

Divergent places of articulation: [w] and [v] in modern spoken Mandarin

Seth Wiener and Ya-ting Shih¹
The Ohio State University

This sociophonetic study examines the production of the modern spoken Mandarin voiced labial-velar approximant /w/ in isolation and zero initial environments. Acoustic analyses of ten native Mandarin subjects' productions reveal that some speakers produce /w/ as both [w] and [v]. The environments in which [w] and [v] appear suggest that this variation may be allophonic, conditioned by the syllable nucleus. Furthermore, our results show evidence of regional and gender variation: northern female Mandarin speakers produce [v] in more contexts and more frequently than speakers from other regions.

1. Introduction

Throughout the world's languages approximants occupy a nebulous phonetic status. Beginning with Ladefoged's first use of the term in his *Phonetic Study of West African Languages* (1964:25), phoneticians have differed in how best to classify approximants within a phonetic inventory (Martinez-Celdran 2004). Even by IPA Handbook standards, approximants lack a well defined status reserved for seemingly more clear-cut categories such as stops and fricatives (International Phonetic Alphabet 1999). Because approximants are produced with one articulator close to another, yet without turbulent airflow, this "approximation" of manners further confounds how best to characterize the speech production, leading some phoneticians to prefer the name glides or semi-vowels (Stevens 1998).

The labial velar approximant /w/ is one of the more challenging approximants, primarily due to its co-articulation; some phonological descriptions do not classify /w/ as both a labial and velar even though both places of articulation are involved in the phonetic production (Ohala and Lorentz 1977). The problem of /w/ becomes even more complicated with respect to Standard Mandarin. Sinologists differ on everything from its place of articulation to its role within a syllable. Traditionally /w/ has been classified as part of the final (medial) position (Cheng 1973), but more recent views of the syllable structure place this approximant in the onset as a consonant-glide cluster (see Lin 2007

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and Duanmu 2007). Norman (1988) considers /w/ a labial voiced continuant, grouping it as part of the onset. Li and Thompson (1981) disagree and view /w/ not as an initial but rather as part of the vowel nucleus or the rime. Duanmu (2005) considers it a variation of one of three underlying high vowels which behaves as a glide in certain contexts.

Thus the disagreement of whether /w/ is part of the onset or rime in Chinese syllables depends on one's view of the Mandarin syllable. Yip (2003) and Wan and Jaeger (1998) have suggested that while the glide /w/ is generally considered part of the rime, secret languages, which break apart the syllable, actually treat the glide /w/ as part of the onset. The issue of classifying /w/ is actually a taxonomic assessment. As Ohala and Lorentz (1977) point out, there may be instances when one classification as a velar is appropriate, another instance when classification as a labial is appropriate and even a third instance when classification as both is the most appropriate choice. The same can be said for classification of /w/ as part of the onset or part of the rime.

Given the phonetic debate surrounding the Mandarin labial velar approximant, there is good reason to explore the phonological realization of /w/ across speakers. Previous studies have suggested that the labiodental approximant [ʋ] serves as a non-phonemic variant along with [w] (Shen 1987, Chan 1996). Shen's study examined a large group of over 400 speakers within Beijing and the surrounding areas. The findings strongly suggest that [ʋ] is more likely to be produced with a less rounded vowel nucleus and with the alveolar nasal [n] coda. Shen concluded that speakers who produced [ʋ] share three traits: they are younger, higher educated and female.

Given that over twenty years have passed since Shen's 1987 study, the present research aims to build on Shen's important findings in three ways. First, Shen relied exclusively on transcription and visual observation of the speakers' mouth shape (lip rounding). The present study utilizes acoustic analysis in order to present a more objective set of results less prone to human error. Second, Shen only analyzed spontaneous speech of eight Mandarin syllables. The present study examines additional modes of production as well as a previously omitted ninth syllable type. Finally, while Shen's study looked at over 400 speakers, all the speakers were concentrated within Beijing and its surrounding areas. The present study, while much smaller in the total number of speakers, examines speakers from throughout China.

Our study shows that despite the passing of time since Shen's (1987) study, females continue to produce [ʋ] more than males. Furthermore, the production context – reading versus spontaneous speech – does not affect the production of [ʋ]. Additionally, we find that [ʋ] is a northern regional, possible dialectal variation, which extends beyond the Beijing area. Finally our findings suggest that [ʋ] serves as a possible allophonic variant of /w/ for some speakers similar to Shen's findings but not across all of Shen's predicted vowel nuclei. This production can be thought of as a process of approximant dentalization conditioned by certain vowel contexts.

