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# Acoustic Variation of Syllable-Initial [ŋ] in Zhengding Chinese

Yanxiao Ma

China University of Mining and Technology, Beijing, China

E-mail: yanxiaoma@foxmail.com

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**Abstract**

The study explores the acoustic properties of syllable-initial [ŋ] in Zhengding dialect, to see whether the younger generation shows the same pattern with the senior group. 60 items with vowel realizations [ʌ, a, ɑ, ə, ɤ] and [ai, ɑo, ou] in '[ŋ]-V' and '[g]-V' structures are produced by 8 native speakers. Three experiments are conducted. Experiment I compares '[ŋ]-V' and '[g]-V' structures in senior speeches. Three acoustic effects due to the initial [ŋ] are established: vowels become less distinctive from each other by decreasing the first formant (F1), increasing the second formant (F2), and shrinking the gap between the second formant (F2) and the third formant (F3). Experiment II is conducted between '[ŋ]-V' and '[g]-V' in the younger speakers, investigating whether they have a similar pattern with the seniors. Experiment III is supplemented to compare the younger speeches in Zhengding dialect and Mandarin, to explore whether the generational variation in Zhengding dialect is relevant to dialect contact, i.e., whether the younger speakers are largely influenced by Mandarin. The result shows the younger generation does not produce the initial [ŋ] with the vowel realizations [ʌ, a, ɑ, ə, ai, ɑo, ou], which traditionally have an initial [ŋ], with an exception in [ɤ]. A fusion process is assumed in [ɤ] in the younger pattern, in which the initial nasal [ŋ] and the following vowel [ɤ] are combined into the single nasalized vowel [ɤ̃], with the nasal effects remained, but the initial nasal then deleted. From the sociovariationist perspective, the nasal-initial pronunciation is a partial variation in Zhengding dialect. Not all speakers pronounce with the velar-initial [ŋ]. The older generation largely remained the velar-initial variant, but the younger generation preferred the zero-onset, which might be due to the influence of dialect contact with Mandarin.

**Keywords:** Sound change, Sociophonetic analysis, Velar nasal, Fusion

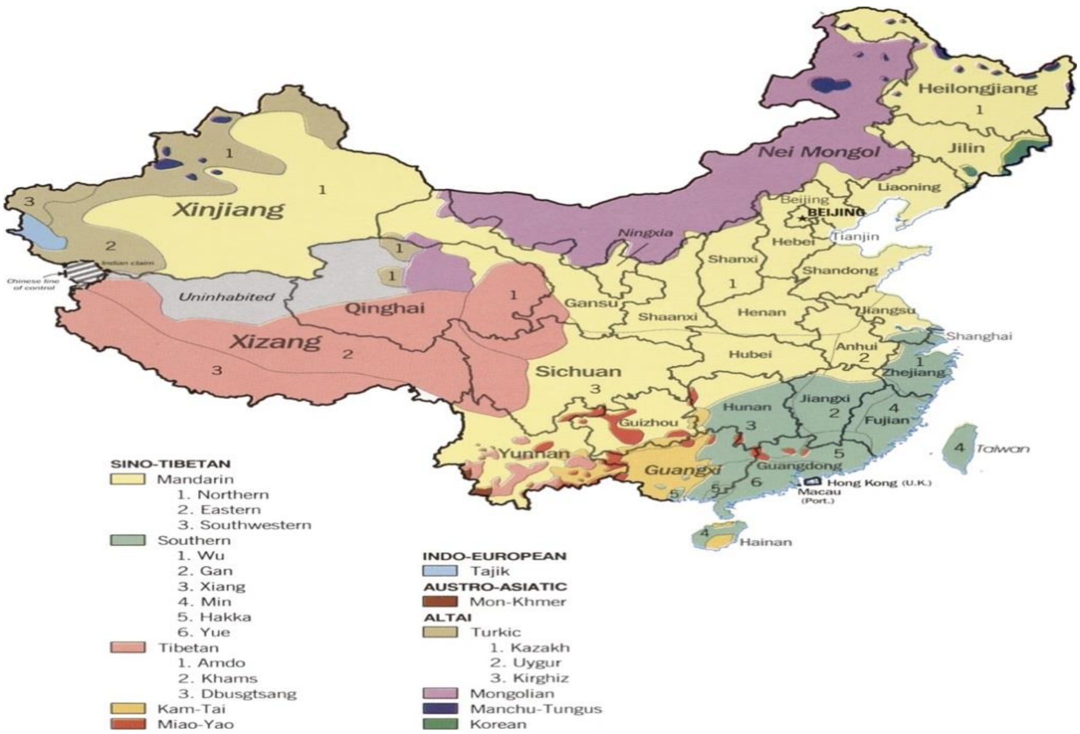
## 1. Introduction

This paper examines the phonetic characteristics of initial velar nasal [ŋ] in Zhengding dialect, a northern variety of Chinese. According to definitions, velar sounds are produced with the back of tongue articulating against the velum (Rogers 2000), and nasal sounds are produced with an oral closure and a velopharyngeal opening (House 1957; Stevens 1998; Chen 2000). The velar nasal [ŋ] is observed in many languages, but it also lacks in some other languages, as seen in the world atlas of language structures (Anderson 2005; 2013). The occurrence of [ŋ] is far more restrictive in word-initial position than the word-final or word-medial positions (Andrew 2013). Chinese, a member of the Sino-Tibetan family of languages, is classified into seven major dialect groups, each with its own sub-varieties, as seen in (1a) (Ramsey 1987; Liu 2010). Northern varieties are called Mandarin dialects (Note 1), and spoken by over 70% Chinese speakers (Duanmu 2005). The other six dialect groups are known as southern dialects. The geographic distribution between northern and southern dialects is presented in (1b). In Mandarin Chinese (Putonghua, the official language spoken in Peoples' Republic of China), the velar nasal can only occur in the coda of the syllable, but not in the initial position (Duanmu 2005). However, the initial velar nasal [ŋ] has been observed in many southern varieties, such as in Suzhou, Wenzhou, Shuangfeng, Yangzhou, Changsha, Guangzhou, Fuzhou, Nanchang (Chang 1971: 200).

(1)a Seven Chinese Dialect Groups (Liu 2010)

| Northern Varieties | Southern Varieties | | | | | |
|---|---|---|---|---|---|---|
| Mandarin Dialects | Wu Dialects | Gan Dialects | Xiang Dialects | Hakka Dialects | Yue Dialects | Min Dialects |

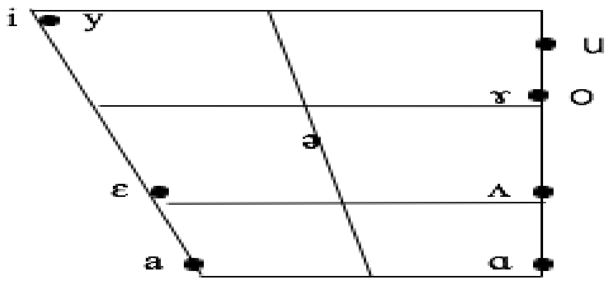
(1)b Geographic Distribution of Chinese dialects




Available from https://en.wikipedia.org/wiki/List_of_varieties_of_Chinese

The velar nasal [ŋ] is also found in syllable-initials in Zhengding dialect (Annals of Zhengding County 1992; Song 1999), a subtype of northern varieties. Zhengding county is located in central Shijiazhuang, in the southwest of Hebei province in China. It is 15 km to the north of the urban area of Shijiazhuang city, and 258 km to the south of Beijing, the capital city of China (Zhengding County Annals, 1992). In Zhengding dialect, three nasal initials are licensed: [m, n, ŋ]; and five vowels are allowed to co-occur with the initial [ŋ]: /a, e, ai, ɑo, ou/ (Annals of Zhengding County 1992), among 9 vowel inventories, as seen in (2).

(2) Vowel Inventories in Zhengding dialect (Note 2)




The precise realization is depending upon the phonetic environment. The vowel phoneme /ɑ/ is phonetically realized as [ʌ], when it follows a consonant or used independently. It is realized as [ɑ] in compound finals (Fuyunmu in Chinese) *ao* and *ang*; and realized as [a] in compound final *ai* and *an*. The vowel phoneme /e/ is realized as [ə] in the compound final *en*, and as [ɤ] when following a consonant or used by itself (based on http:// web.csulb.edu/~txie/461/ Readings/PinyinandIPA), although there were arguments on different vowel variations in oral Chinese dialects (Flege, Bohn and Jang, 1997; Li and Thompson, 1981; Chen & Wang, 2013). Thus eight vowel realizations [ʌ, a, ɑ, ə, ɤ, ai, ɑo, ou] are licensed with initial [ŋ] in Zhengding dialect. Some examples on the word-initial contrast between Zhengding dialect and Mandarin are illustrated in (3), in which the initial [ŋ] is selected in Zhengding dialect, but prohibited in Mandarin. (Note 3)

(3)

| **Character** | **Zhengding Dialect (Note 4)** | **IPA** | **Mandarin Chinese** | **IPA** | **Gloss** | |
|---|---|---|---|---|---|---|
| 碍 | ŋai$^{412}$ | [ŋai] | ai$^{51}$ | [ai] | "to obstruct" | (Song 1999: 104) |
| 岸 | ŋan$^{412}$ | [ŋan] | an$^{51}$ | [an] | "bank" | (Song 1999: 104) |
| 袄 | ŋao$^{55}$ | [ŋɑo] | ao$^{214}$ | [ɑu] | "jacket" | (Zhu 2007: 47) |
| 恩 | ŋen$^{223}$ | [ŋən] | en$^{55}$ | [ən] | "grace" | (Zhu 2007: 47) |
| 饿 | ŋe$^{412}$ | [ŋɤ] | e$^{51}$ | [ɤ] | "hungry" | (Zhu 2007: 47) |

The goal of the study is to see whether all natives in Zhengding dialect produce with the initial [ŋ], and how this sound affects the phonetics of the following vowels in different generations. 8 native speakers, four senior (>/= 45 years old) and four younger (<45 years old), are recruited for participation. It is hoped to deepen the perceptional recognition of the nasal onset [ŋ] in Zhengding dialect, and to specialize the phonological consequence of the generational variations.

