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Analysis of Tone Pronounciation in Beginner-Level Students of Mandarin Language Education Program at Semarang State University (UNNES) Using PRAAT Program Assistance

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Keywords

Mandarin Language, PRAAT, Tone Frequency.

Abstract

Mandarin Chinese is one of the languages that uses a tonal system, errors in tone pronunciation can lead to differences in meaning. Pronunciation differences can be directly perceived by experts, but with the advancement of technology today, detailed differences can be observed through sound processing programs or applications. This study uses PRAAT as an auxiliary sound processing tool, which can display pitch curves of voices and show the frequencies used to analyze tone pronunciation. The subjects of this study are undergraduate students from the class of 2024 of the Mandarin Language Education program at UNNES, at the beginner level. The study uses a descriptive quantitative approach, with the tone pronunciation analysis results of native speakers used as a comparison to the students' tone pronunciations. Data collection techniques in this research include observation, recording field notes, and documentation. The results of this study show that 19.19% of students pronounced tone 1 with a rising frequency, 22.7% of students pronounced tone 2 with a low frequency difference, making it sound similar to tone 1, and more than 93% of students pronounced tone 4 with a high frequency spike. This research is expected to provide a reference for developers of technology-based language learning applications to improve pronunciation analysis features. In addition, it is hoped that this research can contribute to the field of phonetics and serve as a reference for similar studies.

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INTRODUCTION

The role of language in social life is considered highly important because language is the primary tool of communication. All ideas, expressions, intentions, and purposes are conveyed through language (Abdussamad, 2022). For a country, language is not only a means of communication but also a form of culture, a national identity, and a medium for international cooperation. The lifting of restrictions on Chinese cultural practices in Indonesia in 2000 is regarded as a turning point in the diplomatic relations between Indonesia and China (Sutami, 2016). The diplomatic relations between the two countries have since developed rapidly, creating numerous job opportunities where proficiency in Mandarin is a key qualification (Kinanti, 2016).

Mandarin is one of the languages that has a tonal system (Li et al., 2021). The role of tone in Mandarin is to distinguish the meanings of syllables (Fitria et al., 2022). If a tone is pronounced incorrectly, even with the same pinyin, it can result in a completely different meaning and character. Therefore, pronunciation becomes a primary aspect in communicating using a foreign language—not just mastery of vocabulary and correct grammar usage (Yovita, 2020).

In her research on the changes in pitch contour inflection timing in Mandarin Chinese, Lailatul found that 95.8% of fourth-semester Mandarin language learners in the Chinese Studies Program at UAI experienced difficulty mastering tones in Mandarin. Additionally, 75% of students confused the second and third tones, and 66.7% had difficulty completing tone differentiation tests. This is due to the minimal frequency differences, proving that not all tonal pronunciation differences can be heard directly, as each tone begins with a relatively brief rising or falling pitch (Qadriani & Budianingsih, 2021). Therefore, a sound analysis application is needed so that tone differences can be visualized more clearly. In her study, Lailatul used the PRAAT application as a tool to observe tone differences in more detail. Furthermore, she utilized PRAAT's tone manipulation feature to generate sound stimuli. This demonstrates that the PRAAT program can display tone variations in greater detail.

PRAAT is one of the sound processing programs that can directly record audio and break it down into a detailed spectrogram, as well as generate graphs to visualize the results (Heryono, 2019). PRAAT can only be installed on desktop computers and is not yet available for use on Android devices (Nasution & Syarfina, 2023). In addition, PRAAT can differentiate sound waves, generate pitch curves from speech, and display sound frequencies (Narhan et al., 2023). Moreover, PRAAT is available for free as an open-source program, yet it remains user-friendly for researchers without a background in technology, making it one of the most suitable programs for linguistic research (Styler, 2013).