The paper is organized as follows: Section 2 highlights the relevant acoustic differences between [w] and [ʋ]; Section 3 outlines the methodology of the study; Section

4 presents the results; Section 5 offers a discussion of the findings; Section 6 concludes the paper.

2. Acoustic Characteristics

The articulation of /w/ varies depending on the following vowel (Ladefoged, 2006). In Mandarin /w/ appears only as the onset (or medial glide) in the following phonetic contexts:

Table 1. Examples of the 9 Legal Mandarin syllables with /w/

Pinyin	IPA	English Gloss	Character
wǒ	/wo/	I/me	我
wǔ	/wu/	five	五
wēng	/wəŋ/	Weng surname	翁
wèn	/wən/	to ask	问
wèi	/wei/	because of	为
wàng	/wɑŋ/	to forget	忘
wǎn	/wan/	night	晚
wài	/wai/	outside	外
wá	/wa/	doll	娃

Since approximants are often coarticulated, both Ladefoged (2006) and Stevens (1998) have characterized their formant structure as regularly changing. This change can be seen in numerous manifestations, but primarily approximants are responsible for lowering all formants. Stevens (1998:518) calculates the average F1 of male speakers producing /w/ before high vowels at 255 Hz (245 Hz for females) and at 293 Hz for males before non-high vowels (291 Hz for females). Given that approximants' formants are as difficult to quantify as approximants themselves – there are no steady states without a vowel – it is crucially the second formant which offers the most telling characteristics. Lower F2 frequencies are often indicative of approximants, especially in the case of the lip-rounding involved in the production of /w/ (Ladefoged 2006).

Figure 1 below illustrates both the malleability of the approximant /w/ in terms of its ability to resemble the subsequent vowel as well as the lowering of F1 and F2 (first and second formant line). All recordings were productions from a native Beijing Mandarin female speaker who produced /w/ as [w]. The formant measures were taken at the transitional point from onset to vowel using a Praat script (Boersma and Weenink 2011). As the formants show, /w/ significantly lowers the second formant when compared with both the bilabial plosive /p/ and the labiodental fricative /f/, which lack such lip rounding.

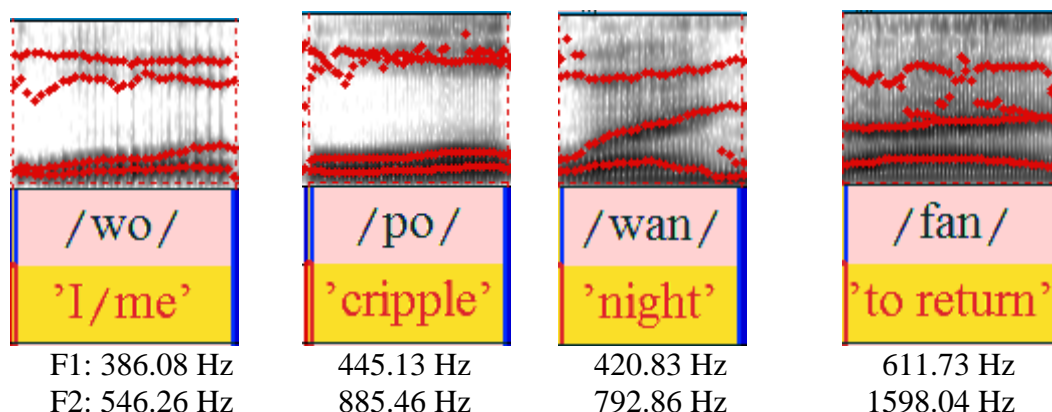


Figure 1. Spectrograms of Mandarin syllables juxtaposing the approximant onset /w/ with the bilabial plosive /p/ and the labiodental fricative /f/ (with F1 and F2 in Hz)

Furthermore, approximants are produced with a narrow vocal tract constriction. Here an important distinction must be made between the constriction of an approximant and a constriction which allows a turbulent airstream like a fricative (Martinez-Celdran 2004). As Stevens (1998:519) has pointed out, this results in a lowering of F1 frequency (as seen above in Figure 1) and reduced spectrum amplitude in F1. Bickley and Stevens (1986) and Espy-Wilson (1987) calculate a lowering of 5 to 10 dB for /w/. Figure 2 below illustrates this drop in spectral amplitude with the labial velar approximant /w/ clearly dipping in dB (left-hand side) when compared with labiodental fricative /f/ (right-hand side). This slight dip in intensity represents approximately a 5 dB difference between the approximant and the fricative from the onset transition to the vowel. Measurements were taken from production of the onset to the transition into the nucleus.

