

The Journal of Teaching Language Skills (JTLS)
5 (2), Summer 2013, Ser. 71/4
ISSN: 2008-8191. pp. 51-67

The Effect of Vowel-Recognition Training on Beginner and Advanced Iranian ESL Learners

M. S. Khaghaninezhad
Assistant Professor, TEFL
Shiraz University, Shiraz
email: mskhaghani@shirazu.ac.ir

Abstract

This study was an attempt to investigate the effect of vowel-recognition training on beginner and advanced Iranian ESL learners. A total of 36 adult Iranian ESL learners (18 advanced and 18 beginners) who were students of various majors at Memorial University (MUN) were recruited for the study. Advanced participants had the experience of living in Canada for at least three years while beginners had lived in Canada less than six months. The study commenced with a pre-test to verify the participants' awareness of English vowel sounds. Predictably, advanced participants were superior to beginners in terms of English vowel awareness. After the pre-test administration, participants of both groups underwent a five-week vowel-recognition training course (focusing on all English vowel sounds). At the end of the vowel-recognition training program, the 80-item multiple choice test which had been once used as the pre-test was conducted again. The findings revealed that both beginner and advanced participants' performance was improved on the second administration of vowel-identification test due to the intensive vowel-recognition training program. It is also revealed that formal instruction of English vowels had raised the beginners' English phonetic knowledge to that of advanced learners. Moreover, it was shown that phonology of the participants' first language (i.e. Farsi) did have an impact on the acquisition of second language phonological features.

Keywords: vowel-recognition training, vowel-identification test, phonetic knowledge, acquisition of second language phonological features

1. Introduction

One of the major problems faced by almost any ESL/EFL learner is the achievement of an acceptable pronunciation that enables him/her to be understood by native speakers. Observation of ESL/EFL learners' pronunciation errors and difficulty of being understood by native speakers would suggest the critical need for ESL/EFL teachers to become more aware of the discrepancies of learners' L1 phonological systems with English phonology and ask for focusing on these possible areas of difficulty as a pedagogic necessity. Considering the fact that Farsi lacks 6 of English vowel sounds (/I/, /ɛ/, /ʌ/, /ʊ/, /ə/, /æ/), 7 of its diphthongs (/Iə/, /eə/, /aI/, /ʊə/, /əʊ/, /ɔI/, /aʊ/) and all its triphthongs (/eIə/, /aIə/, /ɔIə/, /aʊə/, /əʊə/) (e.g. Windfuhr, 1979; Hall, 2007), one common predicament of Iranian ESL/EFL learners is the comprehension and production of English vowel sounds. Consequently, the author decided to investigate the effect of formal English vowel-recognition instruction on Iranian ESL learners with different durations of residence in Canada.

Vowel-recognition training program has proven successful for the betterment of phoneme identification and production for second and foreign language learners (e.g. Iverson et al., 2010). Although different training techniques have been exploited up to the present time, most promising techniques are those which have emphasized presenting listeners a stimuli and asking for a forced-choice judgment and providing feedback indicating whether their selected choice was correct or not (e.g. Pruitt et al., 2006; Hazan et al., 2005). There is also evidence that this perceptual training results in better vowel production (Bradlow et al., 1997).

According to Iverson, Pinet and Evans, (2010), auditory training would be also successful for more experienced second language learners, "although they would receive a much richer array of phonetic experience than could be delivered in a few hours of computer-based training." They continued,

Some experiments have suggested that individuals do not learn contrasts such as /r-/l/ as well in situations where the lexicon or sentence context disambiguates phonetic identity, and learn better when they need to focus on the phonetic information. Listeners may thus learn poorly in natural situations (e.g., a conversation) because there is enough other linguistic information to make it unnecessary for the listener to discern a specific phonetic context. (p. 2)

Several studies indicated that the underlying changes in phonetic processing of training programs may differ from the kinds of changes that

occur as a result of long-term life in second language context. For example, Heeren and Schouten (2008) found that Dutch listeners could be trained to improve their identification of Finnish /t-/t:/ but they do not improve in their ability to discriminate acoustic changes in these consonants. That is, the training does not give them the sensitivity peak at the category boundary that is typical of native Finnish speakers.

