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„Language Transfer vs. Language Talent?
Individual differences and aptitude in L2 phonology of Persian-speaking learners of English"

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In the name of God

The Compassionate

the merciful

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List of Abbreviations

ACH	Aptitude Complex Hypothesis
AoA	Age of Onset of Acquisition
AoL	Age of Onset of Language
CAH	Contrastive Analysis hypothesis
CPH	Critical Period Hypothesis
EEG	Electroencephalography
ERP	Event Related Potential
FL	Foreign language
fMRI	functional Magnetic Resonance Imaging
H	Hypothesis
HAS	High Amplitude Sucking
HTPP	Head-Turn Preference Procedure
ID	Individual Differences
MDH	Markedness Differential Hypothesis
MEG	Magnetoencephalography
MLAT	Modern Language Aptitude Test
MRI	Magnetic Resonance Imaging
ms	Millisecond
NE	Native English
NH	Native Hindi
NK	Native Korean
NNS	Non-native Speaker
NP	Nonprototype
NS	Native Speaker
P	Prototype
PET	Positron Emission Tomography
PME	Perceptual-Magnet Effect
SD	Standard Deviation
SL	Second Language
SLM	Speech Learning Model
TL	Target Language
VOT	Voice Onset Time
WM	Working Memory

List of Symbols

F	F-Ratio
L0	Unknown Language
L1	First language
L2	Second Language
N/n	Sample Size

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1

Introduction

1.Introduction

Second language learning has been the focus of many pedagogical investigations so far. It has been shown that productive skills, speaking and writing, are more difficult for the second language learners than receptive skills, listening and reading, and native like proficiency, e.g. in pronunciation, is reached only by approximately 5-15% of language learners (Reiterer et al. 2011; Selinker 1972). Accordingly, mastering the phonological system of a foreign language can be said to be unlikely at a native speaker level in adulthood (Cabrelli Amaro & Rothman 2010: 277). However, some adult L2 learners can overcome their age related constraints and achieve a near-native L2 accent due to their individual traits.

There are huge individual differences observed in perception and production of ESL learners. Regarding that, I decided to focus on the individual differences in second language (hereafter L2) phonology, by investigating speech production, more specifically: vowel production (vowel length), speech imitation of an unknown language (L0) and by testing language aptitude and cognitive ability of the participants. The main goal of this study is to find out if there is any relationship between the result of language aptitude tests and the proficiency in English pronunciation-in terms of English native-likeness and schwa duration.

The Persian or Farsi language like many other languages has its own sound system with some differences to the English language. These differences obviously are reflected in the speech of the Persian speakers of English and result in phonological errors when speaking English (L1 transfer). We will show that L1 transfer is not a general phenomenon applicable to every speaker, but regards usually only the medium range (70% of a population, one standard deviation above and below the mean) and the lowest quantiles, however not the highest quantiles (5-15%) of speakers with high language aptitude. We are going to investigate the effect of L1 sound system on the production of L2 vowels, here schwa sound, and how some language learners are not affected by the phenomenon of transfer due to their language aptitude. It will be shown that in spite of the common theories of critical period hypothesis regarding biological effects of maturation such as brain lateralization, adults L2 learners with higher cognitive and imitation abilities can attain native-like phonological performance.

In order to present our investigation results, we rely on some of the state of the art background theories of first and second language acquisition that are crucial to giving an account of general framework of L2 phonological system, theories which explain the phenomena of transfer, phonetic aspects of L2 learning and bilingualism and the way that mother tongue or even L2 can interfere or help a second or third language. Finally, we will present the results of our phonological and aptitude data.

2

First language acquisition

2. First language acquisition

Language learning is a complex phenomenon which encompasses many facets. Children develop their language skills at different levels including the phonetic, phonotactic, lexical and syntactic. Before mentioning theories and principles of second language acquisition, it is important to go through first language acquisition. First language acquisition is referred to the acquisition of mother tongue or native language. In this mechanism, a human child starts to grasp the sound system of the language, speech perception, understand the meaning of the linguistic input and start to produce it, speech production. In this process, a human-infant starts to acquire the language without explicit effort and training contrary to language learning which is done consciously, explicitly and externally controlled mostly in a classroom situation (Müller 2002). Language acquisition can be defined as the unconscious and uncontrolled processes of learning language skills in a 'natural environment' through everyday social contacts from interacting with "human beings, but not from a disembodied source, even though the acoustic information remains the same in the two situations" (Kuhl *et al.* 2003 cited in Kuhl *et al.* 2007: 979). Thus, social factors are very important in language acquisition because social interactions result in more robust and durable language learning as learning enhances through social interactions (Kuhl *et al.* 2007: 993).

There are three theories about how a child acquires his first language, namely the behaviorist theory, the innatist theory and the interactionist theory. Concerning the first theory, the psychologist Skinner (1938) promoted the theory that children learn language through stimulus, response and reinforcement. The behaviorists believe that there is nothing inborn with language: language is learned through dialogue and drills. Noam Chomsky (1965) refuted Skinner's behaviorist theory (1938) and promoted the idea that all the children have the innate ability to learn languages by 'biological language acquisition device' or LAD. Thus, language capacity is inborn and transmitted by genes. In other words, children are prewired for linguistic analysis. This view is however subject to criticism because a human child cannot start to speak a language without any interaction with human beings. Children who live in isolation without any contact with human speech "grow up with no language at all"(Rosch 2004).

An important concept in child language acquisition is the phrase "nature versus nurture" which contrasts a person's innate qualities (nativism or innatism) with a person's individual experiences (behaviorism). According to behaviorism or general cognition, a human being has nothing inborn with the language, but assembles functions from different sources. This idea was favored by John Locke in 1690 who postulated the expression 'tabula rasa ' or ' blank slate' (Baird *et al.* 2008). He believed that an individual mind is a 'blank slate' upon birth without innate ideas which through experience with external world will be shaped. However, nativist and behaviorist theories have a common assumption about child language development toward adult model in that such process pursues a smooth and regular path (Gleason 2012). Finally, the idea of interactionists about language development is that children learn language through interaction with caregiver and socially mediated communication. This concept is based on social development theories of a Russian psychologist Lev Vygotsky (Gallaway & Richard 1994).

2.1 Phonological development in infants

Phonological development in individuals can be categorized in two areas of speech perception and speech production. It can be said that speech production is a phenomenon which is very much dependent on speech perception because the latter precedes the former as early as in mother's womb. Scholars have tried to develop techniques to investigate infants' speech perception to see what is recognizable by newborns before they start to produce the language. The main focus of these methods is in how far infants can distinguish changes in speech stimuli. This awareness is observable by babies' reaction to any change in speech stimulus or any preference for any or a set of sounds. Two of the most popular methods which are used for this purpose are High Amplitude Sucking (HAS Eimas, Siqueland, Jusczyk & Vigorito 1971 referred to in Ohala 2008: 20) and Head-Turn Preference Procedure (HTPP; Kemler Nelson, Jusczyk, Mandel, Myers, Turk & Gerken 1995 cited in *ibid.*). The first method assumes that babies like to hear sounds and suck on a pacifier. In this method, new born infants are given pacifiers connected to a pressure transducer which measures the sucking rate of babies. The second method which is used for older babies from 4 months of age, due to having more control on head and neck muscles, is based on the fact that babies like to hear sounds and they tend to look at the source where the sound comes from. These methods are popular and currently in use for research in infants' speech perceptions (Kuhl *et al.* 1992; Fernald & Kuhl 1987).

Through the process of speech perception, infants gradually develop a system of phonemes of their native language and make fix categories which help them in the production of speech sounds. There are two theories which explains phonetic perception in infants namely exemplar based phonology and perceptual magnet effect. These theories refer to the phenomenon of developing an abstract phonology knowledge resulting from a previous phonological input with some differences in the way they regard phonological development. So, the phonological knowledge in children emerges from generalizations over exemplars they heard. Comparably, effects such as the magnet effect (Kuhl 1991) are an emergent consequence of storing exemplars. Some contributors to the theory of exemplar-based models of child phonology acquisition are as follows: Jusczyk 1993, Morgan *et al.* 2001 and Anderson *et al.* 2003 (cited in Johnson 2005: 292). These theories will be explained in detail in 3.4 and 3.5 sub-chapters.

2.2 The critical point in child phonology development

According to Zevin *et al.* (2012: 335), the ability of perception and production of non-native speech sounds start to diminish during early childhood. For example, the Japanese infants cannot distinguish the difference between /r/ and /l/ around 10 months of age (Aoyama *et al.*: 2004) which is also true for Japanese adults (Goto 1971; Strange & Dittmann 1984; Miyawaki *et al.* 1975; Takagi & Mann 1995 cited in Aoyama *et al.* 2004: 234). As Falk (1978: 364) points out, in adults the adaptation of the nervous system and muscles to the production of particular phonetic features make their language learning different from that of children. 6 months of age is agreed upon many scholars to be a critical threshold in language development of infants (Eimas *et.al* 1987; Kuhl 1987, 1991, 2003, 2006; Golestani *et al.* 2002). According to Golestani and her colleagues (2002), in children, from 6 months of age, an improving change from a language-general to a language-specific pattern of phonetic perception happens. Kuhl (1991: 94) explains that infants as early as 6-months of age are sensitive to phonetic categories in their speech perception and their responses to a phonetic stimulus corresponded with that of adults. In this regard, the first year of a child's language perception is characterized by a dual change in infants' language perception in which non-native speech perception skills recede and native language perception increases. The period between 6 and 12 months of age is also very important in child language development due to a massive improvement in native language phonetic perception (Kuhl *et. al* 2007). For example, 6-12 months aged American infants showed an improvement in discriminating /r-l/ contrast (Kuhl *et al.* 2006 cited in Kuhl *et. al* 2007). Also, 6-12 months aged Mandarin-learning and English-learning infants could perform better in native affricate-fricative contrasts (Tsao *et al.* 2006 cited in Kuhl *et al.* 2007). Another study by Kuhl *et al.* (2003) also proves that the period between 6 and 12 months of age is characterized by a sharp decline in "the ability to discriminate foreign-language phonetic units".

It should be considered that in infancy, non-native language skills are as important as native language skills because they give hints about later language development. However, better non-native perception in the first year of life does not necessarily indicate language improvement. As Kuhl *et al.* (2007: 979) mentioned, "better *native* language skill at 7.5 months of age predicts faster language advancement, whereas better *non-native* language skill predicts slower advancement". The latter finding indicates that the brain is in its initial and more immature status (*ibid.*: 985). Conversely, in adulthood the decrease in non-native speech perception leads to difficulty for the L2 learning. According to Golestani *et al.* (2002), in adults, distinguishing certain non-native speech sounds from similar ones in their native language is hardly possible. As an example for this phenomenon, Golestani and Zatorre (2009: 55) point out that native speakers of English are unable to distinguish between English alveolar and the Hindi retroflex stop consonants although for the Hindi native speakers this sound is as easily recognizable as the difference between /b/ and /d/ for an English native speaker. Likewise, for native Japanese-speaking adults ESL learners, English /r/ and /l/ are difficult to acquire (Bradlow 2008; Callan & Akahane-Yamada 2004; MacKain, Best & Strange

1981 cited in Wong & Ettlinger 2011).

2.3 Speech Perception

Speech perception is a mechanism through which acoustic speech signals such as phonemes, words, syllables and prosodic features are perceived via auditory system of individuals. The route from speech production to speech perception in spoken communication is referred to as *speech chain* (Denes & Pinson 1993 referred to in Roach 2000). As it is illustrated in fig. 1, this process starts from speaker's brain and ends in listener's brain.

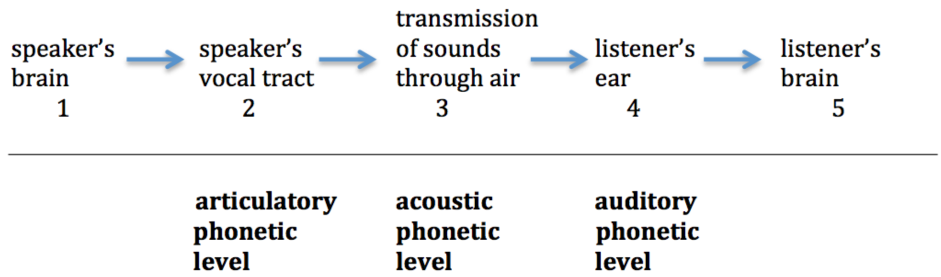


Figure 1. Speech Chain (Roach 2000)

According to Mildner (2006: 24) "perception is conscious reception, adoption, and interpretation of external stimuli (exteroception) or those from one's own body (interoception, proprioception)". The perception of speech sounds in the last decades is considered to be based on a categorization model (Trubetzkoy 1969; Kuhl *et al.* 1992) compared to the previous "selection and the maintenance/loss" model. As Kuhl *et al.* (2007: 980) indicate, "Infants' phonetic abilities were argued to stem from an innate specification of all possible phonetic units, which were subsequently maintained or lost as a function of linguistic experience." An explanation for this phenomenon is that the pattern of phonetic perception in adults is defined by their native language (Kuhl *et al.* 1992) and consequently the unnecessary phonetic patterns will be dismissed. Ontogenetically, the perception of vowel categories in infants is defined by the categories imposed by adult speakers (Grieser & Kuhl 1989 cited in Kuhl 1991). In this regard, Goldinger (1998: 251) mentions that "episodic (or exemplar) theory, [...] assumes that every experience, such as perceiving a spoken word, leaves a unique memory trace. On presentation of a new word, all stored traces are activated, each according to its similarity to the stimulus".

Considering the age in which infants start to distinguish native sounds, Eimas *et.al* (1987) and Kuhl *et al.* (2006) mentioned that six-month-old children can recognize mother tongue phonemes despite of the large acoustic and speaker differences. Apart from phonemes, prosodic features are also very essential for the acquisition of the native language. The start of the acquisition of prosody goes back even to prenatal period which later affects the speech production of babies (Mampe *et. al*: 2009).

According to Kuhl *et al.* (1992), the perception of speech stimuli in human being goes through the route of categorization in equivalent classes. The membership in each category is a partial matter and "Category goodness" of a stimulus is a matter of degree, where some members are recognized as "better exemplars, more representative or prototypic, than others" (Rosch 1975 cited in Kuhl *et al.* 1991: 93).

In a cross-language study, Kuhl (*et al.* 1992) examined phonetic perception in newborns and showed that phonetic perception in infants up to six months of age is characterized by a language universal pattern which is affected by 'innate factors'. For this study, two American and Swedish vowels where chosen namely English /i/ and Swedish /y/. By computerizing these vowels, 32 additional variants for each vowel were produced which were 'acoustically similar, but not identical' to each prototype. In their experience, sixty-four 6-month-old American and Swedish infants were chosen. The aim of the test was to see if the American and Swedish infants would treat the English /i/ and Swedish /y/ as native sounds. The result showed that the subjects "exhibited a strong magnet effect only for native language prototypes" (*ibid.*).

The finding of this experiment is in accordance with Eimas *et al.* (1987) and Kuhl 1987 (cited in Kuhl 1992) who showed that the pattern of phonetic perception in infants is language independent. Afterward, a phonetic pattern which is specific to a child's native language starts to develop which in adulthood will affect their language perception. Principally, from the first year of age, the child's experience with language affects the language perception (Werker & Tees 1984; Werker & Lalonde 1988 cited in Kuhl *et al.* 1992: 606). In adulthood, the ability of individuals in perceiving the acoustic and speaker differences in 'speech sounds' which do not discriminate between words in mother tongue decreases (Got 1971; Miyawaki 1975; Strange & Dittmann 1984 Werker *et.al* 1988 cited in Kuhl *et al.* 1992: 606). In this regard, Golestani and Zatorre (2008) also point out that "[d]uring adulthood, most individuals perceptually assimilate certain non-native speech sounds with similar ones from the native language" (Best *et al.* 1988 referred to in *ibid.*). Notably, the transition from a 'language-universal pattern of phonetic perception' to a 'language specific' pattern is a critical phenomenon in child phonological system development (Werker & Tees 1984; Werker & Lalonde 1988 cited in Kuhl *et al.* 1992: 606).

Mampe *et al.* (2009) who investigated the pre-speech development in French and German infants, found out that in the last trimester of a fetus, the auditory stimuli of external world affects speech perception in that the prosodic information, particularly melody, has an impact on perception of different languages. In their study of cries of 60 babies born in French and German families, different patterns were observed. The cries of French newborns demonstrated a rising melody contour that is in line with the French intonation pattern, whereas the German cries melody showed a falling melody contour which again corresponds to German intonation pattern. This observation proves that the auditory perception is also active before birth i.e. in the last trimester of prenatal phase, which will influence the prospective sound production. Likewise, Mildner (2006) mentions that first reaction to auditory stimulus in form of reflex in prenatal phase of babies starts at 16 weeks before birth which is in accordance with Mampe's theory regarding the time span of the last trimester of birth having a crucial importance in the patterns of babies' cries. On the basis of these two theories, it can be concluded that the first aspects of speech which are acquired by human beings are melody and prosodic features.

2.4 Speech production

Speech production is an observable, contrary to speech perception which is hidden (albeit measurable), human-specific activity through which articulatory movements of the speech organs produce speech sounds. As Rosch (2002: 11) mentions, the most basic fact about speech production is that this activity is a kind of "modified breathing" in which air movement is involved considering that if we do not impede the air we breathe, it would be just ' breathing out'. Also, speech is produced by organs which primarily have other biological functions. In another word, none of speech production organs are exclusively there for producing speech. Clearly, lungs, ears, vocal cords, tongue and nasal cavity have their own function even if not used for speech.

Over the last decades, many attempts have been made by linguists, psychologists, psycholinguists and speech therapists to observe, understand and define the origin and mechanisms of speech sounds and speech errors. Speech production in infants follows a developmental path till producing the first sentence. In the first months of newborns' life, they produce vague bubble of noises having little or no resemblance to the native language they are going to acquire. But from first and second year of life, the strange noises disappear from the child's speech as the child will have acquired the phonetic structure of their native language (Rosch 2002: 47). Kuhl *et al.* (2007: 980) summarize the stages of newborn's language development as follows: up to three months of age, infants just "produce non-speech sounds", from three months age they "produce vowel-like sounds"; In 5 months age they can "imitate vowels"; 7 months age is classified as "canonical babbling" which is followed by "language-specific speech production" at the age of 10 months and the first words are produced at 12 months. Stark (1986 cited in Ohala 2008) refers to babbling as vocal-play and baby's first attempt to produce speech by playing around with speech-like noises: she considers the time span for this behavior four to six months of age. It can be said that, before producing the first words, infants have an active perception which later will be shown in their language performance. 3 years of age is considered the point in the language development where infants start to produce full sentences (Kuhl *et al.* 2007).

3

Second language acquisition

3. Second language acquisition

Bilingualism can be said to be a norm rather than an exception. As Hesling *et al.* (2012: 44) mention, more that 50 percent of the world population is bilingual. Children can be said to have a priority to adults when it comes to language learning because they can learn any language effortlessly and accent-free. This fact is due to the biological condition of children such as brain plasticity (Zevin 2012). Yet, there are some controversies in the privilege of children to adults in acquiring a second language. In this regard, different Language subdomains are taken into consideration, namely phonetics and phonology, prosody, semantics, syntax and vocabulary. Phonology and prosodic features are those subdomains which cause more difficulty for adult learners of a second or foreign language. As due to maturational constraints and adaptation of vocal system for producing certain speech sounds, shifting to new speech sound production in adult L2 learners can be very difficult or even impossible. Because certain differences between L1 and L2 phonetic segments are not even perceived by adult learners. However, adults can overcome their developmental changes in order to reach high proficiency level in second or foreign language. As, Zevin *et. al* (2012: 335) point out, adult L2 learners have to compensate their biological age-related-condition by 'effortful' and 'explicit' learning methods contrasted to "the efficient, implicit learning mechanisms thought to underlie native language processing".

Also, transfer from L1 plays a very important role in producing L2 sounds. For example, the pronunciation of umlauted vowels (/ä/, /ö/ and /ü/) in German is difficult for Persian learners. These vowels are mostly articulated as the vowel without umlaut is pronounced. However, native speakers of Turkish have the privilege of having umlauted vowels in their native language sound system so they can pronounce umlauted vowels easily in German as a second language and consequently use the advantage of positive transfer of mother tongue in learning German as L2. As Falk (1978) indicates, not reaching the native speaker level by adult language learners may be due to less ideal environmental factors and the difficulty to activate their birth-given capacity for acquiring a language. The adult learners, however, have some advantages over children learning their first language. First, the prior knowledge of their mother tongue can help a great deal in performing the linguistic tasks. Moreover, they can benefit from positive transfer. Second, because of the adults' prior knowledge of the world and experience with language, they can master a language in a shorter period of time, one or two year/s, compared to a child who cannot attain such proficiency within this short period.

One of the main concepts which is important in second language acquisition is interlanguage (Selinker 1972). This system considers language learning as an evolving system originated from one's native language and moving towards the second language which is influenced by transfer from the native language and grows by learning new rules of the target language. Moreover, it is a dynamic system that can also include L2 learner's mistakes which can be corrected at any point or ignored and fossilized. As Selinker (1972 cited in Major 2008: 65) defines, transfer is not the only factor in the emergence of interlanguage. There are also some non-transfer errors which are the result of developmental and universal factors similar to native language acquisition. All in all, learning a second language is ideally targeted to reaching native-like proficiency which can be achieved only by few L2 learners.

Another important reason of L2 learning is meaning exchange between speakers of different native languages where there is not much focus on phonological or grammatical aspects of L2 learning but rather meaning. As Krashen (1987) indicates, language acquisition deals with meaningful interaction in the second language where speakers communicate naturally and tend to focus on meaning exchange in the target language not the usage of conscious grammatical rules.

3.1 Cognitive-psychological aspects affecting language learning

Besides biological factors which affect language learning in a positive way, there are some cognitive-psychological aspects that can have an influence on language learning success, such as motivation and personal traits like introversion and extroversion. These two aspects will be discussed in the following.

3.1.1 Motivation

Motivation in Dörnyei's view (2005) "provides the primary impetus to initiate L2 learning and later the driving force to sustain the long and often tedious learning process". A motivated language leaner is eager to put too much effort and time to achieve high proficiency in the target language. According to Ur (1996: 274), there are two types of motivations in regard to learning a foreign language, namely 'integrative' and 'instrumental'. A language learner with integrative motivation admires the culture in which the target language is spoken and is eager to become part of the target language society. Gardner and MacIntyre (1993: 159, quoted in Dörnyei 2005: 68) define integrativeness as the "individual's willingness and interest in social interaction with members of other groups". The second type of motivation, instrumental motivation, is distinguished from the former in that learning a foreign language is aimed at utilization of the language such as professional or other personal goals. However, various research studies demonstrated that the students with integrative motivation can attain a higher achievement in the target language than the ones with instrumental motivation.

3.1.2 Introversion and extroversion

Individual traits such as empathy, extraversion and introversion have an important role in language learning (Naiman *et al.* 1995, Ellis 2008). Among Intelligence and risk-taking ability, Skehan (1989) considers these traits as crucial personality factors for successful language learning. Additionally, Chastain (1988: 124) argues that introvert and extrovert learner types can have both their own advantages. Introverts tend to be self-centered, more 'conscientious' and dedicated toward linguistic tasks, whereas extroverts may have more advantage in regard to practicing the target language and seeking group in order to communicate.

3.2 First language as an aid to second language learning

It is worth mentioning that learning a new language which is similar to an already acquired /learned language can be compared to learning a dialect. Falk (1978: 364) mentions that for an adult to speak a dialect, changes are made in an adult native language by means of applying new rules to it. This fact can be evidence that when there is no substantial difference regarding the learner's native language and the foreign language, such as Portuguese and Spanish, it would not be impossible that the target language can be learned with a native speaker proficiency level because the overlap of phonology, vocabulary and grammar of connected languages facilitate the acquisition of any of those languages.

Erard (2012) in his newly published book *Babel no more: the search for the world's most extraordinary language learners,* which is dedicated to biographies of successful multilinguals throughout history, introduces the case of Giuseppe Mezzofanti, a nineteenth-century cardinal, who was one of the most successful language learners in the world and could speak seventy two languages. His success in learning languages was due to not only the number of languages that he could speak, but also the speed at which he could learn a new language. One story about Mezzofanti says that once a Russian Scholar talked to him in Ukrainian with the aim of puzzling him. Mezzofanti wanted him to go and come back in two weeks. To his great surprise, the Russian scholar found him talking fluently in Ukrainian. Mezzofanti attributed his ability to learn Ukrainian within a fortnight to his prior knowledge of Russian.

Thus, when somebody has already mastered a language, the learning of its related languages would be easier and a high proficiency level can be attained. As with the case of Russian and Ukrainian, these languages are related because they both belong to East Slavic subgroup of the Slavic language family. In regard to non-phonological aspects, for example, six languages which share lexical and grammatical features do not load a person's memory as six unrelated language from different language families *(ibid.* 48), for example, Chinese and English.

3.3 Transfer Models in Second Language acquisition

Undoubtedly, mother tongue influences the acquisition of the second language due to differences in linguistic levels of L1 and L2. Generally speaking, L2 learners' L1 "can play an inhibitive role in speech perception, processing and production"(Zampini: 2008). However, the influence of L1 on L2 is not sharply outlined because some theories stress on the positive effects of similarities between L1 and L2 features in L2 learning, but some, conversely, views such similarities as impeding.

Transfer in learning was investigated by psychologists in about 85 years before the introduction of CA. Transfer in SLA was ignored during 1970s due to shortcoming of CA but from 1980s onward gained popularity again (Major 2008: 65). As Ausubel (1963: 28 referred to in Major 2008: 63) mentions, transfer is involved in all kinds of learning provided that there is some "relevant aspects" with the experience and it is "organically relatable" which was earlier referred to as having "meaningful similarity" by Osgood (1946 cited in *ibid.*). In a simple word, transfer occurs due to "connections between old and new information" (Neuner 2002 referred to in *ibid.*).

Transfer can happen in different levels of language such as phonology (sound systems), morphology (word structure), syntax (sentence structure) and lexical semantics (Thomason: 2001). Also, Goad & White (2006 referred to in Cabrelli Amaro & Rothman 2010: 277) consider the transfer of "prosodic system" of L1 as one of the hindering factors in the acquisition of native-like proficiency in L2.

Theories on language transfer can be viewed in three main strands: first, Full transfer or Full access hypothesis which asserts because of the L1 influence, learning a foreign language after a certain period is hardly possible and second, theories which state that the L1 transfer occurs partially. In this view, some subfield of language are more prone to transfer than others. The third view focuses on individual differences in language transfer regarding aptitude and environmental factors. Further, as Wardhaugh (1970) mentions, language transfer can be positive or negative: positive transfer occurs when L1 and L2 linguistic items are similar and as a result facilitate learning but negative transfer hinders L2 acquisition because of mismatch in L1 and L2.