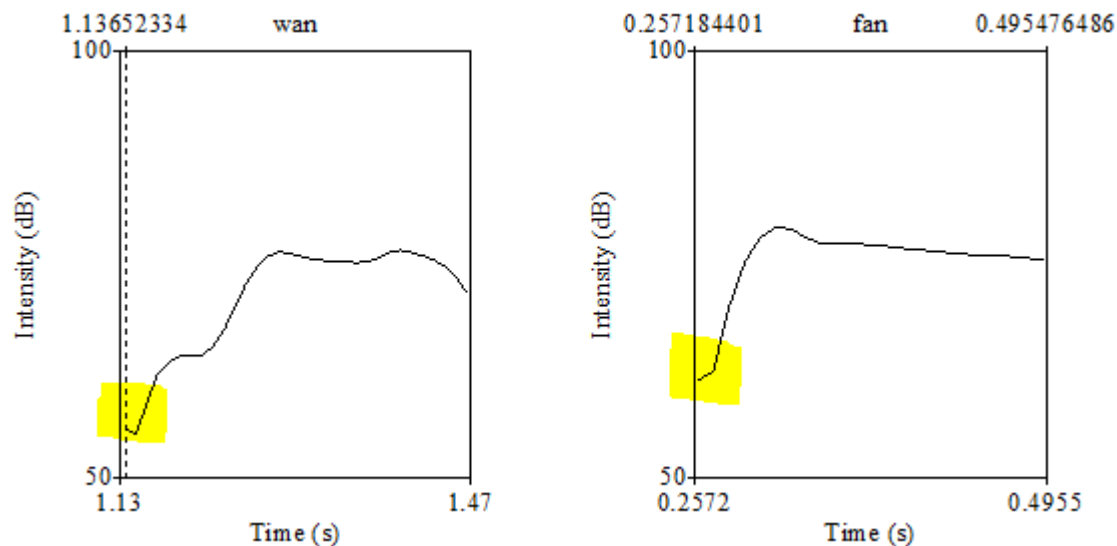


Figure 2. Spectral intensity measurements (in dB) of /wan/ from *wan* ‘evening’ on the left and /fan/ from *fan* ‘to return’ on the right

Since both [w] and [ʋ] are approximants, the lowering of spectral intensity can not alone be used as acoustic evidence to argue for one phoneme over the other. Therefore, the present study will only rely on the most salient acoustic cue: approximants with lip rounding result in F2 lowering. Dissimilarity in formant height (primarily F2) should be robust enough to suggest which approximant was produced. To test this hypothesis, the following production experiment was carried out.

3. Methodology

In order to make use of the aforementioned acoustic cue, the researchers designed a word list containing /w/ in the zero initial position. By combining all possible syllable and tone combinations, 32 target syllables were selected (see appendix for full research instrument). These targets were then placed within a fictional story. The story varied the location of the syllables across sentences; the 32 target syllables were embedded in Mandarin words and put into a paragraph for a total of 41 tokens. Nineteen follow-up content questions were created based on the paragraph. As a result, three specific speech tasks were used to elicit spontaneous speech and speech from reading. First, the subjects were asked to read aloud the paragraph containing the 41 targeted syllables. After reading the paragraph, participants were then asked to answer questions based on the paragraph. The questions were created to elicit the target syllables in a more informal and natural context. Subjects produced approximately 60 spontaneous tokens. Finally, the subjects were asked to read the 32 target syllables in isolation. The entire process took approximately ten minutes and yielded, on average, 120 tokens.

Each subject was tested individually in a quiet room. Recordings were made with a handheld digital Edirol recorder with a built-in microphone, which was placed on the desk in front of them. The sampling rate for the wav recorder was 44.1 kHz. Digital recordings were saved onto a PC and analyzed using the PC program Praat.

In total, 10 native Mandarin speakers (3 male, 7 female) were recruited from a major mid-west university in the United States. The subjects were drawn from northern, central and southern Mandarin speaking regions in China (see appendix for speaker information). The subjects were all graduate students who had been in the United States for less than four years at the time of the experiment.

In order to analyze the data, all of the recordings were first cut into three sound files based on their production contexts – paragraph, questions and wordlist. Each file was further cut into the individual tokens of interest to the study. Sounds which were unclear, produced incorrectly or too heavily influenced by the surrounding words were discarded. A total of 1,183 tokens were analyzed.

The tokens were first transcribed by a native Mandarin speaker. Each token was identified as having either an [w] or [v] initial. These transcriptions were also verified by an advanced non-native Mandarin speaker in order to ensure accuracy. The transcriptions were only used as a guide to organize the data analysis. In order to draw a more objective conclusion regarding the production of [w] or [v], each token was further annotated using Praat textgrids in order to identify the onset and nucleus. In doing so, the token was demarcated from the beginning of the /w/ onset to the transition into the nucleus, but before the coda. This approximately 0.3 second segment was used to extract the average F1 and F2 over the course of the token. A Praat script was used which performed short-term spectral analysis on approximately 40 frames. The average F1 and F2 of every token was output into a text file which was then analyzed using the statistical computing program R (Bell Laboratories 2010).

