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Computer-aided assessment of tone production: A case of Zimbabwean students learning Chinese as a foreign language

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ABSTRACT

This study examined how technology can help in assessing and teaching Chinese tones to foreign students who are not used to tonal languages. It was an attempt to show how we can use the PRAAT software to make learners of Chinese as a foreign language realize their tonal errors. The data used was collected from the students at the University of Zimbabwe studying Chinese and this was part of a continuous assessment for the students' pronunciation of Chinese tones. This method which was used by teachers to assess students' tones was found to be easy to follow such that students could also utilize it for their own pronunciation practice. We argued that the use of computer-aided assessment makes assessment of students' tone acquisition lesser arbitrary than when the teacher merely gives comments based on his or her individual perception. This is because this assessment method gives PRAAT acoustic pictures which show the tone structures for each student; hence, both the student and the teacher can visualize the errors. Since PRAAT can provide a platform to compare the student's pronunciation with that of the native speaker and at the same time can help the teacher to explain why student's pronunciation is wrong, this paper concludes that PRAAT can be a useful tool in assessing and teaching Chinese tones.

Keywords: computer-aided; tone production; assessment; PRAAT; Chinese

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Introduction

Tones in linguistics refer to "pitch variations that affect the meaning of a word" (Ladefoged & Johnstone, 2011, p. 255). Yip (2002) describes tone as a linguistic term for a phonological category distinguishing two utterances. For instance, in Shona language the word /guru/ can mean big if the tones on each syllable are high and level, but it may mean the third stomach of ruminant animal if the first syllable has a low tone while the second syllable has a high tone (Dale, 1981). In Chinese language the syllable /ba/ can have different meanings depending on the tone attached to the syllable, for instance it can mean 'number 8' when it's a level tone bā (八), it can also mean 'to seize' when a rising tone is attached to the syllable bá 拔 and when it has a curving tone /bǎ/ , it will mean 'to guard' as in the word bǎ shǒu (把守). The 419 syllables in Chinese language can be inflected by the 4 tones to produce different words. This makes tone acquisition for Chinese language more challenging than in African languages like Shona where a high and low tone system is used.

According to Fromkin and Rodman (1993), it is estimated that there are more than 1000 tone languages in Africa alone; however, Hao (2009) argues that current data on tonal breakdown come from only a few languages, particularly Mandarin (Chinese), Cantonese, Thai and Norwegian. Many researchers agree to the notion that teaching tones is more difficult than teaching any other components of language since in many languages they are not well described and they are not even taught in class (Walaiporn, 2005; Tsai, 2011). For instance, in Bantu languages, though there are various tones imbedded in these languages, learners are not taught about these tones, rather tones are acquired naturally without any systematic explanation. This implies that when teaching tones to African students they might find them challenging despite the fact that their native languages are also tonal languages. In teaching of Chinese sound system, apart from teaching vowels and consonants which might be difficult to grasp, there is also a need to teach the four tones. Some students might not even be able to feel their own tonal errors, so the question that we attempt to answer in this paper is: how can we assess students' tone acquisition in a way that will allow the students to realize their errors?

This paper is based on the notion that assessing students' tone acquisition based on the teacher's personal perception might not reflect the actual challenges that students face. Many times in teaching Chinese as a second language, teachers feel that their students are making terrible errors in their tonal pronunciation; however, it is difficult to explain to them the kind of errors they are making. This is common especially when the teacher is not the first speaker of Chinese language. In this paper we propose that use of computer-aided tone assessment can help show the actual errors or challenges that the students face. Thus, an attempt will be made to present some procedures which we used to assess the tone acquisition of 15 Chinese language students at the University of Zimbabwe. Students were recorded producing syllable /ma/ with 4 Chinese tones and PRAAT software was used to analyze the pitch structure after which pictorial tone structures for each student were produced.

According to Lieshout (2003), PRAAT is a very flexible tool to do speech analysis which offers a wide range of standard and non-standard procedures, including spectrographic analysis, articulatory synthesis, and neural networks. It is a freeware software program for the analysis and reconstruction of acoustic speech signals. Thus, this makes it quite appropriate for developing countries such as Zimbabwe where many students cannot afford to spend money buying extra software programs for their computers. Though this software is normally used by linguists for speech analysis, in this paper, we propose that use of PRAAT for acoustic analysis is more useful to the language learners than it is to the linguists. Le and Brook (2011) also indicated that it is possible to use PRAAT to teach intonation to ESL students. Gorjian, Hayati and Pourkhoni (2013) also indicated that it is possible to use PRAAT Software in teaching and assessing prosodic features

of English. In this paper we agree to the view that computer-aided pronunciation provides individualized feedback automatically and instantaneously (Neri, Cucchiarini, & Strik, 2002).

Background of the research

According to Stassen, Doherty and Poe (2001), there is a need for systematic and thought-ful student learning assessment especially in higher education. The above authors also further explained that assessment in the past has focused more on issues of external accountability than on developing assessment activities that directly improve educational practices; therefore, assessment has had little effect on the teaching and learning process. In other words, developing appropriate assessment methods can also help in the teaching and learning process. Little has been written on how to assess Chinese tone acquisition in a way that helps students realize their errors; therefore, this area of research requires more exploration.