This study was an attempt to investigate the effect of vowel-recognition training on Iranian ESL learners' vowel comprehension/production improvements. Iranian participants were categorized into two groups of beginners (those who had lived in Canada less than 6 months and had not experienced any formal English instructional courses) and advanced (those who had lived in an Canada more than 3 years and have experienced English instructional courses both in Iran and in Canada). The author tried to find reasonable answers to the following research questions;

- Is formal instruction of English vowel-identification of any help to Iranian ESL learners of both proficiency levels?
- To what extent does English vowel-identification training improve Iranian ESL learners' phonetic awareness?
- Does formal vowel-recognition instruction have the potential to improve the beginner ESL learners' English phonetic knowledge to that of advanced ESL learners?

2. Literature Review

As the world grows smaller, more individuals are in the need of learning other languages in order to communicate with others from different regions, countries and continents. One common issue in adult language learning is that of foreign accent. This is an interesting phenomenon when considering the fact that a learner may achieve native-like proficiency in other aspects of a second language, but continue to have difficulty with the non-native phonemes. Several studies have attempted to improve speech perception in adults with normal hearing and adults with hearing loss through training. These studies have taken various approaches to speech perception training, and evaluated speech recognition for vowels, consonants, syllables, words and phrases (e.g. Bernstein et al., 1991; Gesi et al., 1992).

Despite the fact that vowels and consonants together are the building blocks of natural human languages, it is surprising that these two may be treated differently when it comes to perception. Polka (1994) pointed out that, "although both are processed using categorical and auditory coding, the brevity and small spectral change of consonants favor the former and the length and large spectral change of vowels favor the latter." The perception

of vowels is also a multifaceted phenomenon to study due to the fact that vowels are distinguished based on these auditory and acoustic cues and more loosely on articulatory phenomenon. She added, “the quality of vowels are greatly determined by the consonants surrounding it in natural speech, meaning that one token of a vowel may sound very different from another depending on the context in which it occurred.” (p. 54).

In Rochet’s (1995) study of perception and production of the target language speech sounds, it was found that individuals’ second language phonetic production errors correspond to their perception of the phonemes in question. This was also addressed by Brown (2000), who investigated the difference in ability of speakers of various languages to acquire the English contrasting phonemes. The drawn conclusion was that a learner’s native phonemic categories will influence their perception (and therefore production) of non-native vowel sounds. Flege (1995) accounted for the changes that occur during L2 speech perception by adults quite differently through a model he designed (Second language Model). One hypothesis of his model is that the greater the distance between L2 and L1 vowel sounds, the greater likelihood that it will be perceived and produced more accurately and a new category will be established for it. However, equivalence classification can occur that link L2 phones with a “similar” L1 category. For instance, he noted that because Japanese lacks corresponding vowels for English /æ/ and /ɛ/ in the front low and mid region of the vowel space, respectively, it was predicted that these two vowels would pose less problems for the Japanese learners to acquire.

Cole et al. (1996) suggested that vowels contribute more information to overall auditory speech intelligibility than consonants. He examined the perception of young adults for two types of sentences; sentences in which all of the vowels were replaced with noise (consonants-only sentences), and sentences in which all of the consonants were replaced with noise (vowels-only sentences). The findings revealed that approximately twice as many words were recognized in the vowels-only compared to the consonants-only sentences. The location of the segment boundaries did not strongly affect the large difference in sentence intelligibility found between the vowels-only and consonants-only conditions.

Kewley-Port et al. (2007) replicated and extended Cole’s study using both young adults with normal hearing and elderly adults with hearing loss. The results showed that word intelligibility for vowels-only sentences were significantly greater than for consonants-only sentences, by 14% to 40% across groups. They concluded that vowels contribute more information than consonants to auditory sentence intelligibility, for both young adults with normal hearing and elderly adults with hearing loss. Furthermore, some

studies have shown that vowels often remain relatively audible compared to consonants, for the person with hearing loss. Vowels usually have higher intensity and longer duration, relative to consonants. As Lesner et al. (1987) wrote,

People with high-frequency sensori-neural hearing loss typically demonstrate consonant confusions but less difficulty with vowel identification. This being the case, auditory-visual vowel identification training may capitalize on an ability of the person with hearing loss, rather than something that causes difficulty. The vowel nucleus of a word often may be the only part clearly audible to the hearing-impaired listener. If the vowel is incorrectly identified the word and consequently the entire sentence may be misunderstood. (p. 100)