4. Results

The aforementioned linking assumption that the production of /w/, an approximant which involves lip rounding, will lower F2, was used as the primary acoustic cue to distinguish the production of [w] and [v] (Ladefoged 2005). Figure 3 below shows the clear difference between two speakers' production of the same segment /wən/ 'to ask'.

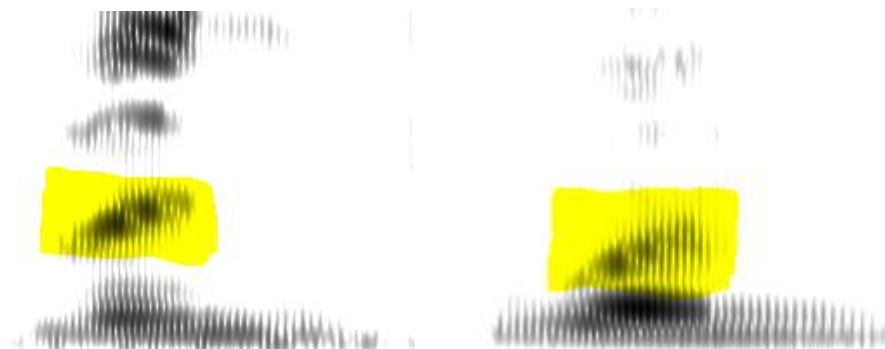


Figure 3. Spectrograms of [vən] (left) and [wən] (right) highlighting the lowering of F2.

Our results show that among the 10 speakers, only two female subjects – Subject 2 and Subject 9 – regularly produced /w/ as [v] in multiple vowel contexts. These two subjects’ productions of /w/ most often resulted in [v] as shown by the divergence in average F1 and F2 when compared with other speakers producing the same token. Two other female speakers – Subject 1 and Subject 4 – produced a restricted number of tokens as [v]; however, the majority of their production was [w].

Figure 4 shows the average F2 results of one of the [v] speaker’s tokens (Subject 2) collapsed across all three production contexts as compared with one of the [w] speaker’s tokens (Subject 8) collapsed across all three production contexts.

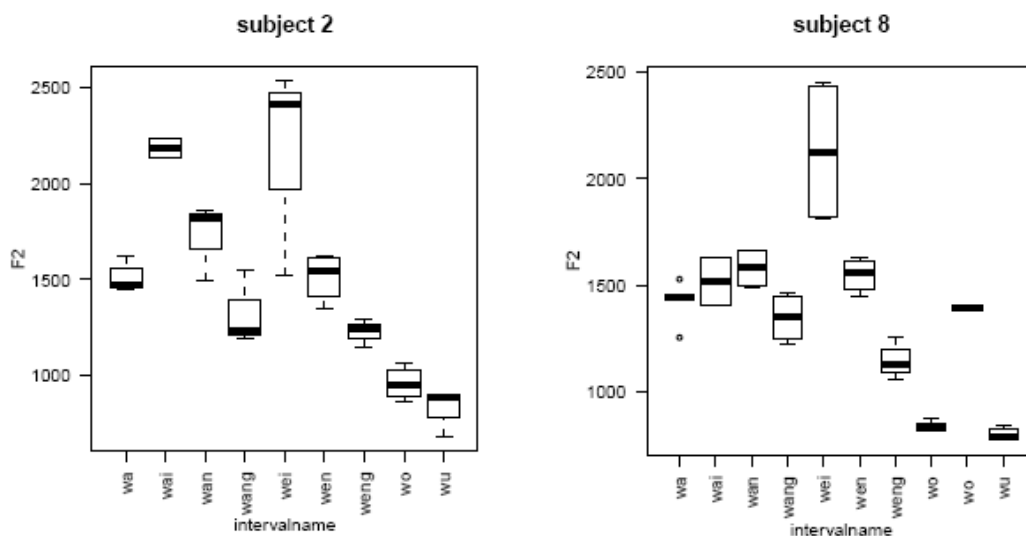


Figure 4. Average F2 (Hz) of Subject 2 and Subject 8’s production across all three contexts

Figure 4 clearly shows that Subject 8's production generally trends towards a much lower F2, which is due to the lip rounding of [w], whereas subject two's production shows a much higher F2 trend implying the non-lip rounded production of [v].

