<th>Accent (circle one)</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

PART B

13. Estimate, in terms of percentages, how often you use your native language and other languages per day (in all daily activities combined, circle one that applied):

Native language: <25%  25%  50%  75%  100%
Second language: <25%  25%  50%  75%  100%
Other languages: <25%  25%  50%  75%  100%
(specify the languages: )
14. Estimate, in terms of hours per day, how often you are engaged in the following activities with your native and second languages.

<table>
<thead>
<tr>
<th>Activities</th>
<th>First Language (hrs)</th>
<th>Second Language (hrs)</th>
<th>Other Languages (specify _____) (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listen to Radio/Watching TV:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading for fun:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading for work:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading on the Internet:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing emails to friends:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing articles/papers:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. Estimate, in terms of hours per day, how often you speak (or used to speak) your native and second languages with the following people.

<table>
<thead>
<tr>
<th>Language</th>
<th></th>
<th>Hours (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grandfather(s):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grandmother(s):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brother(s)/Sister(s):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other family members:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. Estimate, in terms of hours per day, how often you now speak your native and second languages with the following people.

<table>
<thead>
<tr>
<th>Language</th>
<th></th>
<th>Hours (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spouse/partner:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friends:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classmates:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-workers:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17. Write down the name of the language in which you received instruction in school, for each schooling level:

Primary/Elementary School:  
Secondary/Middle School:     
High School:                 
College/University:          

123
18. In which languages do you usually:

- Count, add, multiply, and do simple arithmetic?
- Dream?
- Express anger or affection?

19. When you are speaking, do you ever mix words or sentences from the two or more languages you know? (If no, skip to question 21).

20. List the languages that you mix and rate the frequency of mixing in normal conversation with the following people according to the following scale (write down the number in the table):

<table>
<thead>
<tr>
<th>Rarely</th>
<th>Occasionally</th>
<th>Sometimes</th>
<th>Frequently</th>
<th>Very Frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Languages mixed</th>
<th>Frequency of mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spouse/family members</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Friends</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-workers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classmates</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

21. In which language (among your best two languages) do you feel you usually do better? Write the name of the language under each condition.

<table>
<thead>
<tr>
<th>At home</th>
<th>At work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td></td>
</tr>
<tr>
<td>Writing</td>
<td></td>
</tr>
<tr>
<td>Speaking</td>
<td></td>
</tr>
<tr>
<td>Understanding</td>
<td></td>
</tr>
</tbody>
</table>
22. Among the languages you know, which language is the one that you would prefer to use in these situations?
- At home
- At work
- At a party
- In general

23. If you have lived or travelled in other countries for more than three months, please indicate the name(s) of the country or countries, your length of stay, and the language(s) you learned or tried to learn.

24. If you have taken a standardized test of proficiency for languages other than your native language (e.g., TOEFL or Test of English as a Foreign Language), please indicate the scores you received for each.

<table>
<thead>
<tr>
<th>Language</th>
<th>Scores</th>
<th>Name of the Test</th>
</tr>
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<tbody>
<tr>
<td></td>
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</tbody>
</table>

25. If there is anything else that you feel is interesting or important about your language background or language use, please comment below.

PART C
(Do you have additional questions that you feel are not included above? If yes, please write down your questions and answers on separate sheets.)
APPENDIX B

ASSESSMENT TYPES
Please, while recording, read the text below to the best of your ability, keeping your natural (usual) way of speaking English.

The North Wind and the Sun

The North Wind and the Sun were disputing which was the stronger, when a traveler came along wrapped in a warm cloak.
They agreed that the one who first succeeded in making the traveler take his cloak off should be considered stronger than the other.
Then the North Wind blew as hard as he could, but the more he blew the more closely did the traveler fold his cloak around him;
and at last the North Wind gave up the attempt. Then the Sun shined out warmly, and immediately the traveler took off his cloak.
And so the North Wind was obliged to confess that the Sun was the stronger of the two.
Practice saying this dialogue until you are comfortable with it. Then record it, speaking as naturally as possible.