The remainder of the paper consists of five sections. Previous analyses on initial [ŋ] are presented in section 2. Section 3 introduces fusion process in sound changes, which is applied to explain the sound variation in the young speakers. Section 4 describes the methodology, involving the experiment setup and data analysis. Section 5 presents the results of three acoustic experiments, to investigate whether the young generation shows the similar pattern with the senior speakers, traditionally with the initial [ŋ]. I propose a fusion process undergoes in the young speaker in the vowel [ɤ]. It also suggests dialect contact between Zhengding dialect and Mandarin, contributes to the generational variations in Zhengding dialect. Section 6 presents the conclusion and the limitations about this study.

## 2. Previous Studies of Initial-[ŋ]

The literatures on initial [ŋ] is outlined in this section, involving the distributional and phonotactic characteristics of syllable-initial [ŋ], the origin of the word-initial [ŋ] in cross-linguistically, the current studies on the initial [ŋ] in Cantonese and Shijiazhuang urban dialect from the socio-variationist perspectives, and the acoustic measurements for vowel formant changes.

### *2.1 Distributional and Phonotactic Studies of Initial-[ŋ]*

The velar nasal [ŋ] was acknowledged as one of the most definable sounds in areal and phonotactic distributions across the world (Anderson 2005: 217). Anderson (2013) claimed the sound [ŋ] existed in 48% of the 100-language sample in the World Atlas of language structures. It was included in “languages of North America (especially California), Australian languages, also in Burushaski, Munda languages and the Tibet-Burman family”, and many others. It lacked in “most Dravidian and Indo-European language of South Asia” (Anderson 2013). It may be controversial whether this sound is phonemic (contrastive) or phonetic in some languages. For example, in Japanese, Martin (1952: 12), Jorden (1955: 3), and Bloch (1958: 334) proposed [ŋ] as a separate phoneme (Goodman 1968: 153); while Goodman (1968: 154; 156) argued it was the allophone of [g], and [ŋ] only occurred medially in phonological words.

For the phonotactic characteristics of [ŋ], Anderson (2013) reported [ŋ] might occur in onset or coda word-peripherally (word-initially or word-finally) or word-medially. The velar nasal [ŋ] in Polish was fully determined by contexts. It could appear only before the velar plosive [k, g], such as in *kongo*, *tango*, *ręka* and *drąg*. However, in English it was determined by phonetic contexts to a lesser extent. Although it was impossibly initial, it might occur medially, such as before consonants in *England*, *anchor*, and *anxiety*. It was also licensed finally in *tongue* and *among*. Cross-linguistically, the nasal [ŋ] in the word-initial was more

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restrictive than that in the word-final or word-medial position. The word-initial [ŋ] was found "in languages as Bagirmi, Canela-Krahô, Chukchi, Indonesian, Mangarrayi, Meithei, Oksapmin, and Rama among the 100-language sample, but forbidden in a large number of European, western Asian, western and central Siberian languages" (Anderson 2013).

For the initial [ŋ], Blevins and Kaufman (2012) studied its origins in Palauan, from morphological instead of phonological perspectives. Palauan is "a Malayo-Polynesian language with a long history of independent development". Blevins et al. (2012) argued that the nasalization at word or phrase boundaries in Palauan did not result from natural phonetic motivations, but from a reanalysis of a particle *ŋ. A third person singular marker 'ŋ' in the word-initial position is reanalyzed as a clitic. This marker combined with the following vowel into a phonological word, as a result of pro-cliticization, as seen in (4).

(4) Syntactic word      Phonological word (Blevins 2012: 23)

| | | | |
|---|---|---|---|
| a. | ng oles | [ŋolεs] | 'it is a knife' |
| b. | ng diak | [ndiakh] | 'isn't' ([ŋ] undergoes the assimilation to [n] when followed by a homorganic coronal consonant]) |

The morphological analysis on the origin of the word-initial [ŋ] in Palauan provides a new approach, different from the regular sound changes with phonological motivation. However, for Chinese, which is impoverished in morphology, the phonetic variation from zero-initial to velar nasal [ŋ] in some dialects is widely considered as a process of sound change across time.

### *2.2 Socio-variationist Perspective for Phonetic Variation*

After introducing the origin of the word-initial [ŋ] in particular languages, the socio-variationist perspective is presented in the following part, followed by the case studies on Hong Kong Cantonese (a southern Chinese dialect) (Carol 2015), and Shijiazhuang dialect (a northern Chinese dialect) (Zhu 2007) respectively.

The socio-variationist study involving social factors of age and gender could be dated from Labov (1966, 1972), which analyzed social stratification of -r in New York City (N.Y.C) department stores. The variants of the phonological variable -r were either presence or absence of post-vocalic [r], depending on the social class of speakers. Higher socioeconomic status produced more frequently than those in lower socioeconomic status. Labov's (1966) analysis on post-vocalic [r] presented a variationist perspective for my study. But only the social factor-age, will be mainly focused in my study.

Carol (2015) studied the phonological variation in Cantonese and argued that the zero-initial and the nasal onset [ŋ] were used in strictly different contexts in standard Cantonese in the 20th century. In Cantonese, there are 8 inventories of vowels: [i, y, ɛ, ɵ, u, ɔ, ɐ, a] (Matthews & Yip 1994). Before vowels [a, ɐ, o, ɔ], the nasal [ŋ] was chosen in standard Cantonese. Carol (2015) further mentioned age was relevant with this sound variation. Speakers preferred to speak [ŋ] in syllable-initial before 1950s; however, the zero-initial began to be more frequently chosen by speakers born after 1960 till now. The results indicated that the zero-initial increased popularity in the younger generation (Carol 2015: 343). However, Wong (2005) studied the velar nasal in Cantonese through a questionnaire survey, recording sessions and open ended interviews. A process of alveolarization from [ŋ] to [n] had been observed. The alveolar nasal [n] was considered to be the innovative variant, and the velar nasal [ŋ] to be the conservative variant, depending upon age, gender, and formality of speech. To sum up, the velar-nasal onset [ŋ] in Cantonese was undergoing the process of sound variation to nasal-initial [n] (Wong 2005), or to zero-initial (Carol 2015).

Zhu (2007) studied Shijiazhuang urban dialect (one of northern Chinese dialects) from a socio-variationist perspective. Zhu (2007) divided 44 subjects into two groups according ages: senior generation (> 60 years old) and young generation (</= 60 years old). The whole senior generation was observed speaking with the nasal [ŋ], but the young generation spoke with the zero-initial sounds. Zhu (2007) further argued syllable-initial [ŋ] was a contrastive phoneme in Shijiazhuang dialect, which lacked in syllabic onsets in Mandarin. Shijiazhuang urban area was geographically adjacent to Zhengding county. The current studies mainly pointed out this phenomenon without specific analysis on Zhengding dialect (i.e., the Annals of Zhengding County 1992; Song 1999). My study will explore whether there is also a generational difference in Zhengding dialect, as that in Cantonese and Shijiazhuang urban dialect. Before going to the analysis, a brief introduction for acoustic measurement of formants is presented below.

*2.3 Acoustic Measurement for Nasalization*

Acoustic theories of nasalization reveal that vowel nasalization primarily influences the first formant region F1 in the vowel spectrum. A set of major acoustic effects of nasalization is calculated in House and Stevens (1956), involving the reduction in amplitude of the first formant, the concomitant broadening of the bandwidth, the upward shifting of the frequency of F1, and an overall reduction in the energy of the vowel. Wright (1986) further suggests that nasalization may be expected to cause the raising of low vowels and some mid vowels, or lowering of high vowels and other mid vowels in perceptual findings. This is known as the centralization of nasal vowels in Beddor (1983), and also known as the bi-directional shift of vowel height in perceptual findings in Krakow et al. (1987). That is, the perceptional nasalized vowel quality is largely relevant to the first nasal formant (N1), and the first vowel formant (F1). For instance, for the nasalized/nasal vowel [a], the frequency of N1 is less than the frequency of F1, so the energy is distributed lower than usual. A raising effect is perceived. For the nasalized/nasal vowel [e] and [o], the frequency of N1 exceeds the frequency of F1, then a lowering effect is perceived in quality. The underlying trigger is due to the low-frequency region of the first nasal formant (N1), and the low-frequency of the zero formant (i.e., anti-formants in nasals), which reduced the prominence of F1 in vowels (Krakow et al. 1987). In my study, I will test whether Zhengding dialect shows the same acoustic tendency between the senior and younger speakers, in terms of the frequency of the vowel formants.

In the following section, the theoretical background about "fusion" in phonological change is provided, which will be applied to explain the phonological variation in Zhengding dialect.

## 3. Fusion and Phonetic Variation

Changes in pronunciation are known as phonological changes, or sound changes in a traditional term. Fusion, as one of the triggers for sound changes, occurs when a feature is added to a segment, or removed from a segment, or spread from one segment to another. The redistribution of the features is found in most types of phonological changes (Trask 1996: 52).