2.1 Auditory training

Auditory Training (AT) which is a procedure pioneered in France as a cure for dyslexic and autistic patients, was defined by Cullen (2005) as,

..... a process that involves teaching the brain to listen. People without hearing impairments and auditory processing disorders learn how to listen naturally at a very young age and may not remember this process. In auditory training, people are provided with auditory stimuli and coaching that helps them learn to identify and distinguish sounds. Auditory training is usually supervised by an audiologist or speech-language pathologist. (p. 117)

Cullen (2005) listed some principles of AT for vowels instructional programs as follows,

- The first principle in AT for teaching vowels is to practice and teach in a quiet environment.
- The listener must also know what long and short vowels mean.
- Auditory training demands training of the listener by supplying the sound to each of the vowels as they are written in front of him/her.
- The discrimination of the vowels should include paired comparisons of vowel sounds only. This can be done with same or different judgments or vowel identification in a set of words presented.
- Vowels can be put in a CV, CVC arrangement or word and similar for constructing judgment or identification tasks.

A support for a vowel-based AT approach can also be drawn from one of the earliest empirical studies of lip-reading, done by Heider and Heider (1940), who addressed the issue of the relative contribution of vowels and consonants to speech understanding. They suggested that recognition of vowels may be more important than consonants for learning how to lip-read and continued,

...that a certain consonant belongs, for instance, to the group of *m*, *p*, and *b*, one can see without much training – and no amount of training makes it possible to distinguish accurately between these three consonants. On the other hand with vowels, where the differences are much more gradual, one can learn to make finer and finer differentiations. (p. 141)

Many studies (e.g. Lively et al., 1993; Bradlow et al., 1997; Flege, 1995) have examined the effects of AT on L2 speech acquisition focusing on nonnative vowel contrasts using a discrimination format (differentiating between two or more stimuli) or identification format (assigning labels to individual stimuli) and showed improvement in perception depending upon several factors, including the characteristics of the learners, the relationship of the L1 to the L2, the nature and range of the L1 stimuli, as well as the training methods being employed and use or nonuse of variability in the stimuli.

Logan et al. (1991) utilized a two-alternative, forced-choice identification task that incorporated a variable stimuli procedure with feedback to train Japanese in the American English /r-/l/ contrast. Minimal pairs were used contrasting /r/ and /l/ in a varied environment and with multiple speakers. A pretest-posttest design containing natural tokens was used to assess the effects of identification training. Posttest results showed that listeners significantly improved their identification performance of /r/ and /l/, and that they could generalize to new contexts.

3. Method

3.1 Participants

The study commenced by recruiting 42 adult Iranian ESL learners (22 advanced and 20 beginners) with the age range of 21 to 29. They were all under/postgraduate students of Memorial University (MUN), in St. John's, Canada. Three advanced participants were dropped because their English vowel identification was shown to be greater than 80% correct in the pretest and two beginners were not able to complete all training sessions. Hence, the study's findings accounted for 18 advanced and 18 beginner Iranian ESL learners. Advanced participants had the experience of living in Canada for at

least 3 years (between 3 to 7 years) while beginners had lived in Canada for less than 6 months (between 3 to 6 months). All the participants were recruited in linguistics laboratory of MUN while none of them self-reported that they had hearing problems.

3.2 Materials and instruments

An 80-item vowel-identification multiple choice test was conducted in a quiet laboratory twice, once as the pre-test and once as the post-test at the course termination. To conduct the test, a “Vowel-Identification Software” was installed on all the laboratory’s PCs. With the aid of this software, a stimulus (word containing a vowel sound) was played over headphones at a user-controlled comfortable level. For each stimulus 4 choices were presented on the screen and the participants were asked to click on the word they thought they had heard. For instance, for a stimulus like, “bit”, the participants were provided with “beat/but/bit/boot” on their screens. Before the test commencement, all the participants were fully enlightened about the quality of software’s functioning.