**Two University Students Meet**

A: Excuse me. Where’s the library?
B: It’s on the corner of Main Street and Selling Road.
A: Sorry, did you say Selling or Ceiling?
B: Selling. It’s directly ahead of you, about 2 blocks.
A: Thanks. I need to buy some books for my classes.
B: Oh, then you need the bookstore. You can’t buy books at the library. You can only borrow them there.
A: I guess I confused the words. They’re different in my language.
B: I know how it is. I get mixed up with Spanish words that sound like English words, but have different meanings.
A: Are you studying Spanish?
B: Yes, it’s going to be my major. What are you studying?
A: I’m studying English now, but my major will be economics.
B: Really? My brother wanted to study economics. He took the entrance exam for that department just last week.
A: Did he succeed?
B: No, quite the opposite. He failed.
A: That’s too bad.
B: Oh, it’s OK. He would’ve had to study statistics, and he hated that idea. Anyway, he changed his mind, and now he plans to study music.
A: That’s great! Does he want to compose or perform?
B: Both. He wants to compose and perform. He arranges programs for musicians, but he also plays classical guitar.
A: Well, I wish him a lot of luck. And good luck to you, too. It was nice talking.

---

Survey on Speaking Confidence

L2 Language History Questionnaire Part 1

Participant’s ID:
First 3 letters of Mother’s first name + Last 4 digits of telephone number, all together in one word.
For example: Ana9268

_________________ (Enter this same ID on the Computer Questionnaire)

Please in addition to the online questionnaire you will complete in the computer, answer the following question to the best of your knowledge.

1. To answer this question, please select the best option below. In a scale from 1 (one) to 5 (five), how confident are you about:

   A) Speaking (pronouncing) English:
   1. Very confident
   2. Somewhat confident
   3. Neutral
   4. Not very confident
   5. Not at all confident

   B) Listening to (understanding) English
   1. Very confident
   2. Somewhat confident
   3. Neutral
   4. Not very confident
   5. Not at all confident
APPENDIX C

TRANSCRIPTIONS OF ATM LESSONS
Lesson 1:

Connecting breathing with the movement of the jaw, lips, and tongue.

Before this lesson, the Feldenkrais practitioner presented the participants with a brief review of the history and background of the Feldenkrais technique.

Practitioner:
- The technique looks at habitual movement and teach us what these are so that we do what we want with it […]
- It gives heightened sensitivity to decrease the effort […]
- Everything we do has movement in your life. All of our movements are interconnected we just don’t know it. This teaching will help us become aware of it.
- Please lay on the floor.

(Participants lay on the floor. Each participant receives a towel to cover the floor).

Practitioner:
- Here are some rules of Feldenkrais: nothing is supposed to hurt; rest when you want to rest; there is no “right or wrong” on the way you do the exercises. Try to make it feel comfortable for you.
- Observe how the air comes in and out of the mouth.
- Where does your tongue sit in your mouth as you breathe? Is it close to the bottom, the teeth, or the roof?
- As you inhale, place a hand where you feel it moves when you take the air in. Place hands on belly and chest.
- As you inhale, make your belly big – inflate the belly. As you exhale, contract the belly and lift the chest.
- As you inhale and make the belly bigger, take your teeth and jaw and clench your teeth. As you exhale, release the teeth, suck the belly in, and see what happens.
- Stop and rest; feel what your breathing is right now. Has it changed, is it different?
- Now we do the opposite. As you inhale, suck the belly in and lift the chest. As you exhale, push the belly out.
- As you inhale this time, clench your teeth and suck the belly in. As you exhale, release the teeth and push the belly out.
- Rest and notice yourself on the floor.
- Now let’s do the opposite. Please change hands
- As you inhale, make your belly bigger when you exhale, clench your jaw and push the belly out
- Do it gentler, easy, smaller. The amount is not important, what’s important is the intention of listening to the movement.
- As you exhale, push the belly out and clench your teeth.
- Notice what the breathing feels like. Has it changed?
- Inhale and hold the breath and do this see-saw movement: push the belly out, soften the chest rest, then push the belly in and expand your chest.
- Stop and rest.
- Put your hands the way you want and move your lips forward as if you are going to kiss someone.
- As you inhale, make the belly bigger and do the pecking of the lips; as you exhale and the belly in, and lift the chest, you do the pecking again. It’s the opposite of the first movement.
- Stop and rest; notice the breathing and your body on the floor.
- Now, as you inhale, lift the chest, suck the belly in, and do the pecking; as you exhale, push the belly out and soften the lips.
- Now do the reverse: as you inhale, lift the chest; but as you exhale, push the belly out and push the lips out.
- Stop and put your hands by your side. Feel how you are in the floor. Where is your tongue in your mouth, closer to the front, roof, back, or bottom?
- With eyes closed, set yourself to sit.

