The [æ] Sound in American English

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This study offers a set of acoustic data showing that the [æ] sound in American English is pronounced in a specific area of vowel space different from the area in which Mandarin speakers pronounce the same vowel. Americans use a much lower part of their oral cavity to pronounce [æ] and this lower part of the oral cavity is not commonly used by most Mandarin speakers in Taiwan. In addition, data show that Americans pronounce the [æ] sound more as a diphthong than as a single segment while Mandarin-speaking subjects pronounce it more as a single segment. Computer software like the *Multi-speech Signal Analysis Workstation* provides not only the data one needs for modeling the contrastive vowel space but also the real-time analyses that help an English learner to locate the appropriate position for a specific sound. Knowing these differences proves helpful to those who want to improve their pronunciation of the [æ] sound in American English. The results of this study may also provide a substantial strategy for teachers who have difficulty in finding a good way to teach the [æ] sound in American English.

This study has a very specific goal: to diagnose the pronunciation of a group of 10 students who passed the competitive English proficiency test given by the Ministry of Education in March 1999. These students have little problem with communicating in English. According to an English native speaker's comments[1] on their proficiency in oral expression, they do not have serious problems in either segmental or suprasegmental properties. In other words, their performance in individual sounds, intonation, rhythm, and tone of English is acceptable, though with foreign accents to various degrees and in different types. However, these students were not satisfied with their English pronunciation. Since these students had a strong intrinsic motivation and were fully aware that they were trained to be English teachers, they wished to try all means possible to "correct" their "deviated" sounds. Most of them noticed that there were subtle differences between their own pronunciation and that of native speakers'. But they had no idea how to locate the problems and, even if some of them did, they did not know how to solve the problems satisfactorily. Fully interested in this issue, I started collecting their sounds and then observed the acoustic data of these sounds. The findings and the strategies used to help these students will be discussed in this paper with the focus on how the [æ] sound in American English can be pronounced as an individual sound segment and/or as part of a string of clustered sounds in a passage.

It is well discussed and well accepted that the vowel space varies according to languages spoken by different people (Ladefoged & Maddieson, 1996). People speaking the same language may also have different ways to pronounce the same vowel. According to Boberg and Strassel (2000), people speaking English in different areas also produce the [æ] sound differently. His study also shows that English speakers in Cincinnati pronounce the [æ] (or short-a) sound variously because of the various age groups they belong to. Since there is no [æ] sound in Mandarin, it may

[1] These students were also required to take a course entitled "Drill of English," taught by an English native speaker teaching in the English Department, Chinese Culture University.

not be surprising to find that Mandarin speakers[2] in Taiwan, if they have to, pronounce the [æ] sound in English differently than do native speakers of American English. In addition, even if Mandarin speakers have little problems pronouncing the [æ] sound, the duration and the frequencies of formats may be different from those produced by native speakers of American English, owing to complicated phonological environments such as stress, tone, pitch and intonation. To summarize,

1. The [æ] sound is pronounced differently by Mandarin speakers from that pronounced by American English speakers.
2. American English speakers' awareness of changes of phonological environment of [æ] is more sensitive than that of Mandarin speakers, causing Mandarin speakers to ignore factors that affect the sound of this vowel.

The following sections will show the [æ] sound pronounced by Mandarin speakers and American English speakers in segmental and suprasegmental environments. The discussion section will focus on how the discrepancies were and can be "detected" and on how these discrepancies can be "avoided."

METHOD

The Sample

Most of the data for this study were drawn from ten female students who passed the test given by the Ministry of Education in March 1999 and were required to take the English Pronunciation class to improve their English pronunciation. Some data were from one American female studying Mandarin in Taiwan. Some data were from the tapes and CD ROMs that went with the textbooks: *Focus on Pronunciation* and *Well Said*. The data included the [æ] sound in three phonological environments. One was from an individual word *sad* pronounced as a strong form. Another was from *cap* pronounced as a noun phrase in the sentence "The alien closer to me is wearing a baseball *cap*." The other was from *had* pronounced as a verb in the sentence "I *had* a very strong feeling that they were looking for something precious." This study was not a planned experiment, so the issues concerning age, gender, and phonological conditions like whether the vowel was followed by a voiceless or voiced consonant will not be discussed in this paper. The sound elicited for the study was limited to the vowel [æ] itself and how it was related to the vowel space plotted by the first and the second formant of the [æ] sound in the three phonological environments listed above. The [æ] sound of each situation was produced by two different groups of subjects: (1) the Mandarin-speaking subjects and (2) the American English-speaking subjects.