After the administration of the pre-test and verification of the participants’ awareness of English vowel sounds, a vowel-recognition training course began. This 5-week course focused on all English vowel sounds; 11 vowels (/i/, /e/, /ʊ/, /u/, /ɪ/, /o/, /ə/, /ʌ/, /ɛ/, /æ/, /ɑ/), 9 diphthongs (/Iə/, /eə/, /aɪ/, /ʊə/, /əʊ/, /ɔɪ/, /aʊ/, /eɪ/, /ow/) and 5 triphthongs (/eɪə/, /aɪə/, /ɔɪə/, /aʊə/, /əʊə/). Both advanced and beginner participants were supposed to participate in 3 one-hour sessions every week. During these 15 sessions, the participants were recruited through “minimal pairs” drills, word repetition tasks, peer-correction exercises and listening to authentic vowel pronunciation with the aid of recorded tapes. After the course completion and at the optimal time for test-retest design (according to Iverson et al. 2010), the vowel-identification test was conducted again to see if there was any statistically significant difference between participants’ performances of both groups on the pre- and post-test.

3.3 Procedure

In the beginning of the study, the participants were informed about the purpose of the study and that their identities would be kept confidential in the research report. Each participant was given an information sheet and a consent form that they were required to read and sign. A total of 42 Iranian ESL learners volunteered for the study. Based on their residence duration, 20 were assigned as the participants of the beginner group and 20 were consigned as the advanced subjects out of which four were dropped due to

their performances on the pre-test (they gained over the 80% of the total score).

After the pre-test and the grouping procedure, a five-week course of English vowel-recognition training began. During these five weeks, all the English vowels were introduced to participants; the difference between short/long and lax/tense vowels was explained both in terms of articulation and practically with the aid of “minimal pairs”. As another activity, participants were asked to control the class for a few minutes; they had to come to the board and write a word containing a vowel and ask one of the learners to read it aloud for the class while he was in charge of his/her friend’s correction. Additionally, the participants were exposed to authentic pronunciation of vowels from the third week of the course. In the very last week, the participants were hearing a word played over headphones while they were supposed to select one of the four words on the PC screen which had the same vowel sound. If they gave a correct answer, they saw “Yes!” on the computer screen and if they gave a wrong answer, they saw “Wrong” on the screen accompanied by the taped authentic pronunciation of the correct response over their earphones.

At the end of the vowel-recognition training program, the 80-item multiple choice test which was used as the pre-test 5 weeks before, was conducted again to see if there was any significant difference between participants’ performances of both groups on the pre- and post-test. The results showed whether the instruction course was useful for both the beginner and advanced participants. Moreover, the comparison of advanced and beginner participants’ performances on the second administration of the test made it possible to verify the potential of the vowel recognition training for compensating the short residence of beginner ESL learners.

4. Results and Discussion

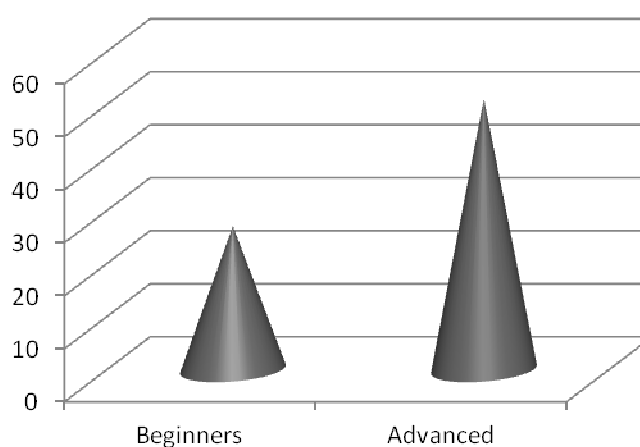
The study commenced with a pre-test to evaluate the participants’ knowledge of English vowel sounds. As it was predictable, advanced Iranians ESL learners (with the average of 51 out of 80) outperformed the beginners (with the average of 27 out of 80) on the vowel-identification pre-test. Their superiority was proven using an independent-sample t-test.

Table 1. Mean comparison of the beginner and advanced participants on the vowel-identification pre-test

Independent-sample t-test for equality of means								
Leven's Test for Equality of Variances								
	F	Sig.		t	df	Mean Difference	Std. Error Difference	Sig.(2-tailed)
Vowel-identification pre-test	23.159	.000	Equal variances assumed	-5.587	34	-23.058	.926	.000
			Equal variances not assumed	-5.489	33.347	-23.058	.939	.000

Figure 1 depicts the mean difference of the beginner and advanced Iranian ESL learners on the vowel-identification pre-test.