The PRAAT program is capable of measuring the rise in speech frequency in language (Rahmatunisa & Syarifudin, 2021). In relation to this, the researcher initiated a study using the PRAAT program entitled "Analysis of Tone Pronunciation in Beginner-Level Students of Mandarin Language Education Program at Semarang State University (UNNES) Using PRAAT Program Assistance". The use of PRAAT in this

research is to assist in analyzing the frequency changes in each Mandarin tone so that the tone pronunciation of the research subjects can be compared to recordings by native speakers. Native speakers are individuals who have acquired the language as their first language since childhood and possess a very high level of language proficiency, typically at an advanced level (Rothman et al., 2019). Therefore, recordings by native speakers are used as a comparison, as they are considered the standard for pronunciation (Widya & Agustiana, 2020). The native speakers in this study are four Mandarin native speakers, whose frequency analysis results will be compared with the analysis results from the students.

This study is expected to assist Mandarin language instructors in identifying the similarities between beginner-level students' tone pronunciation and that of native speakers. It also aims to broaden the perspectives of Mandarin learners and readers in understanding the frequency rise in each Mandarin tone. Additionally, the study seeks to introduce PRAAT as an alternative tool for analyzing tonal

variations in Mandarin. In the field of phonetics, this research is expected to make a meaningful contribution and serve as a reference for future studies on similar topics.

METHOD

This study employs a descriptive quantitative approach. The descriptive approach is used to illustrate speech phenomena based on the tonal frequency changes produced by native speakers and beginner-level students. The characteristics of quantitative research include the use of numerical data and statistical analysis to identify patterns and significance, resulting in objective and generalizable findings (Syahza, 2021). In this study, numerical data are obtained through measurements of frequency changes using the PRAAT program, allowing the data to be analyzed and compared in a measurable manner.

RESULTS AND DISCUSSION

1. Measurement Result on Native Speakers

The result of the tone frequency change analysis on native speakers are presented in table 1:

Table 1. Results of Measurement Analysis on Native Speaker

Data	Tone	Initial Frequency	Curve Point	Final Frequency	Frequency Change	
Male Native Speaker 1 (MNS 1)	Tone 1	148.28 Hz	-	144.8 Hz	3.48 Hz	-
	Tone 2	111.46 Hz	-	177.96 Hz	66.5 Hz	-
	Tone 3	121.8 Hz	82.58 Hz	112.31 Hz	39.32 Hz	29.72 Hz
	Tone 4	160.67 Hz	-	90.37 Hz	70.3 Hz	-
Male Native Speaker 2 (MNS 2)	Tone 1	160.26	-	161.96	1.7	-
	Tone 2	78	-	189.57	111.57	-
	Tone 3	100.19	69.68	92.58	30.51	22.9
	Tone 4	192.9	-	129.07	63.83	-
Female Native Speaker 1 (FNS 1)	Tone 1	298.74 Hz	-	323.8 Hz	19.2 Hz	-
	Tone 2	184.36 Hz	-	304.2 Hz	119.9 Hz	-
	Tone 3	174.93 Hz	156.1 Hz	186.1 Hz	43.9 Hz	32.2 Hz
	Tone 4	408.76 Hz	-	352 Hz	64 Hz	-
Female Native Speaker 2 (FNS 2)	Tone 1	262.78 Hz	-	323.99 Hz	25.25 Hz	-
	Tone 2	187.34 Hz	-	287.11 Hz	102.75 Hz	-
	Tone 3	179.84 Hz	148.1 Hz	177.12 Hz	18.83 Hz	21.02 Hz
	Tone 4	303.71 Hz	-	337.59 Hz	71.17 Hz	-

In the analysis of the third tone, a curve point appears due to Tone 3 being a dipping tone (Xiqiang Xiao, 2020). Across all four sources, it was found that the frequency change in Tone 3 shares a common pattern: the frequency drop is greater than the frequency rise. This pattern will serve as the standard for Tone 3 pronunciation. Based on Table 1, the initial frequency of each tone spoken by native female speakers differs by no more than 110 Hz, whereas male native speakers have a lower starting frequency, with the highest difference exceeding 200 Hz. However, the frequency changes of the tones across the three sources show no significant differences. This proves that regardless of how low a person's voice is, the pronunciation will still be accurate as long as it remains within a safe frequency change range.