3.4 Exemplar-based phonology

Exemplar-based theories of phonological knowledge are rooted mainly in cognitive psychology (Johnson 2005: 291) and the literature on general cognition which are in use in the past 100 years. In this regard, the approach of Semon (1923) about the concepts of *sensation* and *image* in his *Mnemic Psychology* is very important because of the role model of perception. He defines image as "memories of sensory experience that persist in neural structure" (Johnson 2007: 27). He asserts that every piece of experience is added to the "sum of simultaneous engram-complexes" (Semon 1923: 171 cited in Johnson 2007: 27). Therefore, in Semon's view each life experience compiles new exemplars to 'memory' which will be later used in recognition. Two striking points in his view can be observed, firstly, the uninterrupted nature of the new experiences stored to the already existing exemplars i.e. every new exemplar is stored as a 'token' not 'type' of that experience. Hence, it can be said that exemplars use a lot of memory because there is no categorization at the beginning for the storage of the samples. Second, 'new experiences' are conceived with the awareness of the similarities with the past experiences by "partial re-experiencing of images/instances in memory". In another word, every single exemplar is assimilated according to the already absorbed samples. As Johnson (2005) points out, in the exemplar modeling of speech sounds, exemplars which are stored in form of lexemes, are the source from which "smaller phonetic/phonological units" emerge. Moreover, the "representation of exemplars in model stimulations should be rich with phonetic detail". Exemplar-based model of linguistic perception is favored by many linguist among them Goldinger (1996, 1998), Hintzman (1986, 1988), Kruschke (1992), Johnson (2005) and Nosofsky (1986). As Exemplar-based categorization of speech sounds does not concern a split of exemplars, any particular exemplar could be member of different phonological/phonetic categories at the same time. Also, because Exemplar-based categorization of speech sounds concerns memorized tokens and not types of linguistic items, this model is based on a huge storage space in memory. For example, Hintzman's MINERVA 2 model of word perception (1986, 1988 reffered to in Goldinger 1998) considers for each familiar word "a potentially vast collection of partially redundant traces" in memory which upon presentation of a new word "an analog probe is communicated (in parallel) to all traces" that are independently created for each linguistic experiences (*ibid.* 254). This model confirms that the Exemplar model of phonetic perception relies on a heavy memory loads in individuals.

3.5 Perceptual-Magnet Effect (PME)

Magnet effect can be said to be an aftereffect of the exemplar-based phonology (Lacerda 1995). The perceptual magnet effect was proposed by Kuhl (1991) and is widely debated in the language perception literature (Lacerda 1995; Iverson & Kuhl 1996, 2000; Guenther & Gjaja 1996; Lotto *et al.* 1998; Diesch *et al.*1999; Thyer *et al.* 2000). This theory is built upon the idea of 'phonetic prototypes' i.e. "representation of phonetic events stored in long-term memory"(Kuhl 1991: 94). In other words, phonetic prototypes are those segments of speech sounds which are agreed by native speakers of a language to be the best example of a 'given phonetic category'. A prototypical sound acts as "perceptual magnet" or "hot spot" where the other variants of the prototypic member are pulled towards it (*ibid.* 104). But as Kuhl's (*ibid.)* investigation shows, "perceptual potency" is not the same in all members of a phonetic category. In her experiment, 64 variants of the single speech category /i/ were generated which varied acoustically from the prototype. Then, two members of the phonetic category /i/ vowel were selected as referent vowels. First, the prototype of the category and second a nonprototype member (fig.2). Adults and 6-months-old infants were tested on their responses to the category goodness of a vowel stimulus in the two groups. The greater generalization around the prototype vowel, language-specific representation, compared to the non-prototype member, showed an internal structure of phonetic prototypes.

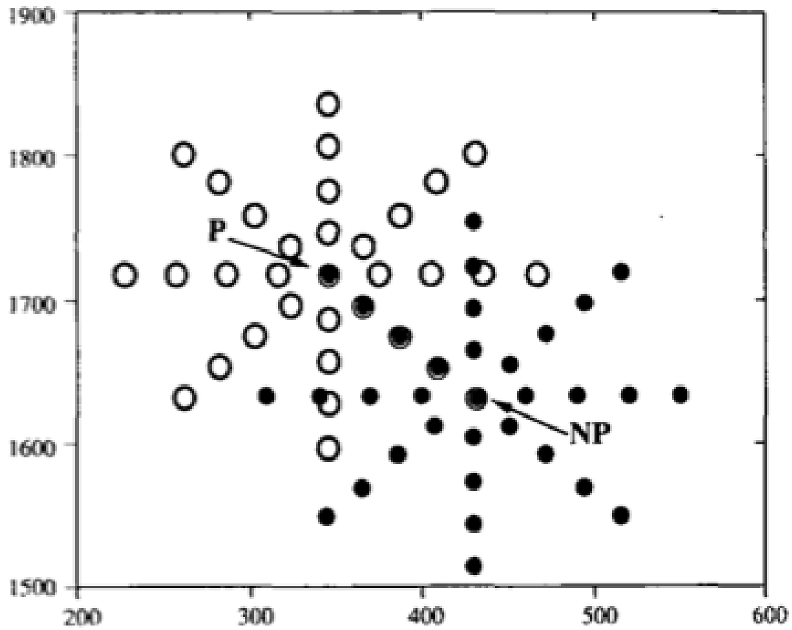


Figure 2. "The prototype /i/ vowel (P) and variants on four orbits surrounding it (open circles) and the non-prototype /i/ vowel (NP) and variants on four orbits surrounding it (closed circles)", Kuhl (1991).

Kuhl (1992, 1994) further proposes "Native Language Magnet Theory" (NLM) regarding the phonological development of newborns which encompasses the magnet effect. This model of phonetic perception is based on phonetic prototypes and their magnetic role in attracting other native speech sounds which belong to the same category. This theory is expanded into a new model NLM-e, the native language magnet theory expanded (NLM-e) with 5 extra principles and predictions which are specifically testable (Kuhl et.al 2007). The principles of NLM-e are as follows: (i) distributional patterns and infant-directed speech are agents of change, (ii) language exposure produces neural commitment that affects future learning, (iii) social interaction influences early language learning at the phonetic level, (iv) the perception-production link is forged developmentally and (v) early speech perception predicts language growth.

One of the criticism to this model is proposed by Lotto *et al.* (1998) who refuted the hypothesis that the perceptual space between a prototype member and its variants shrinks (fig. 3). Lotto *et al.* (*ibid.*) repeated the experiments with the category goodness of vowels /i/ and /e/ conducted by Grieser and Kuhl (1989) and Kuhl (1991). Their experiment showed that the prototype vowel was not rated the highest in goodness rating. They argued that "the distance between vowels was presumably psychophysically […] equal […] one might predict that P and NP would be equally discriminable from their neighbors". Also, they proposed that the "category membership is determined by identification of sounds in isolation" which maintains that the exemplar model of phonological perception is more realistic than PME.

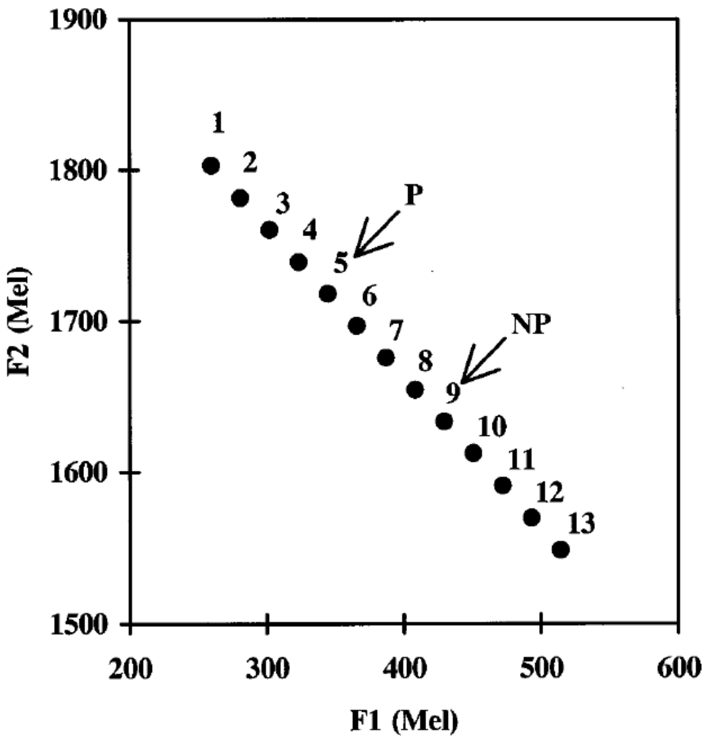


Figure 3. "Formant-frequency values in mel for stimuli used in Iverson and Kuhl (1995) and the present study. P is the "prototype" vowel and NP is the "nonprototype" as specified in Kuhl (1991). Vowels 1 and 13 are not used in the present design" Lotto *et al.* (1998).

A brief review of exemplar and magnet theories points out interesting insights with respect to the way they consider perception and categorization of speech sounds. It can be concluded that exemplar phonology suggests that persons generate a phonetic system based on all exemplars or tokens they heard, but perceptual magnet effect considers a prototypical sound at the center of each category where similar sounds are attracted to it. So, magnet model of phonetic perception do not perceive as much memory load as exemplar storage in phonetic development of individuals. Thus, PME can be said to be based on a more efficient and more simple processing of information than exemplar theory which is in accordance with Zipf's Law (Zipf 1949) regarding the principle of least-effort in human behavior.

3.6 Language contact

"[L]anguage contact is the use of more than one language in the same place at the same time" (Thomason 2001). Language contact happens when in a speech community, more than one official language exists and there is a high degree of communication between people who speak those languages. Such communication can also happen between people of adjusting regions. The co-existence of more than one language has some linguistic consequences in which these languages and the people who speak them tend to influence and be influenced by each other. In this phenomenon, at least one language is influenced by contact.

The influence between two languages would be in different levels of phonetic, syntax and semantic, for example, entering new words, sounds and sentence structures. This phenomenon can happen either in language borders or boundaries where two linguistic areas divide or as result of immigration of different individuals with different linguistic backgrounds who linguistically affect the native community such as the Pennsylvania Dutch in the United States.

There are some key terms in regard to the relation of languages to each other in this phenomenon: *superstratum* namely a language with hegemonic power which influences *substratum* the language with less power. As an example in English history, Norse was the language with hegemonic power which succeeded in maintaining itself and was the source of lexical borrowing for English (Thomason 2001: 18). Also, *adstratum* or *adstrate* relationship refers to mutual borrowing between languages with equal value such as French and Dutch in Belgium.

3.7 Theories of second language acquisition

Theories of second language acquisition deal mostly with explaining how second language is acquired /learned and whether and in how far native-like attainment is possible by L2 learners. Moreover, these theories try to give an account of what is the time point at which native-like accomplishment in L2 skills, especially in phonology, stops or starts to decrease its effectiveness.

3.7.1 Critical Period Hypothesis (CPH)

Critical period mainly stems from the critical periods in biology, where in developmental stages of an organism some activities and competencies have to be acquired in a certain age in an organism in order to be integrated into their behavior (Singleton 1989: 39). Importantly, some scholars prefer the term 'Sensitive period' to 'critical period' because "the decline in the human language learning capacity is not as sharp as that observed for loss of various developmental abilities in lower animals, and […] it appears to be subject to some, albeit small, individual variation also not witnessed in other species" (Granena & Long 2012).

The notion of Critical Period Hypothesis (CPH) was introduced by Penfield and Roberts (1959) and Lenneberg (1967) who hypothesized that there is a critical period for language acquisition namely from early childhood till puberty. According to CPH, there is an ideal time window to acquire language in a linguistically rich environment, with a native-like phonological proficiency. After this period, the ability to native-like L2 proficiency will decline and is almost impossible because maturation results in the reduction in native-like L2 attainment. Consequently, it has been proved that after the critical age it is difficult to pronounce L2 speech sounds without foreign accent. It can be said that after the critical period, L2 pronunciation would be under the influence of L1. The fact about learning a second language after the critical age is that one has already acquired a whole linguistic system of their native language and the brain and articulatory movement of larynx are already wired with L1 phonological and grammatical system. As Lenneberg (1967) mentions, after the age of 12 learning to talk accent-free in L2 will be difficult. This is due to age-related neurological maturation such as the brain lateralization, developmental changes and "the loss of plasticity for language" (Zevin *et al.* 2012: 335) although some adult language learners with high language aptitude can pass as native speakers (Abrahamsson & Hyltenstam 2008).

When talking about CPH, one should be aware of the dividing line between 'phonology' on one hand and 'morphology' and 'syntax' on the other hand. For example, Cabrelli Amaro and Rothman consider 'phonological competence' as opposite to 'morphosyntactic competence' (Cabrelli Amaro & Rothman 2010: 279). Long (2005 cited in Cabrelli Amaro & Rothman 2010: 277) asserts that considering a critical or sensitive period for acquiring any language is the matter of "can and cannot dichotomy". Following this argument, as CPH focuses mainly on the acquisition of phonology rather that morphology and syntax, this so-called "can and cannot" is mostly attributed to the pronunciation rather that 'semantic' and 'morphosyntax' domains of language. However, Hawkins and Chan 1997 and Hawkins and Liska 2004 (cited in Bañón *et al.* 2014: 277) maintain that "syntactic features not instantiated in the learners' L1 cannot be acquired to native-like levels". In line with this view, Long (2005: 280) considers the time span for "native-like morphology and syntax" attainment before the age of 15 which confirms the idea that critical period can also be attributed to other levels rather than phonology.

It should also be taken into consideration that when talking about speech production, different features of speech sounds are involved among them VOT, a segmental aspect, namely "the time that elapses between the release of the obstructed airflow (release burst) and the beginning of vocal cord vibration (voicing)" (Zampini 2008). In this regard and concerning the production of stop consonants, L2 acquisition before 6 years old results in native-like VOT length (*ibid.*).

As Reiterer *et al.* (2013: 366) mention, "adult second language (L2) learners face considerable and often lasting problems with pronunciation, contrasting, eventually, with excellent knowledge of vocabulary and grammar". Regarding that, Reiterer *et al.* (2011: 271) claim that only around five percent of adult language learners seem to be affected by a critical period and reach a native-like attainment. Therefore, the late language learners are contrasted in two extremes of having a talent for phonetic and phonology and a having a talent for syntax and semantic (Nauchi & Sakai 2009 cited in Reiterer *et al.* 2011: 271). In accordance with this remark, a phenomenon called Joseph Conrad phenomenon worth mentioning. Joseph Conrad was a Ukrainian-born Polish national and went to England at the age of 20 starting to learn English so he was quiet a late onset English learner. He became an English novelist who in spite of his excellent knowledge in grammar and vocabularies retained a distinctive L1 accent (Scovel 1969). Albeit being unable to reach native-like pronunciation level, his mastery of the written language was even above that of normal English native speaker.

3.7.2 Contrastive Analysis Hypothesis (CAH)

Historically speaking, Contrastive Analysis (CA) flourished after the Second World War from mid 1940s to late 1960s in the literature of second language teaching (Fries 1945; Weinreich 1953; Lado 1957; Banathy *et. al* 1966; Lee 1968) based on the notion of transfer and explaining why language learners have more difficulty in some areas than others. Under the influence of structural linguistics (Saussure 1916) and behavioral psychology (Skinner 1957), CA views language acquisition as a process of habit formation which is reinforced through positive feedback.

In the process of the acquisition of L2, mother tongue habits are believed to interfere with L2 rules. The central notion of CA is that with analyzing the differences in L1 and L2 all the foreign/ second language learners' errors can be predicted and explained. Lado (1957) systematized the procedures of contrastive analysis of L1 and L2 and claimed to predict the learners' errors. He mentioned "we can predict and describe the patterns that will cause difficulty in learning, and those that will not cause difficulty" (*ibid:* vii). In his view, there is a tendency in foreign language learners to transfer the formal, semantic and cultural aspects of their L1 in L2 productively and receptively (*ibid:* 2). Also, Banathy *et.al* (1966: 37) claimed that the target linguistic behavior of a foreign language learner can be compared with the structural and cultural differences between L1 and L2. The latter aspect is also mentioned by Dörnyei (2003: 4) as one of the two factors, namely social and cultural, which make L2 learning different from other school subjects. The validity of CAH in terms of predictability of learners' errors was put into question when it was proved that some predicted errors was not observed in the linguistic behavior of L2 learners. For example, some German learners of English did not have difficulty in the pronunciation of /r/ (Major 2008: 64).

Since 1970, three version of CA was introduced which are chronologically as follows: 'strong', 'weak' and 'moderate'. Strong version of CA as mentioned before, concerns the primary claims of CA and has pedagogical implications. Strong version views mother tongue interference as the main barrier for L2 learning and claims to predict all L2 learners' errors. This version of CA views the changes which should be made in the linguistic behavior of L2 learners associated with structural differences between L1 and L2 (Banathy 1966). The weak version (Wardhaugh 1970) was introduced as a solution to the strong claims of the primary version of CAH. The weak version did not claim to predict the learners' errors but accepts the L1 and L2 differences which cause difficulty for the learners. This version of CA is in favor of explaining the learners' errors after their occurrence and consequently has an explanatory function which assists language teachers in finding out the origin of L2 learners' errors. As Major (2008) indicates, Wardhaugh (1970) introduced "the *strong* versus the *weak* version of CA". As a falsification for CA, he mentions if prediction means absolute occurrence or nonoccurrence for everybody, CA can be falsified.

The moderate version of CA is proposed as a compromise between weak and strong version of CA. This theory considers the similarities between L1 and L2 as having hindering effects in L2 acquisition. Oller and Ziahosseiny (1970) based this theory on their research on the spelling errors of ESL learners. According to their finding, the similarity in the alphabets, here Roman alphabets, caused more spelling errors in French and Spanish ESL learners than Arabic and Chinese ESL learners whose writing system was not based on Roman alphabets. Thus, in their view, minimally different features tend to be more problematic for L2 learners than dissimilar features.

3.7.3 Phonological Permeability Hypothesis (PPH)

Phonological Permeability Hypothesis (PPH) is a quiet new hypothesis proposed by Cabrelli Amaro and Rothman (2010) referred to as "mental constitution of post-critical period adult phonological acquisition". According to this theory, if L2 phonological system is acquired in a native-like proficiency 'in the same manner', then a third language will affects these two systems, L1 and L2, somehow identically and simultaneously; i.e. if L1 and L2 are identically native-like in their mental configuration they are in the same way protected against the L3 system. On the other hand, if L1 and L2 phonological systems are created 'in a different manner' and consequently having different mental formation, then the acquisition of L3 system will have a rapid and universal 'cross-linguistic interference' on the previously acquired phonological system (i.e L2) (*ibid.:* 278). The reason of taking an L3 into consideration is that the study of such system can indirectly reveal some aspects of SLA theories which cannot be done by examining the L2 alone.

Also it can be concluded that learning a second and third language can influence the production of a person's native language. As an example, it is observed that individuals who have lived abroad for quite a long time and have been immersed in a foreign language speak their own native language with foreign accent being affected by the phenomenon of first language attrition.

3.7.4 Speech learning Model (SLM)

Speech Learning Model (SLM) was developed by James Emil Flege in 90s. This model mainly tries to give an account of how the perception and production of foreign language phonetic segments (vowels, consonants) functions (Flege 2005). This model originates from some postulates of second language acquisition such as Critical Period Hypothesis (CPH), Contrastive Analysis Hypothesis (CAH) and the categorical perception originally introduced by Trubetzkoy (1969). According to SLM, an L2 learner tends to place an L2 phonetic segment into the already existing L1 corresponding category. In another word, L2 "phonology" is perceived through L1 phonology and a new category for L2 sound will be made if the L2 learner could perceive the differences between the L2 and L1 speech sounds. Thus, the more differences there are between an L1 and L2 sound segments, the more likelihood exists in building a new category for it. On the other hand, the more similar an L2 phonetic category is to that of L1, the worst the opportunity would be for the correct perception and production of that sound segment. One possible explanation for this phenomenon could be that this similarity results in not making a new category for the novel speech sound which causes this confusion. As an example, Japanese ESL learners have discrimination difficulty in perception of English [l] and [r] by one Japanese consonant, namely [r] especially in syllable-initial position.

According to SLM, the later learning of an L2 phonetic segment by L2 learners will result in placing the speech sound in the closest L1 phonetic category. To put it in a different way, a lower AoA of L2 leads to building new phonetic categories for L2 phonetic segments (Flege 1995, 1999, 2002 cited in Aoyama *et al.* 2004) which results in a more effective perception and production of novel speech sounds. Flege (1995, 1999) refuted CPH by bringing up that there is no clear evidence of the existence of a sharp drop in native-likeness in the accent of L2 learners after the age of 12. In an experiment with native Korean adults and children residing in U.S. (Flege 1995, 1999), it was shown that children with early age of arrival in an English-speaking community, who studied in English-medium schools and resided four years on average in this environment, had a notable foreign accent compared to NE children.

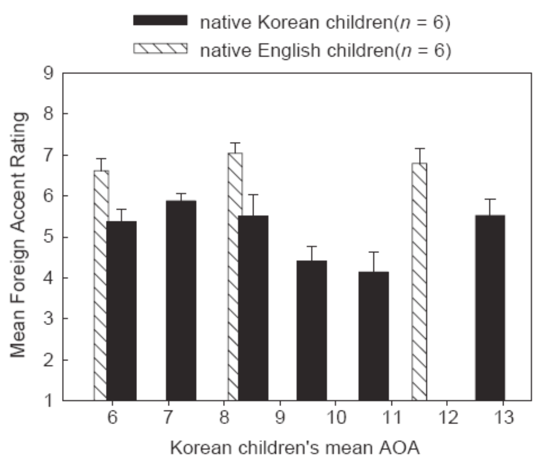


Figure 4. Foreign accent rating of native Korean children grouped on the basis of age of arrival in North America and native English children grouped on age (Flege 2005).

Flege (2005) found that the LoR in native Korean children residing in US and going to school for 4 years was non-significant in regards to catching English native accent because after accent ratings obtained for subgroups of native Korean, it was revealed that they had a detectable foreign accent. In this experiment, NK children got a significantly lower accent rate compared to NE children although they had a significantly better accent than NK adults who also were going to an English-medium school for 4 years. Thus, this findings were in contrast to the hypothesis that the foreign accent in L2 learners is due to the age of onset of language and critical period because it was shown that foreign accent was observed in early AoA subjects.

SLM also gives an account about the learning difficulties of an L2 speech sound. According to SLM, when an L2 learner perceives two L2 phonetic segments as members of two distinct categories, the learner identifies these sounds easily. Conversely, if the two phonetic segments are perceived as belonging to one L1 category, the discrimination would be difficult (Aoyama *et al.* 2004: 234). In another word, the perception of sound segments is on the basis of similarities and differences. Therefore, acquiring an L2 phonetic segment which is similar to an L1 sound would be more difficult than the one which is more different than the closest native speech sound. In this respect, this model can be viewed as a contrast to the strong version of CA hypothesis which predicts that the more different an L2 linguistic item is from the native language counterpart, the more difficult it would be for the L2 learner. At the same time, SLM is in alliance with the moderate version of CA which predicts that the similarities between L1 and L2 will create confusion for language learners and as a result will cause more difficulty (Oller & Ziahosseiny 1970). This hypothesis is also favored by Wode (1981, 1983) who mentions that similarities between L1 and L2 do not necessarily simplify L2 learning.

Flege (2005: 2) refers to the relationship between sound segments in L1 and L2 and an L1 counterpart for an L2 sound perceived by foreign and second language learners. A criticism to this claim is that there are no clear criteria for asserting what is decided by an L2 learner as an L2 equivalent of an L1 sound segment because this is very subjective and a mental perception which resides in an L2 learner's mind, for example, what would be the equivalent for schwa in L1, would be different for another L2 learner. As an Example, it could not be said which of the short vowels namely /ʌ/, /ɪ/ and /ə/ would be mistaken by Persian ESL learners as /a/.

3.7.5 Markedness differential hypothesis (MDH)

Markedness theory was developed by some linguists as a revision for the shortcomings of CAH in terms of predicting learners' degree of difficulties (Trubetzkoy 1969; Jakobson 1941; Eckman 1977, Rutherford 1982, Celce-Murcia and Hawkins 1985, Greenberg 1976). According to this hypothesis, the degree of markedness correlates with the degree of difficulty of linguistic items. In linguistic comparison, unmarked is referred to an item which is more usual and is more widespread than the marked pair. So, a marked item stands out in the linguistic context due to its being less usual. The marked forms are not productive so the irregular forms are marked and as a result less frequent than unmarked items. In a simple formula "A structure X is typologically marked relative to another structure, Y, (and Y is typologically unmarked relative to X) if every language that has X also has Y, but every language that has Y does not necessarily have X." (Gundel *et al.* 1986: 108 cited in Eckman 2008: 96). Thus, the presence of X denotes the presence of Y but not vice versa.

In the process of learning a second language, those linguistic items in L2 which lack in L1 and as a result cause difficulty are marked. Thus, in our study, phonological differences between L2 English and Persian sound systems are considered marked, focusing on schwa pronunciation. Consequently, the degree of markedness of a linguistic domain corresponds with the degree of difficulty of L2.

3.8 Language aptitude and individual differences in non-native speech sound learning

Language Aptitude is a concept which is related to the broader concept of human cognitive abilities, covering a variety of cognitively-based learner differences. Such differences affect any kind of learning in individuals among them L2 learning. Language learners differ in their ability to learn a second or foreign language. Research findings in brain imaging show that a higher proficiency of non-native sound perception and production can be explained by individual differences. Measuring individual differences in L2 learning has become popular particularly in the last two decades (Long 2013: 33). In this regard, two types of assessments have been carried out. Firstly, measuring linguistic talent by means of some language aptitude tests such as, the Modern Language Aptitude Test (MLAT) (Carroll & Sapon, 1959) which are aimed at predicting success or failure in foreign or second language learning. Second, by means of methods of "neuroimaging" (Mildner 2006: 51) and neuro-scientific analysis such as functional magnetic resonance imaging (fMRI), electroencephalogram (EEG), Event Related Potential (ERP) and Positron Emission Tomography (PET). These methods are recently used by some linguists and neurologists for research in individual differences in the acquisition of second language phonology by measuring the amount of brain activation in different parts of the brain while investigating phonological stimuli, brain responses to different stimuli, how two brain hemispheres are connected, or how grey or white matter are concentrated in different brain regions (Reiterer *et al.* 2011, 2013; Golestani *et al.* 2002, 2007; Golestani & Zatorre 2009; Hervais-Adelman *et.al* 2014).