Figure 1. Means of the beginner and advanced participants on the vowel-identification pre-test



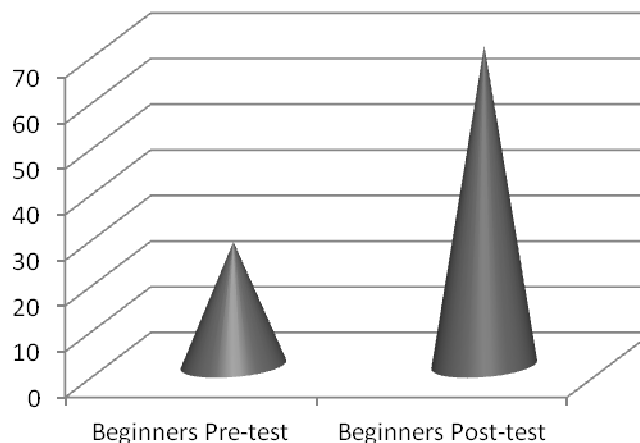
After the participants' recruitment through the vowel-recognition course, the vowel-identification test was administered again to see if beginner participants had any significant progress in English vowel-recognition ability. They performed remarkably better on the second administration with the mean of 70 out of 80. To prove it statistically, the mean of their scores on the second administration of the test was compared with that of those on the first test administration through a paired-samples t-test.

Table 2. Comparison of the beginners' means on the vowel-identification pre- and post-test

Beginners	Mean Difference	Paired differences		t	df	Sig.(2-tailed)
		Std. Deviation	Std. Error Difference			
Vowel-identification pre/post-test comparison	-42.758	14.341	.726	-4.537	17	.000

Figure 2 depicts the mean difference of beginners' means on two administrations of the vowel-identification test.

Figure 2. Means of the beginner participants on two administrations of the vowel-identification test



To be more detailed, the average of scores for each individual vowel was calculated. Table 3 shows the means for each vowel on the two administration of the vowel-identification test for beginners. As it is discernible, beginners' performance on the second administration was improved for every single vowel. Furthermore, the participants' means of absent vowels in Farsi were lower than those of present vowels (pre-test: $20 < 33$, post-test: $64 < 74$) both on the first and second administrations of the test; this would suggest a role of L1 in acquisition of L2 phonological aspects (missing vowels in Farsi are distinguished with an asterisk).

Table 3. Means of the beginners' performances on two administrations of the vowel-identification test for each vowel

Vowels	Test	Mean	Vowels	Test	Mean
/i/	Pre	36	/ʌ/*	Pre	16
	Post	77		Post	53
/ɪ/*	Pre	23	/ɛ/*	Pre	24
	Post	74		Post	59
/e/	Pre	32	/æ/	Pre	39
	Post	76		Post	79
/ʊ/*	Pre	15	/ɑ/	Pre	13
	Post	58		Post	63
/u/	Pre	35	/ɪə/*	Pre	15
	Post	77		Post	64
/o/	Pre	31	/eɪ/	Pre	19
	Post	63		Post	67
/ə/*	Pre	21			
	Post	58			
/eə/*	Pre	18	/ow/	Pre	38
	Post	66		Post	78
/aɪ/*	Pre	31	/eɪə/*	Pre	26
	Post	71		Post	73
/ʊə/*	Pre	25	/aɪə/*	Pre	27
	Post	69		Post	70
/əʊ/*	Pre	36	/ɔɪə/*	Pre	12
	Post	69		Post	67
/ɔɪ/*	Pre	18	/aʊə/*	Pre	27
	Post	75		Post	62
/aʊ/*	Pre	35	əʊə/*	Pre	24
	Post	75		Post	73

Av. for absent vowels on pre 20

Av. for present vowels on pre 33 **Average of means on the pre-test 27**Av. for absent vowels on post 64 **Average of means on the post-test 70**

Av. for present vowels on post 74

The outperformance of the beginner Iranian ESL learners on the second administration of the vowel-identification test was somewhat predictable. However, the more important question was whether advanced ESL learners' performances on the second administration of the test were drastically improved. If so, this 5-week vowel-recognition training program had proven its efficacy even for those who had lived in the second language context more than 3 years as far as vowel-recognition abilities were concerned. The mean of advanced participants on the second administration of the test was raised to 73 out of 80. With the aid of a paired-sample t-test, the significance of their different performances on two administrations of the same test was

statistically attested although their enhancements were not as much as their beginner peers.