The pronunciation range of native speakers is as follows:

- Tone 1: 1.7–25.25 H

- Tone 2: 66.5–119.9 Hz
- Tone 3: 18.83–43.9 Hz
- Tone 4: 63.83–71.7 Hz

These frequency ranges from native speakers will be used as a benchmark to compare the frequency changes of each tone in students.

2. Meassurement Result on Students

The students in the data are first-year students from the 2024/2025 academic year. Based on direct listening, many students have already mastered tone pronunciation, particularly for individual tones. However, after being analyzed using the PRAAT program, several tones showed nearly identical frequency patterns, even though each tone should have distinct frequency change characteristics. The comparison of tone frequency changes between students and native speakers is presented in Table 2 below:

Table 2. Comparison of Tone Frequency Changes Between Students and Native Speakers

Tone	Subject	STFC		NSFCR	S/NS	Tone	Subject	STFC		NSFCR	S/NS
1	Subject 1	17		1.7-25.25	S	1	Subject 23	0.24		1.7-25.25	TS
2		65.2		66.5-119.9	TS	2		36.26		66.5-119.9	TS
3		87.6	109.9	18.83-43.9	TS	3		-41.62	85.46	18.83-43.9	TS
4		266		63.83-71.7	TS	4		143.34		63.83-71.7	TS
1	Subject 2	8.7		1.7-25.25	S	1	Subject 24	4.58		1.7-25.25	S
2		53.1		66.5-119.9	TS	2		62.7		66.5-119.9	TS
3		21.3	40.9	18.83-43.9	TS	3		91.25	141.88	18.83-43.9	TS
4		46.7		63.83-71.7	TS	4		88.3		63.83-71.7	TS
1	Subject 3	2.5		1.7-25.25	S	1	Subject 25	29.07		1.7-25.25	TS
2		88.2		66.5-119.9	S	2		29.27		66.5-119.9	TS
3		86.02	143.72	18.83-43.9	TS	3		29.83	51.11	18.83-43.9	TS
4		129.2		63.83-71.7	TS	4		104.71		63.83-71.7	TS
1	Subject 4	4.6		1.7-25.25	S	1	Subject 26	2.37		1.7-25.25	S
2		22.1		66.5-119.9	TS	2		104.97		66.5-119.9	S
3		84.4	56.5	18.83-43.9	S	3		52.38	132.31	18.83-43.9	TS
4		108.8		63.83-71.7	TS	4		116.09		63.83-71.7	TS
1	Subject 5	4.1		1.7-25.25	S	1	Subject 27	19.72		1.7-25.25	S
2		37.4		66.5-119.9	TS	2		59.56		66.5-119.9	TS
3		36.4	59.5	18.83-43.9	TS	3		51.01	85.42	18.83-43.9	TS
4		90.5		63.83-71.7	TS	4		77.74		63.83-71.7	TS
1	Subject 6	21.1		1.7-25.25	S	1	Subject 28	15.82		1.7-25.25	S
2		62.6		66.5-119.9	TS	2		103.42		66.5-119.9	S
3		45	76.1	18.83-43.9	TS	3		40.83	102.08	18.83-43.9	TS
4		133.2		63.83-71.7	TS	4		131.59		63.83-71.7	TS
1	Subject 7	6.92		1.7-25.25	S	1	Subject 29	34.75		1.7-25.25	TS
2		29.52		66.5-119.9	TS	2		102.52		66.5-119.9	S
3		34.3	46.26	18.83-43.9	TS	3		201.9	260.65	18.83-43.9	TS
4		66.58		63.83-71.7	S	4		152.73		63.83-71.7	TS
1	Subject 8	13.01		1.7-25.25	S	1	Subject 30	12.57		1.7-25.25	S
2		60.78		66.5-119.9	TS	2		11.74		66.5-119.9	TS
3		40.63	72.75	18.83-43.9	TS	3		46.88	95.57	18.83-43.9	TS
4		99.2		63.83-71.7	TS	4		61.49		63.83-71.7	TS
1	Subject 9	22.92		1.7-25.25	S	1	Subject 31	2.64		1.7-25.25	S
2		100.74		66.5-119.9	S	2		60.99		66.5-119.9	TS