Trask (1996: 62) illustrated that this phenomenon widely existed in French historically. The nasal consonant disappeared when vowels preceded the syllable-coda [n] and [m]. This was the origin of *pain* 'bread' ([pɛ̃]), *langue* 'tongue' ([lɑ̃:g]), and *bon* 'good' ([bɔ̃]), etc. The nasal vowels an > ã can be also observed in the word *blanc* > *blã* in French (Crowley & Bowern 2010: 34). This process is known as fusion, in which two segments (an oral vowel and a nasal consonant) combine into single segment. Since the segments are made up of a number of features, as seen in (5a), fusion can be understood as a process that combines different features of the two original sounds into a new set of features upon a single sound. The set of features upon the new segment can decide the nature of the sound (Crowley & Bowern 2010).

| (5)a [m]: | | [a]: |
|---|---|---|
| | [+consonantal] | [-consonantal] |
| | [+voiced] | [+voiced] |
| | [+labial] | [+low] |
| | [+nasal] | |

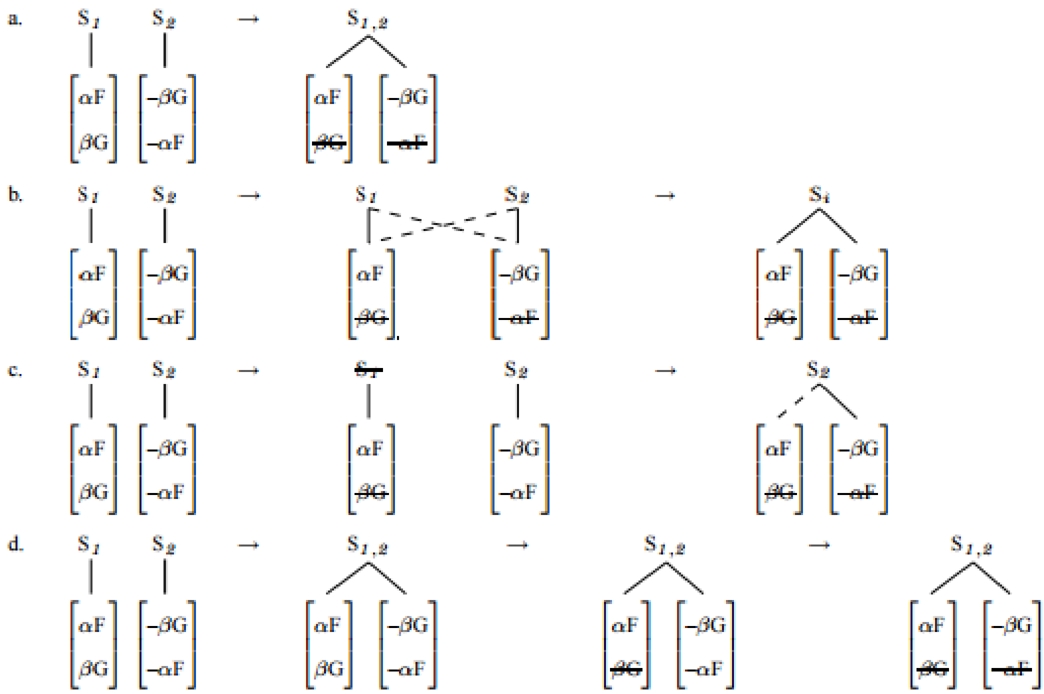
(Crowley & Bowern 2010: 33)

More examples of fusion are illustrated here. Trask (1996: 62) argued that the sequence like [tj], [dj] and [sj] might be pronounced as [t͡ʃ], [d͡ʒ] and [ʃ] in English like *nature*, *education* and *tissue* respectively. The sequence [rj] is combined into [ř] like *Dvořák* in Czech. The combination of post-alveolar [r] with a following dental or alveolar is fused into a single retroflex in *fart* 'speed' ([fɑ:ʈ]), korn 'grain' ([kʊ:ɳ]) in Swedish (Trask 1996: 62). Another fusional analysis in Indonesian about nasal substitution is provided in (5b) (Halle & Clements 1983: 125; cited in Key 2008: 5). The [+nasal] feature in the prefix-final consonant and the [-voiced] feature in the root-initial obstruent are combined upon a single segment.

| | | | |
|---|---|---|---|
| (5)b | /məŋ-pilih/ → məmilih | 'to choose' | |
| | /məŋ-tulis/ → mənulis | 'to write' | |
| | /məŋ-kasih/ → məŋasih | 'to give' | (Key 2008: 5) |

When fusion operation is mentioned, a relevant concept should be distinguished: Coalescence. Key (2008) defines coalescence as a process by merging two input segments into one output segment. But coalescence may be attributed to various operations. It may be resulted from fusion operation, or due to assimilation, deletion or feature stability. Four possible derivations for coalescence are discussed in Key (2008), as illustrated in (6a).

(6)a

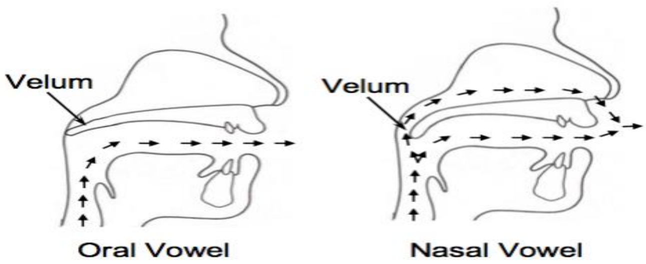


(Key 2008)

The first derivation (a) stands for normal fusional operation in coalescence. Two units $S_1$ and $S_2$ are combined into a single unit $S_{1,2}$, with features of $S_1$ and $S_2$ remained. The second derivation (b) in coalescence is resulted from the segmental spreading (known as 'assimilation'), followed by a segmental deletion. It may be realized through completely independent processes. The third derivation of coalescence (c) is known as stability phenomenon. Segmental deletion occurs, but the feature does not lose itself. Instead, the feature attaches to a neighboring segment. The fourth derivation (d) in coalescence firstly undergoes the classic fusion as seen in (a), and then followed by the deletion of features associated with either of the input segments. To sum up, the first derivation of coalescence in (a) is the classic fusion, which combines different features of the two original sounds into a new set of features upon a single segment.

Two phonological characteristics of fusion are mentioned in previous literatures: word-hood, and sequential permissibility (Mackay 1987: 66-67). Cutting (1973) argued fusional operation had "a longer and linguistically more complex perception than either of the two input speech stimuli". For instance, when the pair *Banket/Lanket* was mentioned, the listening subjects usually suggested hearing *Blanket* instead. Here the "word-hood" is one of the phonological factors that largely influence the occurrence of fusion. The result of the fusion is usually words, no matter whether the stimuli are words or non-words (MacKay 1987: 66). Another feature of phonological fusion is "sequential permissibility". The fusion is allowed only when the fused results are licensed in listeners' language (MacKay 1987: 67). For instance, the sequence *bdad* and *dbad* is not permitted as a result of fusion of *bad* and *dad*. Regarding the fusion between a nasal and a vowel, the original oral vowel changes into a nasal vowel or a nasalized vowel. The nasal vowel and oral vowel are produced in different manner, as seen in (6b). Nasal vowel is produced "from a lowering of the velum during the vowel, which opens the velopharyngeal port and allows air to flow out through the nose and nostrils" (Styler, 2008:3), as illustrated in French historically. Nasalized vowel has no phonemic distinction from oral vowel, and the vowels, adjacent to nasal consonants, are produced partially or fully assimilated, with a lowered velum, as shown in English.

(6)b The production of an oral vowel and a nasal vowel




(Styler 2008: 3)

In this study, I will examine the loss of initial [ŋ] in Zhengding dialect, involving a process of fusion, in which the syllabic onset [ŋ] and the following vowel [ɤ] are fused into a single nasalized vowel in the young speakers in Zhengding dialect.

## 4. Methodology

This section describes the methods on how to collect data, to segment and to measure the frequency of the formants in Zhengding dialect.

### *4.1 Data Collection*

The recording task is proceeded on 8 native speakers in Zhengding dialect. It includes four senior (>/=45 years old) and four younger (<45 years old), with four females and four males in total, as seen in (7). The participants were informed of the research goal and the process of the reading. The recording consists of 60 words traditionally in [ŋ]-V context, and 60 paired items in [g]-V context, including both monosyllabic and multisyllabic words. The Mandarin pronunciation are also recorded by the younger speakers. All of the participants are allowed to review and practice the words before the recording is proceeded. Data are recorded using a recording software 'byly.exe', developed by Beijing Language and Culture University. The recording software is downloaded in an Acer laptop, at 16-bit sampling size, 44,100 Hz sampling rate, with a high quality noise cancelling head-mounted microphone. The recordings are saved in (uncompressed) WAV format. The environment for recording the initial [ŋ] and initial [g] is hold constant, by keeping the distance between the participants and the microphone unchanged. A file was then allocated with their ages and genders for each participant. A code number (N=1, 2…n) is further linked with each participant, to protect their private information.

(7) Information of 8 Native Participants

| Speaker Codes | Age | Gender | Educational Levels |
|---|---|---|---|
| Speaker 1 | 60 | Male | Elementary |
| Speaker 2 | 55 | Male | Middle |
| Speaker 3 | 63 | Female | Elementary |
| Speaker 4 | 54 | Female | Middle |
| Speaker 5 | 40 | Male | Middle |
| Speaker 6 | 33 | Male | College |
| Speaker 7 | 37 | Female | College |
| Speaker 8 | 25 | Female | College |

*4.2 Data Segment and Analysis*

The pronunciations are measured by using the acoustic analysis software Praat (Boersma and Weenink 2012). Since the first three formants are widely acknowledged to differentiate sounds, especially the first and second formants, representing the high-low and front-back distinctions of vowels (cited in Chen et al. 2013: 2), so in this study, the first two formants are plotted in this study. In monophthongs [ʌ, a, ɑ, ɤ, ə], the frequencies at the mid-point, are plotted in [ŋ]-V, [g]-V and zero-initial structures respectively, assuming consonantal effects to be minimal at the mid-point. But a different measurement point is determined for the diphthongs [ai, ɑo, ou]: the frequencies at the assuming average transitional space are plotted, permitting comparisons of dynamic vowel features between two single vowels. Additionally, values of the velar pinch (i.e., F3-F2) are also plotted, to compare the velar effect between the nasal [ŋ] and the plosive [g], both of which are velar segments. Multiple paired t-tests are also conducted, to see whether the formant changes in vowels are significantly distinct between different generations.