(Participants sit on the floor)

Practitioner:
- How to you notice where your tongue is in your mouth? And the breathing?
- Take your time to get up.
- Thank you.
Lesson 2:

Connecting the movement of the head and jaw with that of the pelvis

Before the lesson, the practitioner and participants engaged in a short dialogue:

Practitioner:
- How was the experience of last time?

Participant:
- I don’t know the right way to do some exercises.

Practitioner:
- It isn’t about doing it right, but about exploring how you do it. The articulation of English becomes a self-made exploration of how you say a word so that it becomes a sensation that you can use it […] This idea of the articulation of the tongue and the jaw, and facial movements of the cheek, the eyes … the way you move your eyes may relate to how you move your jaw.

Lesson begins and practitioner notes to participants that the jaw, tongue, and lips, are impacted by how your pelvis moves.

Practitioner speaks:
- Please lay on the floor.
- Feel your body on the floor, bringing attention to yourself. Feel the way the parts of your body make contact with the floor.
- What’s the length of the right leg, and what’s the length of the left leg? Do the same with the arms.
- Gently roll your head a little bit to the left and right.
- Now, put your feet on the floor (bend your knees).
- Pay attention to your chin. Move the chin away from the chest and then move it closer to the chest.
- How does it feel in the back of your head, and in the neck?
- Now, move the head side to side.
- Now do both movements: move the chin away from the chest and pay attention to the point of pressure on the back of the head, closer to the neck; then, move chin closer to chest and pay attention to the point of pressure close to the top of the head.
- Now, roll the head side to side. As you roll, you have two more points of contact in the horizontal plane. Now, you have a total of four points of contact.
- Make a circle around those four points. First, move clockwise, at the 12 o’clock, 3 o’clock, 6 o’clock, 9 o’clock marks. Then reverse the circle, counter-clockwise. Observe what happens in your chest, belly, pelvis, and feet.
- Stop and rest.
- With the pelvis, do the same that was done with the head. Begin first moving it in the vertical axis. Press the feet into the floor to press the lower back into the floor. Then arch your lower back away from the floor.
- Do you feel your head as you move your pelvis up and down?
- Now, roll pelvis to the left and come back to middle.
- Then roll it to the right and come back to middle.
- Now you have four points of reference. Around these four points, make a circle as in a clock. First, move clockwise, at the 12 o’clock, 3 o’clock, 6 o’clock, 9 o’clock marks. Then reverse the circle, counter-clockwise.
- Stop and rest.
- Now open the jaw and close it, open your mouth and close it.
- Now, go to the middle place, not too open, not to close. Lips are soft. Then move the jaw a little to the left and come back (not the head, just the jaw).
- Now do the same thing and do it to the right. Feel what muscles you use, what happens to the throat, the back of the neck. What do your lips do, do you clench them?
- Then do the same movement to the left.
- Then move it left and right. As you move the jaw left and right, what happens to the back of the neck?
- Now, with the jaw, do the circle. First begin clockwise, then counterclockwise.
- Stop and rest.
- Now, move the chin away from the chest and open the mouth a little bit, and also, arch your back, and then come back and do it again.
- And now do the opposite: bring the chin closer to the chest, press the lower back into the floor and close your mouth.
- And can you combine the two? Do the first way then the second way.
- Stop, rest.
- Then, tilt the pelvis to the left and come back, and do the same thing to the right.
- And now, could you put all three of those circles together now? You move your head from 12 to 3, then the jaw from 6 to 9, and then the pelvis. Make circles with all three parts.
- And can you reverse the circles?
- Stop and rest.
- Just go back to the original movement of tilting the head vertically, and observe how the pelvis and back moves.
- Slowly with your eyes closed, roll to side, come to sit and come to standing.
- Thank you.
After the lesson, I spoke to participants that, although it does not seem like, the technique is designed to help us relax and become aware of how we can move the parts of the vocal apparatus. One participant highlighted the importance of breathing to the speech gesture.
Lesson 3:

Exploring the range of motion of the tongue.