Two paired t-tests were run to examine the production of the two speakers (Subject 2 and Subject 9) who produced [v] as well as [w]. The results showed that the F2 of [w] was significantly different than that of the F2 of [v] ($t = 2.97$, $df = 19$, $p = .008$, $t = 3.91$, $df = 14$, $p = .002$ respectively). In order to address which phonological environments conditioned the production of [v], two chi square tests were conducted. The two chi square tests reported that vowel context did play a role in their production of [v] ($\chi^2 = (8, N = 135) = 57.11$, $p = .00$, ($\chi^2 = (8, N = 125) = 57.1$, $p = .00$ respectively). Using a level of significance of .05, the standardized residual was calculated. Results were significantly different if they exceeded the range between -1.96 and 1.96. Thus, our findings suggest that when /w/ was followed by the vowels /ə/ and /ei/, the speakers produced /w/ as [v]. When /w/ was followed by a back rounded vowel such as /o/ and /u/, the speakers usually maintained the production as [w]. The results for the vowel /a/ were inconclusive; although our measurements indicate a divergence in mean F1 and F2 values for those speakers when producing syllables with an /a/ nucleus, our statistical analysis did not return a significant value.

Additionally we examined whether production context played a role in the variation between [w] and [v]. The Chi square tests showed that task, be it reading the paragraph, answering questions in natural speech or reading from a word list, did not play a role in the production of [v].

Finally, in order to investigate whether the production of [v] reflected a regional speech difference or a larger trend in spoken modern Mandarin, a logistic regression model was used. We used the "enter" method with the following four predictors in the model: gender, north/south region, vowel context and production context. The Hosmer-Lemeshow test for goodness of fit yielded $\chi^2 (8)$ of 8.15 and was not significant ($p = .42$). As such, the model used fit the data well. Moreover, as shown in table 2, the model correctly predicted 94 percent of the production.

Observed	Predicted		% Correct
	[w]	[v]	
[w]	983	55	94.7
[v]	14	155	91.7
Overall % correct			94.3

In table 3, the statistical test of individual predictors indicated that among all four predictors, only the variable "region" was significant in predicting the production of [w] and [v] ($p = .00$): northern subjects are more likely to produce /w/ as [v]. Therefore, the

model suggests that the production of the labial dental approximant [v] is a regional difference rather than a more general trend of modern spoken Mandarin.

Table 3. Logistic Regression Analysis of 1207 tokens of the 10 subjects						
Predictor	β	S.E	Wald χ^2	df	Sig.	Exp B (odd ratio)
Constant	-46.18	3191.14	.00	1	.99	2.68E9
Gender	21.71	1822.40	.00	1	.99	117.92
Region	4.76	.35	188.20	1	.00	116.97
VowelCon			12.29	8	.14	
VowelCon(1)	20.10	2619.60	.00	1	.95	5.21E8
VowelCon(2)	20.29	2619.60	.00	1	.95	6.45E8
VowelCon(3)	19.72	2619.60	.00	1	.95	3.66E8
VowelCon(4)	19.95	2619.60	.00	1	.95	4.60E8
VowelCon(5)	20.10	2619.60	.00	1	.95	5.17E8
VowelCon(6)	21.43	2619.60	.00	1	.95	2.03E9
VowelCon(7)	19.21	2619.60	.00	1	.95	2.20E8
VowelCon(8)	-.20	4365.63	.00	1	1.00	.82
Proconx			.96	2	.61	
Proconx(1)	.24	.38	.42	1	.52	1.28
Proconx(2)	.37	.37	.99	1	.32	1.45
Test			χ^2	df	Sig.	
Overall model evaluation						
Likelihood ration test			622.01	13	.00	
Goodness-of-fit test						
Hosmer & Lemeshow			8.15	8	.42	

5. Discussion

Our results have shown that of the ten subjects tested, two consistently produced [v]. These two subjects were both female, which is unsurprising given that the labiodental [v] results in a much higher frequency than the labial [w]. As a result, the labiodental approximant may be perceived by many as feminine sounding. Our finding follows Shen's (1987) results that [v] was produced significantly more frequently by female speakers than by males. In sum, our study effectively corroborated Shen's gender-based observation nearly a quarter of a century later, suggesting that the production of [v] is still a widespread phenomenon.

Additionally, it has been observed that the production of [v] is often heard on news broadcasts where typically (although not exclusively) the labiodental approximant is produced by female reporters throughout China and Taiwan (Chan 1998). The

production of the labiodental variant by newscasters could be interpreted as a more prestigious variety of spoken Mandarin. The two subjects who produced [v] consistently were both Northern Mandarin speakers (Beijing and Inner Mongolia, respectively). Although our subject pool was restricted to only ten subjects (see appendix for additional subject information), our logistical regression findings conclude that this production is the result of regional variation and not a larger trend across Mandarin (i.e. a sociolinguistic phenomenon driven by newscasters' speech or another perceived prestigious dialect).