Tone	Subject	STFC		NSFCR	S/NS
3		49.16	95.44	18.83-43.9	TS
4		139.42		63.83-71.7	TS
1	Subject 10	8.13		1.7-25.25	S
2		109.16		66.5-119.9	S
3		58.32	88.76	18.83-43.9	TS
4		115.09		63.83-71.7	TS
1	Subject 11	16.55		1.7-25.25	S
2		27.13		66.5-119.9	TS
3		113.39	137.4	18.83-43.9	TS
4		164.48		63.83-71.7	TS
1	Subject 12	2.33		1.7-25.25	S
2		38.53		66.5-119.9	TS
3		212.72	204.91	18.83-43.9	S
4		118.19		63.83-71.7	TS
1	Subject 13	5.05		1.7-25.25	S
2		28.52		66.5-119.9	TS
3		76.92	136.42	18.83-43.9	TS
4		29.66		63.83-71.7	TS
1	Subject 14	1.09		1.7-25.25	S
2		72.33		66.5-119.9	S
3		100.36	152.95	18.83-43.9	TS
4		109.8		63.83-71.7	TS
1	Subject 15	6.84		1.7-25.25	S
2		12.37		66.5-119.9	TS
3		21.41	15.34	18.83-43.9	S
4		19.46		63.83-71.7	TS
1	Subject 16	38.53		1.7-25.25	TS
2		111.61		66.5-119.9	S
3		81.26	112.59	18.83-43.9	TS
4		108.84		63.83-71.7	TS
1	Subject 17	1.83		1.7-25.25	S
2		119.1		66.5-119.9	S
3		110.31	170.03	18.83-43.9	TS
4		83.23		63.83-71.7	TS
1	Subject 18	13.15		1.7-25.25	S
2		99.25		66.5-119.9	S
3		56.44	131.65	18.83-43.9	TS
4		157.51		63.83-71.7	TS
1	Subject 19	11.93		1.7-25.25	S
2		42.98		66.5-119.9	TS
3		16	33.82	18.83-43.9	TS
4		76.02		63.83-71.7	TS
1	Subject 20	5.32		1.7-25.25	S
2		43.83		66.5-119.9	TS
3		31.42	39.77	18.83-43.9	TS
4		74.16		63.83-71.7	TS
1	Subject 21	0.85		1.7-25.25	TS
2		74.41		66.5-119.9	S
3		128.13	158.85	18.83-43.9	TS
4		86.02		63.83-71.7	TS
1	Subject 22	1.99		1.7-25.25	S
2		21.12		66.5-119.9	TS
3		144.87	125.42	18.83-43.9	S
4		38.38		63.83-71.7	TS
1	Subject 32	7.24		1.7-25.25	S
2		76		66.5-119.9	S
3		104.28	142.56	18.83-43.9	TS
4		119.67		63.83-71.7	TS
1	Subject 33	14.62		1.7-25.25	S
2		58.86		66.5-119.9	TS
3		33.67	60.44	18.83-43.9	TS
4		106.39		63.83-71.7	TS
1	Subject 34	40.81		1.7-25.25	TS
2		125.51		66.5-119.9	TS
3		51.92	62.65	18.83-43.9	TS
4		133.57		63.83-71.7	TS
1	Subject 35	1.65		1.7-25.25	S
2		65.87		66.5-119.9	TS
3		141.35	143.8	18.83-43.9	TS
4		80.3		63.83-71.7	TS
1	Subject 36	0.29		1.7-25.25	TS
2		97.67		66.5-119.9	S
3		59.4	73.42	18.83-43.9	TS
4		102.01		63.83-71.7	TS
1	Subject 37	2.55		1.7-25.25	S
2		32.16		66.5-119.9	TS
3		42.13	83.49	18.83-43.9	TS
4		40.42		63.83-71.7	TS
1	Subject 38	12.28		1.7-25.25	S
2		143.75		66.5-119.9	TS
3		125.46	255.11	18.83-43.9	TS
4		173.08		63.83-71.7	TS
1	Subject 39	15.14		1.7-25.25	S
2		65.46		66.5-119.9	TS
3		102.8	131.4	18.83-43.9	TS
4		74.59		63.83-71.7	TS
1	Subject 40	4		1.7-25.25	S
2		44.66		66.5-119.9	TS
3		112.13	154.22	18.83-43.9	TS
4		117.78		63.83-71.7	TS
1	Subject 41	0.07		1.7-25.25	TS
2		55.5		66.5-119.9	TS
3		31.15	85.6	18.83-43.9	TS
4		72.24		63.83-71.7	TS
1	Subject 42	2.91		1.7-25.25	S
2		25.67		66.5-119.9	TS
3		153.56	155.23	18.83-43.9	TS
4		128.83		63.83-71.7	TS
1	Subject 43	8.06		1.7-25.25	S
2		22.72		66.5-119.9	TS
3		88.82	96.56	18.83-43.9	TS
4		44.66		63.83-71.7	TS
1	Subject 44	9.48		1.7-25.25	S
2		49.61		66.5-119.9	TS
3		130.23	161.93	18.83-43.9	TS
4		96.27		63.83-71.7	TS