The increased number of students studying Chinese language at the University of Zimbabwe means that the time spent by teachers on assessing students' pronunciation is also reduced; this has encouraged interest in how technology can assist in this area. Therefore, this paper sought to develop a more flexible method that employs simple use of technology to assess students' tone acquisition. At the moment, teachers normally use the conventional method where they listen to the student and give their comments based on their personal perception. In this paper, it is argued that this conventional method might not be practical for a large class where the teacher does not have enough time to do the practice with the students.

Apart from the above, the Confucius Institute at the University of Zimbabwe now has 7 local trained teachers teaching Chinese language to other Zimbabweans. The challenge of teaching tones to other Zimbabweans is that sometimes the teachers though they (teachers) produce the Chinese tones fairly well but they find it difficult to explain the nature of the errors made by students. On the other hand, the students question why the teacher keeps on saying that their (students') pronunciation is not appropriate, yet they themselves feel that they have made an effort to perfect their pronunciation. In other words, tonal errors sometimes are so minute that it is difficult to describe the error by merely listening to the student's pronunciation. Since the use of PRAAT tone analysis presents the actual tone structures in a pictorial form, this helps the teacher to explain tonal errors made by students in a more detailed way, thus helping students to visualize their own errors. This paper attempted to present how use of technology can help to increase self-assessment methods.

Literature review

Much has been written on tones, for instance, Yip (2002) systematically describes tones in Chinese language. Mao (2008) stressed that for a foreigner to understand what native speakers of Chinese say he or she should have strong perception of tones. Linge (2011) also emphasized on how to teach the third tone to foreigners. It is clear that much emphasis has been on describing the nature of tones as well as on how to teach the various tones and little has been written on how we can objectively assess students' tone acquisition not to mention how students can self-assess their tone production.

A lot has also been written about student assessment and its importance, for instance, Stassen, Kathryn and Poe (2001) explored the various methods that can be used to develop course-based assessment strategies that help students learn better. Use of technology in teaching and learning is also not a new topic in language learning; researchers such as Klopfer, Osterweil, Groff and Haas (2009) described use of technology in the classroom as a more deeply-engaging learning experience. Hmard (2006) also explored how computer interaction in a web-based environment helps the learning process.

There have also been various researches on how technology can be used in assessing projects and activities. For instance, Rodemeyer, Sarewitz and Wilsdon (2005) encouraged non-governmental entities to explore alternative methods of assessment that go beyond the traditional 'analysis by expert' approach. Ely, Zwanenberg and Stirling (2011) argue that these new models of technology assessment can make a vital contribution to informing policies and strategies around innovation, particularly in developing regions.

Though these researches are not directly related to language learning, they inform us that use of technology has an important role to play in assessment. There are recent researches which attempt to apply use of PRAAT software in teaching and assessing English language such as Neri, Cucchiarini, and Strik (2002) as well as Le and Brook (2011). These authors applied PRAAT in assessing prosodic features of English language in order to give students individualized feedback automatically and instantaneously. However, to the authors knowledge, there is little (if not none), written about how to use computer-aided assessment for Chinese tones pronunciation; therefore, it is our hope that this paper will contribute both to the teaching and learning of Chinese language as a foreign language.

Theoretical framework and research questions

This paper is based on the hypothesis that assessment is a tool for teaching (Stassen, Doherty & Poe, 2001). Appropriate assessment methods can help both the teaching and learning of Chinese tones. The current conventional assessment method used for assessing students' pronunciation of Chinese tones at the University of Zimbabwe and other institutions where Chinese language is taught is quite arbitrary mainly because the teacher listens to the student and evaluates the student's tone production based on his or her own individual perception. The following questions may be raised from this traditional tone assessment method;

1. Are the teachers able to measure how far the students are from producing a closer to native speakers' tone?

2. Does the teacher's explanation of Chinese tonal error truthfully represent the students' errors?

3. How can the student self-evaluate his or her pronunciation?

In this paper, we are of the view that using the conventional assessment method described above makes it is difficult to measure the students' actual ability to produce Chinese tones. In addition, using the conventional assessment method students totally depend on the teacher's comments for their tone production assessment; hence, it is difficult to self-evaluate their own progress during extra practice at home. Also, due to the fact that apart from pronunciation assessment during normal class time and tutorial time, teachers are busy with other administrative work and are usually unable to attend to individual students' problems the assessment process become monopolistic. In

this paper, the proposed method can help students to be less dependent on teacher's assessment; thus, using their own computers, they will be able to self-evaluate their tone acquisition during their individual practice time. It is also our hope that this computer-aided assessment method will help teachers to develop a less arbitrary assessment method.

Methodology

The data for this research were collected as part of tone acquisition assessment for University of Zimbabwe first year students studying Chinese as a foreign language at the University of Zimbabwe. Fifteen first year students aged between 20 and 24 were recorded producing the syllable [ma] with the four Chinese tones and results were analyzed using PRAAT software. All the participants had passed Chinese Proficiency Test level 2, which means they were able to use simple Chinese phrases. We recorded one native speaker of Chinese language producing the syllable [ma] with the four Chinese tones, and used PRAAT grid picture for his tones production as the base for comparison with those of the learners. Results were then used to explain the challenges that students were facing. Students could also compare their own tone structures with that of the native speaker of Chinese. Below are the simple procedures we followed for the tone assessment process.