Data Collection and Coding

The sounds produced by the subjects were recorded on mini disks (MD) using a Sharp Model MD-MT821-S MD recording machine. The words used in this study were drawn from a passage (see Appendix I) assigned to be read by the subjects and were elicited and analyzed by the computer software *Multi-speech* and *Sonamatch*. The elicitation of the related data was designed to meet the number of tokens of the

[2] The subjects involved were either elementary school teachers or those who had passed the test and were ready to teach English in the elementary school after they finished a training program. Whether Mandarin was the subjects' mother tongue or not, they had little problem using Mandarin as the dominant language. Therefore, they were all treated as Mandarin speakers in this study.

[æ] sound sufficient for analysis in various phonological environments. The data drawn included the following environments: an individual sound read in a strong form (*sad*), a noun in the sentence (*cap*), and a verb in a sentence (*had*). Other data elicited from the tapes (e.g., *Focus on Pronunciation*) were also used as contrastive data to support the data produced by an American female.

ANALYSES AND FINDINGS

The [æ] Sound Pronounced as a Strong Form outside Context

The data of the [æ] sound was elicited from *sad*, an individual word read in a strong form. Figure 1 shows that the vowel space of the [æ] sound in *sad* produced by the Mandarin-speaking subjects is about the same as the vowel space produced by the American English speakers. It is the range of the sound movements that makes the

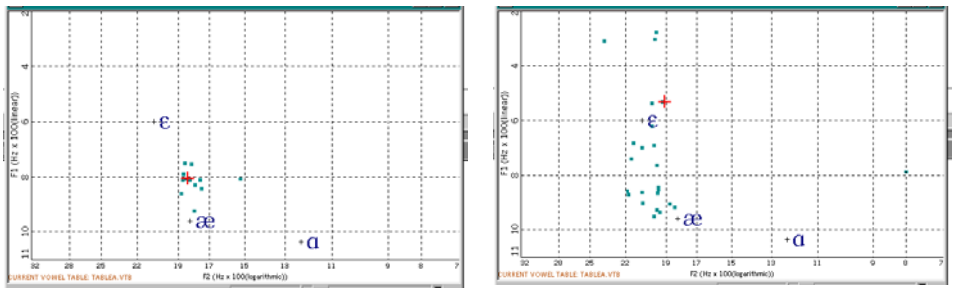

Figure 1. The vowel space produced by a Mandarin-speaking teacher (left) and an American English speaker (right).

difference. The scatterplot in Figure 2 shows how these two subjects produced the [æ] sound in different movements. The movements are plotted with different sized circles (from the small size to the large size), indicating the time when the first and the