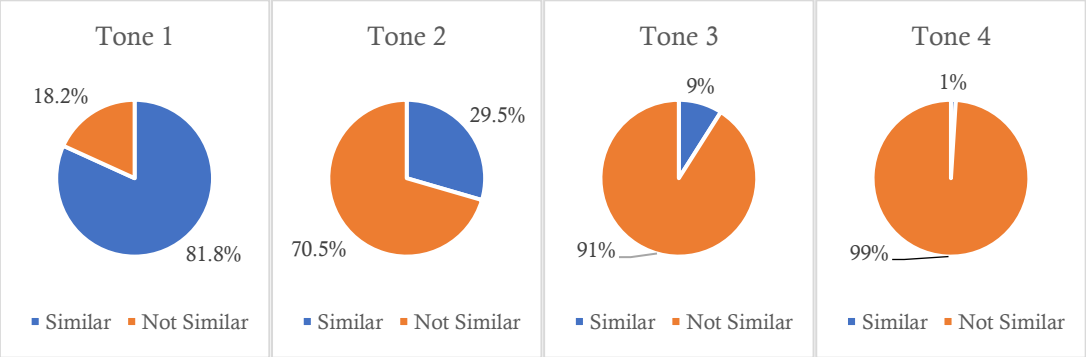
**Stfc students tone of frequency change*

Nsfcr native speaker frequency change range

S/NS similar/not similar

The percentage of students whose pronunciation similarity that of native speakers is presented in more detail in Diagram 1:

Diagram 1. Precentage of Students Pronounciation Similarity



Several students pronounced tone 1 with a rising intonation, resulting in a tone frequency pattern that closely resembles tone 2, as shown in Figures 2 and 3 below:

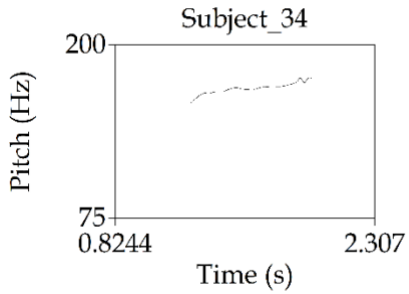


Figure 2. Students Tone 1 Pronounciation

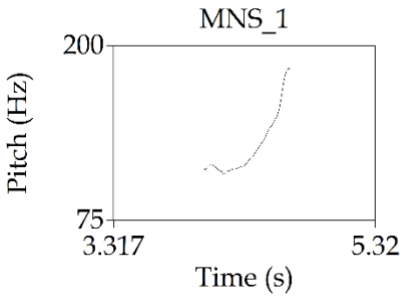


Figure 3. Native Speakers Tone 2 Pronounciation

The frequency change produced by subject 34 when pronouncing tone 1 was 40.81 Hz, which differs by 25 Hz from the native speaker's pronunciation of tone 2. An excessively large frequency change in tone 1 results in an unstable pronunciation, causing the tone contour to rise and closely resemble tone 2. Nevertheless, 81.8% of the students were able to maintain tone stability, resulting in a tone 1 pronunciation similar to that of native speakers.

The pronunciation of tone 2 by native speakers shows a greater frequency change compared to other tones, with a rising range of 66.5–119.9 Hz. However, 70.5% of students produced tone 2 with a weak rise, making its contour appear similar to tone 3. The differences in the pronunciation of tones 2 and 3 between native speakers and students are illustrated more clearly in figures 4 and 5 below:

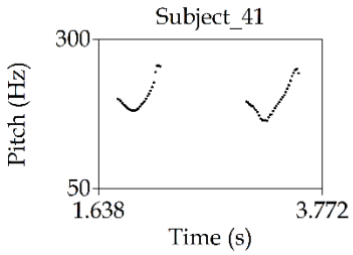


Figure 4. Comparison of Tone 2 and Tone 3 in Students

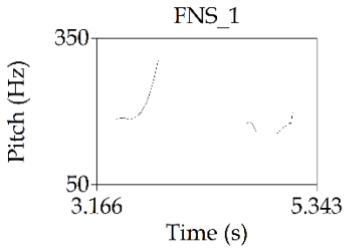


Figure 5. Comparison of Tone 2 and Tone 3 in Native Speakers

From the figures, it can be observed that there is a significant difference in the rising pattern of tone 2 between students and native speakers. The characteristic of tone 2 pronunciation by native speakers involves a long rising intonation, resulting in a steep upward contour on the graph. In contrast, students tend to pronounce tone 2 with a shorter rise. Only 29.5% of the students produced a tone 2 pronunciation similar to that of native speakers.

Tone 3 is a dipping tone, characterized by a falling and then rising pitch. However, in the pronunciation of tone 3 by native speakers, the falling portion of the tone shows a greater frequency change than the rising portion.

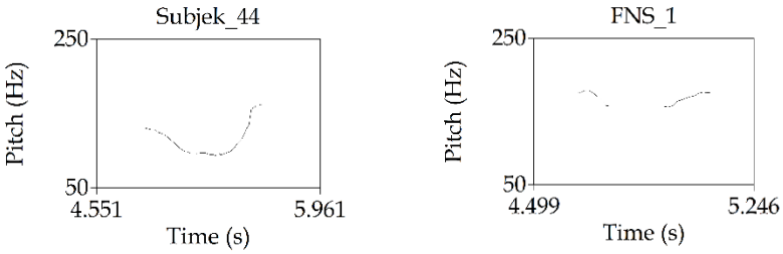


Image 6. Comparison of Tone 3 Between Students and Native Speakers

Based on the comparison image of tone 3 pronunciation by students and native speakers above, it can be seen that the rising part of the tone in students is longer than the falling part—opposite to the pattern observed in native speakers. A total of 91% of students pronounced tone 3 with a longer rising tone, meaning only 9% of the students produced a tone 3 pronunciation consistent with that of native speakers.