## 5. Experimental Analyses of Initial-[ŋ] in Zhengding Dialect

Three acoustic experiments are conducted on Zhengding dialect in this section. Experiment I compares the dialect speech between two syllabic structures in senior speakers: vowels traditionally preceded by initial velar nasal [ŋ] (i.e., [ŋ]+V), and vowels preceded by initial velar plosive [g] (i.e., [g]+V). The goal is to explore the acoustic properties in the traditional [ŋ]+V context. Experiment II is conducted in the young speakers, to see whether the young speakers present the same speech pattern with the seniors, i.e., whether the initial velar nasal [ŋ] is retained in the younger generations. Experiment III compares the younger Zhengding dialect and the Mandarin pronunciation in the younger speakers. The goal is to see whether the younger generation in Zhengding dialect is influenced by Mandarin, the dominant official language spoken in China.

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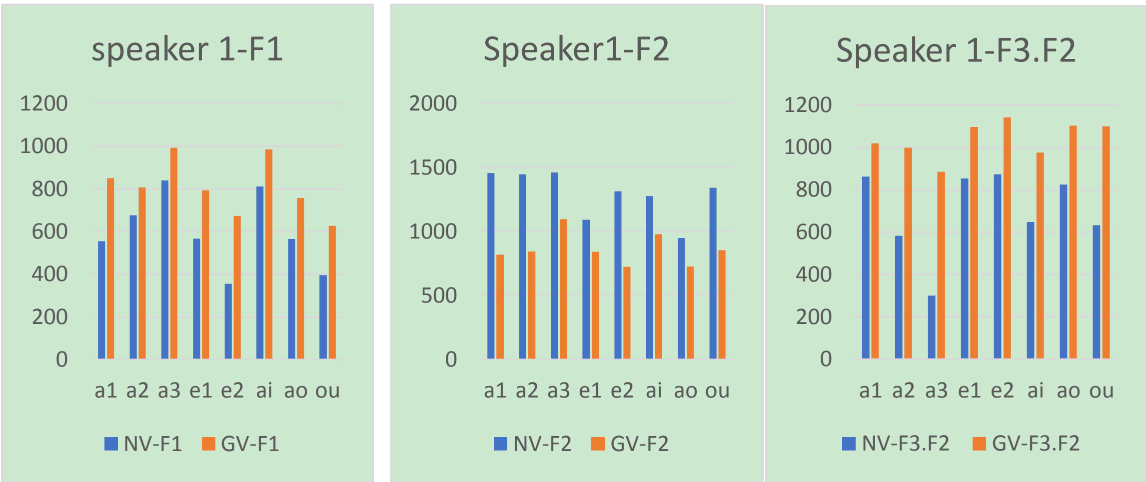
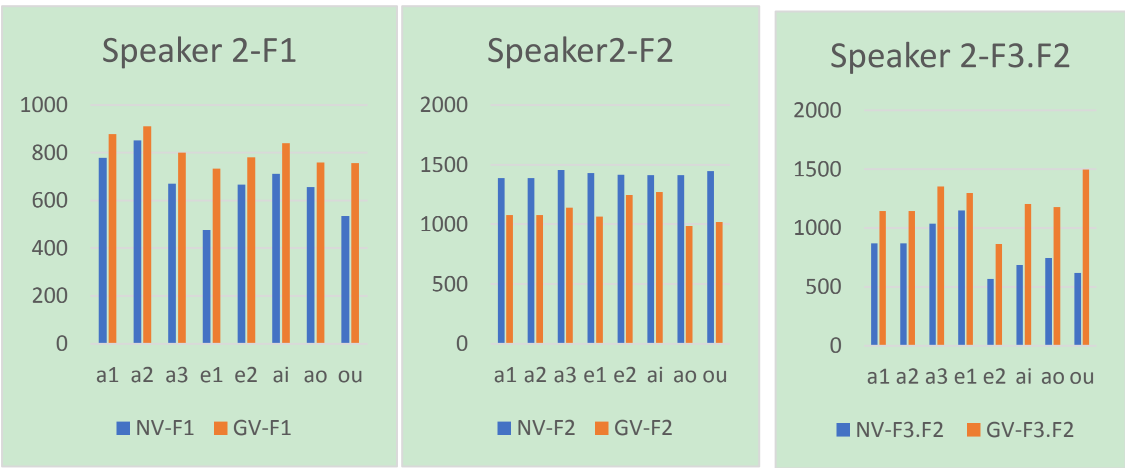
*5.1 Experiment I: Acoustic Effects in Senior Patterns*

This experiment compares the acoustic characteristics of vowels produced by 4 senior speakers, traditionally with the initial velar nasal [ŋ] and with the initial velar plosive [g]. The frequencies of F1, F2 and the pinch values (F3-F2) in eight vowel realizations [ʌ, a, ɑ, ɤ, ə, ai, ɑo, ou] are plotted in (8), which corresponds to the *pinyin* labels "a1, a2, a3, e1, e2, ai, ao, ou" respectively.

(8)a Formant values in the senior (male) speaker 1




(8)b Formant values in the senior (male) speaker 2



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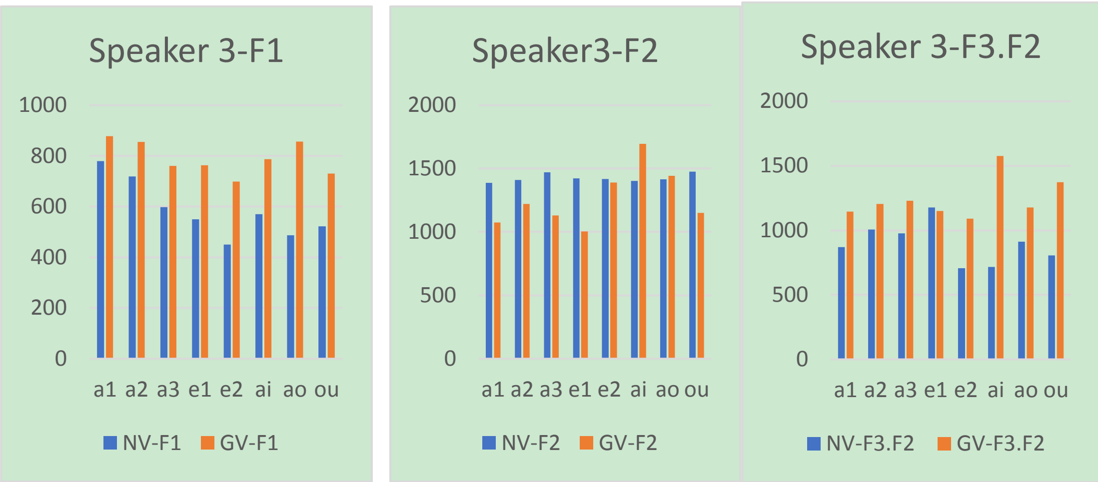
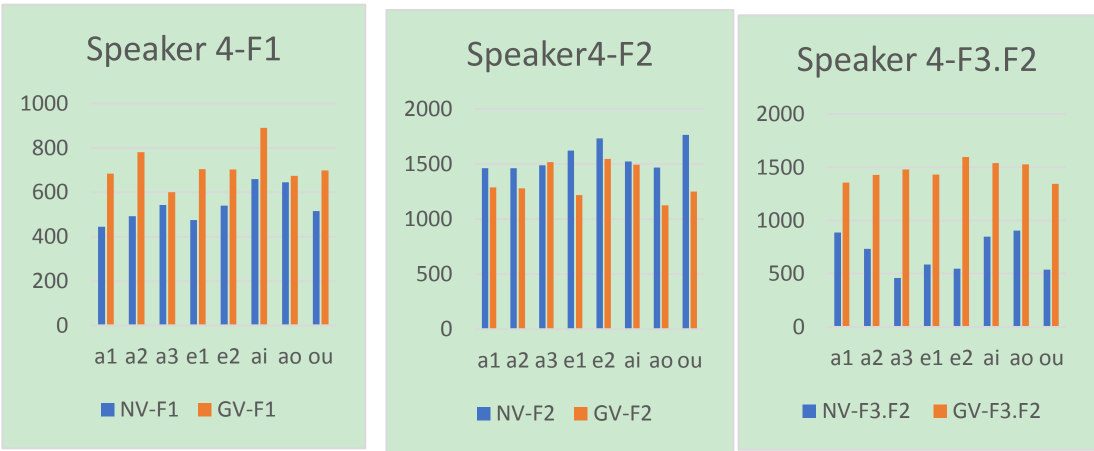
(8)c Formant values in the senior (female) speaker 3




(8)d Formant values in the senior (female) speaker 4




For F1, it seems the frequencies in [ŋ]+V context are lower in four senior speakers, with no deviation from this tendency. This is true for the eight vowel realizations, and supported by multiple paired t-tests across the four speakers. The specific details are presented in (9). For speaker 1, the mean differences between syllabic contexts are 296 HZ, 131 HZ, 154 HZ, 226 HZ, 319 HZ, 173 HZ, 192 HZ, 230 HZ, with all $p<0.05$. For speaker 2, the mean differences between syllabic contexts are smaller, with a less significant lower in the [ŋ]+V context. For speaker 3, the F1 significantly decreases in [ŋ]+V context, and the mean differences are 98 HZ, 136 HZ, 163 HZ, 214 HZ, 248 HZ, 217 HZ, 370 HZ, 208 HZ. For speaker 4, a significant lower in F1 is also observed in the context [ŋ]+V in eight vowel realizations, with $p<0.05$. That is, a significant ($p<0.05$) lower for F1 is unanimously attested in the [ŋ]+V structure among senior speakers.