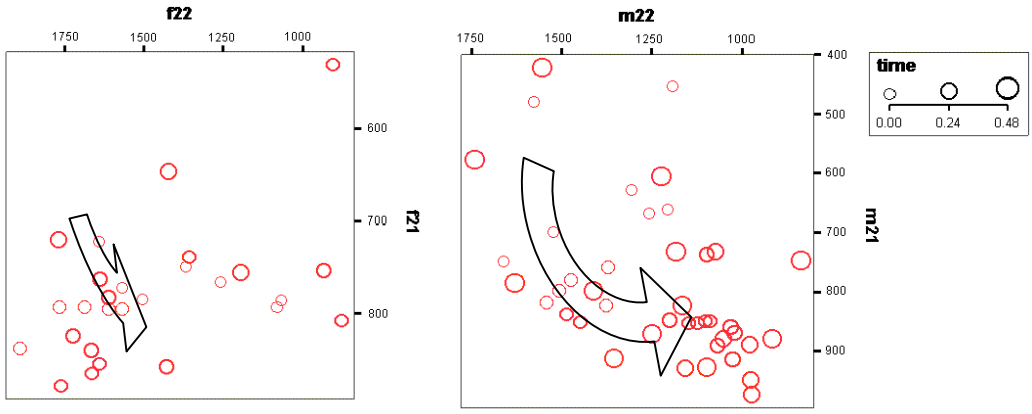

Figure 2: The formant chart shows the frequencies of the first formant (the vertical axis) against the frequencies of the second formant (the horizontal axis) and the size of circle illustrating the movement (small⇨large) along which the [æ] sound was completed by one of the Mandarin speakers (left) and one of the American English speakers (right).

second formants occurred. Compared with the American speaker, the Mandarin speakers seem to use a small area of the vowel space and short duration in producing the [æ] sound. The significant difference between the two groups of subjects is not the location of the [æ] sound, but the pattern of how this vowel was produced and the duration of the time each spent in producing this vowel. Table 1 shows that American speakers spent nearly double the time completing the sound.

Table 1. The duration of each vowel pronounced by each subject

	[æ] in *sad*	
Subjec ID	**AES**	**MS**
1	0.4525	0.1778
2	0.4016	0.3069
3		0.2854
4		0.2209
5		0.1973
6		0.1571
7		0.1881
8		0.1761
9		0.2769
10		0.2513
Average	**0.42705 sec.**	**0.22378 sec.**

The [æ] Sound Elicited from *Cap* in Context

On the other hand, the acoustic data of the [æ] sound drawn from *cap* in the sentence "The alien closer to me was wearing a baseball *cap*" indicates different vowel spaces resulting from different language users. Both American English speakers treated the [æ] sound of *cap* as a tense vowel, which almost overlaps the vowel space they used to produce the [æ] sound of the individual word *sad*. However, the Mandarin-speaking subjects treat the [æ] sound of *cap* as a lax vowel, which is located in a different vowel space from that of the [æ] sound of the individual word *sad*. Figure 3 shows that the Mandarin-speaking subjects tend to produce the [æ] sound without dropping the jaw low enough, causing the pronounced [æ] sound to be

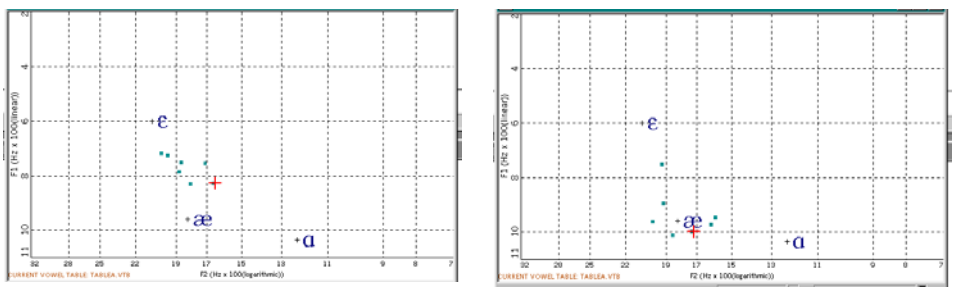

Figure 3. The [æ] in c*a*p pronounced by one MS (left) and the [æ] in cap pronounced by one AES (right).

too close to the mid range of the vowel space or as a front-low vowel rather than as a mid-low vowel. Some Mandarin speakers seemed to try to lower the jaw and tried to use the lower part of the vowel space; yet they did not lower the back part of the jaw, but only the front part of the jaw instead, causing the vowel to approach the front-low part of the vowel space. The vowel chart in Figure 4 shows how the vowel [æ] was pushed to the front part of the vowel space by a Mandarin speaking subject.

If we look at a formant chart (Figure 5) showing the relationship between the average frequencies of [æ] elicited from the word *cap* produced by two American English speakers and the average frequencies of the same [æ] produced by ten Mandarin speakers with the first formant plotted on the vertical axis and the second formant plotted on the horizontal axis, we can clearly see that since the vowel spaces used by the two groups differ, the frequencies of the [æ] sound also differ.