Phonetic aptitude in non-native speech sound learning can be related to different factors such as genetics, "neurophysiological, neuroanatomical, cognitive, and perceptual factors". (Wong & Ettlinger 2011). According to Carroll (1981 cited in Wendy Baker & Haslam 2012), in 50s and 60s, the scholars proposed that L2 learning talent is a particular capability which has to be considered separately from scores in the general intelligence tests although the general intelligence of a person is related to structure and function of the brain which also play a crucial role in foreign language aptitude. There are some biological and birth-given characteristics that can affect language learning in a positive way. In this respect, brain studies show that individuals with higher language aptitude have a greater neurocognitive flexibility and brain bilateral processing (Schneiderman & Desmarais 1988a, 1988b) than persons with low language aptitude. A study by Golestani *et al.* (2002) showed that brain anatomy can predict the ability of distinguishing and producing non-native speech sounds. This study considered the question of whether the individual differences in language related tasks such as learning novel speech sounds might be related to differences in brain anatomy. It was shown that greater asymmetry in the amount of white matter between the brain hemispheres allows more efficient neural processing and the ability to process certain speech sounds. Moreover, a relationship was discovered between the rate of phonetic learning and the grey and white matter volumes in the parietal lobe in the left hemisphere. Imaging results obtained from voxel-based

Morphology and MRI scans showed that faster learners appeared to have more white matter in parietal regions, especially in the left hemisphere and a greater asymmetry in the amount of white matter (fig. 5). Furthermore, a greater number and/or thickness of interhemispheric fibers adjacent to the parieto-occipital suclus suggested that in faster learners, there is a greater interhemispheric connectivity in temporal and temporo-parietal auditory-related brain regions. It was further concluded that in faster learners, the parietal lobes are larger or shaped differently than in slower learners, resulting in a relatively more posterior location of the parieto-occipital sulcus. The findings of this study reveal some brain related facts and further suggest that the brain anatomy is very crucial in perception and production of speech sounds and therefore makes some people more capable language learners than others. These differences in brain anatomy can be said to be the reason why some individual can learn foreign languages better than others such as language genii and hyper-polyglots.

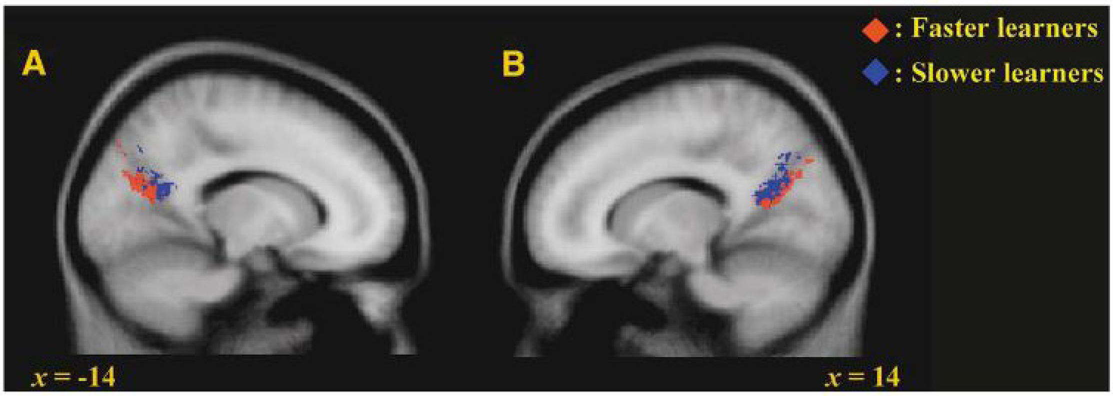


Figure 6. Parieto-Occipital Sulcus Probability Maps
Parieto-occipital sulcus 50% thresholded probability maps in (A) left hemisphere (x = −14) and (B) right hemisphere (x = 14) in faster (red) and in slower (blue) learners.

Figure 5. White matter distribution in left and right hemispheres in fast and slow learners (Golestani *et al.* 2002)

Contrary to Carroll (1981) who discriminates between scores in general intelligence and language aptitude, Dörnyei (2005) takes a different approach and links language aptitude to general intelligence by questioning if language aptitude is a human trait. Dörnyei (2005: 31) connects the idea of language aptitude to the more comprehensive concept of human capacities and puts the idea of the possibility of a change of language aptitude with age in question. Dörnyei (*ibid.: 44*) mentions that "if language aptitude is a trait it should be relatively stable". He refers to a longitudinal survey in Scotland where some subjects in Scotland took part in an intelligence test at the age of 11 and repeated the test in 5 decades later. The comparison of the scores in two periods showed a significant correlation of .8 which proved that intelligence is a permanent attribute (Deary *et al.* 2000, referred to in *ibid.*). Hence, if language aptitude is a trait it will not change over time.

Dörnyei (*ibid*: 33) claims that intelligence is regarded synonymous with the 'ability to learn'. He refers to the first intelligence test developed by Alfred Binet and Theodore Simon called Binet-Simon Intelligence Scale in 1905 which was designed to filter out the students who because of their limited mental capacity were not able to benefit from the school instructions. Accordingly, the concept of intelligence is very much connected to 'learning success' (*ibid.*: 33). Thus, the measurement of learning foreign language ability has been regarded as a useful technique to predict the language learners' success. Such ability has been mentioned also synonymous with 'language aptitude', a special 'propensity' or 'talent' for learning an L2 and a 'flair' or 'knack' for languages (*ibid.* :33). Dr. John B. Carroll refers to language aptitude as "simply an ability or "knack" for learning foreign languages. Language aptitude above all considers L2 learning after puberty, because every healthy person either intelligent or non-intelligent is able to attain any language in native-like level in early ages. The most important factor in talent studies is, then, achieving such level after critical period.

Language scholars proposed different models of foreign language aptitude on the basis of their categorization of cognitive abilities. Robinson (2002) considers cognitive abilities as hierarchical abilities in that each order contributes to the abilities in the next order. For example, considering the relationship between first and second order abilities, *first order abilities* refer to abilities that are measured by psychological tests such as "working memory capacity" and "analogical reasoning". On the other hand, *second order abilities* are abilities which result from special combination of *first order abilities* (e.g. "broad intelligence" and "fluid speediness").

Carroll's model of foreign language aptitude (1981 cited in Skehan 1989; Carroll & Sapon 1959) categorizes the skills for L2 learning as the following: "phonemic coding ability (memory of sounds and their combinations), associative memory (the ability to remember new words), inductive language learning ability (the ability to find patterns in words and sentences), and grammatical sensitivity (the ability to understand sentence structure of unknown languages)". Carroll & Sapon (1959) also mentions *rote memorization ability* previously as one of the subcomponents of their classical model of foreign language aptitude. In this regard, Reiterer *et al.* (2011) point out that a person can either have a "talent for accent" (Obler & Fein 1988; Skehan 2011 cited in Reiterer *et al.* 2011) which can be related to Carroll's "phonemic coding ability" or a "talent for grammar" (Nauchi and Sakai, 2009 referred to in Reiterer *et al.* 2011) corresponding to Carroll's "inductive language learning ability". Another model of language aptitude is proposed by Skehan (2002) who categorizes the subcomponents of FL aptitude in regard to cognitive factors such as *noticing, patterning, controlling* and *lexicalizing.* Additionally, Robinson (2002: 118) defines cognitive resources as three kinds of memory (i.e.: working memory, short term memory and long term memory) plus attention and basic processing speed. His model (2002, 2007) is called *Aptitude Complex Hypothesis* (ACH) which is based on aptitude complexes in instructional contexts with the aim of maximizing pedagogical performance of L2 learners. This model considers mainly L2 processing of L2 learners and their focus of attention and intention with L2 tasks.

Taking all these factors into account, it should be considered that the phonological talent of individuals, who could pass as a native speaker due to their target-like non-native system, can never make them real native speakers of the foreign or second language. Their high proficiency can be, for example, due to factors such as "a particularly good acoustic perception ability" or "relevant muscular dexterity". Indeed, what actually make these people sound like native speakers is on the surface level of their linguistic representation. Thus, the non-native language system of these individuals could not match the native language system because the deep mental representation of their non-native language is different from that of native speakers: their achievement is due to the "so-called surface non-native morphosyntax success" (Bley-Vroman 1990; Clahsen & Felser 2006; Hawkins 2005 referred to in Cabrelli Amaro & Rothman 2010).

The question arises as to which level of L2 phonological attainment can be attributed to native-likeness. As Erard (2012: 45) puts this issue in question, an individual's "nativeness" in language X isn't necessarily the same as another's" because "pronunciations, vocabularies, and grammars are heterogeneous across social divides, genders, and geographical areas". Moreover, one cannot determine how the version of two native speakers from the same language are different from each other because language cannot be measured by quantitative measures such as kilo or inch (*ibid*.: 48).

3.9 Age of Onset of Language/Acquisition (AoL/AoA)

The impact of age on L2 attainment has been the topic of many second language acquisition researches so far (Bongaerts 2005). An outstanding question in research in L2 learning has been if there is a biological time window for achieving native-like proficiency in foreign languages. It has been proved that native-like proficiency in L2 is very much dependent on the age of onset of the second language, namely an increase in AoA, after a certain age, is in relation to the decline in the native-like attainment. In a study conducted by Flege *et al.* (1999), the pronunciation rating of the Italian English learners decreased with the increase of AoA. It should be considered that the age of onset of language in regard to L2 attainment is contrasted in two levels of 'phonology' and 'morphology and syntax' where native-like phonological attainment are always earlier than the other skills. For example, Long (1990 cited in Bongaerts 2005) asserts that "the ability to attain native-like phonological abilities in an SL begins to decline by age 6 in many individuals" but native like ability in morphology and syntax are possible before 15 (*ibid*.).

The critical age in which native like acquisition decreases in individuals is considered differently by researchers ranging from 6 to 15 years. As early as 1939, Penfield a prominent Canadian neurologist in his lecture at Lower Canada College mentioned the important role of human physiology in language learning (Pennfiel and Roberst 1959: 235). He mentioned that "[b]efore the age of nine or twelve, a child is a specialist in learning to speak. At that age he can learn two or three languages as early as one [...] Remember that for the purposes of learning languages, the human brain becomes progressively stiff and rigid after the age of nine". Lenneberg (1967), on the other hand, considers the age from which native language learning is impossible 12 years. Also, Patkowski (1980, 1990 cited in Bongaerts 2005) considers a later age namely 15. He asserts that there is "a sharp discontinuity in L2 pronunciation proficiency around an age of acquisition [...] of 15".

However, the positive effect of language learning aptitude may compensate for "the negative effects of a critical period" (Abrahamsson & Hyltenstam 2008). As Reiterer *et al.* (2011) mention, persons with high imitation ability are capable of speaking an L2 native-like accent in spite of the late AoA. Another factor supporting the possibility of achieving a native speaker proficiency in adulthood is the case of language freaks throughout the history. Although it can be argued that exceptions cannot be a valid evidence for a truth or fallacy of the reality, the existence of exceptions per se can reveal some facts about the phenomenon which should not be neglected. It can be admitted that hyperpolyglots, people who talk more than five languages, for example, Johan Vandewalle (Erard 2012: 253), have not spoken all of the languages they could speak with native speaker proficiency level. However, almost all of them could speak a few of the languages with native speaker level. It should be taken into consideration that some of the languages are from the same family and as a result learning one of them makes learning the other one much easier (cf. sub-chapter 3.2).

4

Sound systems of English and Persian

4. Sound systems of English and Persian

Speech sounds are those sounds which are used by speakers of a particular language to communicate and are rule governed by each language. Generally, speech sounds can be categorized in two distinct groups of vowels i.e. speech sounds which do not involve any obstruction of the airflow and consonants i.e. those speech sounds which are produced by obstructing the airflow through the vocal tract (Roach 2002). In this section, the sound systems of Persian and English are explained. As Persian uses non-Roman alphabets, this language posits a very different writing system compared to languages using Roman alphabets. The most significant differences are in the domain of alphabets, writing direction, joining letters, majuscules and minuscules which will be explained in detail. Also, differences in sound systems of both languages will be presented.

4.1 Persian Language

Persian or Farsi Language is a member of the Iranian branch of Proto-Indo-European family of languages (fig. 6). Apart from Iran, Persian is spoken in Afghanistan, Tajikistan and Uzbekistan. The reason for referring two different names to the language spoken in Iran is that the country was called Persia until 1935 when Reza Shah the king of Iran wanted the foreign delegates to use 'Iran' in their formal correspondence which was also used historically to refer to Iran (http://www.iran-heritage.org/interestgroups/language-article5.htm08.06.2015). The citizens of Iran are called Persian/Iranian but the adjective for referring to the language of Iran is *Persian* or *Farsi*.

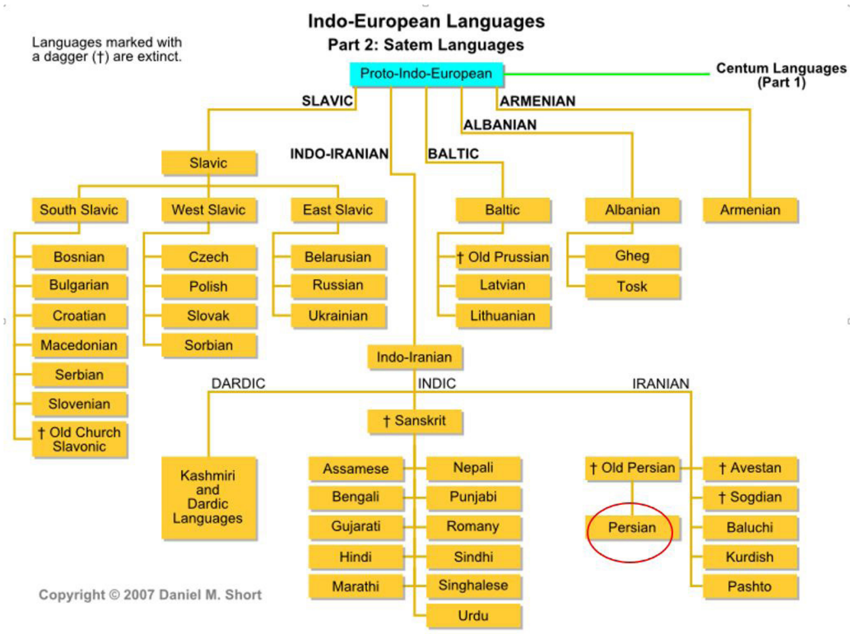


Figure 6. Persian in Indo-European Centum languages family tree

4.1.1 Persian Orthography

Persian has been influenced by Arabic in both writing system and morphology, e.g. the plural ending morpheme /a:t/ is Arabic which is used together with the Persian plural morpheme /ha:/ to build plural forms of nouns. Unlike English, Persian uses Arabic Alphabets in its writing system. After the introduction of Islam, Arabic alphabet was adopted to the Persian language with four extra letters which does not exist in Arabic. Arabic alphabets are composed of 28 letters. Due to the lack of Phonemes پ [p], چ [tʃ], ژ [ʒ], and گ [g] these phonemes were adopted to Arabic alphabets for writing Farsi (Yarmohammadi 1985: 16). Therefore, Persian or Farsi alphabets consists of 32 letters namely :

/ا/ ، /ب/ ، /پ/ ، /ت/ ، /ث/ ، /ج/ ، /چ/ ، /ح/ ، /خ/ ، /د/ ، /ذ/ ، / ر/ ، /ز/ ، /ژ/ ، /س/ ، /ش/ ، /ص/ ، /ض/ ، /ط/

/ظ/ ، /ع/ ، /غ/ ، /ف/ ، /ق/ ، /ک/ ، /گ/ ، /ل/ ، /م/ ، /ن/ ، /و/ ، /ه/ ، /ی/

Each letter has different subsets of initial, medial, final and detached form. The detached form of alphabets refer to the primary letter form which is not attached as appears in the former sentence. Table 1 gives a detailed explanation about the alphabets of Persian Language in different word positions.

Contrary to Roman or Latin alphabets where capital form of letters come at the beginning of words, in Persian writing system, minuscule are used in initial and mid position, but majuscules come at the final word position. One categorization divides the Persian alphabets into two groups of attached and detached. The detached form is the form when the alphabet stands alone. The attached forms appear at the beginning and mid-word position. As it is also shown in the table below, minuscules have two forms of initial and medial and majuscules have two forms of final when they come at the end of the word attaching to the previous letter and detached when they stand alone at the final word position but can also appear in the middle of a word. Because the Persian language is written from right to left, the letter in its final position is attached from its right side. As it can be seen, the difference between attached and detached forms of Persian capital letters is realized by a very tiny joining stroke, i.e. a small extension on the right side of the letter (cf. table 1).

Two orthography rules of Persian alphabets are as follows:

1. The letters (/ا/, /د/, /ذ/, /ر/, /ز/, /ژ/, /ط/, /ظ/ and /و/) are written mostly the same in different positions of words (table 1).
2. The letters (/ب/, /پ/,/ت/, /ث/, /ج/, /چ/, /ح/, /خ/, /س/, /ش/, /ص/, /ض/, /ک/, /گ/, /ل/, /م/, /ن/, and /ی/) have two forms of attached and detached or minuscule and majuscule. (Yarmohammadi 1985: 17) (table 1).

Persian Alphabet / الفبای فارسی

Detached	Initial	Medial	Final	Roman	Name	Detached	Initial	Medial	Final	Roman	Name
ا	ا	ـا	ـا	á	alef	ص	صـ	ـصـ	ـص	ṣ	sád
ب	بـ	ـبـ	ـب	b	be	ض	ضـ	ـضـ	ـض	ḍ	zád
پ	پـ	ـپـ	ـپ	p	pe	ط	طـ	ـطـ	ـط	ṭ	tá
ت	تـ	ـتـ	ـت	t	te	ظ	ظـ	ـظـ	ـظ	ẓ	zá
ث	ثـ	ـثـ	ـث	th	se	ع	عـ	ـعـ	ـع	ʻ	ayn
ج	جـ	ـجـ	ـج	j	jim	غ	غـ	ـغـ	ـغ	gh	ghayn
چ	چـ	ـچـ	ـچ	ch	che	ف	فـ	ـفـ	ـف	f	fe
ح	حـ	ـحـ	ـح	ḥ	ḥe	ق	قـ	ـقـ	ـق	q	qáf
خ	خـ	ـخـ	ـخ	kh	khe	ک	کـ	ـکـ	ـک	k	káf
د	د	ـد	ـد	d	dál	گ	گـ	ـگـ	ـگ	g	gáf
ذ	ذ	ـذ	ـذ	dh	zál	ل	لـ	ـلـ	ـل	l	lám
ر	ر	ـر	ـر	r	re	م	مـ	ـمـ	ـم	m	mím
ز	ز	ـز	ـز	z	ze	ن	نـ	ـنـ	ـن	n	nún
ژ	ژ	ـژ	ـژ	zh	zhe	و	و	ـو	ـو	v/ú	váv
س	سـ	ـسـ	ـس	s	sin	ه	هـ	ـهـ	ـه	h	he
ش	شـ	ـشـ	ـش	sh	shin	ی	یـ	ـیـ	ـی	y/í	ye

Table 1. Persian Alphabets in different word position (http://chinese-school.netfirms.com/Tibet/farsi.html 20.11.2014)

Ideographs are the same in Persian alphabets except numbers which are written according to Arabic system. The question mark in Persian alphabet is the Arabic question mark (؟), a reversed or mirrored question mark of the Roman alphabet. One reason maybe the writing direction of Persian. The following figure illustrates briefly the Persian alphabets in their detached forms and also Persian numbers.

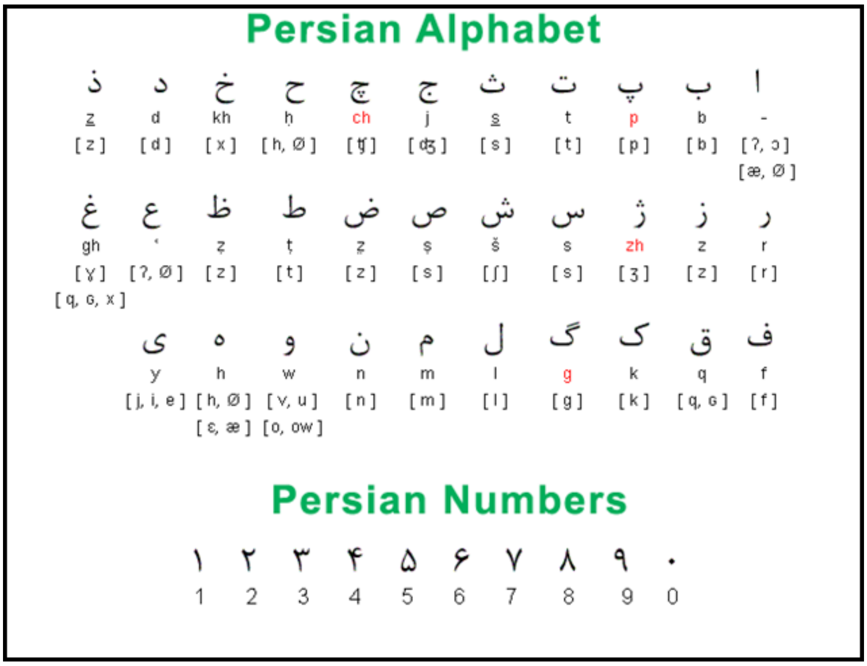


Figure 7. Persian alphabets and numbers (http://www.learn-persian.com/english/images/Persian_Alphabet.php 01.07.2014)

Three major areas can be identified in the phonology of Persian which contributes to typical difficulties and peculiarities in the L2 pronunciation of Persian speakers of English. The first feature is the Persian vowel system which lacks many of the vowels in English sound system. The second factor is Persian consonant system and finally Persian phonological structure which lacks consonant clusters except final CC. These features will be explained in the next sub-chapters.

4.1.2 Persian vowels system

Persian has the advantage of having basic vowels which are found in most of the world's languages, i.e. cardinal vowels. So, for learning Persian as a second language, the learners would have almost no difficulty in learning Persian vowels (cf. English 20 vowels). As Rosch (2002) points out, many of the world languages have almost three vowel phonemes namely /i/, /a/ and /u/: some have these vowels plus /o/ and /e/. Persian possesses fewer vowels than English. Like Arabic, Persian is based on 6 vowel phonemes system with two groups of vowels. The first group is the short vowels, namely /æ/ as in *lad*, /e/ as in *bed* and /o/ as *sold* which are written as diacritical marks only above, /æ/ and /o/, and below, /e/, letters. Iranian children use texts with diacritics just in their first grade. Persian normal texts as in books and newspapers do not use diacritics. They should be learned by heart so when reading Persian the reader should intuitively guess the right short vowels in words. The second group comprises the long vowels, namely /a:/ as in *strawberry*, /u:/ as *Sue* and /i:/ as in *eat*. For long vowels and diphthongs, combination of consonant letters are used in the writing, e.g. /i:/ as in /i:ˈrɑn/ ,Iran ایران(consider the first two alphabets from right to left in the Persian word).

Vowels are defined and categorized mostly according to the relative position of the tongue in the oral cavity during vocalization in regard to tongue highness (high, mid, low) and front or backness (front, central, back) (Zampini 2008). Plotting the position of articulation of vowels was done for the first time by Daniel Jones (1881-1967) (Finch 2005: 38). The figure below shows relative position of Persian vowels indicated in IPA chart. As Finch *(ibid.)* points out, the position of the articulation of vowels in the mouth diagram is not precise but an 'idealised' version, i.e. "they do not represent any actual vowel of any particular language". For example, the French /i/ is slightly higher than the English /i/ (*ibid.*).

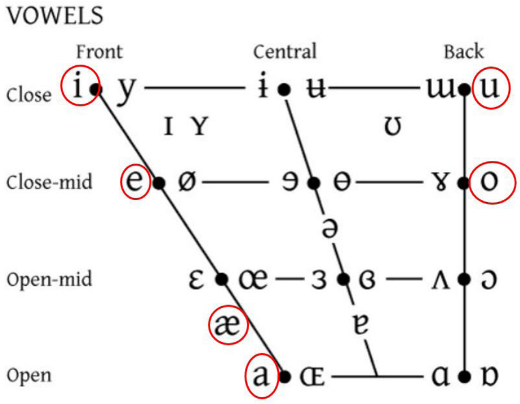


Figure 8. Persian vowels in the "International Phonetic Alphabets chart" (Roach 2005)

4.1.3 Persian consonants system

In Persian, alphabets mainly refer to consonants. Short vowels are written as diacritic marks above and below letters, long vowels are exception. An important fact about the Persian phonology and writing system is that as it is mentioned, Persian uses Arabic alphabets in its writing system and the writing direction is from right to left. Persian also has borrowed many Arabic lexemes. However, by adopting Arabic alphabets and using Arabic words, the Arabic sound system has not entered into Persian language. Some groups of Arabic letters with their own pronunciation form are realized in one phonemic version in Persian. For example, in Arabic, there are four different letters which are pronounced as phoneme /z/ by Persian speakers, namely /ظ/ ,/ز/ ,/ذ/ and /ض/: the Arabic /ذ/ pronunciation corresponds to the English /ð/. Also, there are three letters which are pronounced as /s/ by Persian speakers namely /ص/ ,/س/ ,/ث/ which have also different pronunciations in Arabic, e.g. /ث/ pronunciation correspond to English /θ/. As another example, the letters / ح / and / ه / have distinct pronunciations in Arabic which are also pronounced as one single form /h/ in Persian. Finally, the letters / ق / and / غ / pronunciation is treated as the Persian / ق /. So, when a Persian speaker pronounces words with any of the above letters, the original Arabic phonetic pronunciation is not adopted because Iranian chose to pronounce the letters nearest to their mother tongue version such as the case with English when Iranian pronounce /w/ as /v/.

4.2 English Language

Anglo-Saxon invasions to England in 5th century were the beginning of the establishment of English language. Its oldest texts dates to 7th century and is called **Old English** which preserves many characteristics of Germanic (Crystal 1992). "English is a member of the western branch of the Germanic family of languages" (Crystal 1995) and is "rapidly becoming the first global lingua franca" (Crystal 2003). The first major steps in achieving the status of "world language" has started "in the last decades of 16th century". At that period, almost all, between five and seven millions, of the English native speakers were residing in the British Isles (Crystal 1995). In the time span between 1588 (the end of the reign of Elizabeth I) and 1952 (the beginning of the reign of Elizabeth II) this figure has increased to 250 million with the majority living outside the British Isles and being Americans. The moving of English towards global status begun with expedition "voyages to the Americas, Asia, and the Antipods" (*ibid.*). Today, English is spoken in United Kingdom, the United States, Canada, Australia, Ireland, New Zealand, the Caribbean, Africa and South Asia. English owes its present-day position to "two factors: the expansion of British colonial power […] and the emergence of the United States as the leading economic power of the 20th century (Crystal 1995).