Practitioner:
- Lay on the floor, feel, and observe the contact of the back of the neck, back of head, shoulder and shoulder blades.
- How about the contact of pelvis and buttocks, and heels? Which heels, which leg?
- Observe the contact with the other leg.
- Very gently very easily, can you hold your head one direction and then the other?
- Very gently, see which way you decide to roll your head.
- Stop.
- In your imagination, can you get an idea of where your tongue sits in your mouth?
- Does it sit in the upper palate? What is its distance from the lower part or the jaw?
- What is the distance the tongue is from the top teeth, or from the bottom teeth?
- And now, please do the following, very gently, take your tongue and press your whole tongue on the top of the mouth, then release.
- You’re pressing your tongue many times, and then release. Which side of the mouth you press it more?
- Then press your tongue into the base of the mouth. Do that very gently.
- Which part of the tongue do you feel easily? Maybe you don’t, just feel what’s like.
- Stop and rest for a moment.
- Press or push against the back of your top teeth and then release it
- And now, do the following. Curl the tongue backwards so the tip of the tongue goes towards the back of the throat.
- You’re taking the tongue from the back of the front teeth and you’re gliding towards the roof of the mouth towards the back of the throat. Are you okay with that?
- Find the midpoint of the mouth, by drawing a line from left to left (side to side) and up and down in the mouth. Easily gently, slowly.
- Stop and rest.
- Please come back to where those two lines intersect in the mouth going towards the back of the front top teeth, back to the throat, finding the intersecting line.
- Then, from that point, using the tip of the tongue, use circles, very small circles with the tip of the tongue.
- Gently, easy, notice what happens to your breathing.
- And now, can you reverse the circle? And as you do that can you bring your attention to the back of your head?
- And moving your tongue in this way, how is the head influenced?
- Stop and rest.
- Come back to the tongue again, and do the following. Move your tongue towards the inner edge of the teeth all the way back to the throat on the upper teeth.
- And gently start painting each tooth on the left side of your mouth, up and down. Painting each tooth, inner part, crevices, and outer part.
- Can you touch the part of the tooth that is close to the cheek?
- Not only touching the inner part but also the outer part, all the way towards the front of the teeth.
- Reducing the effort in the jaw, in the chest, and throat. Also reducing the effort in breathing.
- And now go ahead and do the same thing to the right side. Start painting the right upper back part of the upper jaw, closest to the throat, inner part, outer part, and crevice.
- Each tooth, going forward. Gently, don’t do what you can’t do, easily, until you get to the front teeth, once you get there stop and rest.
- Go ahead and bring attention to the tongue again and bottom teeth.
- Press the tip of the tongue to the bottom teeth, underside.
- And then, when you get there, bring the tip of the tongue towards the back, the throat, so there is this line in the middle of your mouth.
- Once you get to the front and back, go side to side drawing a line from side to side.
- Find the intersecting point of those two lines, back of the front, back of the bottom teeth, closest point where your tongue can reach.
- Then once in there, from side to side, those two lines intersecting and then from there, start making a circle. Smaller circle, breathing sensitivity. When you’re ready, reverse the circle, When you do this, what happens to the back of your head, and the jaw?
- Great, stop and rest.
- Bring your attention to the two intersecting points.
- Go ahead start moving your tongue from the bottom jaw, painting away with your tongue, each tooth.
- Each side, top, side closest to the cheek, one tooth at a time, until you get to the front.
- Most front teeth of the bottom side, and once you get there, move your tongue through the left (or other) side), painting away teeth forward.
- Great! Stop and rest
- Sense yourself, lengthen yourself.
- Please, bring your attention to the tongue, bring your tongue forward so the tip of your tongue is between the top front teeth.
- Start moving the tongue to the right, to the outer edge of your teeth and your cheek.
- Start sliding the tongue to the right, on the right side, back to the front, towards the left side, so, between the teeth and the cheek.
- Do it the other side.
- Stop and rest.
- Bring your tongue over your bottom teeth, so your tongue is now in between your lips and the cheek.
- Move the tip of the tongue to the left in the bottom front, next to the cheek and your teeth in the bottom left.
- And continue that and do it to the other side.
- Stop, feel how you give weight to the floor, the length of your body, your heels, buttocks, shoulders, back of the head.
- Gently, roll yourself to the side and come to sitting and come to standing.
- Great, thank you.