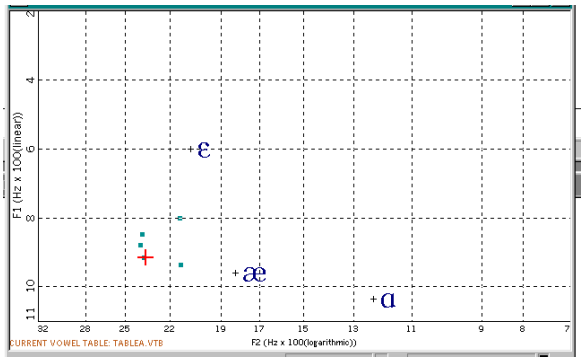

Figure 4. The [æ] sound in *cap* pronounced as a front-low vowel by another MS.

The Mandarin speakers (their average frequencies are plotted with solid squares) use the mid central vowel space while American English speakers (their average frequencies are plotted with empty squares) tend to use the relatively lower part of the vowel space.

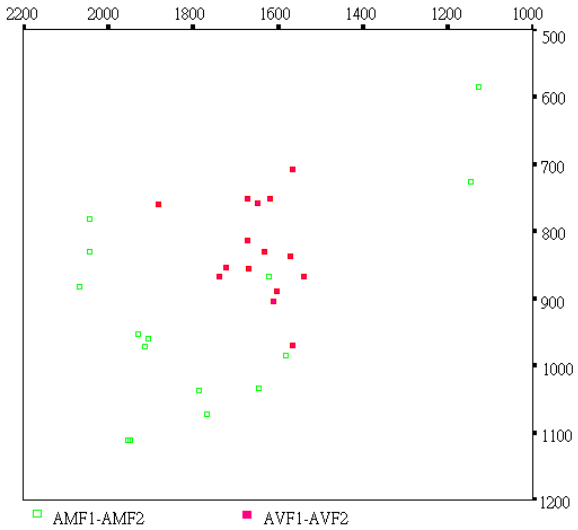

Figure 5: The relationship between the average frequencies of [æ] produced by two American English speakers and the average frequencies of [æ] produced by 10

Mandarin speakers with the first formant plotted on the vertical axis and the second formant plotted on the horizontal axis.

The formant chart showing the average frequencies of the first formant against the average frequencies of the second formant also reveals the movement along which the [æ] sound was completed. In Figures 6 and 7, the size of the circles (from the small size to the large size) indicates the time when the first and the second formants occurred. The circles in Figure 6 (left) have a clear direction of movement marked by an arrow, which says that American English speakers started from the lax vowel [ɛ], moving down toward the mid-low position and completed the [æ] sound (from 750 Hz to 1100 Hz). However, the circles in the right of Figure 6 gather in a more central area (from 750 Hz to 900 Hz) and the direction of sound movement is not as clear as the

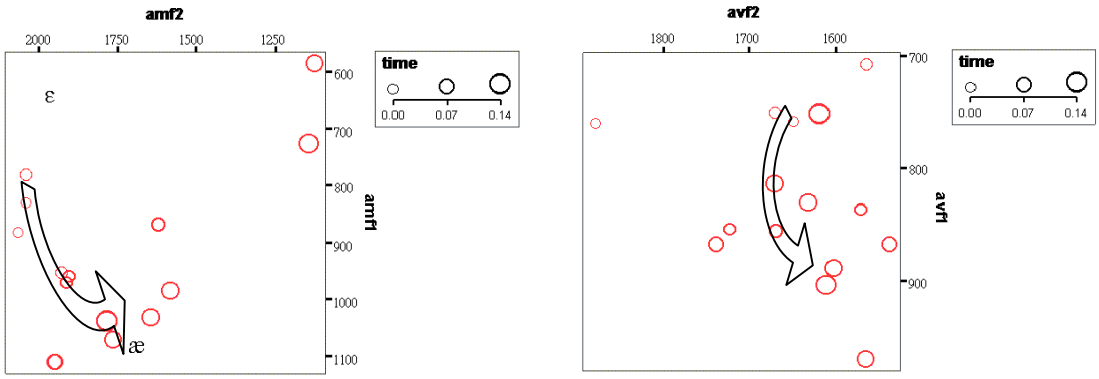

Figure 6: The formant chart shows the average frequencies of the first formant (the vertical axis) against the average frequencies of the second formant (the horizontal axis) and the size of circle illustrating the movement (small⇨large) along which the [æ] sound was completed by 2 American English speakers (left) and 10 Mandarin speakers (right).