Recording process

Great care was placed on recording since wrong recordings could distort the tone assessment. During recording, a Toshiba computer, a new microphone and PRAAT software were used. We recorded the sounds using PRAAT, on the upper part of the PRAAT software page, on the second option after the word PRAAT, there is an option titled 'New' that allows one to select mono recording in order to avoid capturing outside noises. All the recordings were done in the language laboratory during lunch hours to minimize noise from other students. At the bottom of the page, there is an option for recording and title of the sound to be recorded with a default name 'untitled', in order to avoid mixing up students' recorded audios; before recording, we would then substitute the word 'untitled' with the name of the student.

During recording, each student would be given 2 chances to read out the 4 Chinese tones using the syllable /ma/ so as to avoid pronunciation bias due to participant's low voice or poor sound quality caused by body movement and unstable breathing. After this, the audios were saved to the PRAAT software by clicking the option 'Save to list' and then later saved into the computer by clicking the option titled 'Write to Wav' which is available on the option titled 'Write' on top of the PRAAT page. All recorded samples which were kept in wave format were saved in labeled students' individual folders and a backup file was also kept in a separate portable storage drive just in case of computer crush. (See appendix 1 for a pictorial representation of the step by step recording process). After the recording process which took about 40 minutes for all the 15 first year students, we went on to do an acoustic analysis.

Acoustic analysis procedures

The acoustic analysis followed a simple procedure where wave audios would be imported to PRAAT and annotated to text grid, thus producing a text grid file. Then by simultaneously selecting

the original sound as well as the textgrid file and clicking the edit option a textgrid picture showing tone structures in blue lines would then pop up. For a detailed pictorial presentation of the step by step acoustic analysis, see appendix 2. Below are the results for this PRAAT assessment.

Results and Analysis

The analysis of 15 students' tone production showed that all of the participants had almost similar challenges in differentiating the second and third Chinese tones. For the first and fourth tone, the participants could produce both tones well though some PRAAT pictures which showed that the tone values were not exactly like those of the native speaker. Since the students' tone production challenges were almost similar, so, for the purpose of data presentation in this paper, we selected PRAAT pictures for 5 students who had unique tone production errors. We selected five samples only in order to avoid presentation of too many PRAAT pictures with similar pitch contours. Below are the five samples from the results of our computer-aided assessment which show pitch contours for the syllable [ma] produced with the 4 Chinese tones. The pitch contours are the actual tone structures which can help us to explain the student's error in tone production. The first tone grid picture is for the native speaker of Chinese language, which was used as the basis for comparison.

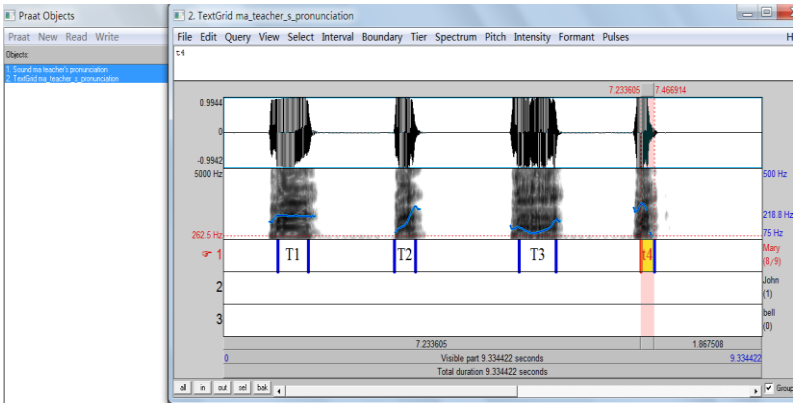

Figure 1: Native speaker's tone structure

The above texgrid picture for the native speaker's tone structure shows T1, which represents the first tone in Chinese language and it is level and high as marked by the blue line. T2 represents second tone. As can be seen from the picture, the tone line rises from low up to the high level clearly equal with the level tone. T3 represents the Chinese's third tone and as can be seen from the blue line it is a curving tone, falling and rising again just to above the level of the first loop. T4 represents the forth tone Chinese. It is a falling tone and as can be seen on the dotted blue line it falls from the highest level as that of the highest point of the second tone falling up below all the other tones. The PRAAT tone picture for the native speaker of Chinese clearly showed the tone patterns as those described by Zhou (1990). According to Zhou, the tones for standard Chinese

follow a four-pitch contour system. The following table is a detailed description of Chinese tones adapted from Zhou's book titled Chinese Phonology.

Table 1

Description of Chinese 4 tones

Tone number	Tone value	Tone pattern	Tone mark
First tone	55	High level tone	–
Second tone	35	rising tone	/
Third tone	214	low-falling-rising tone	V
Fourth tone	51	Falling tone	\

The tone marks used here are the same as the tone structures that we see on the PRAAT picture's blue lines on the native speaker's tone structure picture above. The tone structure picture for the native speaker was then used as the basis for comparison with the students' tone structures as shown in the following PRAAT pictures.