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(9) Frequencies of F1 in [ŋ]+V and [g]+V in senior speakers

| *Pinyin* Labels | IPA | Token Count | Lower in NV | NV (HZ) | GV (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 555 | 851 | 296 | 0.0375 |
| a2 | [a] | 9 | 100% | 676 | 807 | 131 | 0.0472 |
| a3 | [ɑ] | 4 | 100% | 839 | 993 | 154 | 0.0301 |
| e1 | [ɤ] | 10 | 100% | 567 | 739 | 226 | 0.0093 |
| e1 | [ə] | 6 | 100% | 354 | 673 | 319 | 0.0148 |
| ai | [ai] | 8 | 100% | 811 | 984 | 173 | 0.0301 |
| ao | [ɑo] | 11 | 100% | 565 | 757 | 192 | 0.0325 |
| ou | [ou] | 9 | 100% | 396 | 626 | 230 | 0.0098 |
| | Speaker2 | | | | | | |
| a1 | [ʌ] | 3 | 100% | 779 | 877 | 78 | 0.0301 |
| a2 | [a] | 9 | 100% | 852 | 910 | 58 | 0.0398 |
| a3 | [ɑ] | 4 | 100% | 670 | 800 | 130 | 0.0452 |
| e1 | [ɤ] | 10 | 100% | 476 | 733 | 257 | 0.0106 |
| e1 | [ə] | 6 | 100% | 666 | 780 | 114 | 0.0369 |
| ai | [ai] | 8 | 100% | 712 | 838 | 126 | 0.0402 |
| ao | [ɑo] | 11 | 100% | 655 | 758 | 103 | 0.0307 |
| ou | [ou] | 9 | 100% | 534 | 756 | 222 | 0.0086 |
| | Speaker3 | | | | | | |
| a1 | [ʌ] | 3 | 100% | 779 | 877 | 98 | 0.0301 |
| a2 | [a] | 9 | 100% | 718 | 854 | 136 | 0.0428 |
| a3 | [ɑ] | 4 | 100% | 597 | 760 | 163 | 0.0426 |
| e1 | [ɤ] | 10 | 100% | 549 | 763 | 214 | 0.0095 |
| e1 | [ə] | 6 | 100% | 450 | 698 | 248 | 0.0174 |
| ai | [ai] | 8 | 100% | 569 | 786 | 217 | 0.0325 |
| ao | [ɑo] | 11 | 100% | 486 | 856 | 370 | 0.0202 |
| ou | [ou] | 9 | 100% | 522 | 730 | 208 | 0.0397 |
| | Speaker4 | | | | | | |
| a1 | [ʌ] | 3 | 100% | 444 | 684 | 240 | 0.0301 |
| a2 | [a] | 9 | 100% | 491 | 780 | 289 | 0.0382 |
| a3 | [ɑ] | 4 | 100% | 542 | 600 | 58 | 0.0423 |
| e1 | [ɤ] | 10 | 100% | 474 | 704 | 230 | 0.0378 |
| e1 | [ə] | 6 | 100% | 540 | 703 | 163 | 0.0079 |
| ai | [ai] | 8 | 100% | 659 | 891 | 232 | 0.0125 |
| ao | [ɑo] | 11 | 100% | 645 | 674 | 29 | 0.0476 |
| ou | [ou] | 9 | 100% | 515 | 698 | 183 | 0.0387 |

Turning to the frequencies of F2, it seems F2s in the [ŋ]+V structure are generally higher in four speakers. According to the multiple paired t-tests in (10), we can see for speaker 1, speaker 2, and speaker 4, a significant ($p<0.05$) higher F2 in the [ŋ]+V structure is examined in 100% of the tokens. However, deviation is found in speaker 3: only 50% of the tokens with [ə] (labeled e2), and 36.36% of the tokens with [ɑo] (labeled ao), show a non-significant ($p>0.05$) higher F2 in the [ŋ]+V context. However, a significant ($p<0.05$) lower F2 is found with [ai] in [ŋ]-V context, although 37.5% of the tokens have a higher F2 in the [ŋ]+V context. That is, three of the senior speakers produce a significant ($p<0.05$) higher F2 in the [ŋ]+V context, with a deviation in speaker 3.

(10) Frequencies of F2 in contexts [ŋ]+V and [g]+V

| *Pinyin* Labels | IPA | Token Count | Higher in NV | NV (HZ) | GV (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 1456 | 1021 | 435 | 0.0255 |
| a2 | [a] | 9 | 100% | 1447 | 1045 | 402 | 0.0262 |
| a3 | [ɑ] | 4 | 100% | 1462 | 1193 | 269 | 0.0394 |
| e1 | [ɤ] | 10 | 100% | 1093 | 839 | 254 | 0.0391 |
| e2 | [ə] | 6 | 100% | 1315 | 973 | 342 | 0.0248 |
| ai | [ai] | 8 | 100% | 1278 | 1080 | 198 | 0.0401 |
| ao | [ɑo] | 11 | 100% | 951 | 726 | 225 | 0.0371 |
| ou | [ou] | 9 | 100% | 1342 | 854 | 488 | 0.0194 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 1368 | 1075 | 293 | 0.0393 |
| a2 | [a] | 9 | 100% | 1386 | 1075 | 311 | 0.0302 |
| a3 | [ɑ] | 4 | 100% | 1455 | 1139 | 316 | 0.0473 |
| e1 | [ɤ] | 10 | 100% | 1430 | 1065 | 365 | 0.0205 |
| e2 | [ə] | 6 | 100% | 1415 | 1246 | 169 | 0.0373 |
| ai | [ai] | 8 | 100% | 1410 | 1272 | 138 | 0.0406 |
| ao | [ɑo] | 11 | 100% | 1411 | 985 | 426 | 0.0381 |
| ou | [ou] | 9 | 100% | 1446 | 1020 | 426 | 0.0284 |
| Speaker3 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 1386 | 1075 | 311 | 0.0345 |
| a2 | [a] | 9 | 100% | 1410 | 1219 | 191 | 0.0409 |
| a3 | [ɑ] | 4 | 100% | 1469 | 1130 | 339 | 0.0434 |
| e1 | [ɤ] | 10 | 100% | 1422 | 1004 | 418 | 0.0164 |
| **e2** | **[ə]** | **6** | **50%** | **1416** | **1389** | **27** | **0.0853** |
| **ai** | **[ai]** | **8** | **37.5%** | **1403** | **1689** | **289** | **0.0458** |
| **ao** | **[ɑo]** | **11** | **36.36%** | **1413** | **1243** | **170** | **0.0843** |
| ou | [ou] | 9 | 100% | 1475 | 1150 | 325 | 0.0391 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 1463 | 1287 | 176 | 0.0254 |
| a2 | [a] | 9 | 100% | 1462 | 1280 | 182 | 0.0306 |
| a3 | [ɑ] | 4 | 100% | 1489 | 1217 | 272 | 0.0371 |
| e1 | [ɤ] | 10 | 100% | 1621 | 1217 | 404 | 0.0481 |
| e2 | [ə] | 6 | 100% | 1733 | 1547 | 186 | 0.0179 |
| ai | [ai] | 8 | 100% | 1523 | 1494 | 29 | 0.0205 |
| ao | [ɑo] | 11 | 100% | 1467 | 1129 | 338 | 0.0371 |
| ou | [ou] | 9 | 100% | 1764 | 1250 | 514 | 0.0326 |

After reporting the F1, F2, the frequencies of pinch value (i.e., F3-F2) are compared. We will expect no significant differences between these two contexts, since the vowels in both contexts are preceded by a velar segment (either [ŋ] or [g]). However, it seems the pinch values are lower in the [ŋ]+V context, indicating a stronger velar pinch in [ŋ]-V context. The multiple paired t-tests further support this result, as seen in (11). For all of the four speakers, the mean differences between contexts do show a significant ($p<0.05$) lower in the [ŋ]+V context. Only 50% of the tokens with [a] (labelled a3) in speaker 3 are lower in the [ŋ]+V context, but it does not influence the significant ($p=0.0493$) decreasing tendency in speaker 3.

(11) Values of Velar Pinch (F3-F2) in contexts [ŋ]+V and [g]+V

| *Pinyin* Labels | IPA | Token Count | Smaller in NV | NV (HZ) | GV (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 861 | 1018 | 157 | 0.0371 |
| a2 | [a] | 9 | 100% | 582 | 997 | 415 | 0.0416 |
| a3 | [ɑ] | 4 | 100% | 300 | 852 | 552 | 0.0285 |
| e1 | [ɤ] | 10 | 100% | 853 | 1096 | 243 | 0.0318 |
| e2 | [ə] | 6 | 100% | 872 | 1140 | 268 | 0.0287 |
| ai | [ai] | 8 | 100% | 647 | 975 | 328 | 0.0403 |
| ao | [ɑo] | 11 | 100% | 824 | 1102 | 278 | 0.0306 |
| ou | [ou] | 9 | 100% | 632 | 1099 | 467 | 0.0191 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 870 | 1144 | 274 | 0.0386 |
| a2 | [a] | 9 | 100% | 870 | 1144 | 274 | 0.0305 |
| a3 | [ɑ] | 4 | 100% | 1038 | 1354 | 316 | 0.0476 |
| e1 | [ɤ] | 10 | 100% | 1150 | 1299 | 149 | 0.0225 |
| e2 | [ə] | 6 | 100% | 567 | 864 | 297 | 0.0354 |
| ai | [ai] | 8 | 100% | 684 | 1205 | 521 | 0.0405 |
| ao | [ɑo] | 11 | 100% | 746 | 1176 | 430 | 0.0372 |
| ou | [ou] | 9 | 100% | 620 | 1497 | 877 | 0.0242 |
| Speaker3 | | | | | | | |