one made by the American English speakers. This can be accounted for by the heterogeneous patterns of sound movement made by the ten Mandarin speakers. For instance, while two Mandarin speakers have entirely two opposite directions of sound movement (Figure 7), the two American English speakers share a very similar pattern

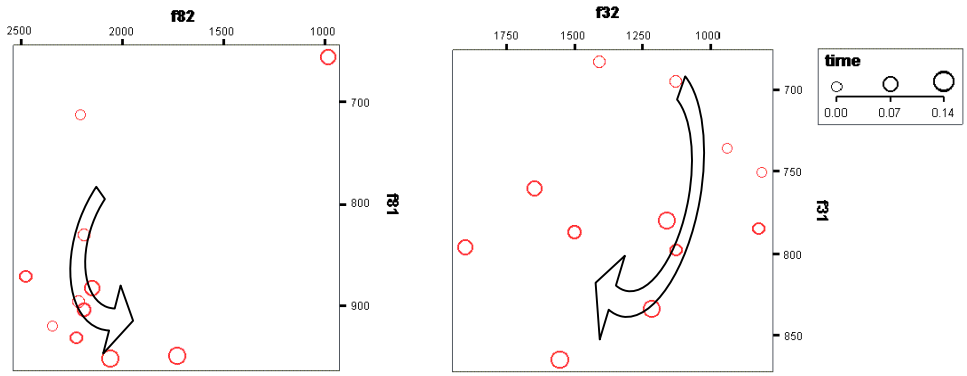

Figure 7: The formant chart showing the frequencies of the first formant (the vertical axis) against the frequencies of the second formant (the horizontal axis) and the size of circle illustrating the movement (small⇨large) along which the [æ] sound was completed by two Mandarin speakers.

of sound movement for the vowel [æ] elicited from the word *cap* (Figure 8). The eighth subject of the Mandarin speakers in this study (shown in Figure 7, left) seems to have the same pattern as what American English speakers do (Figure 8, left and right), but the range of the vowel space is very different in that the Mandarin speakers used only the space with the frequency of the first formant (the vertical axis) no more than 1000 Hz while the American English speakers used about 1100 Hz. As for the third subject (right in Figure 7) of the Mandarin speakers, she produced an opposite direction of the vowel movement, from the position of *schwa* to the front-low position. Although only two American English samples were used in this study, the agreement of the two cannot be found in any pair of the ten Mandarin-speaking subjects. This probably means that American English speakers have a better instinct in producing the proper sound to fit in different phonological environments; while Mandarin speakers do not have the same phonological intuition.

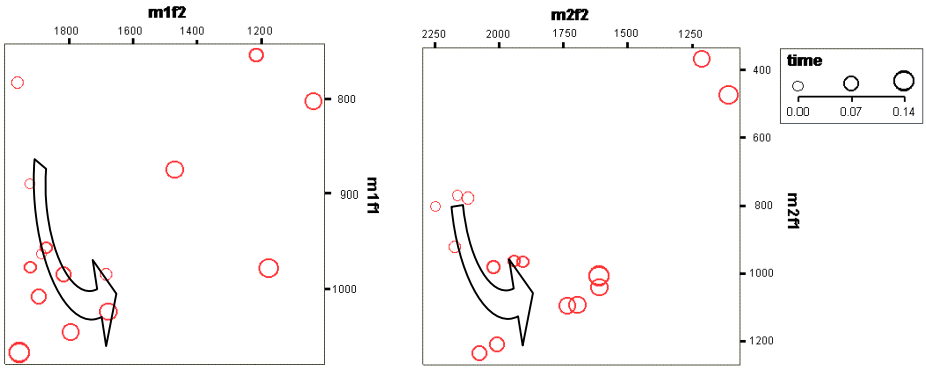

Figure 8: The formant chart shows the frequencies of the first formant (the vertical axis) against the frequencies of the second formant (the horizontal axis) and the size of circle illustrating the movement (small⇨large) along which the [æ] sound was completed by two American English speakers.