After the lesson, I asked participants to share their experience of speaking both their native language and English and observing the kinesthetic difference of the two articulatory settings. One Japanese participant said in order to do that, she spoke English with a Japanese accent and then she saw how different the settings were. I then highlighted there was a visible difference in the degree of jaw opening, to which she agreed.
Lesson 4:
Exploring the movement of the lips.

Before the lesson, the practitioner and participants engaged in a short dialogue:

Practitioner:
- How did you enjoy the lesson last time

Participant:
- I enjoyed the technique but did not understand what you wanted me to feel.

Practitioner:
- When you do movement, each person responds differently, so I don’t expect anybody to move in specific way. What I expect is that each person develops senses to move each part so that each person can use a specific part differently than he or she used before
- When you’re swimming, there is one way to breathe in respect to the function you’re doing. When you swim, you breathe differently from when you breathe when you’re writing an essay. So there is not “one” way. The brain changes pattern when you need it in certain situations, that’s what we call it spontaneity.
- This is the genius of Feldenkrais; it works with the brain in that ‘chaotic’ mechanism of patterns.

Exercises begin.
Practitioner:
- In this lesson, you are going to speak out loud. There is a phrase from a religious text, if you don’t want to say that phrase, just use another one, it doesn’t make a difference to me.
- Lay down; take a look at the back of your head. Is the right ear closer to the shoulder, or the left ear?
- And feel yourself which shoulder makes contact to the floor more than the other.
- Notice the buttocks and the length of one leg from the buttock to the heel. And the other leg, one heel to the other buttock.
- Feel how the air comes in and out, and let me know when you don’t understand what I’m saying.
- Please close your lips so you’re breathing through the nose and as you excel, start counting until ten, and say it aloud, but with the mouth close.
- Do it again, but count loudly. It’s kind of funny, right? I totally get it, so you do what you can do.
- With your mouth open your lips apart, make the lowest sound you can make.  
- Make it aloud, so everybody can hear it and we can always hear these sounds together, right?  
- Many times, maybe 10 times, listen to the sound you’re making.  
- You’re not counting, you are actually make this really low sound.  
- Now close your lips, go ahead, and make that low sound again.  
- Listen to the difference between when lips are close and lips are open.  
- With your right hand, place the index finger on the right nostril.  
- Go ahead and make that lower sound possible, breathing through the left nostril.  
- Listen to the difference of sound when you had both nostrils open.  
- Stop and switch around, so now you breathe through the right nostril.  
- Using each hand at a time, go between, alternating between one and the other and listen to which sound is more vibrant, and the side that is weaker.  
- Continue to work with that side maybe 5, 10, or 15 more times.  
- Observe how we allow air to go through our vocal cords and the nostrils It’s kind of different.  
- Stop and rest.  
- Now with the mouth open make the highest pitched sound you can make.  
- Now do the same thing, but do with your mouth closed. Many times.  