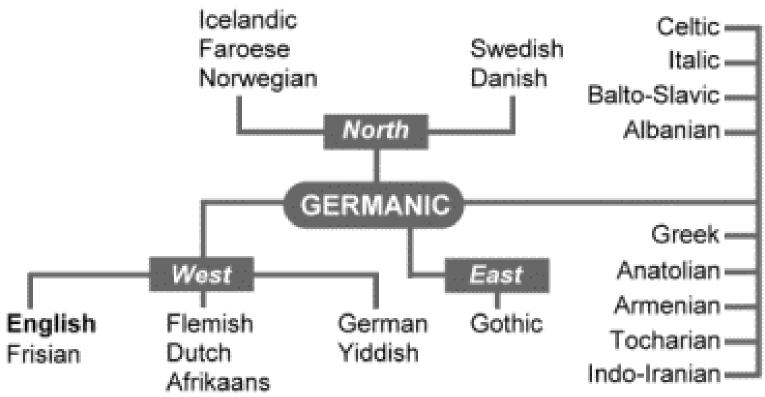


Figure 9. English in western branch of the Germanic family of languages (Crystal 1995: 6)

4.2.1 English vowels system

British English (BBC accent) is claimed to have 20 vowels consisting of 'short vowels', 'long vowels' and 'diphthongs'. With treating long vowels and diphthongs separately, considering those as combination of two phonemes, the vowels of British English would be: /i, e, a, o, ʌ, u /. In this six vowel analysis of the British English, the schwa vowel [ə] could be considered as an allophone of some of these vowels. A possible case is that [ʌ] is the stressed and [ə] and unstressed allophone of the same phoneme (Roach 2002: 48). Contrary to Roach, Finch (2005) considers a 12 members system of British short vowels illustrated in fig. 10.

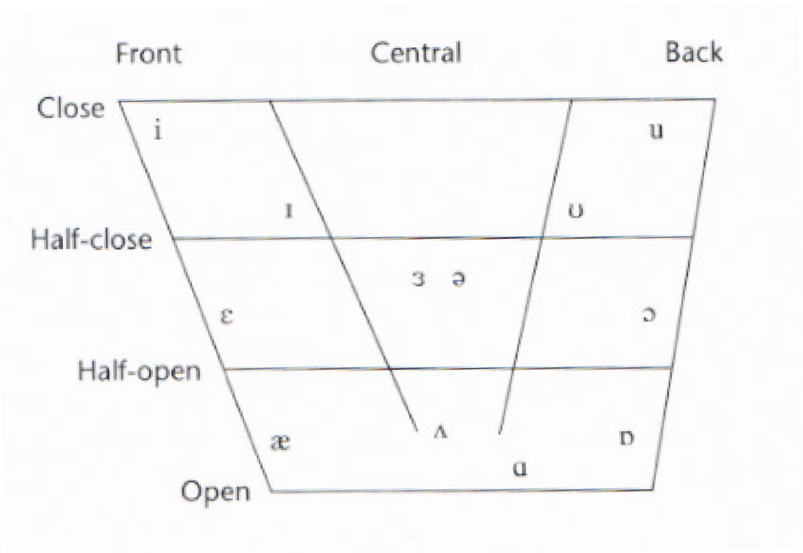


Figure 10. English vowels (Finch 2005)

4.2.2 English consonants system

According to articulatory phonetics which deals with how speech sounds are produced, consonants are described with regard to the place of articulation and the manner of articulation. The primary aspect of consonant description is how the position of vocal cords are when the air pushed through lungs is passing from vocal cords. Voiceless sounds are those sounds produced when the air passes unimpeded via vocal cords and voiced sounds are those which are articulated when the vocal cords are drawn together and producing a vibration effect.

For the second aspect of consonant description namely place of articulation one way is to start from "the front of the mouth and work back" with keeping voiced and unvoiced features in mind. There are seven places of articulation for the description of English consonants namely: bilabial, labiodentals, dentals, alveolars, alveo-palatals, velars and glottals. Manner of articulation deals with how consonants are articulated. Such description helps to differentiate consonants which have the same place of articulation such as [t] and [s]. In one categorization, five manners of articulations are stops, fricatives, affricates, nasals and approximants (Yule 1996). Roach (2005), for example, includes an extra feature regarding manner of articulation namely *laterals* which have one single entry namely /l/. There are some controversies for the placements of /h/ and /l/ in Roach and Yule systems. Yule includes /h/ as approximant but Roach considers this sound as fricative. Also, Roach groups /l/ as a lateral sound, whereas Yule considers it as an approximant (table 2).

	Bilabial		Labio-dental		Dental		Alveolar		Alveo-palatal		Velar		Glottal	
	-V	+V	-V	+V	-V	+V	-V	+V	-V	+V	-V	+V	-V	+V
Stops	p	b					t	d			k	g		
Fricatives			f	v	θ	ð	s	z	ʃ	ʒ				
Affricates									tʃ	dʒ				
Nasals		m						n				ŋ		
Approximants		w						l,r		y			h	

Table 2. English consonants grouped by manner and place of articulation (Yule 1996)

4.3 Persian phoneme System compared to English

Because of the rich consonant system of Farsi, Persian speakers are privileged over native speakers of some other languages such as English, German, Hindi and Urdu. They can pronounce many different consonants which other native speakers of different languages are unable or hardly able to articulate. For example, the phonemes /x/ is easily pronounced by a Persian native speaker in initial, middle and final word position, whereas an English native speaker mostly pronounce /k/ instead of /x/. For example, an English native speaker would pronounce the velar fricative sound in German word *Achtung* as /æktung/. Moreover, Persian speakers can easily pronounce /ʒ/ in initial, middle and final position (a typically French sound as in *Jouliette)*. But for German native speakers, the initial /ʒ/ is mostly pronounced as /ʃ/, although the middle /ʒ/ is easily pronounced as in *pleasure*. Moreover, unlike Urdu and Hindi native speakers, the voicing of unvoiced consonants in syllable-initial position such as the pronunciation of /d/ for /t/ as /du:/ for *two* does not happen in the pronunciation of Persian L2 leaners of English.

In spite of that, there are also some consonants which do not exist in Persian such as /w/, /θ/ and /ð/. The lack of these consonants in Persian leads to deviant pronunciations of /vest/ for /west/, /dis/ for *this* and /tink/ for *think*. Vice versa, /q/ is a Persian consonant which does not exist in English, for example in the word *Nastaliq* /næstæli:q/-the predominant Persian calligraphy hand. This phoneme is mainly pronounced /g/ by English or German native speakers. Regarding allophones in English, the dark or velarized allophone of the phoneme /l/ namely [ɫ], does not exist in Persian. So, Persian ESL speakers tend to perceptually assimilate dark /l/ with clear and non-velarized /l/, [l], of their native language. This phenomenon is also pointed out by Weinreich (1953) who indicates that linguistic interference from L1 leads to the substitution of the closest L1 sound for an L2 phonetic segment.

4.3.1 Consonant clusters

Consonant cluster is one of the linguistic issues that can be examined in the sphere of second language learning. It is self-evident that there are some controversies in sound system of the second language learners' mother tongue and that of the target language. But this fact is not limited to the individual sound segments themselves, because in order to articulate a word correctly it is not only important to pronounce 'every single sound' correctly, but also to shift from one segment to the other within a word or between words. For example, in Persian language individual phonemes of /s/, /p/, /i:/ and /k/ exist. However, a normal ESL Persian speaker tends to pronounce the word *speak* /spiːk/ as /espi:k/. This observation can be related to the difficulty of pronouncing consonant clusters by Persian native speakers. Not all of the speech communities have this feature in their own language, or if they do it does not occur as onset and syllable initial position. Such lack of initial CC can be attributed to 'phonotactic probability' which is "expressed as the probability that a sequence of sounds will occur in a lexical item"(Edwrads *et al.* 2004). To cope with this problem, a speaker of Spanish or Persian may turn to some strategies like inserting a vowel between the consonants or at the beginning of a cluster of consonants. Phonological rules that explain these insertions are "segment insertion" (Falk 1978: 142) and "epenthesis" (Singh 2002: 6-7). As Falk (1978: 142) points out, "Spanish has a segment insertion rule that supplies the vowel [e] whenever a word would otherwise begin with [s] followed by another [+consonantal] segments." Such as: escula 'school', especie 'species' and estampa 'stamp'. The later phenomenon, epenthesis, refers to a process by which segments are inserted into a phonetic sequence. Epenthesis vowels, for example, typically break up consonant clusters, as in pronunciations such as [fɪlɪm] (film) and [arʊm] (arm) (Singh 2002: 6-7).

Particularly, Persian lacks onset clusters and the only type of consonant cluster existing in Persian language is CC at the end of the word, such as /æst/ (the Persian word for *is*). Accordingly, the typical phonological error by Persian native speakers for pronouncing consonant clusters is using the aid of vowel insertion. For example, the word *ski* is pronounced as /eski/ by Persian native speakers. This aspect will be explained in more detail in sub-chapter 4.3.3.

4.3.2 Some features not instantiated in Persian Language

This section analyses the difference between Persian and English sound systems in greater depth. Short vowels which do not exist in Persian are /ʌ/, /ɪ/ and /ə/. The last vowel exists just in some dialects of Farsi; in the Gilaki dialect, to take just one example, the pronunciation of /mæn/ in the standard Persian, the Persian word for *I*, is pronounced with the second segment /ə/ which is lacking in Persian sound system (Ghader-pour 1992: 57) implying that /ə/ in some dialects of Farsi is an allophone of the phoneme /æ/. Regarding the above features, the vowel system of Persian tends to be transferred into FL phonological system in Persian L2 learners. This phenomenon is named "underdifferentiation" by Weinreich (1953) which means that two different phonological categories in TL are realized by one category in L1. This typical performance can be observed in average and elementary language learners; advanced learners of English, however, have overcome these difficulties. For example, considering schwa, the lack of this vowel in the standard language causes some difficulty for Iranian ESL learners in producing initial and inside schwa as it is the case with Spanish native speakers. This is an important issue in the present study as the focus of our phonetic measurement is on initial and inside schwa pronunciation.

Regarding personal pronouns in nominative case, Persian native speakers do not realize gender agreement in third person because in contrast to English, Persian only realizes one form for referring to third person singular /u:/ which is realized in three separate forms of *it*, *he*, *she* in English. This is an example of split where one item in native language becomes two or more in the target language.

4.3.3 Regularities for the pronunciation of consonant clusters by Persian L1 learners of English

Persian L2 speakers' foreign accent in ESL and other foreign languages is largely due to the lack of consonant clusters. In Persian sound system, no more than two adjustment consonants (CC coda combination) are permitted and the only syllable type with consonant cluster is CVCC. So, the coda in Persian does not contain more than two consonants. As with the loan words, the coda is reduced to CC where one of the consonants is omitted (deleting the consonant in a CCC sequence). For example *tambre*, the French loan word for *stamp*, is pronounced in Persian as /tæmr/ to adjust to CC coda although in written version /b/ is written.

Persian ESL speakers tend to insert /e/ at the beginning and between CC in consonant clusters and /i/ mainly between consonants because the phonological rules of Persian does not allow /s/ onset clusters. Table 3 illustrates phonetic transcription of some examples of mispronunciations of English words containing consonant clusters with /s/ onset by low and medium ability ESL learners.

English word	Phonetic Transcription	Persian ESL learners' version
ski	/skiː/	/eskiː/
speak	/spiːk/	/espiːk/
student	/ˈstjuːd(ə)nt/	/ˈestjuːdent/
school	/skuːl/	/eskuːl/
street	/striːt/	/estiːriːt/
sky	/skʌɪ/	/eskaɪ/
screen	/skriːn/	/eskiːriːn/
spring	/sprɪŋ/	/espiːriːng/

Table 3. English words with /s/ onset

Looking at those examples, it can be concluded that with onset consonant clusters which start with /s/, /e/ is added at the beginning of the word. Otherwise, when the word begins with [s] but is followed by a vowel this rule does not apply. For example, for the pronunciation of *successful* no /e/ is added at the beginning of the word; the Persian ESL learner's pronunciation would be /sakˈses-fu:l/. Taking another example *complete*, /kəmpli:t/, Persian ESL speakers mostly mispronounce this word as /kampi:li:t/. It can be observed that with CCC clusters followed by /i:/, the segment which breaks the consonant clusters is /i:/ not /e/ and the insertion occurs between the last two consonants.

4.3.4 Regularities for vowel shift by Persian ESL learners

As it was stated, due to the lack of wide range of vowels in L1 Farsi, Persian ESL speakers turn to some substitution strategies for the pronunciation of English words. Concerning vowels, it can be observed that the vowel shift in Persian ESL pronunciation mainly concerns fronting and backing of the vowels (fig. 11). Table 4 shows phonetic transcription of some of the typical mispronunciations.

Table 4. Some of the typical mispronunciations concerning vowel shift by Persian ESL learners

English word	Phonetic Transcription	Persian ESL learners' version
good	/gʊd/	/gu:d/
but	/bʌt/	/bat/
pot	/pɒt/	/pat/
sit	/sɪt/	/si:t/
about	/əˈbaʊt/	/eˈbat/
got	/gɒt/	/gat/

Thus, from the examples it can be concluded that the main movements in substitution strategies concerning vowel shift by Persian ESL learners are /ʊ/ to /u:/, /ʌ/ to /a/, /ɒ/ to /a/,/ɪ/ to /i:/ and /ə/ to /e/. As it is illustrated in Figure 11, Persian native speakers do not tend to use central part of the tongue to produce vowels as much as is the case with English native speakers.

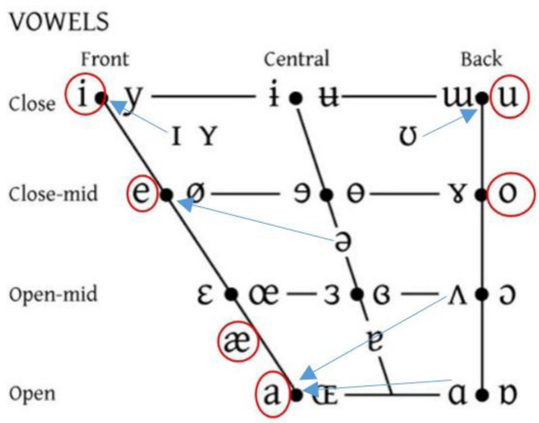


Figure 11. Vowel shift in Persian ESL speakers

5

Foreign language teaching in Iran

5. Foreign language teaching in Iran

Students start to learn English at the second grade middle school in Iran. Arabic is taught in middle school from the first year as part of the religion curriculum, because the official religion of Iran is Islam and Quran, the holy book of Muslims, is written in Arabic. After Arabic which uses non-Roman alphabet system, English is almost the only foreign language offered in school curriculum in Iran. French and German are also offered at high schools, but just a small number of students, mainly in the capital city of Iran, choose those languages as foreign language. Thus, learning English in Iran is more favored than French and German for international communications. Due to geographical location of Iran, this country does not have neighboring countries where European languages are spoken so another language, rather than English, which is learned in Iran for commercial purposes, especially in North East of Iran, is Russian.

6

Experimental Procedures

6. Experimental Procedures

This chapter looks into our subjects' selection procedure, the tests chosen for measuring participants' linguistic behavior, the reason for including them in the study and some historical backgrounds regarding those tests. Also, the types of data which was gathered and analyzed is introduced.

6.1 Rationale for the design of the experiment

To assess the language aptitude of the subjects, different tests were administered to all participants, namely three language aptitude tests, MLAT III, IV and V plus LLAMA D test (Meara 2005) and also one cognitive ability tests [Working Memory (Tewes 1994)]. Because of the lack of schwa in Persian sound system, among other languages, we decided to focus on schwa pronunciation measurement in our data analysis. For testing the subjects' English pronunciations, two short stories with schwa-containing words were used. Oral English data were used for two purposes, first, for measuring the English pronunciation in terms of the degree of native-likeness and second, for the purpose of phonetic analysis, here schwa duration. Finally, an additional imitation ability task (Reiterer 2011, 2013) was added to the study to evaluate the subjects' ability of imitating an unknown language (L0), namely Hindi in order to find out to what extent the participants can reproduce an unknown phonological stimuli. For this purpose, Hindi sentences with different syllables were embedded in the recording part of the test. Finally, the main aim of this study was targeted towards investigating the effect of L1 transfer on L2 learning.

6.2 Research questions and hypotheses

At the outset of the study, we formulated eight hypotheses considering that factors such as phonological transfer, gender, age, language aptitude, schwa pronunciation length, imitation ability, education and memory would have an effect on native like L2 attainment. The hypotheses were as follows:

H1: ESL learners tend to transfer some parts of their mother tongue phonological categories in their English pronunciation.

H2: Females are better language learners than males.

H3: An earlier age of onset of language influences L2 learning in a positive way.

H4: The subjects with higher language aptitude test scores will be better in L2 English pronunciation.

H5: The subjects with better English pronunciation tend to pronounce schwa shorter.

H6: The ability to imitate an unknown language is related to L2 learning aptitude.

H7: Education level would have an impact on English pronunciation.

H8: Higher L2 aptitude is the result of a better working memory.

6.3 Participants

30 L2 healthy Iranian learners of English (10 non-proficient, 10 proficient, 10 average), gender balanced have been recruited for the analysis. They were all native speakers of Persian raised by monolingual parents, with no significant exposure to English or other languages before puberty (age of acquisition range: 2-16, mean age 11.03 years) and grew up in North East Iran. Their age range at the time of testing was 20 to 40 (mean age 26.08) with different English pronunciation ability levels. All of the participants met the following criteria: (a) completed their study at high school, (b) were studying or have finished their study at the university in B.A, Master and PhD levels and (c) had no prior contact or immersion in Hindi language. To have a balance in different language aptitude levels, the ESL subjects with different pronunciation abilities (low to advanced) were chosen. On average, they reported having studied English for approximately 16 years (range 5 to 28 years). They all reported using English mainly for educational purposes not to communicate with native speakers of English. Almost all of the participants were living in North East of Iran with no particular immersion in English language.

6.4 Recruitment

The subjects were English learners volunteers who were taking ESL courses in some private language institutes in Iran with academic study ranging from B.A. to PhD. Some of the participants were learning English in IELTS preparation courses for continuing education abroad or for immigration to Canada. In order to have a balanced population in terms of English pronunciation talent and following Sapon's guideline (Dörnyei 2005) for choosing participants, namely "select a group of people with high levels of the attribute under investigation and a second group with low levels", we did not exclusively choose participants with good and excellent pronunciation abilities. Recruitment process of the subjects was conducted in two rounds. In the first round, subjects with different English pronunciation abilities were chosen. The recruitment, test taking and voice recording of the subjects in the first round took about 3 months in summer 2013. After finishing the first investigation tour in Iran, a second tour was organized in February 2014. The second phase of recruitment of subjects was done with the help of advertisement for very good English learners, which was paid about 20 Euros to each participant.

6.5 Data collection

After choosing the formants, different sessions were arranged for testing and recording the subjects. The procedure began with filling out a questionnaire about basic information of the participants regarding their age, education, time spend abroad and learning English. Afterwards, three

MLAT aptitude sub-tests namely MLAT III, IV, V (Carroll & Sapon 1959) were administered which along with answering questionnaires took about two hours. Every day about five subjects were tested. Due to the written nature of the test, the testees were tested in one room so it was possible to test 5 subjects at once. In the second session of the test, the participants were tested separately in a cognitive ability test (Working Memory), LLAMAD test, English pronunciation and Hindi imitation task.

To implement LLAMA_D test, the subjects were tested individually in a closed room sitting at a table in front of an APPLE MacBook Air 13" 128 GB MJVE2D/A. At first, the subjects were instructed in Persian: the procedure was explained for them briefly before the test started. They were told that they will hear 20 non-word sound samples in the first phase of the test which they are required to listen carefully for the later recognition task. As the test started, the subjects listened to the sound samples over headphones to establish a better concentration on the task. After the end of the listening part, the program continued playing random stimuli selected from the 20 stimuli from the first part which was mixed by other sound samples (non-words) in the program not included in the first part. Subjects were asked to press ☺ bottom if they heard the stimulus on the first part and 😐 bottom if they did not hear the stimulus in the first part. After the completion of the task, the program provided the test result in percentage.

The speech recordings of the participants were conducted with a PHILIPS Digital Voice recorder (model LFH0662). In cases when voice recording was not possible in language institutes where subjects took part in written tests, the second session was held in a voice recording studio. During the recording, the distance between the recorder and the participant's mouth was around 16 centimeters. The subjects were asked to read out two short English texts namely "The North wind and the Sun" (Aesop fable) and "The lightning" (short story by Marc Twain) in their best accent possible (American or British English). They were given 10 minutes to prepare for the reading. Individual recordings of the first short story took about 1 minute and the second story 2 minutes. Depending on the participants' reading pace, the time was slightly above or below this threshold. After finishing the English pronunciation task, every subjects was asked to listen to 4 Hindi sentences, read out by a native Hindi person, 3 times each and imitate the sentence afterwards as close to the original sentence as possible. In this part of the recording, there were just phonological stimuli and no lexical stimuli contrary to English pronunciation task where subjects had to read from a printed text. Subjects listened to the Stimuli over the same laptop-APPLE MacBook Air 13" 128 GB MJVE2D/A.

30 subjects were tested completely. 8 subjects were eliminated from the experiment as they were not present for the recordings or did not complete other tests. After the completion of the recordings, the recorded data of the participants with very low English pronunciation ability were dismissed. The aptitude testing sessions and the recording sessions held 1 week apart. The record-

ing materials resulted in 180 tokens (6 x 30 speakers=180) namely two short stories and 4 Hindi sentences for each subject.

6.6 Rating

4 NE-speaking adult listeners rated the sentences for the overall impression of native-likeness using a 10-point scale. Hindi sentences were also rated by 4 NH-speaking adult listeners for the subjects' performance on the Hindi imitation task using a 10-point scale. The raters were given an assessment sheet (see A. 2) with the participants' initial (in each rater's sheet the order of the subjects was different). I organized different rating sessions with the raters and played the sound files from the lap top APPLE MacBook Air 13" 128 GB MJVE2D/A. The sound tracks were also played in accordance with the order in the rater's assessment sheet. Each rater was asked to listen to the recordings and note down their note using a scale from 0 (the poorest performance) to 10 (a native-like performance). The rating with decimal, e.g. 9.5, was also possible. The participants were then split in three parts according to their performance in English pronunciation task: i.e. good pronunciation (n= 10), average pronunciation (n= 10) and poor pronunciation (n=10).

The Hindi raters were asked to judge the perceived native-likeness of the subjects' sentences on the basis of the 'referent stimuli' which was served as a model for the subjects' performance. Because as the Hindi raters mentioned, there are many dialects of Hindi and the model stimuli was one instance of Hindi accent. The Hindi raters themselves were from different regions of India and so had different accents. English raters, on the other hand, were asked to rate according to their native language English.

6.7 Questionnaire

The questionnaire was designed to get some information regarding the subjects' personal and linguistic background data such as date and place of birth, age of onset of language, exposure to any other foreign language rather than English, number of Languages spoken, time spent in English speaking countries, number of dialects, type of exposure to English language and education level. The question of mobility was not relevant for our subjects because very few participants had living-abroad experience, so we did not consider this item in our statistical analysis.

6.8 Tests

In this section, language aptitude tests, the cognitive ability test and their origins will be explained briefly.

6.8.1 Language Aptitude tests

Clearly, language aptitude and learners' differences are interrelated. The history of Language aptitude tests goes back to 1920s and 1930s in the United States when failing foreign language courses at school was common because the school program dedicated little time to foreign language study. As a result, the education system invested in the design of 'prognosis tests' in order to detect potential 'causalities' (Spolsky 1995 cited in Dörnyei 2005: 34). Between 1925 and 1930 three tests were designed which did not have specific 'theoretical foundation' but were based on two shared approaches for the measurement of language aptitude. Such tests in Spolsky's view are categorized as *analytical* and *synthetic* with the former testing special cognitive abilities that are carried out in the students' first language and the latter containing 'mini tasks' that are centered in learning an artificial foreign language or a rare existing L2. After 30 years in the period between 1950s and 1960s, which in Rees' (2000 cited in Dörnyei 2005: 34) words is referred to as "golden period' of scientific language aptitude testing", two 'systematic tests' were developed by John Carroll and Stanley Sapon and also by Paul Pimsleur (*ibid*.: 35). The first test which is designed by John Carroll and Stanley Sapon is named *The Modern Language Aptitude Test* (MLAT). This test was conducted on about 5000 participants in Harvard University from 1953 to 1958 and aimed to predict the accomplishment in foreign languages (Carroll and Sapon 1959: 3 quoted in Dörnyei 2005: 35). *The Modern Language Aptitude Test* (MLAT) is comprised of five sub-tests namely MLAT I, II, III, IV and V. Each test is aimed to measure different subcomponent of language aptitude according to Carroll's model of foreign language aptitude (1959, 1981 cited in Skehan 1998), namely *phonemic coding ability, associative memory, inductive language learning ability*, and *grammatical sensitivity*. For the present study we administered the three last parts, namely MLAT III, IV and V. The only problem with these tests with our subjects was that this test is designed originally for English native speakers, so our participants needed more time to process the questions and choose the right answer. Even the low ability subjects have sometimes trouble with understanding the text. These tests will be explained in the following sub-chapters.

6.8.1.1 MLAT III

MLAT III or *Spelling Clues* is designed to measure three constructs: associative memory, phonetic coding ability and vocabulary knowledge and is composed of 50 items. In each question, one reduced (in terms of spelling) word is given. Normally, the omissions in test words concerns vowels, so it is not difficult to guess the original word.

25. nektr...	○ waste material	○ part of the body	○ sweet liquid	○ sharp weapon	○ fur-bearing animal

Table 5. MLAT III sample test item

Sometimes the vowel/or two vowels are replaced with another vowel which phonetically correspond to the pronunciation of the original word. For example, the word love is transcribes as *luv* in instruction part of the test.

I. luv...	A. carry	B. exist	C. affection	D. wash	E. spy

Table 6. MLAT III sample test item

The answer should be chosen from five alternatives with the right choice being synonymous with test word. According to Dörnyei (2005: 37), the result of this test depends "on vocabulary knowledge in one's first language" which again cannot be the case with our subjects who were NNS of English.