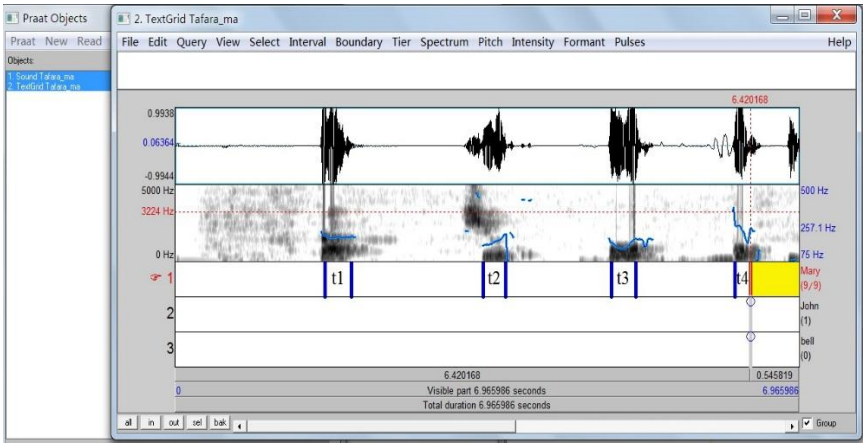

Figure 2: Tone structure for Student A

Student A managed to produce the first and the second tones almost like the native speaker. As can be seen on the PRAAT picture above, the level tone is at the highest level equal to the highest point of the rising tone. However, this student's curving tone (t3) had equal loops suggesting that it was not yet as perfect as that of the native speaker. The student could not produce the falling tone appropriately since the falling tone (t3) could not fall down below all the other tones. The student was encouraged to practice the third and the forth tones. For the third curving tone, the student is not supposed to raise his pitch too much at the beginning of the syllable and for the fourth tone this student seems to be producing a very short vowel; thus, the student was encouraged to continue practicing the release of air that allows his pitch to fall from high to lower level. Generally, the student's tone production was fair; the errors shown on PRAAT pictures above cannot be perceived by merely listening to the speaker, and these are the cases where the teachers feel the student's pronunciation is not perfect, yet he/she cannot explain clearly what is wrong with the tone or what should be done.

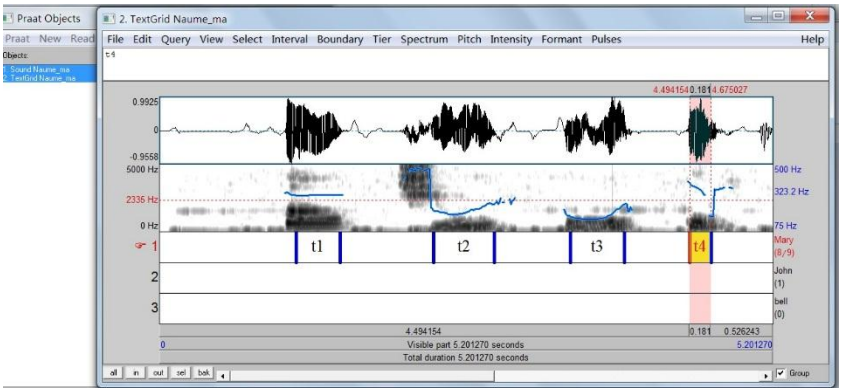

Figure 3: Tone structure for Student B

Student B managed to produce T1 appropriately but for T2, T3 and T4 the student still needed more practice. From the PRAAT pictures it was possible to see that the student could not differentiate the second and the third tones where the student would produce the first part of the syllable as a low-level tone and a slight rise at the end. For the fourth tone, the student was not able to release the air enough to make the pitch fall below the other tones' lowest levels. Therefore, this student was encouraged to work more on differentiating the second and the third tones; the student was supposed to avoid low lying pitch for the second tone, by practicing a rising pitch right from the beginning of the syllable. For the third tone, it was almost similar to that of the native speaker but it was apparent that the student could not lower the pitch enough to produce a near-native tone. For the falling tone, the student was advised to continue practicing the release of air that allows his voice to come to rest.

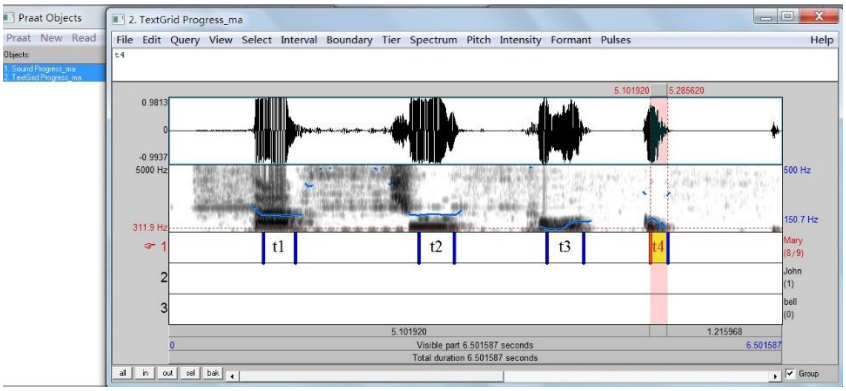

Figure 4: Tone structure for Student C

Student C managed to produce the first tone well; however, as can be seen from the T2 slot, the student's second tone which was supposed to be a rising tone was a level tone, so the student was encouraged to practice more how to produce this rising tone. The student is supposed to be taught how to raise the pitch from the beginning of the syllable. The third tone was a clearly curving tone as it is supposed to be; however, after a closer look and comparison with the native speaker's curving tone, it was noted that the student's pitch was so low that the listeners might not discern that it is a curving tone. This student requires drills on how to avoid producing too low pitch. The student's falling tone was exactly like that of the native speaker falling from a high level to the lowest point suggesting that the student had no problems with this tone.