- Close your right nostril and make that really high sound, closing your right nostril.  
- Now you can see how you make that nasal, right? Now switch it over and close the left nostril. Beautiful!  
- Now go ahead and put both hands on the nostrils and alternate between one and the other.  
- Good, stop, just rest for a moment.  
- Now close your mouth and lips and your teeth so nothing is moving, even the tongue.  
- Now count to 10 without moving any of those things.  
- Now, do the following, feel when you do this where the tongue lies in your mouth  
- You’re going to do exactly you did, counting, but focus your attention to where the tongue is in the mouth.  
- Now you’re going to do exactly the same thing, except that you are going to say it to somebody outside the building, farther away, count to10, the same way you did before, but very loud. Does the tongue rest on the base of the mouth?  
- Now, keep your tongue and your lips together and say the following. “In the beginning, God created the heaven and the earth. And the earth was without form. And God said, let there be light and light was created. And God saw that light was good and God divided the light from the darkness”.  
- You’re going to say the same thing, but you can move your lips, however, the tongue and the teeth are clinched together. Then say “In the beginning, God created the heaven and the earth. And God said, let there be light and light was created. And God saw that the light was good and God divided the light from the darkness”.  
- Now your tongue and your teeth can move, but the lips need to stay together. Repeat after me. “In the beginning God created the heaven and the earth and God said let
there be light and there was light. And God saw that the light was good and God divided the light from the darkness”.
- Now allow the lips to move, the tongue to move, but don’t move the teeth, keep the teeth together. Now we say, “In the beginning, God created the heaven and the earth. And the earth was without form. And God said, let there be light and light was created. And God saw that light was good and God divided the light from the darkness”.
- Please come back to the idea of making the lowest sound possible. Listen to it and see if it’s changed.
- Then close one nostril and make the same sound, then, close the other nostril.
- Then stop that and make the highest sound you can make with the lips closed.
- Do the same with closing one nostril, then the other nostril.
- Then go from making the lowest sound to the highest sound and back.
- Stop, rest. Crazy, huh?
- (Laughing)
- Now do the following. Go ahead and make the lowest sound possible with your mouth open. Listen to it now and see if it sounds differently.
- Now do it again and see the difference.
- Now make the highest sound possible and see if it’s different.
- Now make that lowest sound again and from that same breath make the highest sound and go back and forth.
- Stop (laughing)
- As you did in the very beginning, go ahead and count out aloud to 10.
- And now do it only so only you can hear yourself.
- Do it aloud and see if becomes a different duration.
- Stop and rest.
- Bring your attention to the contact of the back of the head, contact of the shoulders, contact of the pelvis, notice if you feel any difference.
- Gently, roll yourself to the side and come to sitting and come to standing.
- Thank you.
Lesson 5:

Exploring making sounds through the nose as well as through the mouth.

Practitioner:

- Feel where the contact of your body on the floor is; where is the first place where your attention draws to. Keep that in your pocket.
- How do you distinguish where it's flat or long, and then where do you note the second place, how do you distinguish that?
- And then, do the same thing for a third place, right? Good.
- Just gently, bring your attention to how your face feels, how much effort you have in your forehead, cheeks, throat, lips, tongue, feel that sensation.
- And as you were kissing a person in front of you, do a gently kissing movement (like a normal kiss), then let your lips come forward, and bring your lips closer to the ceiling, and as you allow that, let your lips come back to neutral. And stop.
- Please put your arms out perpendicular to yourself so that they are at shoulder level and with your nose pointing towards the ceiling, go ahead and roll the fists pointing backwards so the fingers are pointing to the ceiling, very softly, very gently, many times, roll back and then come to neutral.
- As you do that, notice what happens in the back of the neck.
- And now, as you roll the arms, do that kissing movement, slowly, really slowly, notice which one goes first, the arms or the lips to the ceiling, the right or left arm?
- Stop and do the following. Go ahead, roll the arms down and do the kiss, and as you roll them back let the lips come back to neutral, gently. Great.
- Stop and rest.
- Go ahead, bring the arms back to the side, go ahead, do that kissing movement towards the ceiling, and see how it feels this time. And stop.
- Do the following. Go ahead and bring the sides of your mouth closer to each ear, softly smile, you're kind of smiling very gently and see which side of the mouth seems to contract first.
- And now, whichever side of the mouth seems to contract first, just notice that and do the following. Contract that smile and with an index finger hold that side of the mouth that contracts first. Keep that side of the smile and bring the other side to come down.
- Then move the latter side to a smile again and let it come down again.
- Stop and rest.
- Switch the hands, put your index finger on the other side, keep that side on smile, and then allow the other side to come back and smile again and come back again.
- Then allow both sides to go to rest and do the full smile again, and rest.
- With your right hand, take your right hand about a palm away from you, take your index finger with the thumb (or middle finger), and hold your upper lip with that.
- Then gently pull the lips up (headward) and down (footward), repeat.
- And keeping the hold, move the lips to the right five or six times. Then stop that and move it to the left five or six times.
- Stop and take a good rest.
- With the same hand, get hold of the bottom lip with your index finger and the thumb. Then gently, move it downward several times.
- And then you're done, move it towards your nose.
- Then, five or six times to the right, and then to the left. Great, stop, put your arms down, and rest.
- This time with your thumb, get a hold of the bottom lip and with the index finger the top lip.
- Then very gently, easily, softly start pulling both lips towards your nose.
- Then after several times, pull them towards your feet or chin.
- And then of course pull them five or ten times to the right, and to the left, gently. softly, just where it goes easily.
- And now, start to find the middle point of pulling to the nose, to the right, towards your chin, and towards your left, and make a circle around it.
- Focus on the quality of the movement, how gently, easily, you can do it. Stop.
- Please bring your arms to the side, and this time, instead of rolling the fists headwards we are gonna roll it footwards. And as you do that, feel what happens to the back of the neck.
- Then, leave your arms out there, but make a shape with your lips, like you were sucking a thick milkshake with a straw, engaging all the way to the back of the throat, almost pulling the lips towards the floor.
- And as you pull the lips towards the floor, sucking that milkshake in, roll the arms down.
- As you pull the lips in, roll the arms down.
- Now continue to do this, but add the head turning to the right. Do it five or ten times.
- And now do it several times to the left. Go slow, take your time.
- Come back to the middle, keep your head neutral and go ahead and pull your lips inwards and let your arms roll down.
- And as you come back, let the lips come back to neutral.
- Great, stop, bring your arms down to your side, and just rest for one second.
- Go back now and do the original movement of kissing, moving your lips forward to the ceiling and feel what you can notice now.
- Do you notice your tongue, jaw, cheeks, and the back of the head? Then stop.
- And bring your attention now to the touch of your body against the floor. How do you feel the body now? Is that the same or different?
- How about the second thing, how about the third thing.
- How does it compare to the first time you came in here.
- Slowly, come up to your side, and come back to sitting.
- Great, thank you.
Harvard Phonetically Balanced Sentences
From the appendix of: IEEE Subcommittee on Subjective Measurements IEEE
and Electroacoustics*. vol 17, 227-46, 1969. Also found at CMU site.

List 1
1. The birch canoe slid on the smooth planks.
2. Glue the sheet to the dark blue background.
3. It's easy to tell the depth of a well.
4. These days a chicken leg is a rare dish.
5. Rice is often served in round bowls.
6. The juice of lemons makes fine punch.
7. The box was thrown beside the parked truck.
8. The hogs were fed chopped corn and garbage.
9. Four hours of steady work faced us.
10. Large size in stockings is hard to sell.

List 2
1. The boy was there when the sun rose.
2. A rod is used to catch pink salmon.
3. The source of the huge river is the clear spring.
4. Kick the ball straight and follow through.
5. Help the woman get back to her feet.
6. A pot of tea helps to pass the evening.
7. Smoky fires lack flame and heat.
8. The soft cushion broke the man's fall.
9. The salt breeze came across from the sea.
10. The girl at the booth sold fifty bonds.

List 3
1. The small pup gnawed a hole in the sock.
2. The fish twisted and turned on the bent hook.
3. Press the pants and sew a button on the vest.
4. The swan dive was far short of perfect.
5. The beauty of the view stunned the young boy.
6. Two blue fish swam in the tank.
7. Her purse was full of useless trash.
8. The colt reared and threw the tall rider.
9. It snowed, rained, and hailed the same morning.
10. Read verse out loud for pleasure.