The [æ] Sound Pronounced as a Weak Form in the Text

The Mandarin speaking subjects differ from the two American English speakers in pronouncing the [æ] sound in *had* from the context "I *had* a very strong feeling that they were looking for something precious." Both American English speakers pronounced [æ] as [ɛ] while the Mandarin speakers treated it either as *schwa* or as the pattern they pronounced in a strong form (see the previous section). The relationship (in Figure 9) between the average frequencies of the [æ] produced by the two American English speakers (plotted with empty squares) and the average frequencies of the [æ] sound produced by the ten Mandarin speakers in this study (plotted with solid squares) reveal a different message from what we have seen in the previous section. In Figure 5, the data show that the American English speakers dropped their jaws lower than the Mandarin speakers so that they used a lower part of the oral space than the Mandarin speakers while producing the [æ] sound in a strong form. However, the American English speakers were both aware—and this awareness is what Mandarin speakers seem to lack—that the [æ] sound of the word *had* in the expression "I had a strong feeling that…" should not be pronounced in a strong form and accordingly pronounced it as a sound close to the lax vowel [ɛ]. Eight out of ten Mandarin speaking subjects did not seem to be affected by the changes of

phonological environments because the solid squares in Figure 5 and in Figure 8 seem to be plotted in the same area.

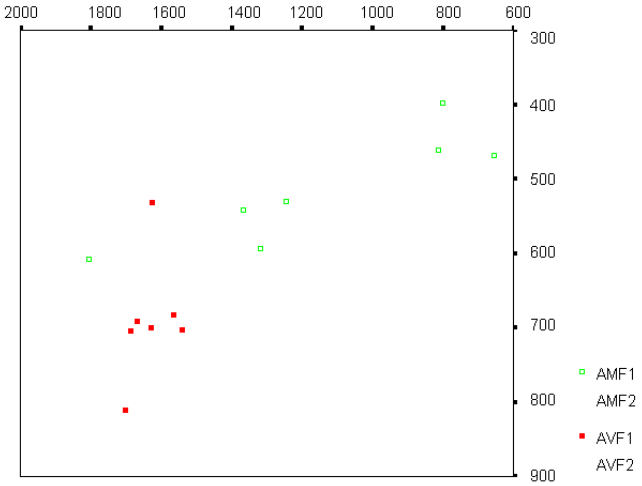

Figure 9: The relationship between the average frequencies of [æ] produced by two American English speakers and the average frequencies of [æ] produced by 10 Mandarin speakers with the first formant plotted on the vertical axis and the second formant plotted on the horizontal axis.

DISCUSSION

Acoustic data have provided plenty of information telling how American English speakers and Mandarin speakers differ in pronouncing the [æ] sound under various phonological environments. The next question that comes to all English learners is whether these findings can provide necessary assistance if the learners want to improve their English pronunciation. Although the idea of fossilization has been deeply ingrained in many second language learners, especially in acquisition of phonology, most language training programs, ironically, never seem to forget to offer a course like "orthoepy" or "English Pronunciation." Also ironically, a study (Hsieh, 1999) shows that when teachers who attended an English training program were asked to evaluate which course in their schedule was most urgent and necessary, the answer was "English Pronunciation." At the same time, they also commented that the most useless course they had attended was "English Pronunciation." If this message were understood by most non-native English teachers on this island, effective strategies to improve the English pronunciation of both the teachers and students should be and could be sought.

In fact, the analyzed data above have brought us some useful clues in terms of how [æ] should be pronounced as a strong form in an individual word:

(1) The vowel charts reveal that American English speakers tend to drop their jaws lower than Mandarin speakers, especially the back part of the jaw.
(2) American English speakers tend to move the vowel downward to the mid-low position while Mandarin speakers tend to push the vowel to the front mid-low position.
(3) American English speakers tend to have a longer duration in pronouncing [æ] than Mandarin speakers do.