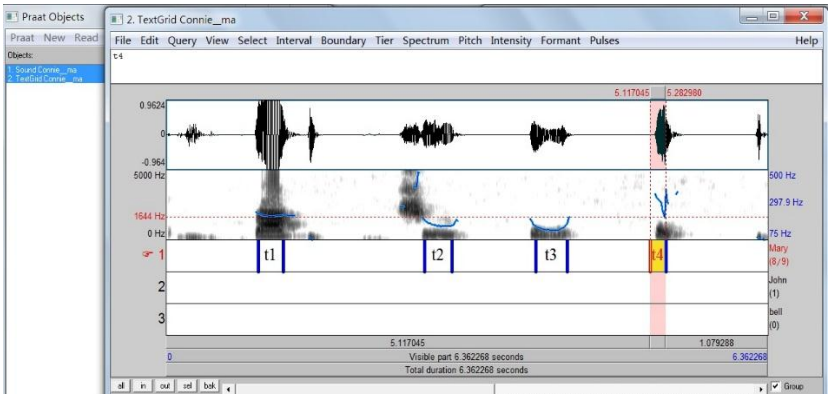

Figure 5: Tone structure for Student D

Student D like the other students managed to produce the first level tone without any problem; however, the student could not differentiate between the second and third tone. Though the student's falling tone clearly shows a falling line on the PRAAT picture, it was not similar to the one shown on the native speaker's PRAAT picture because the line did not fall below the other tones. This shows that this student's pronunciation is not the standard Chinese tone as the one suggested by Zhou (ibid) with a tone value that falls from level 5 to level 1.

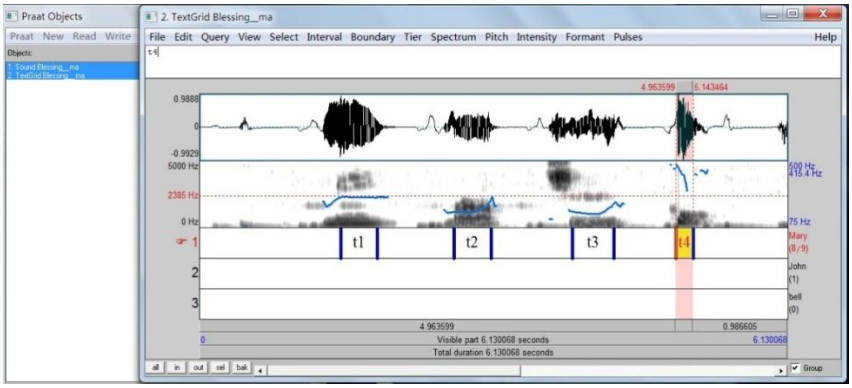

Figure 6: Tone structure for Student E

Student E like all other students could produce the first level tone, but T2 and T3 which are supposed to be a rising tone and a curving tone, respectively, looked the same. Student E like Student D could not produce a standard falling tone. Both Student D and student E required similar pronunciation drills to help them differentiate between the rising tone and curving tone; they also required to practice how to produce a tone that falls up to low levels.

Discussion

Through the use of PRAAT, the teachers were able to identify the tone patterns for University of Zimbabwe students, it was clear that almost all of the students could produce the level tone without any challenges; however, the majority could not differentiate between the rising tone and falling tone. This was quite helpful as it informed the teaching strategies required, students required drills to help them produce the second tone with a rising pitch that does not begin as a low lying level tone. Using this method of assessment, both the teacher and students will be informed on what to work on, so they can start working on new teaching and learning strategies. Unlike in the conventional assessment method where the teacher might not be able to give a clear description of the students' errors, through computer-aided tone assessment method, the teacher will be able to see why the students' pronunciation do not sound like that of the native speaker. This suggests that this computer-aided assessment method contributes to the teaching of Chinese tone.

The use of computer-aided assessment method showed that it was possible to identify students' minute tone production challenges which might be difficult to discern through merely listening to

the student's pronunciation as is the case in the conventional assessment method. It is a method that allows both the evaluator and the evaluated to see the results in picture form; thus, reducing the arbitrariness of the conventional method where the teacher listens and evaluates the student. Moreover, this assessment method keeps records for students' progress so that it will be possible to check if the student is making any progress, a method that helps to avoid fossilization. According to Jinan (2011), fossilization refers to the process in which incorrect language becomes a habit and cannot easily be corrected; it stops the students from realizing his errors; thus, the student's pronunciation will never improve. It was concluded that use of PRAAT as an assessment tool contributes to the teaching of Chinese tones because it helps both the teacher and student to see the pronunciation errors in picture form thus allowing the students to realize their errors.

Conclusion

Through the use of this computer-aided tonal assessment method, we were able to describe students' errors with a better point of reference than in the conventional method. With the help of PRAAT software program, it was possible to see the tone structure for each student; that way, both students and teachers could visualize the error, and as a result, teachers could explain students' errors more objectively. PRAAT software has its own limitations; for instance, it does not go beyond showing students' errors, it does not provide explanation to the errors. Also, it is noise sensitive; as a result, if a sound is recorded under noisy environment the result might not reflect the actual tone structure. However, from the results of this assessment project, we were convinced that it is an effective tone assessment method that can help both teaching and learning Chinese tones.