Table 4. Comparison of the advanced learners' means on the vowel-identification pre- and post-test

Paired differences						
Advanced	Mean Difference	Std. Deviation	Std. Error Difference	t	df	Sig.(2-tailed)
Vowel-identification pre/post-test comparison	-21.345	9.287	.321	-2.539	17	.003

Figure 3 depicts the mean difference of advanced Iranian ESL learners' means on two administrations of the vowel-identification test.

Figure 3. Means of the advanced participants on two administrations of the vowel-identification test

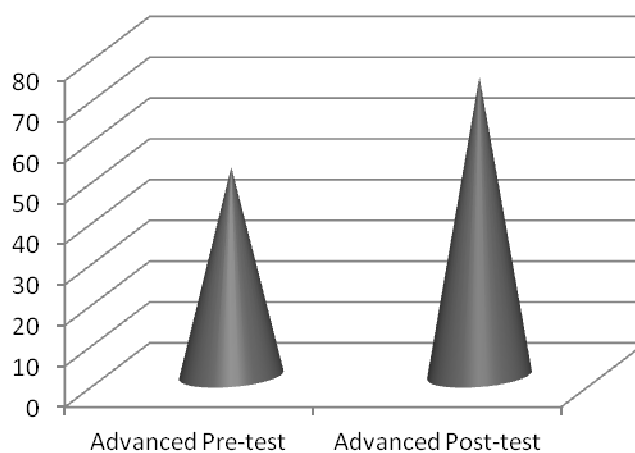


Table 5 presents the detailed description of the advanced participants' performance for each English vowel. The findings showed that advanced learners, like the beginners, outperformed on the second administration of the test in recognition of all the English vowel sounds and as it can be discerned, their means for present vowels were higher than that of theirs for missing vowels in Farsi (pre-test: 58 > 48, post-test: 75 > 71) on both of the test administrations; this suggests the role of participants' L1 in acquisition of L2 phonological features (missing vowels in Farsi are distinguished with an asterisk).

Table 5. Means of the advanced learners' performance on two administrations of the vowel-identification test for each vowel

Vowels	Test	Mean	Vowels	Test	Mean
/i/	Pre	66	/Δ/*	Pre	46
	Post	78		Post	73
/I/*	Pre	41	/ε/*	Pre	40
	Post	75		Post	66
/e/	Pre	55	/æ/	Pre	70
	Post	79		Post	79
/U/*	Pre	42	/ɑ/	Pre	38
	Post	76		Post	71
/u/	Pre	63	/Iə/*	Pre	35
	Post	77		Post	66
/o/	Pre	59	/eI/	Pre	47
	Post	73		Post	67
/ə/*	Pre	50			
	Post	72			
/eə/*	Pre	49	/ow/	Pre	64
	Post	69		Post	76
/aI/*	Pre	57	/eIə/*	Pre	52
	Post	76		Post	76
/Uə/*	Pre	54	/aIə/*	Pre	54
	Post	75		Post	70
/əU/*	Pre	49	/ɔIə/*	Pre	40
	Post	75		Post	69
/ɔI/*	Pre	43	/aUə/*	Pre	48
	Post	73		Post	63
/aU/*	Pre	59	əUə/*	Pre	46
	Post	76		Post	71
Av. for absent vowels on pre		47			
Av. for present vowels on pre		58	Average of means on the pre-test		51
Av. for absent vowels on post		71	Average of means on the post-test		73
Av. for present vowels on post		75			