6.8.1.2 MLAT IV

MLAT IV, as the forth subset of MLAT battery, which is called 'Words in Sentences', measures the subject's sensitivity to grammatical structure without any grammatical terminology in the test instruction. This implies that the test is targeted to a lay person. For example, as the instruction reads: "Which word in the second sentence does the same thing in that sentence as LONDON does in the key sentence?". This sort of formulating the question is somehow similar to saying: find the word which has the same part of speech as the test word. The scores range from 0 to 45 with every correct answer scoring one point.

2. I expect him to do good WORK. On his trip[A] across the United States[B] and up to Alaska[C], Fred expected to see many[D] interesting things[E].

Table 7. MLAT IV sample test item

The problem with the administration of this test was that some subjects needed a long time to answer the questions even more than one hour: the average time for answering this test was an hour. This is much longer than what Dörnyei (2005: 37) mentions as the time required for answering this test (the whole MLAT battery test is estimated to take about 60-70 minutes). Another observation was that the test items were arranged with increasingly difficulty so the last answers were mostly wrong and the test takers were not properly concentrated at the end of the test.

6.8.1.3 MLAT V

MLAT V sub-test is designed for measuring retention by means of testing paired associates. The instruction page of the test includes 24 English/Kurdish word pairs which should be memorized just in 2 minutes. Afterwards, the testee is required to choose the English equivalent of the Kurdish word from 5 alternatives which are chosen from the 24 English words in the first part.

Kurdish – English Vocabulary (Memorize for 2 minutes)	
hij – draw	kete – camel
naq – that	chie – few
sidqu – news	yong – hawk

Table 8. Extract from the instruction part of MLAT V (English/Kurdish word pairs)

6.8.1.4 LLAMA_D

LLAMA_D is a relatively new ‘sound recognition’ test which is one of the four sub-tests of The LLAMA (Language Aptitude Tests) battery by Paul Meara (2005). This test is designed to measure L2 learning ability by testing the ability to remember computer generated non-words. As Munson *et al.* (2005a) describe, non-words are “unfamiliar strings of phonemes” which are meant to measure the person’s cognitive ability “such as perceiving and discriminating the acoustic signal, matching the signal with phonological representations in memory, […] and executing the response”.

Meara (2005) based these tests which he calls ‘exploratory tests’ on the idea that the ability to recall linguistic patterns in spoken language is an indication of L2 learning ability (Service 1992; Service and Kohonen 1995; Speciale *et al.* 2004 referred to in Meara *ibid.*: 8). Thus, if a language leaner “can recognize repeated patterns” he or she can better recall novel words when hearing them for the second time. This ability is as a result an indication of a talent for acquiring vocabularies in L2 (*ibid.*).

The non-words generated for this subtest are “based on a dialect of a language spoken in Northern Canada […] generated by a speech engine” which are similar to no language, unless the test takers “have extensive familiarity with the languages of North West British Columbia” (Meara 2005: 2). Considering non-words as an L0 stimuli, this test can be referred to as L0 recognition task.

LLAMA_D software runs under windows operating system, Windows 2000 and Windows XP and is freely downloadable from the *lognostics* website. The program has a simple interface in blue and yellow color as shown in figure 12.

Figure 12. Llama_D interface

For running the test, after clicking on  button in the start panel, 10 random sound strings will be played. The testee is required to listen carefully to the sound strings for the later recalling. After finishing this stage, the testing phase begins. In this stage, the 10 non-words that were played are mixed with other 20 non-words and will be played randomly. The program gives feedback by a ding sound for a right answer and a bleep sound for a wrong answer. Scoring is on the basis of recognizing the previously played words. Wrong realization ends up to losing points. Scores are between 0 and 100 in the form of percentage which will be displayed when the test finishes. The results are interpreted as shown in the table below.

0-10	a very poor score
15-35	an average score; most people score within this range
40-60	a good score
75-100	an outstandingly good score. Few people manage to score in this range.

Table 9. Scores in Llama_D test

6.8.2 Cognitive Tests

Interacting orally in a second language is very much dependent on the individuals' cognitive abilities such as short term memory abilities. This aspect of language aptitude defines ability as memory and data retrieval. Relying on Robinson (2002), we considered one of the *first order abilities* of L2 aptitude, here working memory capacity, (other cognitive abilities components are: *analogical reasoning, fluid* and *crystalized intelligence, general intelligence* and etc.) (*ibid.*).

6.8.2.1 Working Memory

The role of memory, a cognitive ability, cannot be neglected in any kind of learning including language learning. One of the criteria for measuring talent in L2 learning is the ability to retain verbal information for reproducing them in speech which is related to having a good memory. Rota and Reiterer (2009: 78) define working memory "as a temporary retention of recently acquired information". In the context of L2 exposure, this ability enables language learners to retain the L2 phonological input for restoring in their L2 production. Hu *et al.* (2013: 367) refer to this human capacity as phonological working memory (PWM) which is one of the "cognitive and personality factors" for the prediction of L2 pronunciation talent (Baddeley 2003; Baddeley *et al.* 1998; Miyake & Friedman 1998 cited in Hu *et al.* 2013: 367). Baddeley (1990 referred to in *ibid.*) defines PMW as a "phonological store" which retains phonological data and a "sub-vocal articulatory rehearsal" that refreshes the "memory trace" in order to stop its impairment.

The working memory model by Cowan (1995) considers working memory as a subdivision of the images which are held in long-term memory. In his view, information-processing in the brain are as a result of the cooperation between memory and attention. Cowan bases his model on Broadbent whose hypothesis is based on elementary processing modules which is based on selection and memory processes. Behavioral measures of WM consider that short term memory capacity divides the received information into chunks for processing in the brain. As Miller (1956 cited in Rota & Reiterer 2009: 79) hypothesizes, short-term memory capacity of data processing is somewhere around number seven. But Cowan (2001 referred to in Rota & Reiterer 2009: 80) considers a more limited capacity of four chunks in young adults which is less for children and older adults. In his working memory model, Cowan (1995) integrates three parts namely, a sensory store, a long term memory store and a central executive. He defines sensory store where incoming stimuli are momentarily held.

As Rota & Reiterer (2009: 80) indicate, WM is a predicting factor for academic achievement which can obviously said to be necessary in any learning activity and have indication for language learning as well. Thus, for measuring working memory abilities of the subjects, we incorporated the working memory test Auditory Working Memory (Digit Span, Tewes 1991) as a cognitive test in our study. This included forward and backward repetition of numbers. Due to the native language of the participants, Persian, we did not include word repetition task which was originally designed for German native speakers. The participants were tested on forward and backward repetition of numbers with every correct answer scoring one point.

6.9 Data Analysis

In this part, different methods used in analyzing participants' data will be presented. The first analysis of the data deals with phonological analysis of the digital data and the second, statistical analysis.

6.9.1 Phonological data

There are some acoustic correlates of linguistic sounds which can be studied. We focused on one of the acoustic correlates of vowel identity namely duration i.e. vowel length measurement. Other acoustic properties which can also be examined are: fundamental frequency (F0), first formant (F1) and second formant (F2) (Rosch 2002).

For the study of English pronunciation talent of the participants, two methods were implemented using the same digital recordings, first, rating by English native listeners and second, phonetic analysis with software. In the first method, after the readings of the participants were rated, the subjects were grouped according to their scores in three proficiency groups (10 talented speakers, 10 non-talents and 10 middle-talents). The Hindi recording data was just used for measuring imitation ability of the subjects of an unknown language and not for grouping the subjects in different ability groups as it was the case with English data. Regarding the second method, phonetic analysis, phonological measurement of schwa pronunciation was used to measure schwa duration in millisecond.

For our analysis, the recorded data was transferred to computer. We measured schwa duration of initial and inside schwa sounds existing in function and lexical words in the short stories mentioned which amounted to 28 words for each subject-we measured one schwa in each word i.e. 28 schwas for each participant. For the analysis, the computer program ‘Cool Edit Pro’ was used - the version was applicable under windows operating system. After running the software, the digital sound files of the subject recordings in MP3 format was imported to this program for the analysis. In total, 60 sound files (30 subjects each reading two short stories) were used. A headphone was employed to reach the maximum concentration on the task as this analysis required very careful listening. Every file was played from the beginning up to each schwa containing word. Then the waveform of the word containing schwa was maximized to detect the schwa spot: in order to do this, each schwa containing word was played over and over again to identify the exact position of schwa boundaries in the waveform. Then, the duration of a schwa token was computed as the time between its start point and its end point, as determined by the software in millisecond (ms).

The schwa containing words in the short stories as they appear in the texts are as follows. For the whole texts please refer to Appendices (A.1). In cases where a word appears more than once in one short story, it is indicated with numbers, e.g. *ashamed-1*.

In “Northwind” story, the function words are as follows with the schwa sounds which were measured underlined:

along, agreed, succeeded, considered, around, attempt, obliged, confess

Lexical words in “Northwind” story:

and-1, as, and-2, at, and-3, and-4, of

All the schwa-containing words mentioned have initial schwa except *succeeded, considered, confess*

In the next fable, “Mrs. McWilliams and the Lightning” story, the function words are as follows where again all the words have initial schwa except *confined*.

afflicted, confined, ashamed-1, ashamed-2, asleep-1, ashamed-3, asleep-2

lexical words: and-1, and-2, and-3, and-4, and-5, and-6

After our observation of the subjects tending to pronounce the schwa sound in the last *and* from the second story longer than usual, with cases who pronounced it up to 300 milliseconds, we decided to omit this schwa duration for the analysis because of affecting the whole result. The reason of this behavior could have been due to its last position in the sentence and two adjacent hyphen marks afterwards as is shown in the sentence below:

“I`m sorry, dear - I`m truly sorry. Come back and-6 --”

6.9.2 Statistical data

Statistical analyses were performed in SPSS Statistics 20.0 [IBM Corporation, New York, USA]. For the significance of the interaction of variables on each other, *p* values less than .05 were considered as significant and *p* values less than .01 were considered highly significant.

7

Results

7. Results

In order to give an overview of our most important results, it would be useful to compare and contrast different groups of subjects in case of gender, extreme (high / low ability) groups comparison in terms of English proficiency, schwa length pronunciation, L0 imitation score and English aptitude tests. In the analysis, we refer to schwa length pronunciation (the millisecond value of schwa sound) as 'phonetic score' which should not be mistaken with English pronunciation score which is the mean of the English pronunciation scores by 4 NE raters..

7.1 Participants' age

There were thirty participants in total with 18 females and 12 males. The average age of females was 25.83 years (SD= ±4.719, Min 20, Max 34) and the average age of males was 28.25 years (SD= ±3.957, Min 24, Max 39) so females were on average 2.42 years younger than males.

sex = female

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
age	18	20	34	25.83	4.719
Valid N (listwise)	18				

a. sex = female

sex = male

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
age	12	24	39	28.25	3.957
Valid N (listwise)	12				

a. sex = male

Table 10. Age of the participants (males and females)

7.2 The result of the digital recordings

In this section the rating results of English and Hindi native speakers are presented alongside phonetic measurement. As it is mentioned before, the grouping of the subjects in poor, medium and advanced ability groups is according to their English native-like pronunciation scores.

7.2.1 English pronunciation score

In the following graph, the distribution of English pronunciation scores of the 30 participants in this study is depicted. The scores are given on the scale of 0-10 with 0 being the poorest performance and 10 the most native like performance. As it was mentioned, English pronunciation score for each subject is the mean of scores given by four English native raters. The population under investigation is scored from 2.50 to 9.50 points. As it is shown, the most common English talent score which is off the chart is in the range of 3.20 to 4 and the mean of all scores is around 5.20. Nobody is scored at the native speaker level and the graph slightly tends toward positive skewedness.

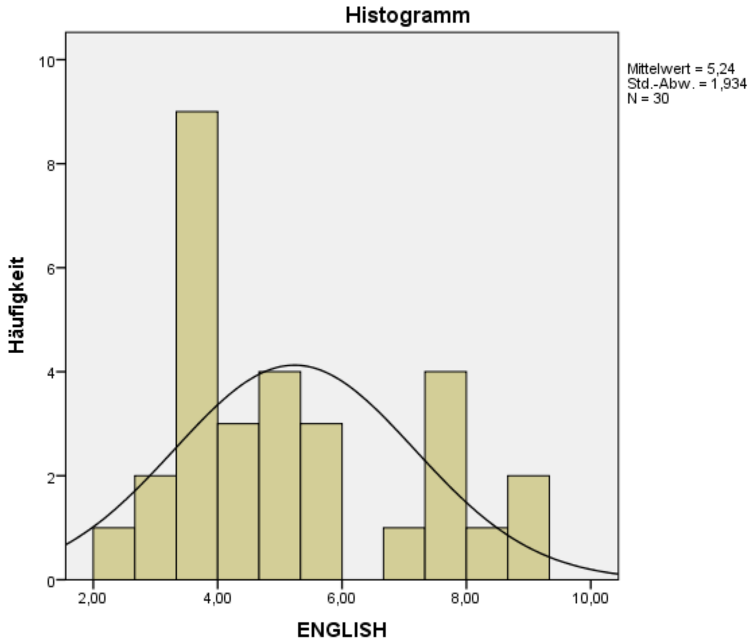


Figure 13. Histogram-Distribution of the subjects with respect to English talent score

The bar chart (fig. 14) illustrates females and males average scores on English pronunciation proficiency. The scores by English native speakers (range from 0 to 10) are depicted on the Y-axis. As it is shown, females performed better in English pronunciation than males. This result supports the long-standing idea that females are better language learners than males and proves our second hypothesis regarding priority of females to males in L2 learning.

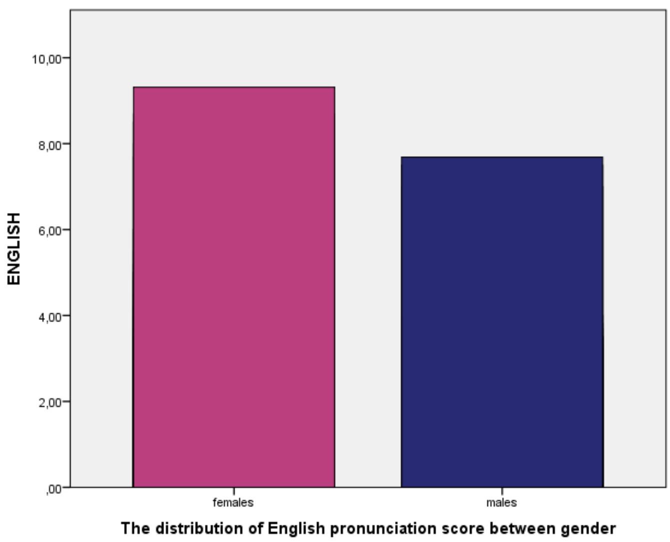


Figure 14. English pronunciation score in females and males

7.2.2 Hindi imitation score

The following figure depicts the distribution of Hindi imitation scores of the 30 participants in our study. As with the English pronunciation scores, these scores are the mean of the scores given by four Hindi native raters and are given on the scale of 0-10 with 0 being the poorest performance and 10 the most native like performance. As it is shown, the scores are mostly spread around 6 which is more in the region of native-like pronunciation. Thus, comparing with English talent score, surprisingly, not very advanced English pronouncers could get better scores in Hindi imitation task .The scores are spread from about 2 to 8 with the histogram negatively skewed.

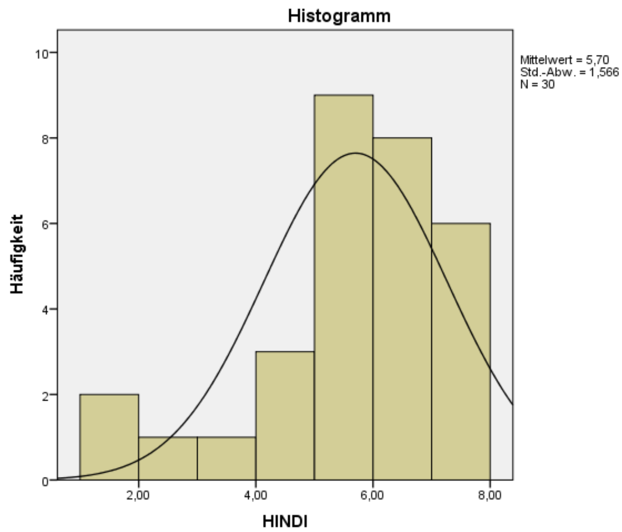


Figure 15. Histogram-Distribution of the subjects with respect to Hindi imitation score

The correlation chart below compares the correlation between Hindi and English tasks. As it is shown, there is a significant positive correlation between the scores in Hindi imitation task and English pronunciation ability r=.36, p (two-tailed) < .05 which confirms that better English pronunciation is related to better L0 (here Hindi) imitation ability.

Correlations

		ENGLISH	HINDI
ENGLISH	Pearson Correlation	1	,365*
	Sig. (2-tailed)		,048
	N	30	30
HINDI	Pearson Correlation	,365*	1
	Sig. (2-tailed)	,048	
	N	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

Table 11. Correlation between Hindi imitation task and English pronunciation score

Also, the scatter plot depicts the correlation between Hindi imitation score and English pronunciation ability in two extreme groups. The result of the correlation between extreme groups (r=.44) is higher than the whole group (r=.36).

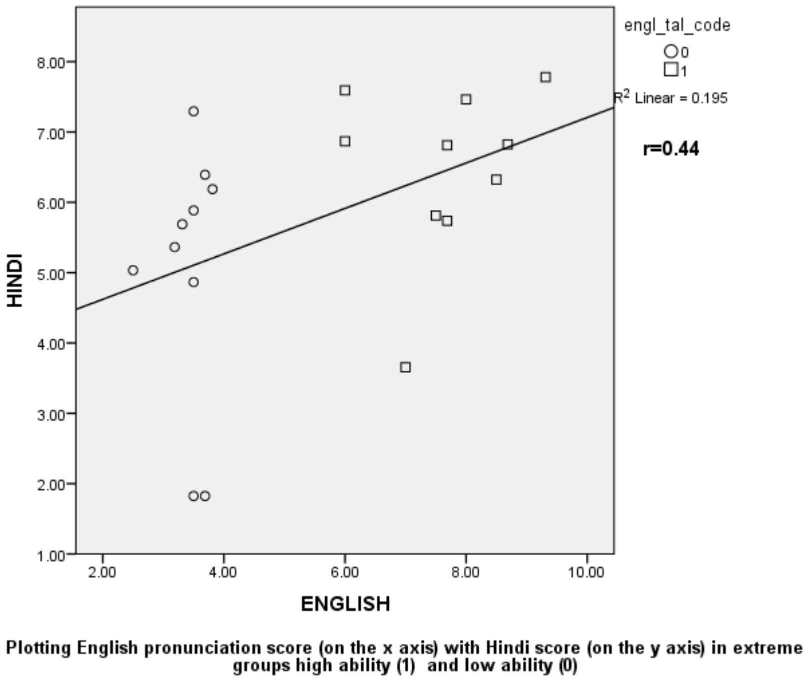


Figure 16. Correlation between English pronunciation score and Hindi imitation task in extreme groups

This finding is also demonstrated in the bar chart below concerning male and female performances. It is shown that females performed significantly better than males in Hindi and English tasks. More details are illustrated in the descriptive statistics chart below (table 12).

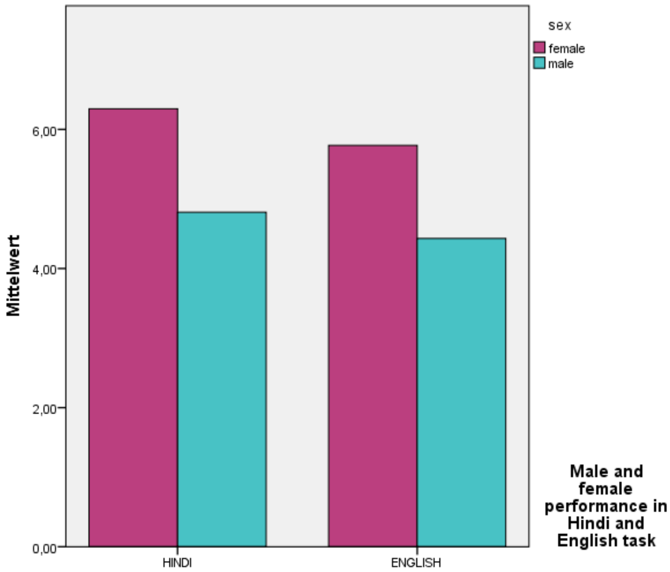


Figure 17. Hindi and English scores by males and females

The results of Hindi imitation and English pronunciation abilities show that females generally scored higher than males. The average score of females in Hindi imitation task was 6.3 with SD= ±1.20 (Min 2.79, Max 7.78). Mean of males' scores was 4.8 with SD= ±1.66, (Min 1.82, Max 7.29). Regarding English pronunciation ability, the mean score of females was 5.77 (SD= ±1.85, Min 3.5, Max 9.31). The average of males' scores was 4.43 (SD= ±1.83, Min 2.5, Max 7.69). The comparison shows that males scored roughly the same in English (M 4.43) and Hindi (M 4.80) tasks with 0.37 points difference and their maximum scores in both task was also similar with 0.30 points difference. Females scored on average 1.49 points higher in Hindi and 1.34 points higher in English scores than males.

sex = female

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
HINDI	18	2.79	7.78	6.2957	1.20739
ENGLISH	18	3.50	9.31	5.7708	1.85739
Valid N (listwise)	18				

a. sex = female

sex = male

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean	Std. Deviation
HINDI	12	1.82	7.29	4.8090	1.66194
ENGLISH	12	2.50	7.69	4.4323	1.83082
Valid N (listwise)	12				

a. sex = male

Table 12. Females vs. males in Hindi and English performance tasks

7.2.3 Phonetic analysis: measuring vowel length duration

In this section, the results of phonetic analysis of the subjects are presented. The measurement of the phonetic data, vowel length measurement, was performed with the computer program 'Cool Edit Pro'- which is an advanced multi track sound editing program for Windows.

7.2.3.1 Vowel duration in two extreme groups

One of the major parts of our analysis was dedicated to phonetic measurement of the subjects' schwa pronunciation. We hypothesized (H5) that the subjects who would be rated higher by NE speakers tend to pronounce schwa shorter. As it was expected, there was a significant difference in schwa length pronunciation in high and low ability groups. As the bar chart (fig. 18) shows, low ability group's average of schwa duration was 110 millisecond and high ability group on average pronounced schwa around 75 milliseconds which shows a significant difference of about 35 milliseconds.

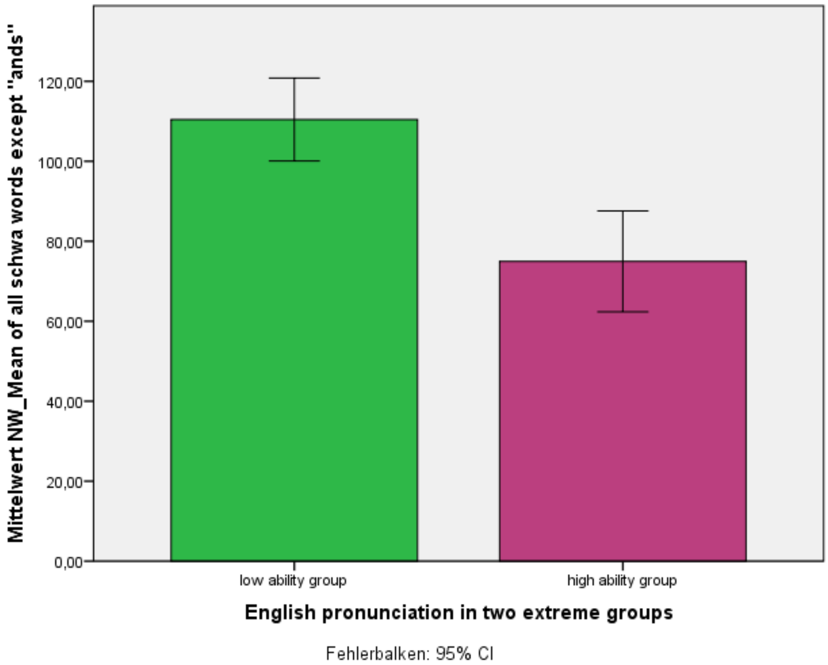


Figure 18. Schwa length pronunciation in extreme groups

The t-test analysis (table 13) illustrates the mean of schwa duration (indicated as phonetic score) in high ability participants, 75 milliseconds, (SD=±17.66) and the average of low ability group's schwa duration, 110 ms (SD = ± 14.5) with zero being allocated to the low ability group and one to high ability subjects in the chart. The difference between high and low ability phonetic scores was 35.5 milliseconds which is highly significant (sometimes a native speaker tends to pronounce schwa in this length). The difference between standard deviation of high and low ability groups was SD = ± 3.16 ms. The Sig. (2-Tailed) value in the data is 0.000, so it demonstrates that there is a statistically significant difference between the means of schwa duration in extreme ability groups.

Group Statistics

	engl_tal_code	N	Mean	Std. Deviation	Std. Error Mean
Phonetic Score	0	10	110.4545	14.50158	4.58580
	1	10	74.9636	17.66306	5.58555

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Phonetic Score	Equal variances assumed	.082	.778	4.911	18	.000	35.49091	7.22689	20.30777	50.67404
	Equal variances not assumed			4.911	17.343	.000	35.49091	7.22689	20.26641	50.71541

Table 13. T-test high and low ability groups

The bar chart below depicts the schwa duration average of initial schwa in *along*. Surprisingly, there is no significant difference in vowel length between medium and talent group but there is a significant difference between high ability and the rest of the subjects. This result could suggest that in some cases the native-likeness of L2 accent is determined by some qualitative measures rather than quantitative measures like vowel length.