As already noted; PRAAT acoustic analysis has many functions, such as analyzing and reconstructing acoustic speech signal. As a result, it is possible to use this software in other areas of language assessment and teaching. However, in this paper, we showed the use of PRAAT for tone production assessment only. As Gorjian, Hayati and Pourkhoni (2013) already noted that it is possible to use PRAAT Software in teaching and assessing prosodic features of English, it is our hope that future researches will attempt to show whether PRAAT can also be used in teaching and assessing prosodic features of other foreign languages.

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Appendix 1: Pictorial presentation of the recoding process

Step 1

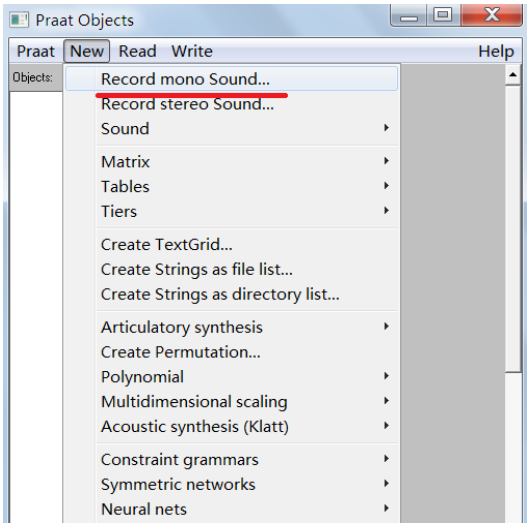

Figure 1: Selecting recording options

Step 2

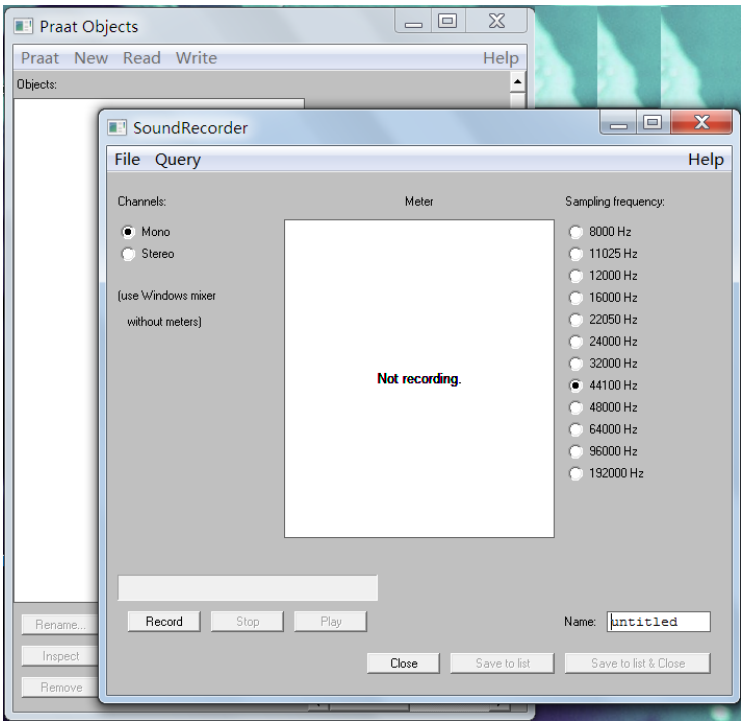

Figure 2: Select sampling frequency

After selecting mono stereo recording mode and sampling frequency of 44100 then give a title of the sound in the section written labeled "Name:".

Step 3

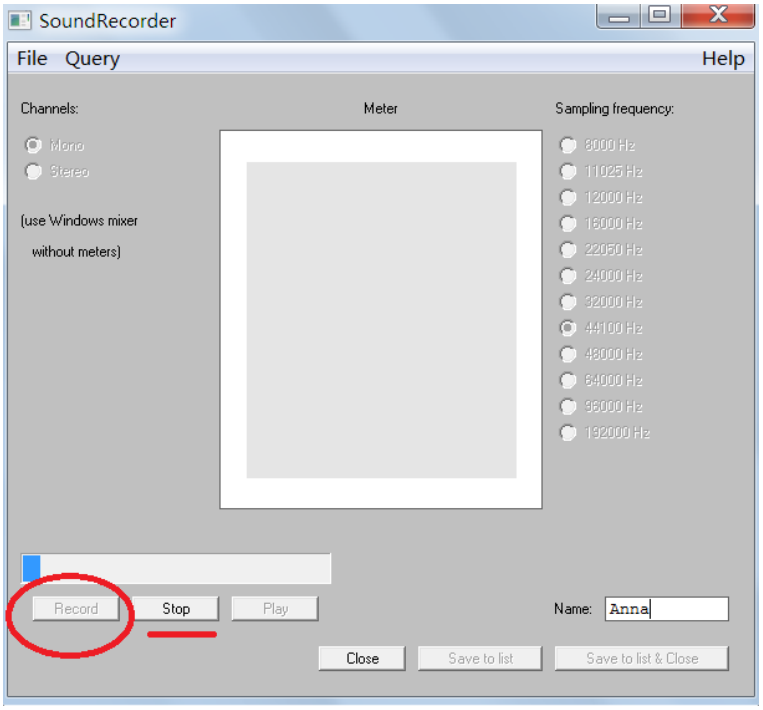

Figure 3: Start recording

After giving a title to the sound sample click "record" to start recording and click "stop" just after the last syllable is produced to avoid capturing a long sound wave which might be difficult to analyze.