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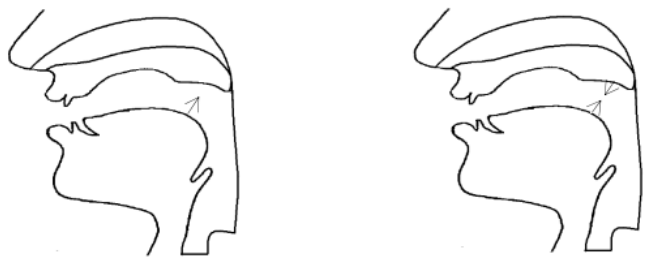
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a1 | [ʌ] | 3 | 100% | 870 | 1144 | 274 | 0.0305 |
| a2 | [a] | 9 | 100% | 1006 | 1204 | 198 | 0.0372 |
| a3 | [ɑ] | 2 | 50% | 1077 | 1299 | 222 | 0.0493 |
| e1 | [ɤ] | 10 | 100% | 1176 | 1151 | 25 | 0.0345 |
| e2 | [ə] | 6 | 100% | 706 | 1090 | 384 | 0.0207 |
| ai | [ai] | 8 | 100% | 715 | 1575 | 860 | 0.0412 |
| ao | [ɑo] | 11 | 100% | 911 | 1176 | 265 | 0.0382 |
| ou | [ou] | 9 | 100% | 805 | 1373 | 568 | 0.0421 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 886 | 1156 | 270 | 0.0236 |
| a2 | [a] | 9 | 100% | 733 | 929 | 196 | 0.0317 |
| a3 | [ɑ] | 4 | 100% | 458 | 1078 | 620 | 0.0097 |
| e1 | [ɤ] | 10 | 100% | 586 | 930 | 344 | 0.0364 |
| e2 | [ə] | 6 | 100% | 546 | 1096 | 550 | 0.0284 |
| ai | [ai] | 8 | 100% | 846 | 1038 | 192 | 0.0392 |
| ao | [ɑo] | 11 | 100% | 903 | 1126 | 223 | 0.0316 |
| ou | [ou] | 9 | 100% | 538 | 1145 | 607 | 0.0358 |

A remaining question arises immediately: why does [ŋ] have a more velarizing effect than [g], although both are velar segments? One of the possible explanations may be due to the different articulations between the velar plosive and velar nasal. For the velar plosive [g], the tongue dorsum raises during the articulation, which constrict the dorsum near the velum. However, for the velar nasal [ŋ], the tongue dorsum raises during the articulation, and the velum also lowers, and these two factors contribute to the velar effect, as seen in (12a) (Baker et al. 2008). That is, the velar nasal [ŋ] is ‘more velar’ than the velar plosive [g], resulted from the double articulation factors.

(12)a Articulation differences between the velar plosive and the velar nasal (Baker et al. 2008: 61)



a. [g]: constriction by dorsum near velum    b. [ŋ]: constriction by dorsum *and* velum

The similar explanation is found in the different realizations of short-*a*, before oral voiced stops, before [m] and [n], and before the velar nasal in Western American English (Baker et al. 2008). The spectrogram in (12b) shows the velar pinch of short-*a* before [ŋ] is more enlarged, when compared the formant trajectories of short-*a* before [g]. In the right figure, we can see the velar

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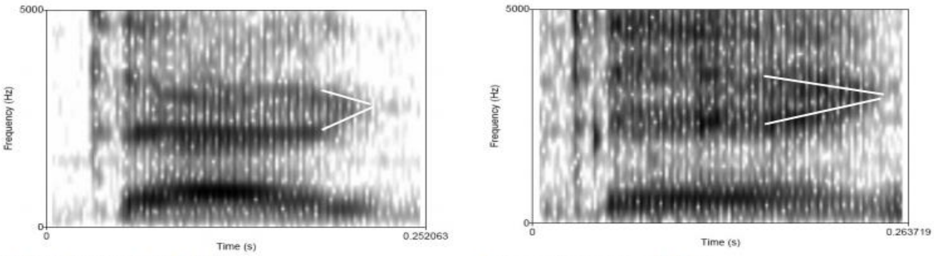
pinch starts almost from the midpoint of the vowel in the short-*a* right before [ŋ], which indicates a stronger velar effect acoustically.

(12)b Velar pinches of vowel preceding velar plosive and velar nasal (Baker et al. 2008: 61)




a. spectrogram of *dag* b. spectrogram of *dang*

Here I adopt the idea and propose that the initial [ŋ] is more velar than initial [g] in Zhengding dialect. So it is not surprising there is a smaller pinch values in [ŋ]-V structure, which indicates a stronger velar effect in the minimal pairs.

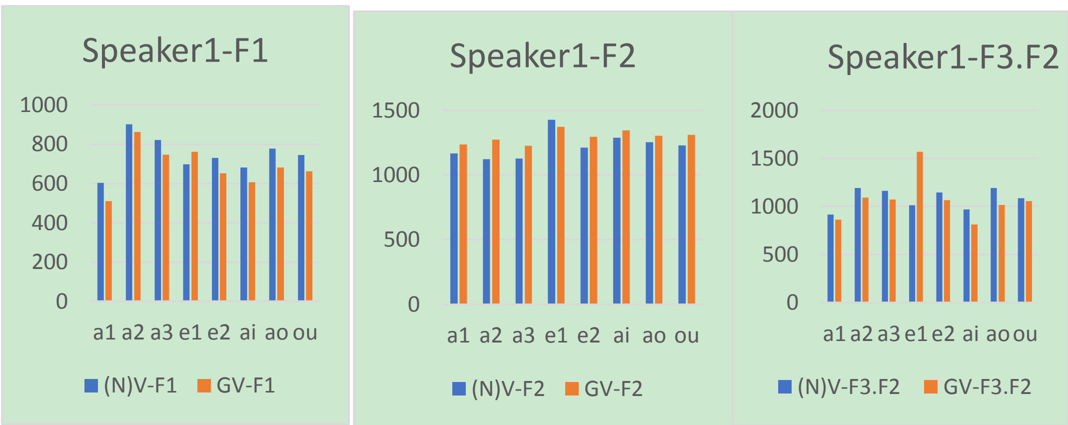
**Summary of Experiment I:** based on the F1, F2 and the pinch values between contexts, three acoustic characteristics are calculated in the traditional [ŋ]-V context in senior speakers: a lower F1, a higher F2, and a small F3-F2 value (indicating a strong velar effect).

For my purpose, in the following experiment, I will test whether the younger generation shows the same speech pattern reported above for the seniors.

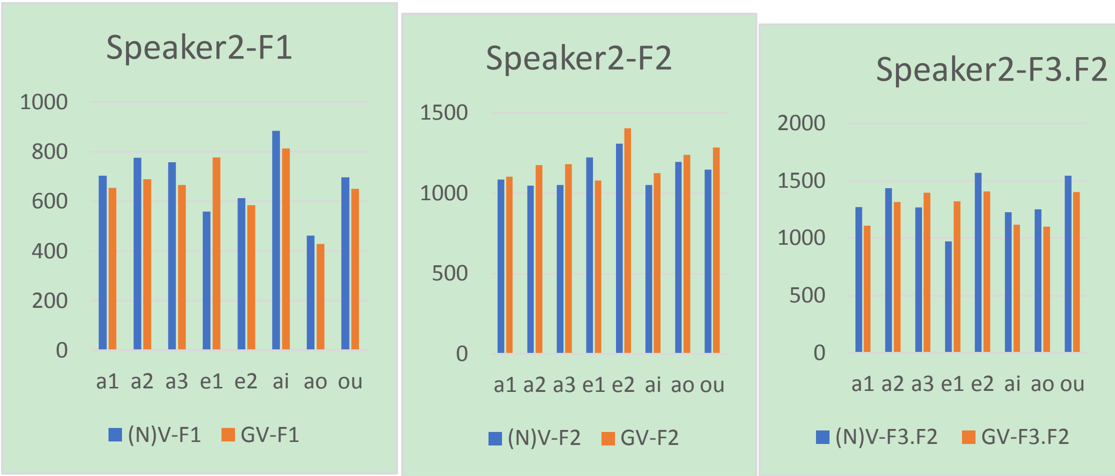
*5.2 Experiment II: Nasal Deletion in Young Patterns*

This section focuses on the phonetic characteristics of younger speakers, examining whether the onset [ŋ] is also present in their speeches. 60 items in ([ŋ]-)V and [g]-V structures are produced by four young speakers (2 males and 2 females). The mean frequencies of F1, F2, and velar pinch (F3-F2) in [ʌ, ɑ, a, ɤ, ə, ai, ɑo, ou] are plotted in (13), with the *pinyin* labels "a1, a2, a3, e1, e2, ai, ao, ou".