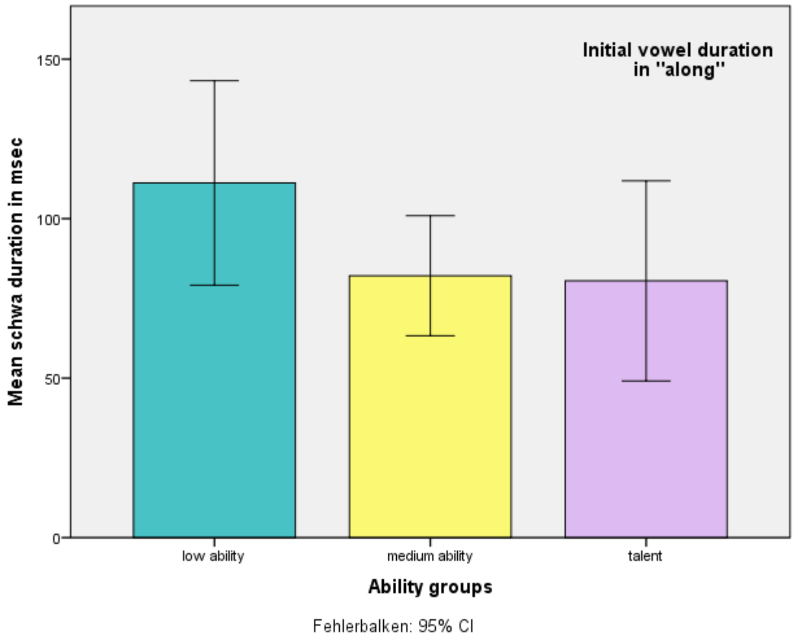


Figure 19. Schwa length pronunciation in different ability groups (milliseconds values) in along

7.2.3.2 Schwa sound duration in different ability groups and English native speakers

In this part of the analysis the spectrograms of *ashamed*-2 from "The lightning" story in different ability groups is depicted. As it can be seen in the sound waves of different ability groups, this word is pronounced in significant length difference by each NNS participants and also in comparison with English native speakers.

a) Acoustic spectrograms of schwa articulation by a talented speaker

Let us take a look at the following figures displaying the spectrograms of the word *ashamed*-2 by a talented ESL learner (subject code 36). The part of the figure with the white background illustrates the pronunciation of the word *ashamed*-2 which includes onset schwa sound.

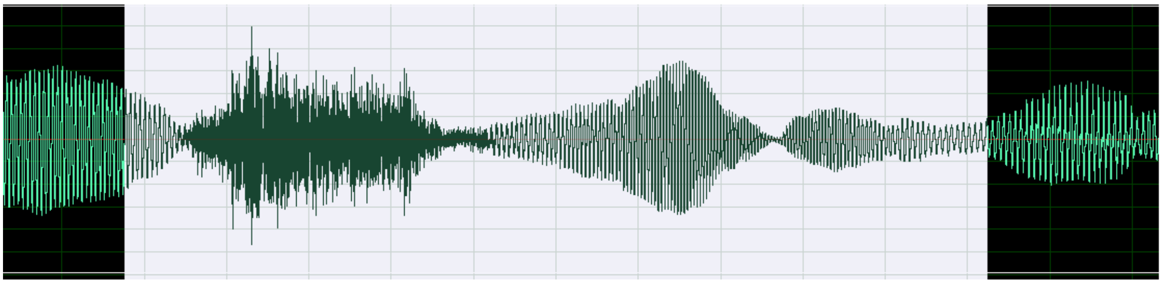


Figure 20. Pronunciation of *ashamed*-2 in a talented subject (36)

Figure 21 casts a closer look at schwa pronunciation zone of this subject. As it can be seen below the spectrogram against the white background, the schwa is pronounced in 48 milliseconds which is very close to native like pronunciation length.

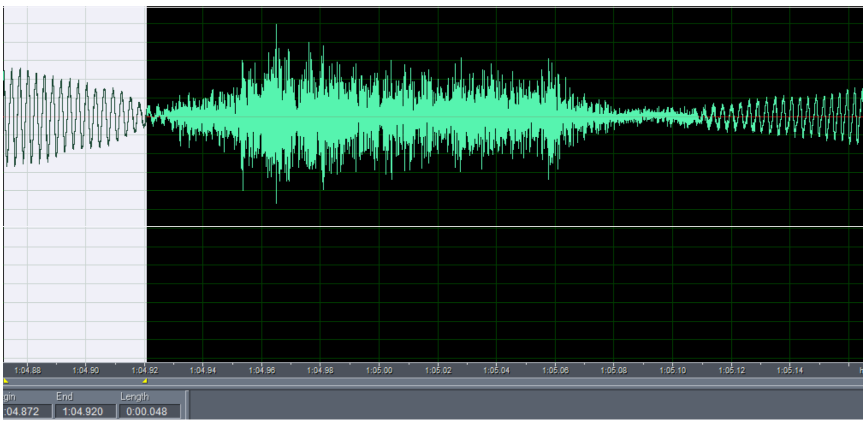


Figure 21. Schwa duration of a talented subject (36) in the word *ashamed* -2

b) Acoustic spectrograms of schwa articulation by a middle ability speaker

The following figures display the spectrograms of the word *ashamed*-2 by a medium ability ESL learner (subject code 17). As it is depicted, the schwa duration of this subject is 75 milliseconds (fig. 23).

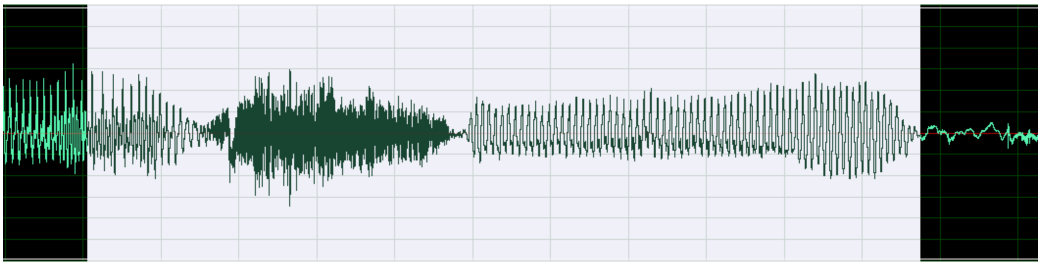


Figure 22. Pronunciation of *ashamed*-2 in a medium talent subject (17)

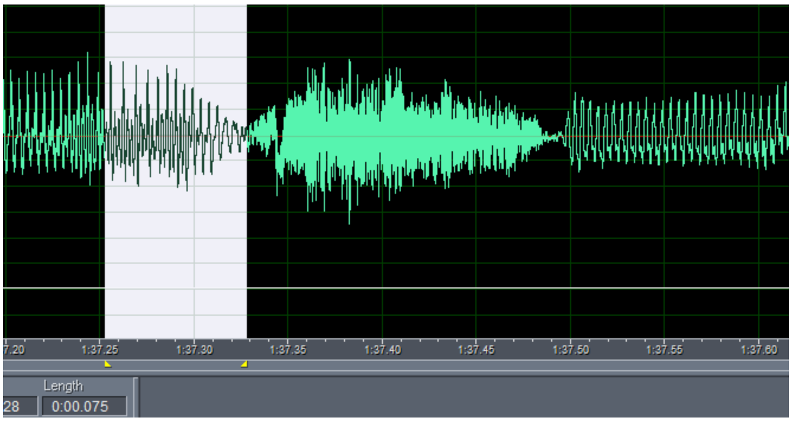


Figure 23. Schwa duration of a medium talent subject (17) in the word *ashamed*-2

c) Acoustic spectrograms of schwa articulation by a low ability speaker

The following spectrograms depict *ashamed*-2 pronunciation by a low ability subject. As it is visualized in the second figure, the schwa length articulation of this subject is longer than the subjects in other ability groups namely 123 milliseconds.

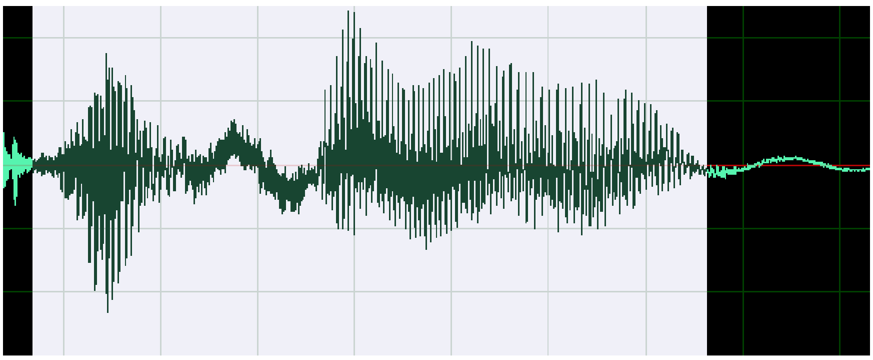


Figure 24. Pronunciation of *ashamed*-2 in a low talent subject (16)

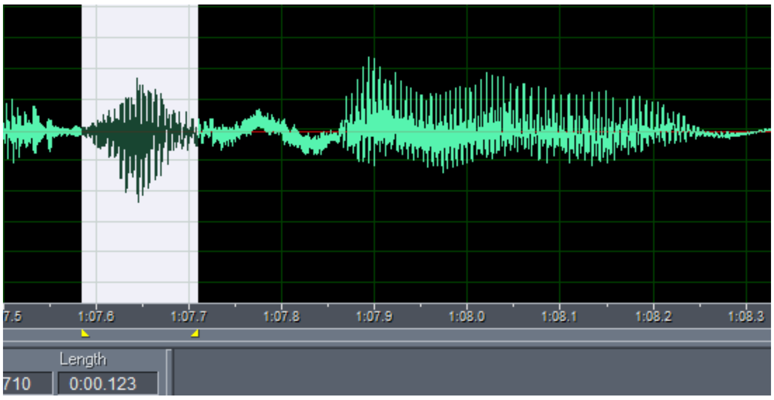


Figure 25. Schwa duration of a low talent subject (16) in the word *ashamed*-2

d) Acoustic spectrograms of schwa articulation by two native speakers of English.

The following spectrograms depict *ashamed*-2 pronunciation by two English native speakers with wave forms that highlight the schwa articulation areas for each speaker (Fig. 26-29). The first native speaker articulated schwa in 44 ms and the second one in 43 ms.

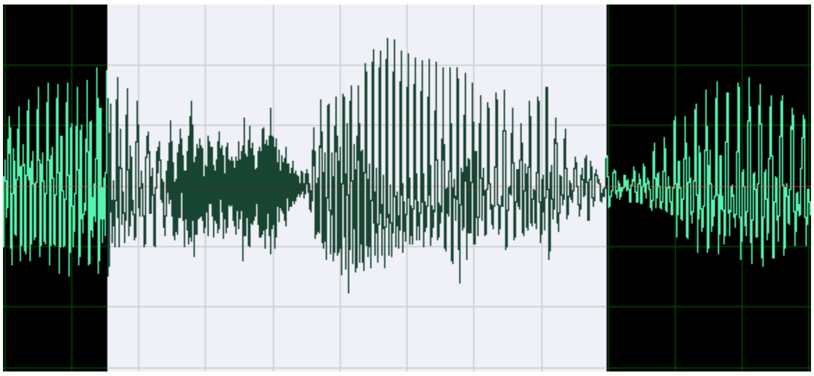


Figure 26. Pronunciation of *ashamed*-2 by an English native speaker (1)

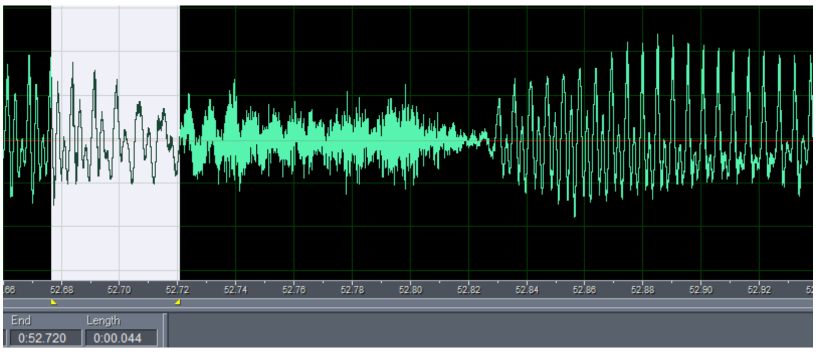


Figure 27. Schwa duration of English native speaker (1) in *ashamed*-2

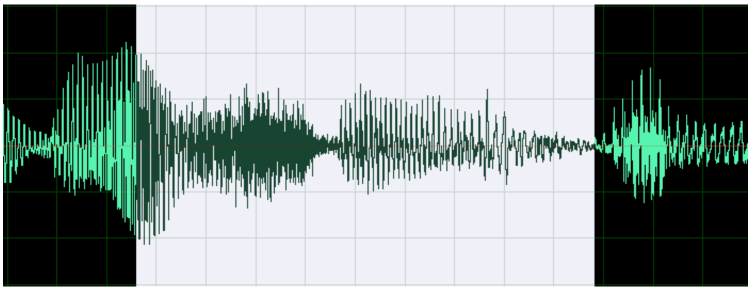


Figure 28. Pronunciation of *ashamed*-2 by English native speaker (2)

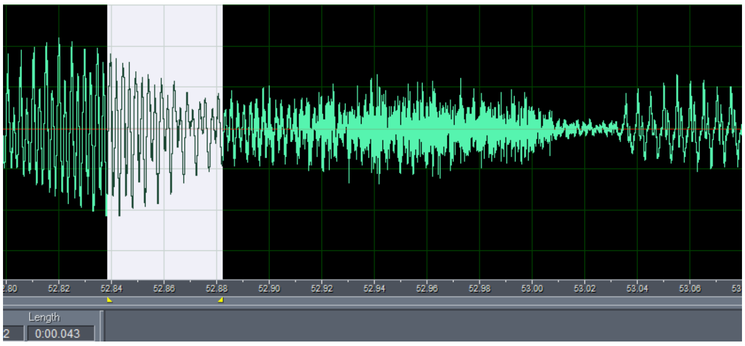


Figure 29. Schwa duration of English native speaker (2) of *ashamed*-2

The sound waves of the schwa pronunciation of two different native speakers showed that native-like schwa duration can be said to be around 44 milliseconds. As it is illustrated in the result for different ability subjects, the increase of schwa duration is related to the decrease of the proficiency. The schwa sound duration in ascending order in these examples would be as follows: 43 ms (NS), 48 ms (high ability), 75 ms (medium ability) and 123 ms (low talent) which is demonstrated in fig. 30. This finding proves our fifth hypothesis which assumed that the L2 learners with higher native like attainment tend to pronounce schwa shorter.

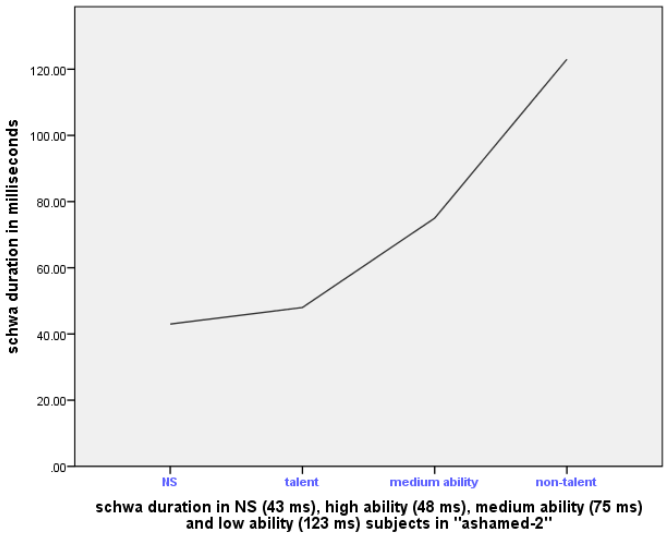


Figure 30. Schwa length pronunciation in*ashamed*-2 in different ability groups (milliseconds values)

7.2.3.3 Correlation between English pronunciation score and schwa length pronunciation

As it was explained, the high ability subjects tended to pronounce schwa shorter than other participants. The scatter plot (fig. 31) illustrates this finding and shows a very significant negative correlation (r=-0.8) between these two variable in all ability groups. It shows that the shorter the schwa sound is pronounced, the higher the score in English pronunciation would be.

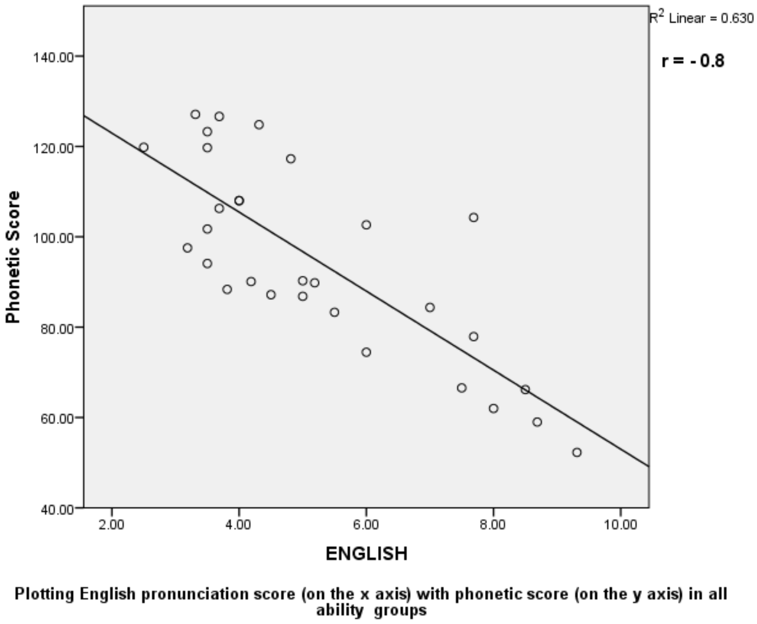


Figure 31. Correlation between English pronunciation score and phonetic score

7.2.3.4 Correlation between Hindi imitation score and schwa length pronunciation

We hypothesized that L0 imitation ability is associated with L2 talent (H6). To test this hypothesis, we compared Hindi imitation score and vowel length. As it is illustrated in the correlation chart (table 14), there is a significant negative correlation between the schwa length pronunciation and Hindi imitation score r=-.35 in all ability groups. This result confirms that the better imitation talent is positively related to more native-like performance, here shorter pronunciation of schwa.

Correlations

		Phonetic Score	HINDI
Phonetic Score	Pearson Correlation	1	-,351
	Sig. (2-tailed)		,057
	N	30	30
HINDI	Pearson Correlation	-,351	1
	Sig. (2-tailed)	,057	
	N	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

Table 14. Correlation between Hindi imitation task and schwa length duration

7.2.3.5 Correlation analysis t-test (Hindi imitation score and gender)

The Group Statistics box below reveals that the mean for female performance in Hindi imitation task was 6.30 (SD=1.21). The male group scored on average 4.80, SD= ± 1.66. The difference between males and females mean scores was 1.50 points and the difference between standard deviation of male and female groups was 0.45 with one being allocated to the female group and two to the male subjects. The Sig. (2-Tailed) value in the data is 0.008 so it demonstrates that there is a statistically significant difference between the mean of Hindi imitation scores for females and males.

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
HINDI	1	18	6,2957	1,20739	,28458
	2	12	4,8090	1,66194	,47976

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
HINDI	Equal variances assumed	1,520	,228	2,842	28	,008	1,48671	,52310	,41518	2,55823
	Equal variances not assumed			2,665	18,612	,015	1,48671	,55782	,31753	2,65588

Table 15. T-test Hindi imitation score and gender

7.2.3.6 Correlation analysis t-test (English talent score and gender)

In the Group Statistics box below the mean of English talent score is compared in males and females. The first row refers to female subjects. The mean of English pronunciation talent score for female was 5.78 (SD = ± 1.86) and the mean for males was 4.44 (SD = ± 1.83). The standard deviations are about the same. The Sig. (2-Tailed) value in our data is 0.062 which suggests that there is a statistically significant difference between the mean of females' and males' scores in English pronunciation. The female participants outperformed the male subjects with 1.34 points difference.

Group Statistics

	sex	N	Mean	Std. Deviation	Std. Error Mean
ENGLISH	1	18	5,7708	1,85739	,43779
	2	12	4,4323	1,83082	,52851

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
ENGLISH	Equal variances assumed	,019	,891	1,945	28	,062	1,33854	,68834	-,07145	2,74853
	Equal variances not assumed			1,950	23,972	,063	1,33854	,68628	-,07797	2,75505

Table 16. T-test English talent score and gender

7.3 Age of onset of language and schwa length pronunciation

As table 17 indicates, there is a positive correlation between age of onset of language and the length of schwa duration. This result suggests that the later ESL learners start to learn a foreign language, the less they can achieve native like pronunciation. In another word, the longer the subject pronounced schwa, the older they were when they started to learn English. In the correlation matrix (table 17), it is shown that there was a significant correlation between the length of schwa pronunciation and the age of onset of the language r=.41, p (two-tailed) < .05. This finding is in line with Ioup (2008) who relies on Scovel's idea (1988) and asserts that "phonological accents in a second language (L2), more than other linguistic skills, would more exhibit age effect because accent was the only part of language that was physical and demanded neuromuscular programming".

The scatter plot (fig. 32) depicts the correlation between the age of onset of language and English pronunciation score. It is shown that there is a highly significant negative relationship (r=-0.7) between the age of onset of language and English pronunciation score in two extreme groups (high vs. low ability). It is depicted that as the English pronunciation score increase, the age of onset of language decreases. Thus, the participants who started to learn English earlier were better rated by English native speakers. This finding is also depicted in the bar chart below. We divided our participants in two groups of early (2-10) and late (11-16) age of onsets (fig. 33). As it is shown, the mean

Correlations

		Phonetic Score	age_of_onset
Phonetic Score	Pearson Correlation	1	,416*
	Sig. (2-tailed)		,022
	N	30	30
age_of_onset	Pearson Correlation	,416*	1
	Sig. (2-tailed)	,022	
	N	30	30

*. Correlation is significant at the 0.05 level (2-tailed).

Table 17. Positive correlation between the age of onset of language and phonetic score

of English pronunciation score in early age of onset learners (slightly above 7) is significantly higher (circa 3 scores) than late AoA group (slightly above 4).

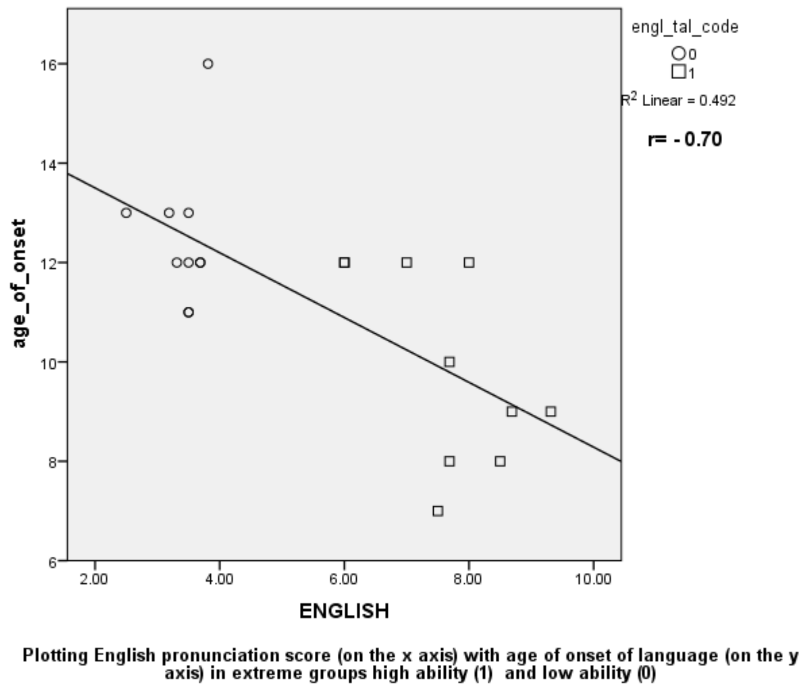


Figure 32. Correlation of AoA and English Pronunciation score

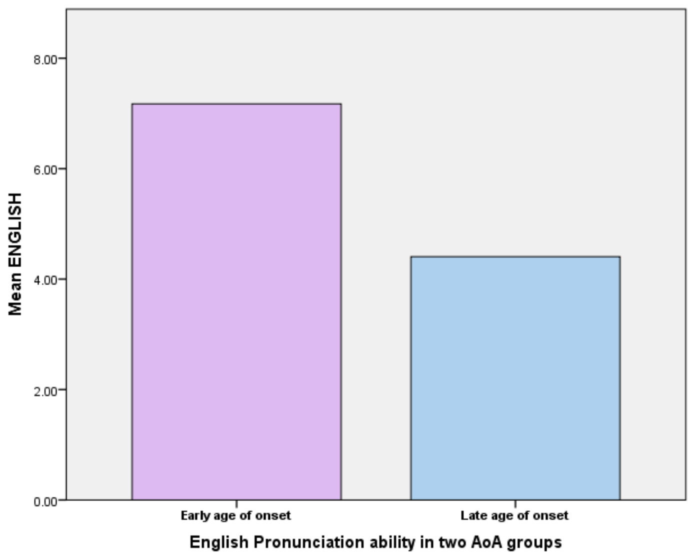


Figure 33. Early vs. late AoA and English Pronunciation score

7.4 Number of foreign languages spoken and schwa length pronunciation

Another significant result of the present study is the relationship between the number of foreign languages spoken and schwa length pronunciation-in correlation chart referred to as phonetic score. The correlation chart, depicts a very strong negative correlation between the number of languages and schwa duration namely, r=-.74, *p* (two-tailed)< .01. The bar chart (fig. 34) shows that the more languages a person knows, the shorter the schwa duration pronunciation would be. For example, subjects who knows 5 languages pronounced schwa, on average, at the length of 60 milliseconds but participants who could speak just two foreign languages pronounced schwa almost twice as long as subjects who spoke 5 languages, namely about 110 millisecond on average. Thus, the data suggest that the more languages a person knows, the shorter they tend to pronounce schwa and accordingly better imitate a foreign language sound.

Correlations

		Phonetic Score	no_languages
Phonetic Score	Pearson Correlation	1	-,736**
	Sig. (2-tailed)		,000
	N	30	30
no_languages	Pearson Correlation	-,736**	1
	Sig. (2-tailed)	,000	
	N	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

Table 18. Negative correlation between number of languages and phonetic score

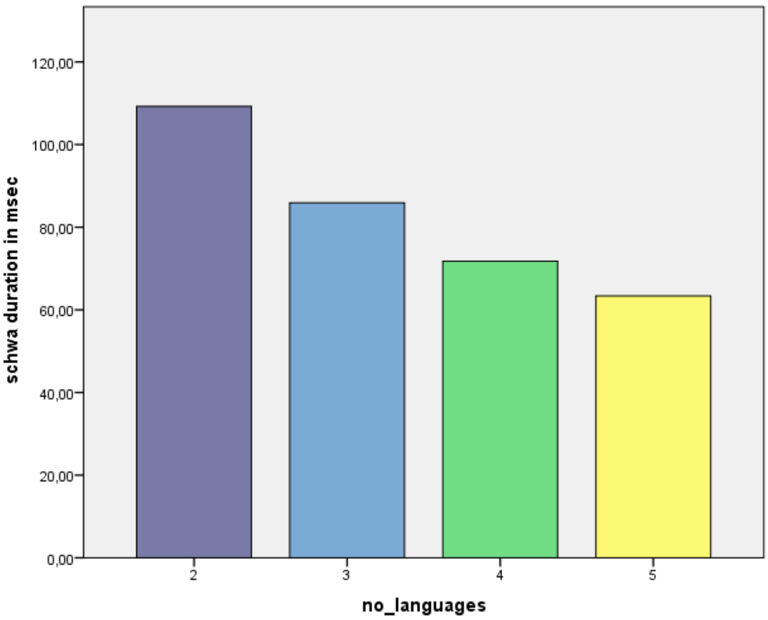


Figure 34. Number of languages and phonetic score

7.5 Correlation between English pronunciation score and English aptitude tests

In this section, the results of English pronunciation ability and language aptitude tests will be presented. The data confirmed that there is a significant association between the scores in language aptitude tests and a person's native-likeness in ESL.