Step 4

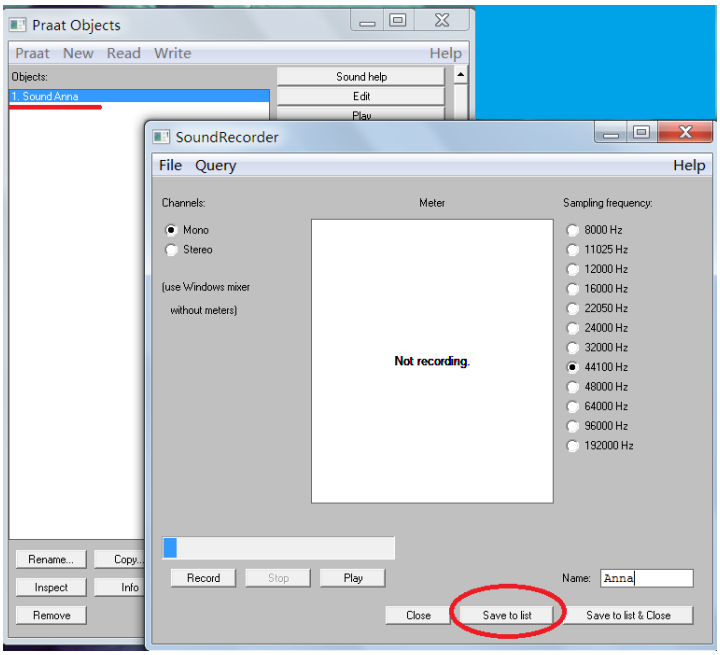

Figure 4: Saving the file

Then save the sound wave to the PRAAT software by clicking on the option "Save to list", but if there are other sounds to be recorded, if there are no more sounds to record click the option "Save to list & Close**"**. If the PRAAT software is closed after this stage all recorded sounds will be lost, so the next step is important to complete the recording process.

Step 5

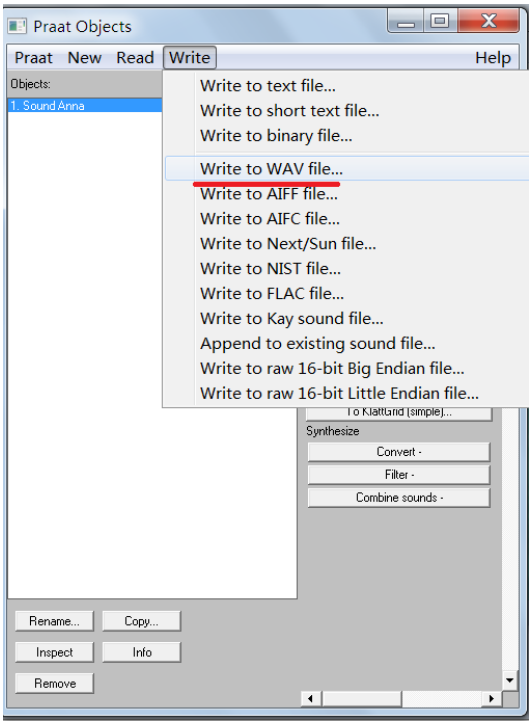

Figure 5: Select file format

Click "Write to Wav file" option as shown above to save the file into the computer so that the file can be accessed in future. It is advisable to create folders on the desktop where the files can be easily accessed for further acoustic analysis.

Appendix 2: Step by step pictorial procedure for Acoustic analysis

Below is a step by step procedure which was followed to produce PRAAT pictures;

Step 1

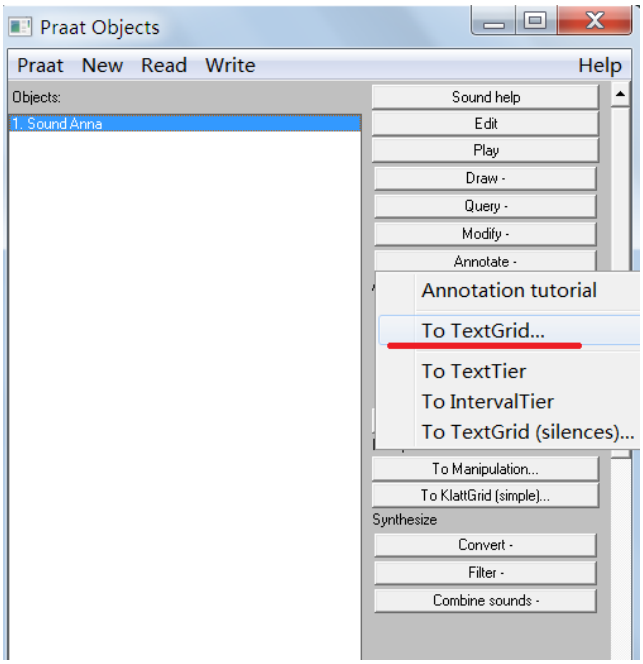

Figure 6: Annotating imported file

Import the saved files by clicking the option "Read" and then "Read from file", this will allow you to select the audio to be analyzed. After importing the audio, click the option "Annotate", then select the option "To TextGrid" and the following picture will appear.