The most important finding of the present study is the statistically significant production of [v] when conditioned by the subsequent /ə/ and /ei/ nucleus. While /wəŋ/, /wən/, and /wei/ were not the only syllables in which [v] was produced, statistically these syllables were regularly shown to condition the labiodental approximant to be produced. These findings both support and contradict Shen's (1987) findings.

Both the present study and Shen's study concluded that /wən/ was produced as [vən] more often than any other syllable. Both studies also reported /wei/ as a syllable with a significant production of [v] tokens as [vei]. Shen, however, reported /wan/ and /wa/ as the second highest percentage of syllables containing [v]. In the present study these syllable types were not statistically significant. The difference in the present study and Shen's study may be accounted for by the considerably large discrepancy in number of subjects, the method of analysis (transcription versus acoustic analysis), or the passing of time since Shen's research. Future research will need to address this difference between the two studies.

Based on the findings from the ten speakers analyzed, we explain the production of [v] in the following ways. First, it may be the case that the production of [v] is the result of dentalization in close-mid vowel contexts. This would imply that the produced labiodental approximant is not necessarily due to an allophonic variation but rather due to a phonological process resulting in a change in place of articulation by certain speakers. This dentalization rule can be expressed as:

$$\text{Approximant dentalization rule: } /w/ \rightarrow [v] / _ \left(\begin{array}{c} \text{ə} \\ \text{ei} \end{array} \right)$$

This rule seemingly holds true for the two speakers in our study. Additionally, a rule such as this maintains that [v] is merely the surface form of /w/ and that speakers of this variety of Mandarin do not underlyingly possess /v/.

Alternatively, it may be the case that [v] is an allophone of /w/ and that speakers of this variety of Mandarin produce /w/ as both [v] and [w]. This allophonic variation was repeatedly observed during the acoustic analysis of Subject 9's sound files. Figure 5 shows an especially interesting production of /wei/ 'power'.

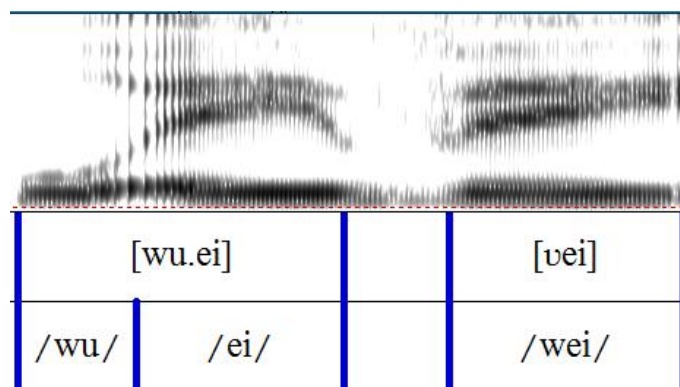


Figure 5. Production of a /wei/ syllable as [w] as the onset (with [u]), [ei] as the vowel and [vei] as the complete syllable

Figure 5 shows the speaker is able to produce the onset and nucleus as individual segments, but when combining them to form the complete syllable, the onset changes from /w/ to [v]. We see this as possible evidence for classifying [v] as an allophone of /w/. Future research will need to address this debate and begin identifying whether or not minimal pairs with [w] and [v] are produced in this variety of Mandarin and what role, if any, the perception of [v] plays. Future research may also want to examine children's production to see if this alternation is phonologized among northern speakers at a certain age.

Future studies should also explore the production of [v] in syllables with an /a/ nucleus. Though our data was statistically inconclusive, it may be that the production of [v] is spreading across other vowel contexts. Follow-up studies should explore the production of [v] across generations to see if the number of vowel contexts in which the labiodental approximant is produced varies across different age groups. Since the present study examined speakers all within the same age range, it is possible that the production of [v] is either increasing or decreasing among speakers.

Finally, future studies should continue to explore the perceived prestige of [v] and what, if any, role [v] plays among speaker's social dynamics. The production of the labiodental approximant may prove to be a salient cue of a certain variety of Mandarin in the same way that rhotacization does (Zhang 2005).

6. Conclusion

This paper has outlined some of the important features of the labial velar approximant /w/ in Standard Mandarin. Its narrow constriction and highly vowel-like formants result in a lowered first formant and a natural phonetic basis to treat it as a semi-vowel (Stevens 1998). Yet, the constriction, unlike fricatives, remains weak enough that no turbulent noise is produced (Laver 1994). The labial velar approximant /w/, especially in the onset position of Standard Mandarin, acts differently than the vowel alone. Due to

the inherent lip rounding involved in its production, a lowered second formant is visibly apparent in spectrograms.