7.5.1 MLAT III and English pronunciation score

The scatter plot (fig. 35) depicts the correlation between English pronunciation scores and the results in MLAT III test in extreme groups (high vs. low ability). As it is illustrated, there is a very significant positive correlation r= .85 between MLAT III and English pronunciation scores. We can see that as English pronunciation score increases in value, so does the score in MLAT III.

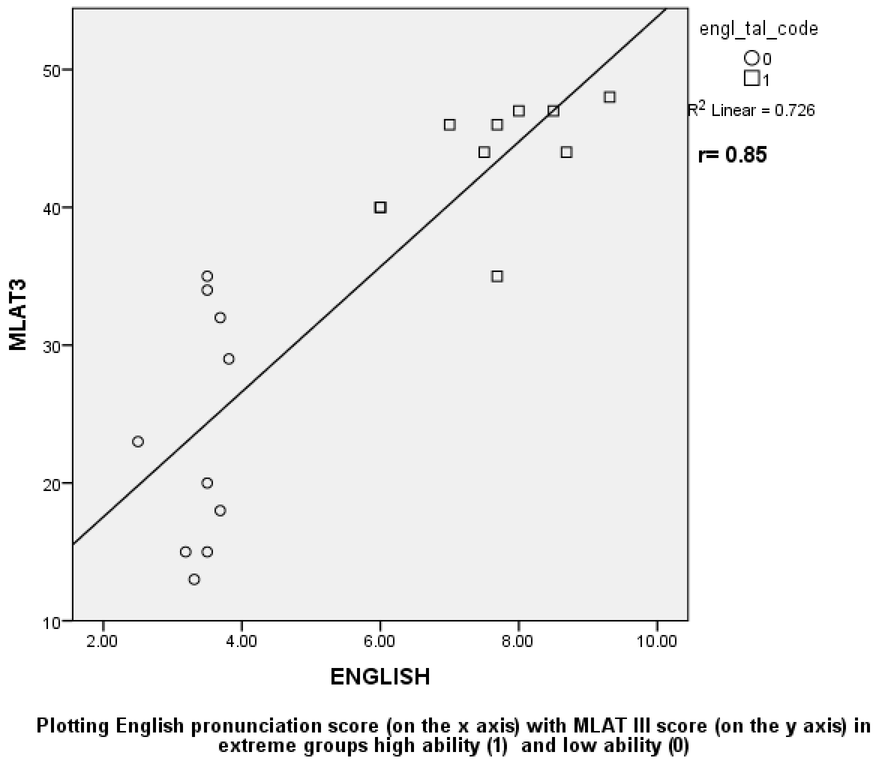
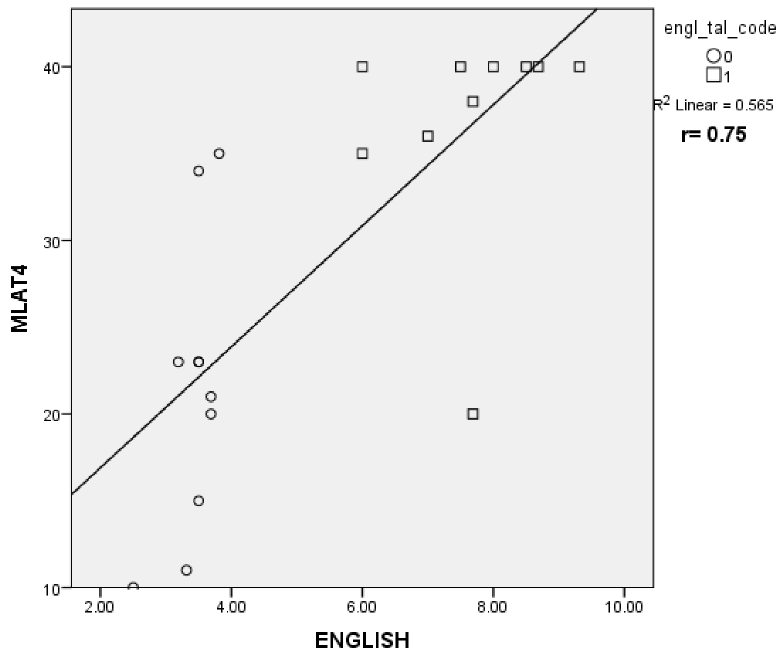


Figure 35. Correlation between English pronunciation score and MLAT III

7.5.2 MLAT IV and English pronunciation score

The scatter plot (fig. 36) shows the correlation between English pronunciation score and MLAT IV in extreme groups. As it is illustrated, there is a very significant correlation between English pronunciation scores and MLAT IV (Pearson r=.75) scores in high and low ability groups.

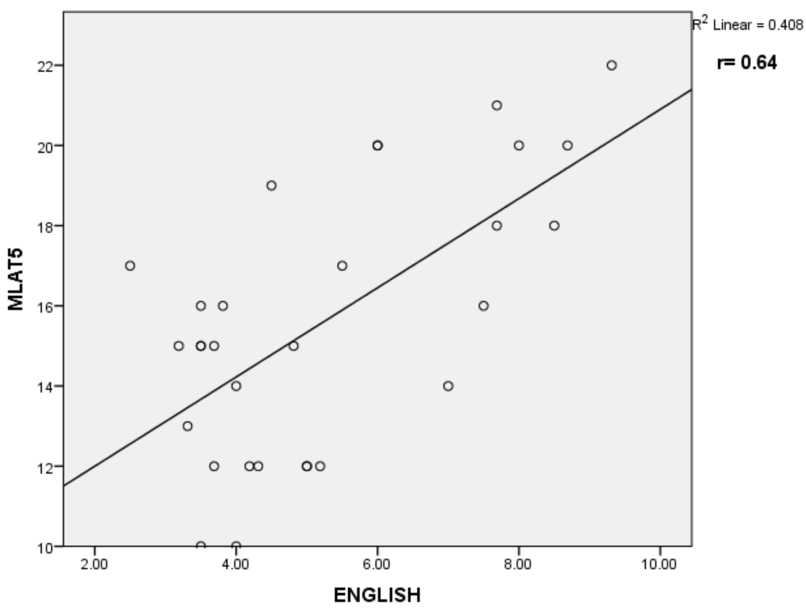


Plotting English pronunciation score (on the x axis) with MLAT IV score (on the y axis) in extreme groups high ability (1) and low ability (0)

Figure 36. Correlation between English pronunciation score and MLAT IV

7.5.3 MLAT V and English pronunciation score

In the scatterplot (fig. 37), the correlation between the last subset of MLAT battery in the whole population with English pronunciation score is depicted. As with MLAT III and IV test results, MLAT V scores correlate highly with English pronunciation scores r= 0.64.



Plotting English pronunciation score (on the x axis) with MLAT V score (on the y axis) in all ability groups

Figure 37. Correlation between English pronunciation score and MLAT V

7.5.4 Llama_D and English pronunciation score

This figure illustrates the relationship between English pronunciation score and Llama_D test which was the last L2 aptitude test used. The linear squares regression line shows a strong positive correlation between the scores in English pronunciation score and Llama_D (Pearson r = 0.66).

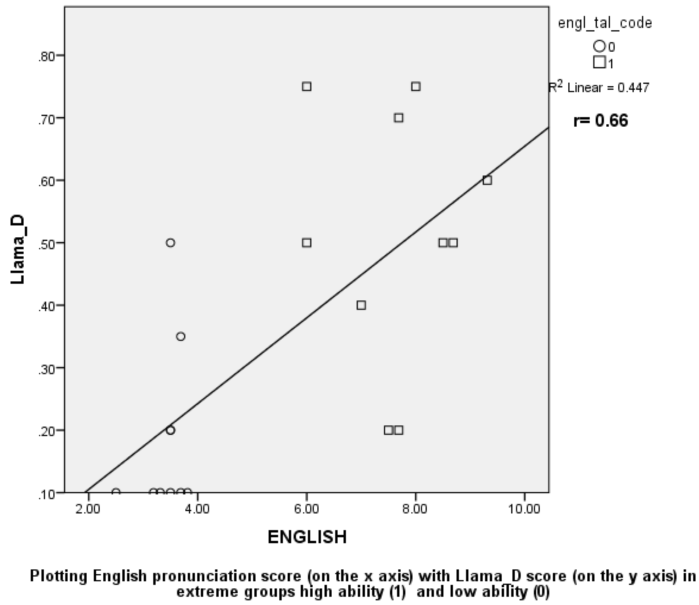


Figure 38. Correlation between English pronunciation score and Llama_D (percentage values)

7.6 Correlation between working memory and other factors

As it was mentioned, the only cognitive ability test which was implemented in the present study was working memory so we deal with the correlations of this score with other measures of language aptitude tests separately. In this section, we turn to examine the correlation of WM test with other variables such as English pronunciation score, schwa length pronunciation and language aptitude tests. We hypothesized that WM capacity is an effective factor in native like attainment (H8): confirmly, the results of WM tests revealed significant correlations at $p < .01$ level with all the variables.

7.6.1 Correlation between working memory and English pronunciation

The graph below illustrates the relationship between the scores of two extreme groups regarding English pronunciation (high and low ability groups) and the scores in working memory test. As the graph depicts, there is a strong correlation between English pronunciation score and the performance in working memory test, r=.83.

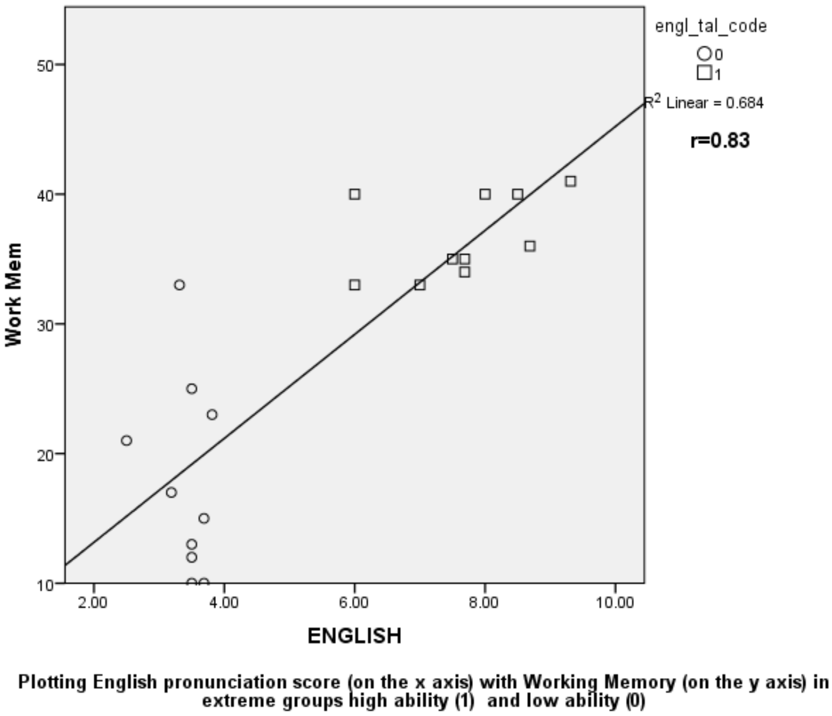


Figure 39. Correlation between English pronunciation score and working memory in extreme groups

The graph below depicts the same comparison in the all (different proficiency) groups. As it is shown, the scatterplot reveals a significant correlation of r = 0.78 showing that ESL speakers with higher working memory scores also performed better in English pronunciation.

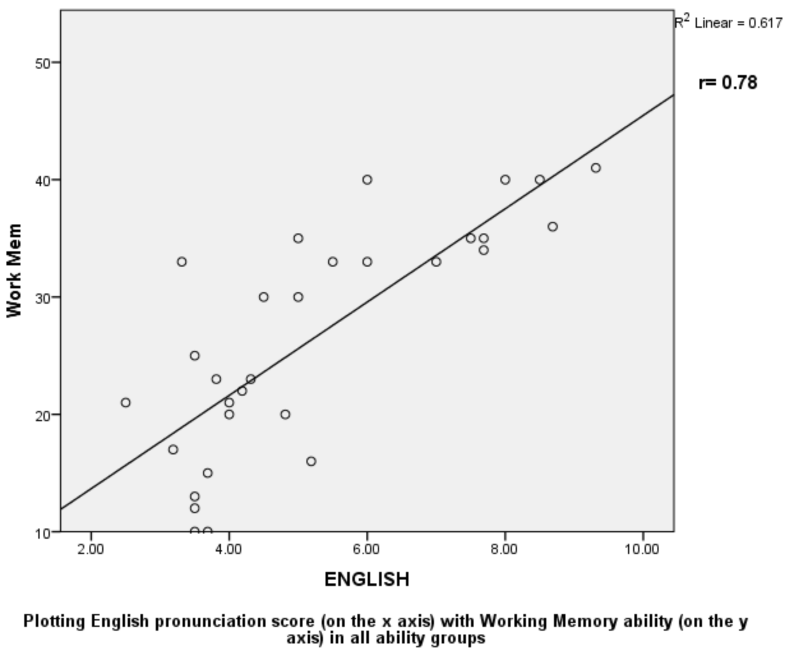
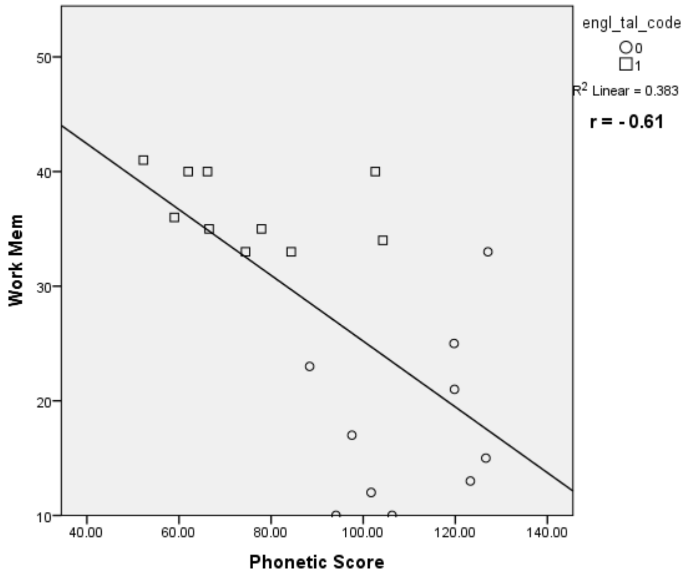


Figure 40. Correlation between English pronunciation score and working memory in all ability groups

7.6.2 Correlation between working memory and vowel length (phonetic score)

The scatter plot illustrates a significant negative correlation (r=-0.61) between working memory score and schwa length pronunciation in extreme groups. As it is depicted, participants who pronounced schwa shorter got higher WM scores and vice versa.



Plotting schwa length duration (on the x axis) with Working Memory (on the y axis) in extreme groups high ability (1) and low ability (0)

Figure 41. Correlation between schwa length duration and working memory in extreme groups

7.6.3 Correlation between working memory and language aptitude tests results

There are two significant results in regard to language aptitude and the cognitive test of the study. First, it was shown that females could outperform males in aptitude and cognitive tests (fig. 43). Second, the results of all tests correlate significantly with each other (table 19). As the correlation matrix shows, the correlations of all tests with each other is highly significant at p (two-tailed) < .01 level, for example, the correlation between MLAT III and working memory, r= .628, or the correlation between MLAT III and MLAT IV, r= .661. Accordingly, the data suggest that the performance in one test could be a reliable predictor for the result of other tests. Hence, a person with a higher working memoryz is expected to perform better in MLAT III test and in the same way a good result in MLAT III suggests a better result in MLAT IV.

		Work Mem	MLAT3	MLAT4	MLAT5	Llama_D
Work Mem	Pearson Correlation	1	,628**	,543**	,603**	,475**
	Sig. (2-tailed)		,000	,002	,000	,008
	N	30	30	30	30	30
MLAT3	Pearson Correlation	,628**	1	,661**	,535**	,656**
	Sig. (2-tailed)	,000		,000	,002	,000
	N	30	30	30	30	30
MLAT4	Pearson Correlation	,543**	,661**	1	,481**	,615**
	Sig. (2-tailed)	,002	,000		,007	,000
	N	30	30	30	30	30
MLAT5	Pearson Correlation	,603**	,535**	,481**	1	,662**
	Sig. (2-tailed)	,000	,002	,007		,000
	N	30	30	30	30	30
Llama_D	Pearson Correlation	,475**	,656**	,615**	,662**	1
	Sig. (2-tailed)	,008	,000	,000	,000	
	N	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

Table 19. Positive correlation between working memory and the result of language aptitude tests

Extreme group comparison (fig. 42) shows that there is a significant difference between the performances of both groups in all tests. Due to the comparison with other tests, the scores of Llama_D test was multiplied by 100 as the test results of Llama_D are presented in percentages.

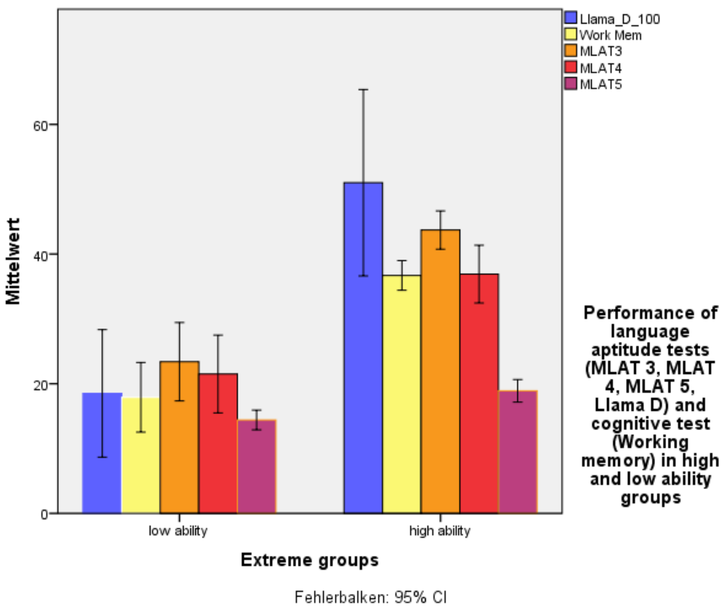


Figure 42. Correlation between the results of language aptitude tests (MLAT 3, MLAT 4, MLAT 5, Llama D) and cognitive test (working memory) in extreme groups

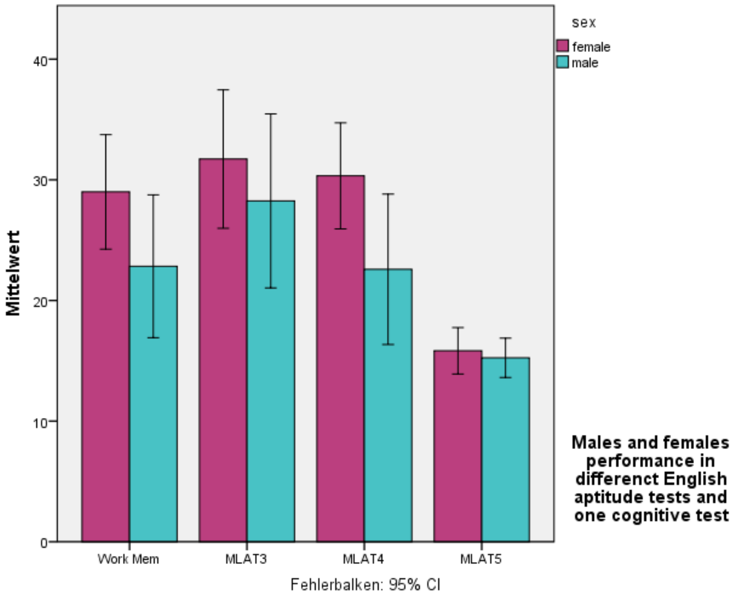


Figure 43. Males' and females' performances in MLAT 3, MLAT 4, MLAT 5 and working memory

The bar chart (fig. 43) compares the result of aptitude and cognitive tests in different ability groups. As it was expected, the result of talent group in all tests is significantly higher than medium and low ability groups especially in MLAT III test. However, in MLAT V test, different ability groups did not perform so much differently. Even in this case, the low ability group was slightly better than medium ability group. Also the result of MLAT III and IV show no significant difference between these two groups. Working memory test results showed a clear-cut difference in performance between all ability groups including medium and low abilities which were not observed in other test results. Also, the data show that female outperformed males in aptitude and cognitive tests (fig. 44).

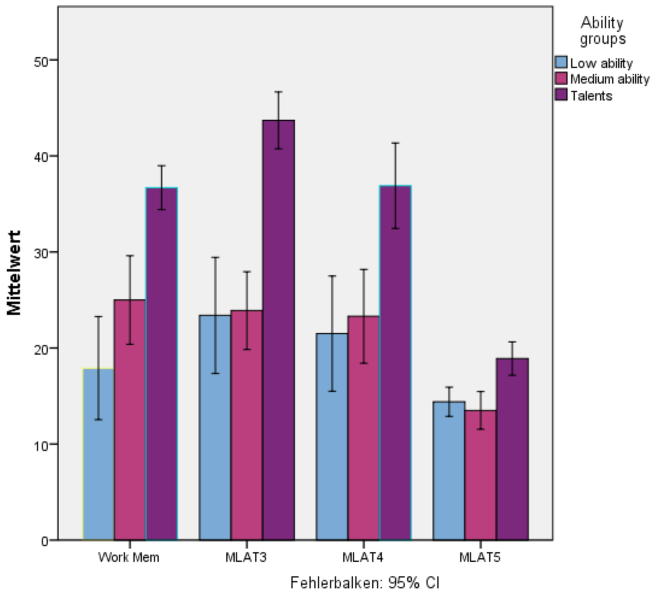


Figure 44. Different ability groups' performances in MLAT 3, MLAT 4, MLAT 5 and working memory

8

Multiple Regressions

8. Multiple Regressions

In a stepwise multiple regression, we used the English score as dependent variable. The order of entering the independent variables into the MLR depended on their statistical contribution when explaining the variance in the dependent variable. The criterion when entering independent variables was a probability of F-change <0.05. Results of the stepwise multiple regressions show that there are four substantial factors that can explain the English pronunciation ability (dependent variable) of the subjects in this study. As it is shown in table 20, the first model explains 55% of English pronunciation ability (the mean of native-likeness score by 4 EN-listeners) by MLAT III score. The second model, explain 70% of grades in English score by MLAT III and working memory. The third model regards MLAT III, working Memory and MLAT IV with 74% influence on English pronunciation score and the last model shows that these three variables plus age of onset of language were able to explain 77% influence on English score. The result shows that all four variables correlate highly with English aptitude score (table 21).

Model Summary[e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.743[a]	.552	.543	1.06461	.552	59.173	1	48	.000	
2	.838[b]	.703	.690	.87607	.151	23.884	1	47	.000	
3	.861[c]	.742	.725	.82513	.039	6.982	1	46	.011	
4	.878[d]	.771	.751	.78570	.029	5.733	1	45	.021	1.628

a. Predictors: (Constant), MLAT3
b. Predictors: (Constant), MLAT3, Work Mem
c. Predictors: (Constant), MLAT3, Work Mem, MLAT4
d. Predictors: (Constant), MLAT3, Work Mem, MLAT4, ageofonset
e. Dependent Variable: ENGLISH

Table 20. Multiple regression demonstrates the four predictors which can explain 77% of the English pronunciation score

Correlations

		MLAT3	Work Mem	MLAT4	age_of_onset	ENGLISH
MLAT3	Pearson Correlation	1	,628**	,661**	-,232	,809**
	Sig. (2-tailed)		,000	,000	,218	,000
	N	30	30	30	30	30
Work Mem	Pearson Correlation	,628**	1	,543**	-,273	,786**
	Sig. (2-tailed)	,000		,002	,145	,000
	N	30	30	30	30	30
MLAT4	Pearson Correlation	,661**	,543**	1	-,261	,730**
	Sig. (2-tailed)	,000	,002		,163	,000
	N	30	30	30	30	30
age_of_onset	Pearson Correlation	-,232	-,273	-,261	1	-,422*
	Sig. (2-tailed)	,218	,145	,163		,020
	N	30	30	30	30	30
ENGLISH	Pearson Correlation	,809**	,786**	,730**	-,422*	1
	Sig. (2-tailed)	,000	,000	,000	,020	
	N	30	30	30	30	30

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 21. Correlation between English pronunciation score with four variables

9

Discussion

9. Discussion

Phonological aptitude presents an interesting case study for second language research because it is the area in which L2 learners have the most difficulty in it. Native-like accent in L2 has been the ultimate goal in foreign and second language learning. Moreover, mastery in L2 phonology and L2 native-like accent is rather exception than the norm and is just achieved by a few number of L2 learners. The present study examined how L2 phonological proficiency is impacted by aptitude and cognitive measurements of ESL learners by investigating the relationship between English pronunciation and imitation scores and some measures of linguistic talent in Persian ESL learners.

Two central research questions of this study were 'can adult L2 learners produce phonological features in a native-like manner?' and 'in how far language aptitude, cognitive and mimicking abilities contribute to the establishment of native-like L2 attainment?'. We addressed these questions by developing a combination of some language aptitude tests plus testing subjects on their English accent and imitation abilities. Since the L0 imitation task did not involve any prior experience with Hindi language, we regard this task as a non-word repetition task (Munson *et al.* 2005b). The result of our study showed significant correlations between native-like English pronunciation ability, language aptitude, cognitive ability, L0 imitation, L0 recognition (Llama_D), schwa duration, the age of onset of language and the number of foreign languages spoken. Particularly, it was observed that ultimate attainment in L2 is mostly relied on individual and cognitive differences such as language aptitude and memory. Moreover, female participants performed better than males in English pronunciation, language aptitude tests and imitation tasks.