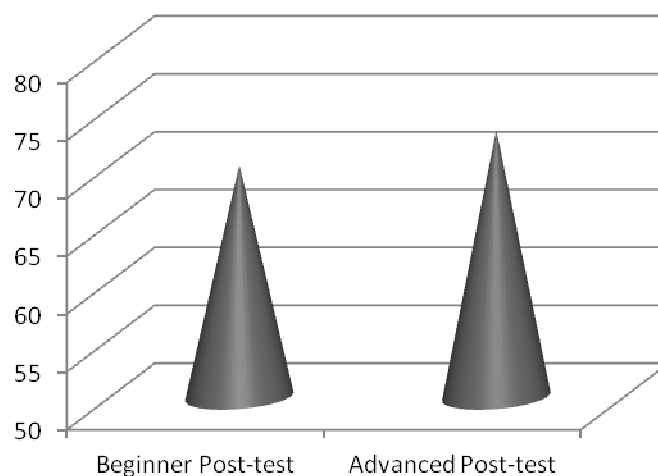
In order to see whether there was a statistically meaningful difference between beginner and advanced Iranian ESL learners' vowel-recognition abilities after the conduction of an intensive vowel-training course, their means on the second administration of the vowel-identification test were compared with the aid of an independent-sample t-test. Surprisingly, it was shown that advanced participants' performances were not significantly different from those of their beginner peers. In better words, although the mean score of the advanced participants was higher than that of the beginners (73 > 70), they were at the same level of English vowel familiarity with beginners after a 5-week vowel-recognition training program.

Table 6. Comparison of the beginner and advanced learners' mean scores on the vowel-identification post-test

Independent-sample t-test for equality of means							
	Leven's Test for Equality of Variances		t	df	Mean Difference	Std. Error Difference	Sig.(2-tailed)
	F	Sig.					
Vowel-identification post-test comparison	3.611	.084	-0.039	34	-2.354	.728	.084
			-0.037	33.347	-2.354	.717	.084

Figure 4 depicts the mean difference of beginner and advanced Iranian ESL learners' means on the second administration of the vowel-identification test.

Figure 4. Mean scores of the beginner and advanced participants on vowel-identification post-test



In fact, vowel-recognition training was shown to have the potential to extend the beginner ESL learners' English phonetic knowledge to that of advanced ESL learners. It had compensated their short duration of residence in Canada as English vowel-identification was concerned.

5. Conclusion

The findings showed that not only both beginner and advanced Iranian participants' performances were improved under an intensive vowel-recognition training program on the second administration of vowel-identification test, but also the fact that formal instruction of English vowel-recognition can raise beginner ESL learners' English phonetic knowledge to that of advanced ESL learners. The comparison of the vowel-identification pre- and post-tests helped to argue how auditory training courses differ from acquiring the second language through natural language exposure. Though experiencing natural speech improves speech perception and production at multiple levels simultaneously, formal instruction of the phonology of the target language should not be underestimated.

Moreover, it was revealed that participants' L1 (i.e. Farsi) phonological system does have an influence on the acquisition of L2 (i.e., English) phonological features; the performances of beginner and advanced participants were better for the present vowel sounds rather than missing vowels in Farsi both on the pre- and the post-test. This is also in accord with previous findings with training Japanese speakers to identify English /r/-/l/ (Iverson et al., 2005); listeners improved when trained on highly variable speech, but they appeared to learn by more systematically applying their L1 flap /r/ category to English (i.e., labeling stimuli that were close to their flap as English /l/) rather than learning new categories based on this acoustic variability. This can be considered as a support for CAH's cross-linguistic claims.

The experiments reveal that beginner Iranian ESL learners receive more benefit from vowel-recognition training program, even though their exposure to natural flows of English during their residence in Canada was much less than advanced participants who had experienced living in Canada for a longer time and daily interactions with native English speakers. This supports a conclusion that it is not the exposure alone to natural speech that improves performance in vowel-recognition task; rather, there are some aspects of the focused attention to phonetic differences of the target language that improves L2 vowel perception. Generally speaking, Auditory Training (AT) seems to have the potential for improving the efficiency of identification of vowel sounds in a non-superficial manner (i.e. generalizing vowel sounds and putting them in different categories and retaining them over time; Bradlow et al., 1999; Lively et al. 1997; Logan et al., 1991) and provides a useful background to real-world L2 experience.