These features were used to analyze the production of /w/ by ten native Mandarin speakers from different parts of China. It was found that the place of articulation of /w/ shifted from labial velar to labial dental [v] in four female speakers. Of those four, only two speakers – both Northern Mandarin speakers – produced [v] consistently and predictably. These findings are very much in line with the claim that the production of [v] is perceived as feminine, primarily found in Beijing Mandarin and thus produced by younger female speakers (Shen 1987). Our findings were further supported by a logistic regression model which showed that statistically a speaker's region (north) plays the most important role in the production of [v]. These findings uphold Shen's research nearly a quarter of a century later. The present study, taken in conjunction with Shen's groundbreaking work, proves that the labiodental approximant [v] is a robust phonetic production found in Northern Mandarin.

Our findings can be explained through a proposed approximant dentalization rule, which causes /w/ to become dentalized before /ə/ and /ei/. We also put forth the possibility of [v] serving as an allophone of /w/ for speakers of certain varieties of Northern Mandarin. This claim requires additional fieldwork and further phonetic studies to examine the extent of [v] production as well as its role across the speaker's language. Future studies may also want to consider the perception of [v] and explore whether or not minimal pairs exist within that variety of Mandarin.

7.1 Appendix: Research Instrument Word List

Sound in IPA	Tone of the target word	Target word	Target word in phrase	Pinyin	English gloss
[wu]	Tone 1	屋	屋子	Wuzi	House
	Tone 2	无	无穷	Wuqiong	Endless
	Tone 3	五	五月	Wuyue	May
	Tone 4	雾	雾气	Wuqi	Fog
[wa]	Tone 1	挖	挖土	Watu	Dig
	Tone 2	娃	娃娃	Wawa	Baby
	Tone 3	瓦	瓦片	Wapian	Tile
	Tone 4	袜	袜子	WaZi	Sox
[wo]	Tone 1	莴	莴苣	Wuju	lettuce
	Tone 3	我	我们	Women	We/us
	Tone 4	握	握手	Woshou	Shake hands
[wan]	Tone 1	弯	弯曲	Wanqu	Winding
	Tone 2	顽	顽皮	Wanpi	Naughty
	Tone 3	晚	晚上	Wanshang	Evening
	Tone 4	惋	惋惜	Wanxi	Feel sorry for
[wai]	Tone 1	歪	歪曲	Waiqu	Misrepresent
	Tone 4	外	外面	Waimian	Outside
[wei]	Tone 1	威	威风	Weifeng	Mighty
	Tone 2	违	违规	Weigui	Violate rules
	Tone 3	纬	纬度	Weidu	Latitude
	Tone 4	味	味道	Weidao	Smell
[wən]	Tone 1	温	温暖	Wennuan	Warmth
	Tone 2	蚊	蚊子	Wenzi	Mosquito
	Tone 3	稳	稳健	Wenjian	Stability
	Tone 4	问	问题	Wenti	Question
[wɑŋ]	Tone 1	汪	汪洋	Wangyang	Boundless/vast
	Tone 2	王	王子	Wangzi	Prince
	Tone 3	网	网球	Wangqiu	Tennis
	Tone 4	忘	忘记	Wangji	Forget
[wəŋ]	Tone 1	嗡	嗡嗡	Wengweng	Humming sound
	Tone 3	蓊	蓊郁	Wengyu	Luxuriant
	Tone 4	瓮	瓮	Weng	Jar/pot

7.2. Appendix: Research Instrument Paragraph

英国的威廉王子今年五月到北欧的瑞典进行访问。瑞典因为纬度较高,因此即使是五月,天气还是很冷,不仅屋子里需要开暖气,早上外面的雾气也很浓。威廉王子魅力无穷,他穿上正式服装,看起来相当威风。沿途上很多民众争相跟他握手,他还顽皮地抱起路旁在玩挖土游戏的娃娃,他亲切的态度与他已故的母亲黛安娜王妃一样使人感觉很温暖,我们都很喜欢他。晚上,在晚宴之前,威廉王子先参加了记者会,他稳健地回答记者的问题并说明他接下来的公益活动,他同时也表达对于有一些记者报导他的私生活且歪曲事实,还说他利用贵族的身分违规停车,对此他感到很遗憾与惋惜。晚宴里,他表示餐点的味道相当好,其中还有他最喜欢的莴苣。