Step 3

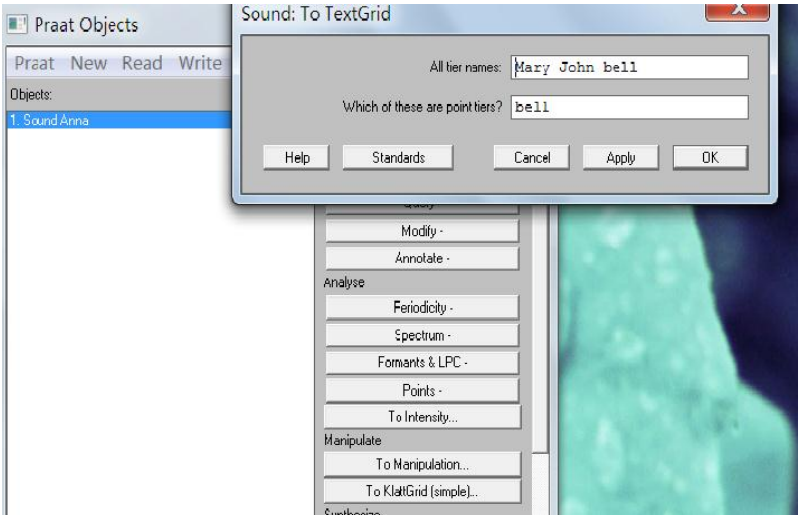

Figure 7: Text grid settings

Click "Ok" or "apply" without changing anything then a textgrid for the sound will appear below the original sound wave as shown below.

Step 4

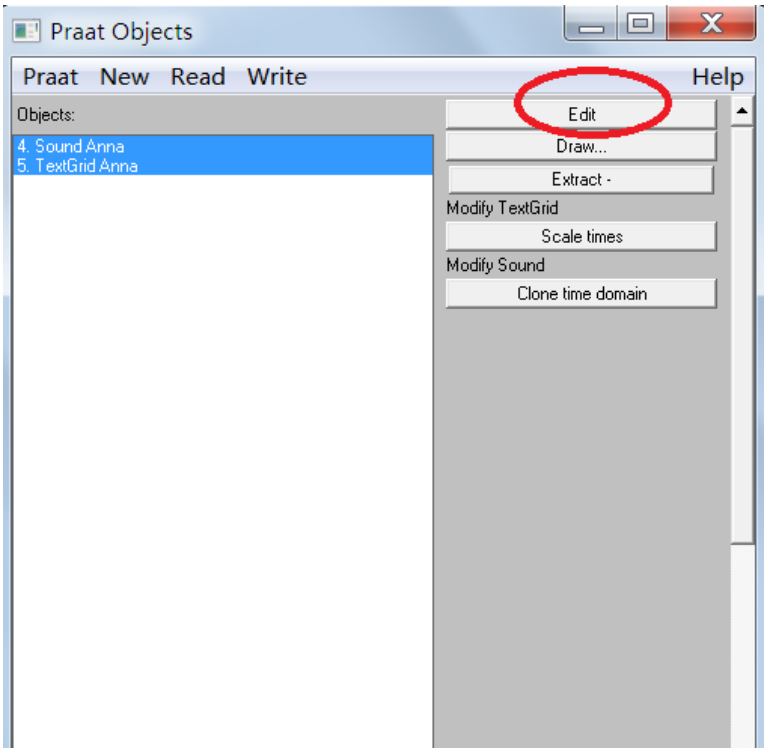

Figure 8: Producing the tone structure pictures

The last step is to simultaneously select the original sound and the textgrid file by holding down the control key on the keyboard and clicking on the sound and textgrid sound, then click "Edit" and a texgrid picture will appear which shows tone contours in blue lines as shown below;

Step 5

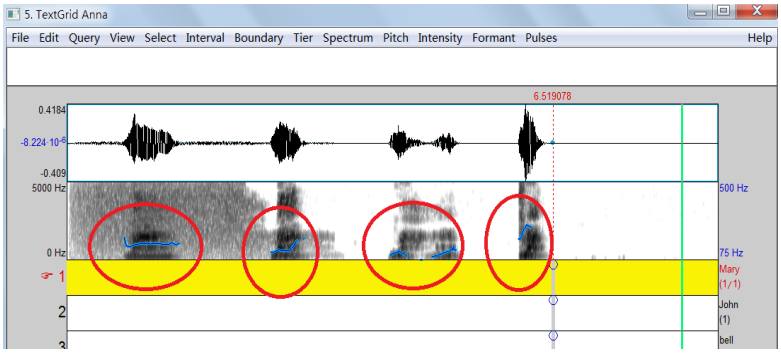

Figure 9: Final tone structures pictures

In the above pictorial texgrid, a level tone, rising tone, curving ton and another rising tone are shown in the circled blue lines.

Appendix 2: Students' profile for the 5 students

	Sex	age	Chinese proficiency level
Student A:	male,	21 years	HSK3
Student B:	Female	22 years	HSK 3
Student C:	Male	24 years	HSK 3
Student D:	Male	20 years	HSK 2
Student E:	Female	20years	HSK2