When I applied these clues to my "English Pronunciation" class, I noticed that my students could greatly improve their [æ] sound.

As for how English learners can be aware of the suprasegmental properties as sensitively as American English speakers, this study does not provide much information. The only clue that can be found is that if an English learner cannot pronounce the individual sound segment well, he/she cannot handle the vowel with suprasegmental properties. On the other hand, if an English learner has managed to learn to pronounce the individual sound segment well, it still takes a great amount of practice before he/she can really fit the vowel into all different phonological environments. The suprasegmental environment, properties such as pause, syllable duration, stress, rhythm, and intonation may turn the individual sound segment into an expression that includes emotion, culture, and other registers unique to specific situations. For instance, the [æ] sound pronounced by a native speaker of American English in Figure 1 and that in Figure 3 have different qualities. The [æ] sound in "sad" (0.4016 sec.) was obviously pronounced longer than the [æ] sound in "cap" (0.1125 sec.) because the vowel before a voiced consonant is generally pronounced longer than that before a voiceless consonant (Gilbert, 1996; Lane, 1993; Tseng, 1995). In this study, the group of Mandarin-speaking subjects seem to have had problems with individual sound segments, and also with the suprasegmentals. The findings in this study may provide good strategies to help some Mandarin-speaking students or teachers improve the [æ] sound. However, these findings do not have clear information to account for how the perception and the production of the [æ] sound are interacted, though it is believed that perception and production used to be considered to go hand in hand (Tseng, 1995). Hence, these findings may need further support before they can help Mandarin-speaking students with suprasegmentals since the suprasegmetnals are found difficult for Chinese students (Guo, 2000).

Since this study was not a planned experiment, many situations are not discussed in this paper. The variables that may definitely affect the duration of vowels, such as the properties of different consonants, are not part of the data. In the following study, it is suggested that [æ], or other vowels, be collected under all types of phonological endings like voiceless stops (*lack*, *cap*), voiceless fricatives (*gas*, *lash*), voiced stop (*cab*; *had*), etc. It will be even better if minimal pairs be considered and the same materials be pronounced in context where suprasegmentals are naturally involved. The acoustic data in this situation will provide much richer information or clues for the teaching of English pronunciation.

APPENDIX I

I. Individual sounds and words formed with each sound:

1.	[iy]	s**ee**	l**ea**f
2.	[i]	k**i**ss	l**i**ve
3.	[ey]	s**ay**	r**ai**se
4.	[ɛ]	g**e**t	br**ea**d
5.	[æ]	s**a**d	**a**pple
6.	[ɑ]	f**a**r	n**o**t
7.	[ɔ]	b**ou**ght	**a**ll
8.	[ow]	n**o**	b**oa**t
9.	[ʊ]	b**oo**k	p**u**t
10.	[ɯw]	r**u**de	c**oo**l

II. Sounds in short phrases or in multi-syllable words:

11.	hot water	熱水
12.	good job	好差事
13.	a popular show	一個受歡迎的表演
14.	a lot	很多
15.	a. luck	運氣
	b. lack	缺少
	c. lock	鎖
16.	daughter-in-law	媳婦
17.	take a walk	散步
18.	a long time	很久的時間
19.	Don't lose it.	不要丟了。
20.	too old	太老
21.	do it	做
22.	cowboy boots	牛仔靴
23.	good	好的
24.	foot	腳
26.	push or pull	推或拉
27.	a textbook	一本教科書
28.	woman	女人
29.	in the woods	在森林裏
30.	a taxi cab	一部計程車
31.	fast food	速食
32.	a madman	一位瘋子

III. A passage that includes different vowels in different phonological environments:

Two Aliens

Once I saw two aliens. I was taking a walk in the woods when I saw them. They were under a tree and I believe they were looking for treasure. I'm not sure why I think that. But at the time, I had a very strong feeling that they were looking for something precious.

They were small, only three feet tall, and their skin looked like cherry. I didn't feel scared at all. The alien closer to me was wearing a baseball cap, I think. He looked at me for a minute. Then he turned to his friend and whispered something to her, and they

both started laughing. I walked over to them and started looking for treasure too. But I knew we wouldn't find any.

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