In our analysis, we considered that the shorter pronunciation of schwa is an indication of native-likeness in English pronunciation in regard to phonological talent (H5). As it was presented before, particularly, this is a feature which is lacked in sound system of Persian. So, schwa pronunciation can be a reliable indicator of mimicking ability in Persian ESL learners. The phonetic analysis showed that subjects who pronounced schwa shorter got better scores in English pronunciation from English native speakers. The scoring of the NE raters had to do with their perceived impression of native-likeness and not attention to schwa duration. Schwa duration measurements were carried out independently by us which was found to have a strong correlation with English pronunciation scores ($r = -0.8$). Based on previous research (Scovel 1988) and CPH (Penfield and Roberts 1959; Lenneberg 1967), it was hypothesized that native Persian speakers of English especially late AoA subjects would transfer their L1 phonology system to L2 English due to anatomical and biological constraints. Also, the usual L2 phonological theories would predict transfer of the L1 system (leading to foreign accent). But talented Iranian L2 learners who have successfully achieved near-native phonological proficiency without specific immersion in English showed that transfer theories do not attribute to all individuals. Speech production data and results of language aptitude tests showed a significant impact of language talent in L2 learning ability. The following sub-chapters deal with the most significant results of our study.

9.1 Summary of all correlations

To start with, a summary of all correlations of our results which is mentioned in result sections is shown in table 22 in descending values. The correlations which deal with extreme groups are shown separately. In some cases the same correlation was calculated for both all ability groups and extreme groups. Extreme groups' comparison was mostly higher (obviously) between two variables. In two cases this difference was very minor, just .05 percent, namely the correlation between English pronunciation and working memory in extreme groups (r=.83) and all ability groups (r = 0.78) and the relationship between English pronunciation scores and MLAT III in extreme groups (r = .85) and in all ability groups (r= 0.8).

All ability groups		
English pronunciation score and schwa length pronunciation	r = -.8	
English pronunciation scores and MLAT III	r= .8	*p* (one-tailed) < .01
English pronunciation and working memory	r = .78	
The number of foreign languages spoken and schwa length pronunciation	r =-.74	*p* (one-tailed) < .01
English pronunciation score and MLAT V	r=.64	
Working memory and MLAT III	r =.63	*p* (two-tailed) < .01
Working memory and MLAT V	r = .60	*p* (two-tailed) < .01
Working memory and MLAT IV	r = .55	*p* (two-tailed) < .01
Working memory and Llama_D	r =. 47	*p* (two-tailed) < .01
AoA and English pronunciation score	r=.42	*p* (two-tailed) < .05
AoA and schwa length pronunciation	r=.41	*p* (two-tailed) < .05
Hindi imitation score and English pronunciation score	r=.36	*p* (two-tailed) < .05
Hindi imitation score and schwa length pronunciation	r= -.35	

Table 22. Summary of correlations in descending order (Pearson *r* coefficients)

(table continued on next page)

(table continued from previous page)

Extreme groups	
English pronunciation scores and MLAT III	r = .85
English pronunciation and working memory	r =.83
English pronunciation score and MLAT IV	r = .75
AoA and English pronunciation score	r = -.7
English pronunciation score and Llama_D	r = .66
Working memory and vowel length (phonetic score)	r =-.61
Hindi imitation score and English pronunciation score	r=.44

9.2 Two most significant results of the study

Our study mainly focused on phonological aspect of L2 learning and the native-like pronunciation attainment. To measure this construct of L2 learning, we tested subjects on English native-like accent (rating by EN raters), mimicking ability (Hindi imitation) and MLAT III which is the only subpart of MLAT battery which measures phonetic coding ability. Two most salient results regarding phonetic aptitude of our analysis was the relationship between English proficiency score with schwa length pronunciation and MLAT III. It was shown that (1) as duration of schwa increases, score on English pronunciation decreases (r = -0.8), and (2) as the score on MLAT III increases, the score on English pronunciation increases (r= .80) (table 22 & fig. 45). This observation suggests that schwa duration and MLAT III correlate to the same extent with native-like L2 attainment (Pearson's *r*, one positively and one negatively) and are stronger predictors for phonetic aptitude than other variables.

9.3 Impact of AoA on Second Language learning

The results of this study demonstrate that there are different factors which contribute to L2 accent and English aptitude score. Our results confirmed Lennberg's hypothesis (1967) and the claims of CPH about the fact that pronunciation is biologically conditioned. The effect of brain maturation and consequent biological changes such as "the end of neural plasticity and thus the completion of hemispheric lateralization in the human brain" result in difficulty in perception and production of novel sounds. This fact explains the idea behind CPH which was introduced firstly by Lennberg (1967 referred to in Ioup 2008: 48) and explains why the participants in our study with later AoA pronounced schwa longer than persons with earlier AoA. Our analysis proved that AoA plays a major role in L2 phonological acquisition and "ultimate L2 attainment generally deteriorates with increasing AO" (Jia & Fuse 2007; Krashen *et al.* 1979 cited in Granea & Long 2012).

The correlation between length of schwa pronunciation and age of onset of language showed a positive effect of r=.41, *p* (one-tailed) < .05 and the correlation between age of onset of language and English pronunciation score showed a positive effect of r=.42, *p* (two-tailed) < .05. These findings show that an early exposure to an L2 results in more native-like L2 accent, here shorter schwa pronunciation, and more native-like performance and vice versa. Thus, our data confirms Granea and Long's (2012) claim that "Age of first meaningful second language (L2) exposure, or age of onset (AO), is widely recognized as a robust predictor of success in second language acquisition (SLA)".

Another factor which can explain the effect of AoA on L2 acquisition is the influence of NL phonetic categories on L2 perception. Because the more experience with native language results in fixation of already built language categories. As perceptual assimilation model (NLM) by Kuhl (1992) suggests, the phonetic categories of L1 play an important role in L2 perception and "by adulthood, linguistic experience has had a profound effect on speech perception" (*ibid.* 606). Because "[e] xposure to a specific language results in a reduction in the ability to perceive differences between speech sounds that do not differentiate between word [sic] in one's native language" (Goto 1971; Miyawaki *et al.* 1975; Strange & Dittmann 1984; Werker & Tees 1984; Werker & Lalonde 1988 quoted in Kuhl *et al.* 1992). Also, higher native-like pronunciation in early AoA learners is due to the flexibility of speech muscles and articulators in adapting to novel sounds production.

9.4 Schwa length pronunciation

The present production data showed an impact of Persian native vowel system in schwa production. The result of the vowel length measurement revealed a significant difference between talent group and the rest of the participants (low ability and medium ability groups). Talent group pronounced schwa significantly shorter than other groups i.e. around half the time spent by other ability groups whose schwa duration length ranged from 52 to 127 milliseconds. Also, as illustrated in table 22, the most significant correlation of our data concerns the correlation between English pronunciation score and schwa length pronunciation in all ability groups r = -0.8.

However, there were some drawbacks in phonological measurement due to schwa being a special speech sound. As it was stated in part dealing with English vowels, schwa [ə] is considered as an allophone of [ʌ] and [ə]. This fact is due to a special characteristic of schwa as is stated by Baumotte (2009) "consonantal effects on F2 for [ə] are large because no defined vocal-tract shape is necessary for the production of [ə]". Due to this special feature of schwa, the pronunciation of this sound is affected by its previous and subsequent sound segments. In our schwa length duration measurement, we encountered cases where there was no visually dividing point between schwa and its previous/consequent vowel/consonant. There were, for example, coarticulations with /i:/ in *be ashamed* where the transition of /i:/ to schwa (/Vlə/-sequence) was not detectable.

Moreover, some subjects' voices had messy and irregularly shaped spectrograms and as a result the phonological measurement was very time consuming. In some cases, for detecting words and schwas we had to listen to the sound string over and over again to detect the schwa articulation area. However, some subjects had very neat and clear speech wave where schwa detection was more easily done, e.g. case 36.

9.5 Mimicking ability

For the present study, we followed L0 measurement used by Reiterer *et al.* (2011, 2013) as an indication of phonemic coding ability to investigate phonetic imitation and English native-likeness in Persian subjects. It was proved that ESL learners with better L0 mimicking ability had better English native-like performance, here shorter schwa pronunciation, $r=-.35$ and also there was a significant relationship between English pronunciation and Hindi imitation scores ($r=.36$, p two-tailed) $< .05$.

Moreover, following Kuhl *et al.* (1992) and the principles of Magnet effect, one of the significant findings of our study is that adult L2 learners in their L2 sound production (here vowel production) already reproduce some of the vowels which perceptually match their native vowel systems-in our subjects longer pronunciation of schwa which matched Persian long vowel /a/ and /e/.

9.6 The role of education in L2 attainment

Contrary to our expectation, education level played no role in the English talent score. One explanation is that our subjects with higher level of education were older than other subjects. This result implies that more experience with FL does not necessarily result in better native-like attainment-in our experiment the persons with higher education did not get better results. The key factor would be accordingly AoA not the experience with language and the chronological age of the participants. As it is mentioned, our study proved that earlier AoA results in better language learning as a result of more experience with L2, but the finding about education level and L2 phonological attainment may suggest that it is important in which time period the experience with the language has taken place, because experience after critical period is not as effective as in younger age. Thus, more educated participants who have had a later age of onset could not benefit from more experience with the language as the younger subjects who have had an earlier AoA.

9.7 L0 recognition ability

As an L0 recognition task, we followed Munson *et al.* (2005b) who suggested that novel-word repetition in non-word repetition task could be a reliable predictor for L2 learning capacity-here our subjects were not supposed to repeat the words but to recognize them in the second phase of the test. We integrated Llama_D test as this test uses invented non-words and is relied on the subjects' immediate and long term memory-long term memory in the sense that the recognition of non-word prompts takes place after a set of stimuli were presented. The scores in Llama_D test revealed a significant positive relationship with the subjects' English pronunciation score (r=0.66) which proves that the subjects with better short and long term memories could achieve a higher native-like attainment in second language.

9.8 Working memory

One of the major hypotheses (H8) of our study was if working memory capacity has a relationship with L2 aptitude which was proved to be highly significant. The results of WM score with different L2 aptitude tests showed a general positive correlation. The Most significant result was obtained between WM and English pronunciation score (r=. 79), p (one-tailed) < .01. This strong correlation can be attributed to Robinson (2005) who presented L2 talent model with the focus on cognitive abilities and suggested that memory plays the most important role in FL learning success. Our results also support Miyake and Friedman (1998) who considered working memory as a fundamental constituent of language aptitude. As it is mentioned by Rota & Reiterer (2009: 80) higher working memory capacity is an indispensable criteria for academic achievement.

The correlations with other language aptitude tests were also very significant. The most significant correlation between WM and L2 aptitude tests was observed with MLAT III (r= .63) p (one-tailed) < .01 followed by schwa length pronunciation (phonetic score), with a negative correlation (r=-.61) p (one-tailed) < .01 suggesting that participants with better working memory could perform better in L2 pronunciation. This observation implies that Persian ESL learners with better memory can make an ad hoc phonetic category for imitating English schwa pronunciation that results in native like, i.e. shorter, pronunciation of schwa sound. The next significant result was observed between WM and MLAT V test which was almost the same as phonetic score result (r= .60) p (one-tailed) < .01. This observation indicates that schwa pronunciation and memory are similarly accounted for by working memory. MLAT IV also highly correlated with WM (r= .55) p (one-tailed) < .01. These results are depicted in the correlation chart below:

Correlations

		Phonetic Score	MLAT3	MLAT4	MLAT5	Llama_D	ENGLISH	Work Mem
Phonetic Score	Pearson Correlation	1	-.594**	-.737**	-.531**	-.512**	-.793**	-.611**
	Sig. (1-tailed)		.000	.000	.001	.002	.000	.000
	N	30	30	30	30	30	30	30
MLAT3	Pearson Correlation	-.594**	1	.661**	.535**	.656**	.809**	.628**
	Sig. (1-tailed)	.000		.000	.001	.000	.000	.000
	N	30	30	30	30	30	30	30
MLAT4	Pearson Correlation	-.737**	.661**	1	.481**	.615**	.730**	.543**
	Sig. (1-tailed)	.000	.000		.004	.000	.000	.001
	N	30	30	30	30	30	30	30
MLAT5	Pearson Correlation	-.531**	.535**	.481**	1	.662**	.639**	.603**
	Sig. (1-tailed)	.001	.001	.004		.000	.000	.000
	N	30	30	30	30	30	30	30
Llama_D	Pearson Correlation	-.512**	.656**	.615**	.662**	1	.650**	.475**
	Sig. (1-tailed)	.002	.000	.000	.000		.000	.004
	N	30	30	30	30	30	30	30
ENGLISH	Pearson Correlation	-.793**	.809**	.730**	.639**	.650**	1	.786**
	Sig. (1-tailed)	.000	.000	.000	.000	.000		.000
	N	30	30	30	30	30	30	30
Work Mem	Pearson Correlation	-.611**	.628**	.543**	.603**	.475**	.786**	1
	Sig. (1-tailed)	.000	.000	.001	.000	.004	.000	
	N	30	30	30	30	30	30	30

**. Correlation is significant at the 0.01 level (1-tailed).

Figure 45. Correlations between WM, English pronunciation ability and other language aptitude tests

9.9 Language aptitude

The result of Persian near-native L2 speakers confirms Abrahamson and Hyltenstam (2008) who concluded that language aptitude can compensate for the later age of onset. In all three English pronunciation ability groups, scores in English aptitude tests correlated highly with English pronunciation score and there was a tendency for younger age of onset to shorter schwa duration.

Following Wong *et al.* (2011) for our language talent measurement, we relied on cognitive aspects of L2 aptitude (other factors being "neurophysiological" and "neuroanatomical" aspects). The result of language aptitude tests of this study showed that these measurements are reliable predictors for L2 success or failure of English phonological behavior, here English native-like attainment and shorter schwa pronunciation.

Robinson (2005: 50) argued that these tests are not valid criteria for L2 aptitude measurement in advanced L2 learners. He mentioned that "[b]y 1990, there was also concern that whereas traditional tests such as MLAT were effective in predicting initial progress in language learning, they were seen to be less effective at predicting success at more advanced stages". However, as it was observed in our data, the MLAT battery can be a good predictor for measuring talent in foreign or second language for both early and advanced language learners because of the high correlation of MLAT battery test results with English pronunciation score. As it was indicated, the correlation of

English pronunciation score in extreme groups and MLAT III was r=.85 and with MLAT IV was r=.75. Finally, English pronunciation score correlated highly with MLAT V r= 0.64 in all ability groups. So, these results prove the validity of MLAT aptitude tests for predicting L2 learning ability. It should also be taken into consideration that our study concerned mainly phonological aptitude, so other aspects of L2 learning such as grammar and writing can be attributed to Robinson's claim regarding the inefficiency of MLAT battery.

9.10 Impact of memory on Second Language learning

Our data suggests that memory capacity is one of the most significant factors in achieving native-like English pronunciation. For example, L0 imitation task which is aimed to predict individual's ability in novel sound repetition relies mostly on cognitive abilities because memory ability plays a conclusive role in perception and production of L2 sounds. According to Munson *et al.* (2005a), "nonword repetition relies on a number of cognitive processes, such as perceiving and discriminating the acoustic signal, matching the signal with phonological representations in memory, planning the articulatory movements required to replicate the nonword, and executing the response". This assumption maintains that the quality of linguistic input and output is depended on the cognitive ability.

In a stepwise multiple linear regression analysis, we included tests which measured memory of the subjects as independent variables, namely WM and Llama_D, excluding MLAT V. The order in which the independent variables were added into the MLR depended on their statistical contribution in explaining the variation in the dependent variable i.e. English pronunciation. The criterion when entering independent variables was a probability of F-change <0.05. The first model, explains 79% of grades in English score by working memory and the second model, WM and Llama_D, explains 85% of the variability of the English pronunciation score. Both models show the significance of memory on FL attainment (Table 23). This finding reveals the highest percentage among the behavioral measures used in this study comparing with the result of multiple regression in section 8 where MLAT III, working Memory, MLAT IV and age of onset of language explained 77% influence on English pronunciation ability. The question arises if every language learner would be able to get native-like phonological attainment with practice or, on the other hand, without inborn cognitive capacity this achievement would not be possible.

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.786[a]	.617	.604	1.21707	
2	.846[b]	.716	.695	1.06714	1.250

a. Predictors: (Constant), Work Mem

b. Predictors: (Constant), Work Mem, Llama_D

c. Dependent Variable: ENGLISH

Table 23. Multiple regression demonstrates the two predictors which can explain 84% of the English pronunciation score

10

Conclusion

10. Conclusion

Our experiment shows that the large individual variability in L2/L3 success in adults can be attributed to scores in language aptitude, cognitive ability, AoA, multilingualism and imitation ability. Following Rota & Reiterer (2009: 80) in considering higher working memory capacity as an indispensable criterion for academic achievement, our data also confirmed that higher language aptitude is reflected by better scores in working memory ability tests. It can be seen that individuals with higher WM are better language learners and are able to achieve more native-like English accent. Because better working memory capacity is a facilitating factor for L2 learning in that L2 phonological input can be more effectively processed for L2 production.

This finding leads us to information processing in individuals and the fact that the difference in ESL learners' linguistic behavior is due to some extent to their difference in dealing with linguistic data. The question arises if mispronunciations of ESL speakers are as a result of their difficulty to get the exact L2 sound segments or their being unable to reproduce novel sounds. This argument can be attributed to prototypical perception in that after a certain age, individuals cannot recognize between words that do not differentiate meaning in their mother tongue (Kuhl 1992). So, for linguistic production it is important how individuals retrieve the novel linguistic information. The data suggest that ESL learners with better sound imitation possess a better memory and the quality of the L2 sound segments which they store is higher. Therefore, it is of crucial importance how precisely one perceives and recalls linguistic input. In other words, the higher quality of sound segments in L2 pronunciation is based on the exact phonological information and better processing and encoding of language tokens. Accordingly, the quality of the traces a person stores is reflected in his/her linguistic productions. Also, some people restore words with different vowels which leads to different L2 production. It can be concluded that the ultimate attainment in L2 productions depends on the ability of brain to categorize linguistic input which is more attributed to general cognitive ability and the concept of Emergent Phonology as a perception model.

Our data shows particularly an influence of AoA and number of languages on ultimate L2 pronunciation proficiency. Younger FL language learners were more successful in their native-like attainment which suggests that earlier AoA inhibit more L1 transfer. Thus, in older L2 learners more experience with native language is a hindering effect in L2 native-like attainment. It can be concluded that bilingual articulators are more trained to adopt to new speech sound categories because for imitating a new language sound they can adopt their speech organs to produce novel sounds. Another observation was that the female subjects of our study performed better than males in all levels. However, the age data showed that females were on average 2.5 years younger than male subjects. Therefore, one way of interpreting the better performance of our female subjects could be their younger age and thereby a better neuromuscular plasticity/flexibility and L2 phonological processing. All in all, more experience with L2 /L3 learning, here earlier age of onset, and polyglotism are crucial factors in successful foreign language learning. Also, reaching an auditory target in multilinguals is more likely to achieve than monolingual and bilinguals. This finding can be compared with the view of Edwards *et al.* (2004) that a better phonological processing is a consequent of a larger vocabulary size which can be attributed to multilingualism. Also, the languages tested (L0 Hindi and L2 English) followed the same trend of positive relationship with language aptitude tests. Particularly, our data posits new evidence about the relationship between schwa length pronunciation and L2 learning ability.

A full investigation of all language aptitude tests and their influence on L2 phonological achievement was beyond the scope of this paper, so we focused on a few selected aptitude and cognitive ability tests. In short, the most significant correlations of our study involved English pronunciation score and schwa length pronunciation (r = -0.8), English pronunciation score and MLAT III (r= 0.8), English pronunciation and working memory (r = 0.78), the number of foreign languages spoken and schwa length pronunciation (r=-.74) and English pronunciation score and MLAT V (r= 0.64). Taken together, our result provides evidence of the decisive impact of AoA, multilingualism and working memory capacity in native-like L2 attainment.

11

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11. References

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12

Appendices

12. Appendices

A.1 Short stories

Northwind

The North Wind and1 the Sun were disputing which was the stronger, when a traveller came along wrapped in a warm cloak. They agreed that the one who first succeeded in making the traveller 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 traveller fold his cloak around him; And2 at last the North Wind gave up the attempt. Then the Sun shined out warmly, and3 immediately the traveller took off his cloak. And4 so the North Wind was obliged to confess that the Sun was the stronger of the two.

Mark Twain: Mrs. McWilliams and the Lightning

The fear of lightning is one of the most distressing infirmities a human being can be afflicted with. It is mostly confined to women; but now and-1 then you find it in a little dog, and-2 sometimes in a man. A woman who could face the devil himself - or a mouse - loses her grip and goes all to pieces in front of a flash of lightning.

Well, as I was telling you, I woke up, with that smothered and-3 unlocatable cry of "Mortimer! Mortimer!" wailing in my ears; and as soon as I could scrape my faculties together I reached over in the dark and-4 then said: "Evangeline, is that you calling? What is the matter? Where are you?"

"In the closet. You ought to be ashamed-1 to lie there and-5 sleep when such an awful storm is going on."

"Why, how can one be ashamed-2 when he is asleep-1? It is unreasonable. A man can't be ashamed-3 when he is asleep-2, Evangeline."

"You never try, Mortimer - you know very well you never try."

I caught the sound of muffled sobs.

"I`m sorry, dear - I`m truly sorry. Come back and-6 --"

"MORTIMER!"

"Heavens! What is the matter, my love?"

"Do you mean to say you are still in that bed?"

"Why, of course."

"Come out of it instantly. I should think you would take some little care of your life, for my sake and the children`s, if you will not for your own."

"But my love --"

A.2 Rating Sheet

Expert ratings for English language speech production recordings

Rater:

Name of the participants	North wind	Lightning

A.3 Abstract

Up to now, only few studies in the phonology of English of Persian native speakers have been performed. In the present study, we compared different individual cognitive factors which result in ESL Iranian English pronunciation such as cognitive ability and short-term memory (Working Memory and LLAMA D), language aptitude tests, such as MLAT III, IV and V [Carroll 1960], LLAMA D test [Paul Meara] and a working memory test (Tewes 1994). These measures were then correlated to English pronunciation and phonetic measurements (vowel length measurement) of Persian ESL learners. The sample comprised 30 Iranians with L1 Farsi and academic education with chronological age from 20 to 40 (mean age 26.08) and age of onset of learning from 2-16 (mean age 11.03). Results for three learner groups defined by language proficiency, confirmed previous findings regarding the significance of age of onset of acquisition in ultimate L2 attainment and the contribution of cognitive factors, language aptitude and multilingualism in L2 phonological processing. The observed relationships indicated that individuals with a higher L2 aptitude, better cognitive ability and shorter schwa duration were rated higher on English pronunciation by English native speakers.

We observed significant correlations between English pronunciation scores and these factors: schwa length pronunciation ($r = -0.8$), MLAT III ($r = 0.8$) and working memory ($r = 0.78$). Schwa length production also correlated highly with number of learned languages ($r = -.74$) and the age of onset of acquisition ($r=.41$). Our cross-linguistic results suggest that phonological native-like L2 achievement in ESL adult learners is possible in that individuals with higher L2 aptitude and working memory capacity can overcome the transfer of L1 phonological categories in L2 processing.

A.4 Zusammenfassung

Bis jetzt existieren nur wenige Studien der englischen Phonologie über Muttersprachler der persischen Sprache. In der vorliegenden Studie haben wir verschiedene individuelle kognitive Faktoren verglichen, die in iranische englische Aussprache von Englisch als Zweitsprache resultierten wie kognitive Fähigkeit und Kurzzeitgedächtnis (Gedächtnisleistung und LLAMA_D [Paul Meara]), Sprachbegabung (MLAT III, IV und V) [Carroll 1960] und Arbeitsgedächtniskapazität (Tewes 1994).

Diese Maßnahmen wurden dann auf englische Aussprache und phonetische Messungen (vokale Längenmessung) von persischem Englisch als Zweitsprache Lernende korreliert. Die Probe umfasste die Teilnahme von 30 IranerInnen mit akademischer Ausbildung und mit chronologischem Alter von 20 bis 40 (mittleres Alter 26.08) und die Alter bei Erwerbsbeginn von 2-16 Jahren (Mittelwert 11.03).

Ergebnisse für drei Englisch-Aussprache-Talent Gruppen bestätigen vorherige Ergebnisse bezüglich der Signifikanz des Altes bei Erwerbsbeginn zur Erreichung von Zweitspracherwerb und der Hinzunahme kognitiver Faktoren in der Sprachbegabung und Mehrsprachlichkeit in Hinsicht auf phonologische Verarbeitung. Die beobachteten Zusammenhänge haben angezeigt, dass Personen mit einer höheren L2 Begabung, besseren kognitiven Fähigkeiten und kürzeren Zeiten der Schwa Artikulation höher geschätzt sind in ihrer englischen Aussprache von englische Muttersprachler Bewerter.

Wir haben bedeutende Korrelationen zwischen Werten englischer Aussprache und die folgenden Faktoren beobachtet: Länge der Schwa Artikulation (r =-0.8), MLAT III Test (r = 0.8) und Gedächtnisleistung (r = 0.78). Die Länge der Schwa Artikulation wies Zusammenhänge mit der Anzahl gesprochener Fremdsprachen (r =-.74) und dem Alter bei Erwerbsbeginn (r =. 41) auf. Unsere cross-linguistic Ergebnisse zeigen, dass phonologische nativ-ähnlichen L2 Aussprache in Englisch als Fremdsprache erwachsene Lernende möglich ist, in dem die Personen mit höherer L2 Eignung und Arbeitsgedächtniskapazität die Übertragung von L1 phonologischen Kategorien in L2 Verarbeitung überwinden könnten.

A.5 Declaration of authority

I hereby certify, to the best of my knowledge, that I am the sole author of this master's thesis and my thesis does not infringe upon anyone's copyright nor violate any proprietary rights and that any ideas, techniques, quotations, images or any other material from the work of other people included in my thesis, published or otherwise, are fully acknowledged in accordance with the standard referencing practices.

Zhaleh Ghafoorian Maddah

Vienna, November 2015

Signature

A.6 Curriculum Vitae

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1993–1997	Gymnasium, Matura in Naturwissenschaften, Mashad, Iran
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WEITERBILDUNG

2008-2014	Technik der Ölmalerei : Material- und Handwerkskunde der Acryl- und Ölmalerei an der Künstlerischen Volkshochschule, Wien
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2002-2005	Englischlehrerin für Kinder und Erwachsene an “Golestan Foreign Language” Institut, Mashad, Iran
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07.2007	Zertifikat der Kalligraphie mit Auszeichnung von der “Calligraphy and Lettering Art Society”, CLAS London
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SPRACHKENTNISSE

Persisch	Muttersprache
Englisch	verhandlungssicher
Deutsch	verhandlungssicher
Arabisch	passive Grundkenntnisse
Französisch	passive Grundkenntnisse
Latein	passive Grundkenntnisse