Contrary to the common assumption that tone 4 involves a large frequency change due to its sharp, forceful nature, the analysis of native speakers' tone 4 pronunciation shows a frequency range of only 63.83–71.7 Hz. Only 1% of students produced tone 4 within the same range as native speakers. Over 99% of the students pronounced tone 4 with excessive force or started at a pitch level higher than 5 (the

maximum tone level), resulting in sharp frequency spikes ranging from 117.78 to 266 Hz. For further clarification, a comparison of tone 4 pronunciation between students and native speakers is presented in figure 7.

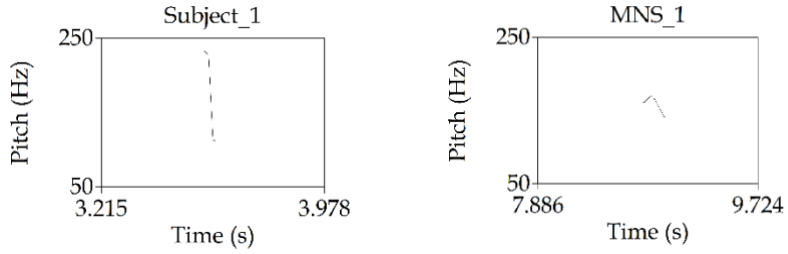


Figure 7. Comparison of Tone 4 Between Students and Native Speaker

Based on the analysis above, first-year students demonstrated the highest accuracy in pronouncing tone 1, with 81.8% producing pronunciations similar to native speakers. Tone 1 is a level tone, and stable pronunciation is essential for it to be perceived correctly. In the analysis of tone 2, students generally struggled to produce the long rising intonation characteristic of native speaker pronunciation. As a result, only 29.5% of students achieved a rising tone within a range similar to that of native speakers. The majority of students pronounced tone 3 with a longer rising phase after the dip, as opposed to the native pattern where the falling phase is more prominent. Only 9% of students produced tone 3 in a manner similar to native speakers. tone 4 is a falling tone that should be pronounced with a sharp drop. However, the drop should remain within a controlled range to sound natural in conversation. Only 1% of students were able to pronounce tone 4 with good control, avoiding an overly forceful drop in frequency.

The results above are still within a reasonable range, as learning is a process whose outcomes are not immediate but develop gradually. Pronunciation mismatches of tones by beginner-level students are quite likely to occur because Mandarin language learners require step-by-step stages in learning, which in turn affect their pronunciation outcomes (Wulan, 2015). However, if pronunciation inaccuracies are not identified early in the learning process, the development of students' skills may be hindered, and it could take a long time to progress to the next level. Mistakes in language learning are very likely to happen, but such errors can be minimized to ensure that learning objectives are achieved (Selviana, 2021).

CONCLUSION

This study reveals a significant difference between the frequency changes in tone pronunciation by beginner-level students and native speakers, particularly in tones 3 and 4. Measurements using the PRAAT program indicate that beginner students often struggle to maintain accurate tone pronunciation. The rising part of tone 3 is frequently pronounced longer than the falling part, whereas

ideally, the rise after the curve point in tone 3 should be brief. Meanwhile, tone 4 tends to be pronounced with a forceful drop, resulting in an excessively large frequency change.

In addition, the study found that beginner-level students are generally more successful in mastering tone 1 (level) and tone 2 (rising), while accuracy in tones 3 and 4 requires more intensive practice. These findings suggest that pronunciation errors among beginner students are largely due to difficulty in controlling pitch variation within short time spans.

The results of this study demonstrate that the PRAAT program is effective as a learning aid in Mandarin tone instruction, as it provides visual feedback that helps students objectively and measurably identify and correct tone errors. Therefore, the continued use of PRAAT is recommended as part of Mandarin pronunciation training at the beginner level.

This research also shows that the variation in single-tone frequency changes directly affects pronunciation accuracy. These changes can serve as a reference for Mandarin instructors in evaluating student pronunciation compared to native speakers, helping to inform teaching strategies for tone pronunciation at the beginner level. Additionally, this study may serve as a reference for future researchers interested in exploring similar topics.

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