隔天早上,威廉王子先去打了网球,接着下午又到附近的山林走走,由于山里气温较低,他换上了较厚重的衣服和袜子以保暖。他对随行的人员说他已经忘记上一次到山里走走是什么时候了。他说山林里的小路弯曲蔓延,草木蓊郁,又有蜜蜂在耳边嗡嗡地叫,虽然偶而有蚊子,但是登上高处远眺汪洋的大海和山下的点点的屋瓦,让人心曩神怡。

7.3. Appendix: Research Instrument English translation

Prince William of the United Kingdom visited Sweden this May. Because of the high latitude of Sweden, even though it was already May, it was still cold. People there still needed a heater in the house and there was also a heavy fog outside. Prince William looks very charming, especially when he dresses up in formal attire. Many Swedes like him and they all wanted to shake hands with him. Prince William also mischievously picked up a child playing and digging on the playground. Prince William is very down-to-earth and nice. His warm attitude is just like his mother, Princess Diana. We all like him a lot. In the evening, Prince William had a press conference before the banquet. At the press conference, he answered all the questions and also talked about some charity activities he plans to do next. He also said that he felt deeply sorry that some paparazzi gave inaccurate reports of his personal life and also claimed that he violated some parking rules. At the banquet, he said that he liked the food very much and his favorite vegetable is lettuce.

The next day, Prince William played tennis in the morning and then went hiking in the afternoon. Due to the possible lower temperature in the mountains, he puts on a coat and socks to keep him warm. He told his entourage that he couldn't remember the last time he went hiking. In the mountain, there were winding trails, luxuriant forest and bees. Though, sometimes, there were mosquitoes, he felt great when he reached the top of the mountain and looked down at the sea and the small houses below.

7.4. Appendix: Research Instrument Questions

1. 威廉王子几月到瑞典访问?
2. 五月瑞典的天气怎样么? 还需要暖气吗? 早上雾气是否也很浓?
3. 瑞典为什么五月天气还是很冷?
4. 瑞典的民众喜欢威廉王子吗?
5. 在晚宴前的记者会,威廉王子表现得怎么样?
6. 威廉王子对总是报导他私生活的记者怎么样?
7. 威廉王子觉得晚宴的餐点怎么样? 他最喜欢吃什么?
8. 威廉王子隔天在登山前做了什么运动?
9. 在山里威廉王子看到哪些小昆虫?
10. 威廉王子从山顶往下看看到什么?
11. 威廉王子换上怎样的衣服去爬山?
12. 威廉王子记得上次去爬山是什么时候吗?
13. 山里的景色怎么样?
14. 威廉王子什么时候参加记者会?
15. 有很多人想跟威廉王子握手吗?
16. 威廉王子穿上正式的衣服看起来怎样?
17. 威廉王子抱起了谁?
18. 威廉王子很有魅力吗?
19. 威廉王子真的有违规停车吗?这是事实吗?

7.5. Appendix: Research Instrument English translation

1. When did Prince William visit Sweden?
2. How was the weather in Sweden in May? Did people there still need a heater? Was there heavy fog in the morning?
3. Why was it cold in Sweden in May?
4. Do Swedes like Prince William?
5. How did Prince William do in the press conference before the banquet?
6. How did Prince William feel about the paparazzi?
7. How did Prince William like the food at the banquet? What did he like the most?
8. What did Prince William do the next day before he went hiking?
9. What insects did Prince William see in the mountain?
10. What did Prince William see from the top of the mountain?
11. What did Prince William wear when he went hiking?
12. Did Prince William remember the last time he went hiking?
13. How was the scenery in the mountains?
14. When did Prince William have the press conference?
15. Did many people want to shake hands with Prince William?
16. How did Prince William look when he dressed up in formal attire?

- 17. What did Prince William hold in his arms?
- 18. Is Prince William charming?
- 19. Did Prince William violate parking rules? Was it true?

7.6. Appendix: Participants information

Subject ID	Gender	Age	Place, Province (In Chinese)	Place, Province (In English)	Categorized region in the study
1	Female	35	湖北省, 武汉,	Wuhan, Hubei,	South
2	Female	30	内蒙古自治区, 赤峰	Chifeng, Inner Mongolia	North
3	Male	27	福建省, 尤溪	Youxi, FuJian	South
4	Female	36	江苏省, 徐州	Xuzhou, Jiangsu	South
5	Female	26	江苏省, 南京	Nanjing, Jiangsu	South
6	Male	35	辽宁省, 沈阳	Shenyang, Liaoning	North
7	Female	29	湖南省, 水潭	Shuitan Hunan	South
8	Female	25	广东省, 新会	Xinhui, Guangdong	South
9	Female	30	北京市	Beijing	North
10	Male	30	陕西省, 西安	Xi'an, Shanxi	North

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