References

- Bernstein, L. E., Demorest, M. E., Coulter, D. C., O'Connell, M. P. (1991). Lip-reading sentences with vibrotactile recorders: Performance of normal-hearing and hearing-impaired subjects. *Journal of the Acoustical Society of America*, 90, 2971-2984.
- Bradlaw, A. R. Rvachew, S., Shiffrin, R., Schneider, W. Dittman, S. (1997). Speech perception training can facilitate sound production learning. *Journal of Speech and Hearing Research*, 37, 347-357.
- Bradlow, A. R., Pisoni, D. B., Yamada, R. A., Tohkura, Y. (1997). Training Japanese listeners to identify English /r/ and /l/: Some effects of perceptual learning on speech production. *Journal of the Acoustical Society of America*, 101, 2299-2310.
- Brown, C. (2000). *The interrelation between speech perception and phonological acquisition from infant to adult*. Blackwell Publications.
- Cole, R., Yan, Y., Mak, B., Fanty, M., Bailey, T. (1996). The contribution of consonants versus vowels to word recognition in fluent speech. *Proceedings of the International Conference on Acoustics, Speech and Signal Processing*. Atlanta.
- Cullen, C. (2005). *Auditory integration training: a critical review*. Rutledge Press.
- Flege, J. E. (1995). *Second language speech learning: Theory, findings, and problems*. Baltimore: York Press.
- Gesi, A., Massaro, D., Cohen, M. (1992). Discovery and expository method in teaching visual consonant and word identification. *Journal of Speech and Hearing Research*, 35, 1180 - 1188.
- Hack, R., Erber, D. (1982). Perceptual learning in speech. *Cognitive Psychology*, 47, 204-238.
- Hall, M. (2007). *Phonological characteristics of Farsi speakers of English and L1 Australian English speakers' perceptions of proficiency*. Unpublished master's thesis, Curtin University, Australia.
- Hazan, V., Sennema, A., Iba, M., Faulkner, A. (2005). Effect of audiovisual perceptual training on the perception and production of consonants in Japanese learners of English. *Speech Communication*, 47, 360-378.
- Heeren, W., Schouten, M. E. H. (2008). Perceptual development of phoneme contrasts: How sensitivity changes along acoustic dimensions that contrast phoneme categories. *Journal of the Acoustical Society of America*, 124, 2291-2302.
- Heider, F., Heider, G. (1940). An experimental investigation of lip-reading. *Psychological Monographs*, 52, 124-153.
- Iverson, P., Kuhl, P. K., Akahane-Yamada, R., Diesch, E., Tohkura, Y., Kettermann, A. (2005). A perceptual interference account of

- acquisition difficulties for non-native phonemes. *Cognition*, 87, 47–57.
- Iverson, P., Pinet, M., Evans B. G. (2010). Auditory training for experienced and inexperienced second-language learners: Native French speakers learning English vowels. *Applied Psycholinguistics*, 26 (2), 1-16.
- Kewley-Port, D., Burkle, T., Lee, J. (2007). Contribution of consonant versus vowel information to sentence intelligibility for young normal-hearing and elderly hearing-impaired listeners. *The Journal of the Acoustical Society of America*, 122, 2365-2375.
- Lesner, S., Sandridge, S., Kricos, P. (1987). Training influences on visual consonant and sentence recognition. *Ear and Hearing*, 8, 283-287.
- Lively, S. E., Logan, J. S., Pisoni, D. B. (1997). Training Japanese listeners to identify English /r/ and /l/: The role of phonetic environment and talker variability in learning new perceptual categories. *Journal of the Acoustical Society of America*, 94, 1242–1255.
- Logan, R., Akane–Yamada, R., Kubo, R., Trent, S., Nishi, K., Jenkins, J. (1991). Perceptual assimilations of American English vowels by Japanese listeners. *Journal of the Acoustical Society of America*, 26, 311–344.
- Polka, L. (1994). Linguistic influences in adult perception of non-native vowel contrasts. *Journal of the Acoustical Society of America*, 97, 1286–1296.
- Pruitt, J. S., Jenkins, J. J., Strange, W. (2006). Training the perception of Hindi dental and retroflex stops by native speakers of American English and Japanese. *Journal of the Acoustical Society of America*, 119, 1684–1696.
- Rochet, B. L. (1995). Perception and production of second-language speech sounds by adults. In Strange, W. (Ed.). *Speech perception and linguistic experience: Issues in cross-language research*. Baltimore, MD: York Press.
- Windfuhr, G. L. (1979). *The World's Major Languages*. Oxford University Press.