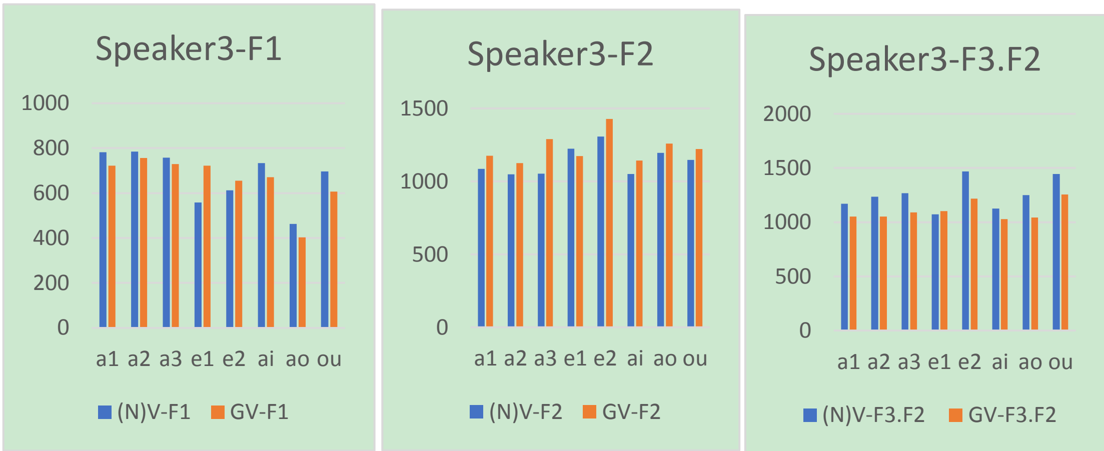
(13)a Formant values in the young (male) speaker 1



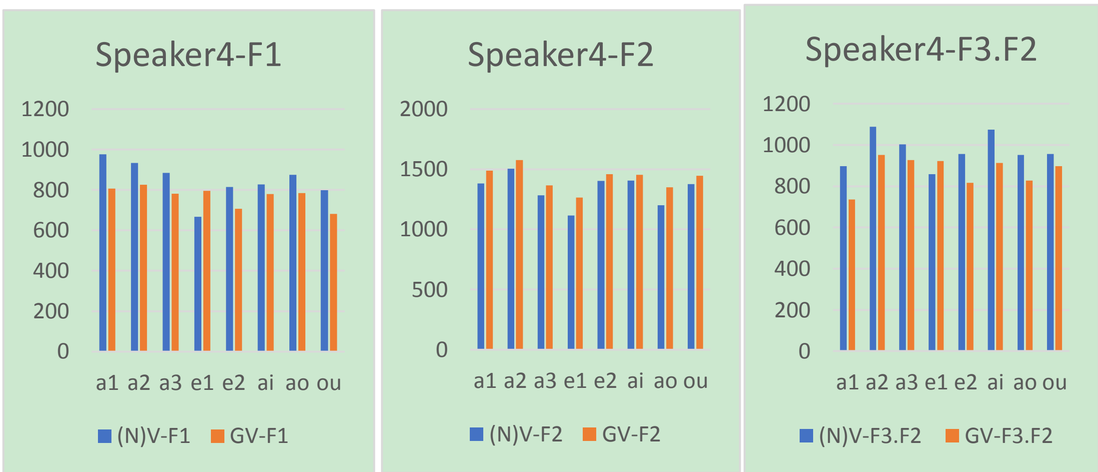
(13)b Formant values in the young (male) speaker 2




(13)c Formant values in the young (female) speaker 3




(13)d Formant values in the young (female) speaker 4




If the younger generation has the similar speech pattern with the senior group, then we may expect the same frequency in F1, F2, and the velar pinch between the two generations. If the younger generation has different patterns from the senior group, then different frequencies in F1, F2, and the velar pinch are supposed to be observed.

For F1, it seems the frequencies in the traditional [ŋ]-V context are not lowered, as the senior pattern. Instead, a significant ($p<0.05$) higher F1 is found in [ʌ, ɑ, a, ə, ɑi, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou) in the traditional [ŋ]-V context. A deviation is found in [ɤ] (labeled e1, in the bold fonts): without significant difference between the two syllabic structures across four younger speakers ($p>0.05$), as seen in (14).

(14) Frequencies of F1 in contexts [ŋ]+V and [g]+V in young speakers

| *Pinyin* Labels | IPA | Token Count | Lower in NV | NV (HZ) | GV (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 603 | 510 | 93 | 0.0475 |
| a2 | [a] | 9 | 22.22% | 902 | 862 | 40 | 0.0472 |
| a3 | [ɑ] | 4 | 25% | 821 | 747 | 74 | 0.0401 |
| **e1** | [ɤ] | 10 | **30%** | **697** | **761** | **64** | **0.0534** |
| e2 | [ə] | 6 | 16.67% | 731 | 652 | 79 | 0.0348 |
| ai | [ai] | 8 | 50% | 682 | 607 | 75 | 0.0310 |
| ao | [ɑo] | 11 | 18.18% | 778 | 682 | 96 | 0.0432 |
| ou | [ou] | 9 | 22.22% | 745 | 662 | 83 | 0.0198 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 33.3% | 703 | 654 | 49 | 0.0302 |
| a2 | [a] | 9 | 22.22% | 775 | 689 | 86 | 0.0297 |
| a3 | [ɑ] | 4 | 50% | 757 | 666 | 91 | 0.0354 |
| **e1** | [ɤ] | 10 | **30%** | **558** | **777** | **219** | **0.0611** |
| e2 | [ə] | 6 | 33.33% | 613 | 584 | 29 | 0.0364 |
| ai | [ai] | 8 | 25% | 884 | 813 | 71 | 0.0131 |
| ao | [ɑo] | 11 | 27.27% | 462 | 428 | 34 | 0.0485 |
| ou | [ou] | 9 | 33.33% | 696 | 651 | 45 | 0.0401 |
| Speaker3 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 781 | 722 | 59 | 0.0224 |
| a2 | [a] | 9 | 33.33% | 785 | 755 | 30 | 0.0143 |
| a3 | [ɑ] | 4 | 25% | 757 | 729 | 28 | 0.0274 |
| **e1** | [ɤ] | 10 | **25%** | **558** | **722** | **164** | **0.0691** |
| e2 | **[ə]** | **3** | 30% | 613 | 655 | 42 | 0.0345 |
| ai | **[ai]** | **3** | 33.33% | 734 | 670 | 64 | 0.0463 |
| ao | **[ɑo]** | **11** | 18.18% | 462 | 403 | 59 | 0.0111 |
| ou | [ou] | 9 | 33.33% | 696 | 606 | 90 | 0.0321 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 976 | 806 | 170 | 0.0311 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a2 | [a] | 9 | 33.33% | 993 | 826 | 167 | 0.0324 |
| a3 | [ɑ] | 4 | 25% | 884 | 781 | 103 | 0.0452 |
| **e1** | [ɤ] | 10 | **30%** | **667** | **795** | **128** | **0.1351** |
| e2 | [ə] | 6 | 20% | 814 | 706 | 108 | 0.0116 |
| ai | [ai] | 8 | 25% | 827 | 779 | 48 | 0.0452 |
| ao | [ɑo] | 11 | 27.27% | 874 | 783 | 91 | 0.0365 |
| ou | [ou] | 9 | 33.33% | 798 | 681 | 117 | 0.0481 |

Up to now, a different pattern in F1 is found in the younger generation, except for [ɤ] (labelled e1). Based on this, we may tentatively assume the younger speakers do not produce with the initial [ŋ], at least based on the evidence of F1. If this assumption is acceptable, then we may further expect a different pattern should be observed in F2 and pinch values in the younger group.

For F2, differing from the senior speakers, a significant ($p<0.05$) lower frequency is found in [ŋ]-V context in [ʌ, ɑ, a, ə, ai, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou). A deviation is found in [ɤ] (labelled e1, in bold fonts), with no significant difference between contexts across four speakers. This is true and supported by the multiple paired t-tests across the speakers in (15).

(15) Frequencies of F2 in [ŋ]+V and [g]+V in younger speakers

| *Pinyin* Labels | IPA | Token Count | Higher in NV | Traditional NV (HZ) | GV (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 1166 | 1234 | 68 | 0.0451 |
| a2 | [a] | 9 | 33.33% | 1122 | 1272 | 150 | 0.0302 |
| a3 | [ɑ] | 4 | 0% | 1126 | 1226 | 100 | 0.0245 |
| **e1** | [ɤ] | 10 | **20%** | **1426** | **1371** | **55** | **0.0891** |
| e2 | [ə] | 6 | 33.33% | 1210 | 1295 | 85 | 0.0352 |
| ai | [ai] | 8 | 25% | 1288 | 1345 | 57 | 0.0107 |
| ao | [ɑo] | 11 | 27.27% | 1253 | 1301 | 48 | 0.0228 |
| ou | [ou] | 9 | 33.33% | 1227 | 1310 | 83 | 0.0459 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 66.66% | 1085 | 1103 | 18 | 0.0191 |
| a2 | [a] | 9 | 22.22% | 1048 | 1174 | 126 | 0.0102 |
| a3 | [ɑ] | 4 | 25% | 1052 | 1180 | 128 | 0.0477 |
| **e1** | [ɤ] | 10 | **20%** | **1224** | **1079** | **145** | **0.1309** |
| e2 | [ə] | 6 | 33.33% | 1307 | 1403 | 96 | 0.0462 |
| ai | [ai] | 8 | 25% | 1050 | 1125 | 75 | 0.0201 |
| ao | [ɑo] | 11 | 18.18% | 1194 | 1239 | 45 | 0.0222 |
| ou | [ou] | 9 | 22.22% | 1146 | 1284 | 138 | 0.0285 |
| Speaker3 | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a1 | [ʌ] | 3 | 33.33% | 1085 | 1176 | 91 | 0.0446 |
| a2 | [a] | 9 | 66.66% | 1048 | 1124 | 76 | 0.0409 |
| a3 | [ɑ] | 4 | 25% | 1052 | 1289 | 237 | 0.0436 |
| **e1** | [ɤ] | 10 | **50%** | **1224** | **1172** | **52** | **0.0967** |
| e2 | **[ə]** | **3** | 33.33% | 1307 | 1428 | 121 | 0.0287 |
| ai | **[ai]** | **3** | 33.33% | 1050 | 1142 | 92 | 0.0174 |
| ao | **[ɑo]** | **11** | 18.18% | 1194 | 1259 | 65 | 0.0439 |
| ou | [ou] | 9 | 33.33% | 1146 | 1222 | 76 | 0.0492 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 66.66% | 1381 | 1489 | 108 | 0.0157 |
| a2 | [a] | 9 | 66.66% | 1504 | 1575 | 71 | 0.0107 |
| a3 | [ɑ] | 4 | 75% | 1284 | 1366 | 82 | 0.0478 |
| **e1** | [ɤ] | 10 | **20%** | **1115** | **1266** | **151** | **0.0886** |
| e2 | [ə] | 6 | 33.33% | 1402 | 1459 | 57 | 0.0278 |
| ai | [ai] | 8 | 25% | 1404 | 1455 | 51 | 0.0203 |
| ao | [ɑo] | 11 | 36.36% | 1201 | 1350 | 149 | 0.0473 |
| ou | [ou] | 9 | 33.33% | 1377 | 1445 | 68 | 0.0327 |

The significant ($p<0.05$) lower in [ʌ, ɑ, a, ə, ai, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou) in the traditional [ŋ]-V context is consistent with the assumption that the initial [ŋ] has been deleted in the younger generation. When we compare the initial-deleted and the [g]-V context, it is not surprising to see a raising F2 in the [g]-V context-an effect usually caused by the lowering of the tongue body, during the articulation.

Turning to the velar pinch (F3-F2), if the younger generation has lost the initial velar nasal, then the two generations should not have the same patterns for the velar pinch. If the younger speakers have retained the nasal, they should show a similar pattern with the older group. Differing from the senior patterns, the result shows an increasing tendency of the pinch values in [ʌ, ɑ, a, ə, ai, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou) in the traditional [ŋ]-V context. A deviation is seen in [ɤ] (labelled e1), with no significant difference in speaker 1, speaker 2, and speaker 4, but a significant difference in speaker 3. The multiple paired t-tests in (16) support the observation. This result is also consistent with the assumption that the initial [ŋ] has disappeared in the younger speakers, except for [ɤ] (labelled e1). When compared the initial-deleted context, the smaller pinch value in the [g]-V context, indicating a stronger velar effect, is attributed to the lowering of the tongue dorsum, during the articulation.

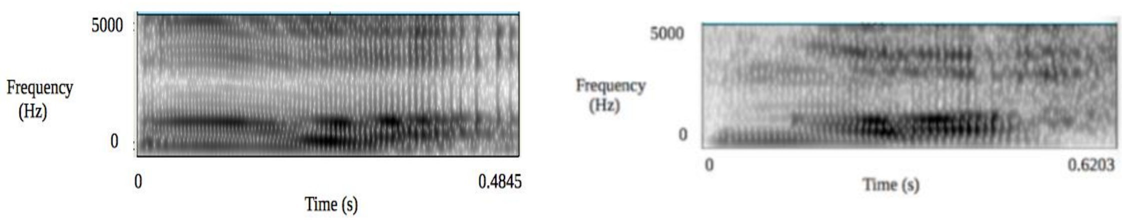
(16) Frequencies of velar pinch (F3-F2) in [ŋ]+V and [g]+V in younger speakers

| *Pinyin* Labels | IPA | Token Count | smaller in NV | Traditional NV (HZ) | GV (HZ) | Mean Difference (HZ) | p-value |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 0% | 916 | 862 | 54 | 0.0457 |
| a2 | [a] | 9 | 33.33% | 1192 | 1091 | 101 | 0.0205 |
| a3 | [ɑ] | 4 | 25% | 1161 | 1072 | 89 | 0.0203 |
| **e1** | **[ɤ]** | **10** | **25%** | **1010** | **1566** | **556** | **0.0985** |
| e2 | [ə] | 6 | 33.33% | 1143 | 1065 | 78 | 0.0437 |
| ai | [ai] | 8 | 25% | 968 | 810 | 158 | 0.0115 |
| ao | [ɑo] | 11 | 18.18% | 1192 | 1015 | 177 | 0.0158 |
| ou | [ou] | 9 | 33.33% | 1083 | 1054 | 29 | 0.0281 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 66.66% | 1270 | 1109 | 161 | 0.0404 |
| a2 | [a] | 9 | 22.22% | 1436 | 1315 | 121 | 0.0262 |
| a3 | [ɑ] | 4 | 25% | 1269 | 1396 | 127 | 0.0329 |
| **e1** | [ɤ] | 10 | **10%** | **972** | **1321** | **349** | **0.0848** |
| e2 | [ə] | 6 | 16.67% | 1569 | 1407 | 162 | 0.0473 |
| ai | [ai] | 8 | 37.5% | 1226 | 1117 | 109 | 0.0145 |
| ao | [ɑo] | 11 | 27.27% | 1251 | 1101 | 150 | 0.0113 |
| ou | [ou] | 9 | 33.33% | 1544 | 1403 | 141 | 0.0115 |
| Speaker3 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 1170 | 1051 | 119 | 0.0337 |
| a2 | [a] | 9 | 33.33% | 1236 | 1051 | 185 | 0.0319 |
| a3 | [ɑ] | 4 | 25% | 1269 | 1089 | 31 | 0.0346 |
| e1 | [ɤ] | 10 | 25% | 1072 | 1103 | 31 | 0.0366 |
| e2 | **[ə]** | **6** | 33.33% | 1469 | 1216 | 253 | 0.0451 |
| ai | **[ai]** | **8** | 50% | 1251 | 1029 | 222 | 0.0146 |
| ao | **[ɑo]** | **11** | 9.09% | 1126 | 1042 | 84 | 0.0414 |
| ou | [ou] | 9 | 44.44% | 1444 | 1255 | 189 | 0.0481 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 0% | 896 | 735 | 161 | 0.0312 |
| a2 | [a] | 9 | 33.33% | 1088 | 951 | 137 | 0.0314 |
| a3 | [ɑ] | 4 | 25% | 1003 | 926 | 77 | 0.0131 |
| **e1** | [ɤ] | 10 | **0%** | **857** | **921** | **64** | **0.1457** |
| e2 | [ə] | 6 | 33.33% | 956 | 816 | 140 | 0.0383 |
| ai | [ai] | 8 | 25% | 1074 | 912 | 162 | 0.0392 |
| ao | [ɑo] | 11 | 45.45% | 951 | 827 | 124 | 0.0361 |
| ou | [ou] | 9 | 33.33% | 955 | 897 | 58 | 0.0166 |

Turning to deviational [ɤ] (labelled e1), the pinch values do not have any significant difference between the traditional [ŋ]-V context and the [g]-V context. This may suggest that the velar (nasal) effect is still retained upon this vowel in the younger generation, since both contexts have a velar segment, or have features upon a velar segment.

When further observing the spectrogram trajectories in [ɤ] in the younger group, we cannot obviously visualize the low-frequency of the nasal preceding the darker vowel bands on the spectrogram, as seen in left figure in (17). However, in the senior group, a comparatively obvious low-frequency transition is found preceding the vowel bands, as seen in the right spectrogram in (17).

(17). Vowel [ɤ] in the traditional NV words in the younger (left) and senior (right) speakers




In this study, I tentatively hypothesize a fusion process occurs between the initial nasal [ŋ] and the subsequent vowel [ɤ], contributing to the nasalized vowel [ɤ̃] in the younger Zhengding dialect. This hypothesis is mainly based on two empirical observations on [ɤ]: (a) no low-frequency of the initial nasal is obviously visualized on the spectrograms; (b) three established nasal effects are still tested on this vowel: a lower F1, higher F2, and smaller velar pinch values, when compared with the [g]-V context. That is, the nasal effects are attached on the subsequent vowel [ɤ], and then the initial nasal [ŋ] has been deleted in the younger Zhengding dialect. The fusion in this study covers two phonological processes: nasalization of the vowel, followed by deletion of the initial nasal. The fusion on [ɤ̃] does not occur systematically in other vowels (or vowel realizations) in Zhengding dialect, and the number of the distinctive sounds in this dialect is not changed, so this sound change is a non-phonemic (allophonic) change.

However, it is sometimes difficult to attest whether it is a nasalized vowel resulted from the fusion (such as [ɤ̃] in the younger Zhengding speakers), or an oral vowel in nasal coupling (such as [ŋ]+[ɤ] in the senior speakers in Zhengding dialect). Ohala (1975) discussed the acoustic similarity between nasal vowels and velar nasals. Ohala argued that nasal vowels and velar nasals share more acoustic similarity than they are with labial or coronal nasals. Although nasals are produced with closure of the oral cavity, and the sound is radiated through the nasal cavity, the coronal and labial nasals are different from the velar nasal in manner of articulation. For instance, [m] and [n] are produced as a side branch in the vocal tract, which can form a low-frequency zeros or anti-formants. However, the velar nasal [ŋ] does not have obvious acoustic anti-formants, which makes [ŋ] more similar to vowels in the spectrum than nasals [m] and [n] (Ohala 1975; Mackenzie, et. al. 2007: 535). Alternatively speaking, if the nasal vowels are misperceived as a nasal, the nasal is highly supposed to be a velar nasal (Mackenzie, et. al. 2007: 535), rather than coronal or labial nasals.

Following Ohala (1975), I hypothesize the nasalized vowel (such as [ɤ̃] in the younger Zhengding speakers), are also not that easy to distinguish from the oral vowel in nasal coupling (such as [ɤ] in [ŋ]+[ɤ] structure in the senior Zhengding dialect), since the low-frequency anti-formants usually cannot be visualized on the spectrograms.

**Summary of Experiment II:** in this experiment, different speech patterns on F1, F2, and velar pinch are examined in the younger generation. The multiple paired t-tests indicate the initial velar nasal [ŋ] is not characterized in [ʌ, ɑ, a, ə, ai, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou) in the younger Zhengding dialect. The deviation is found in [ɤ] (labelled e1), in which a fusion (Note 5) process is proposed, with the nasal effects retained upon the vowels.

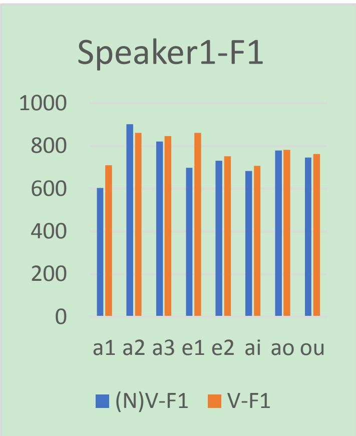
Considering the differences between the senior and the younger speakers in experiment I and experiment II, we can see the younger generation does not have the similar pattern with the senior speakers. However, a deviation is found in [ɤ] (labelled e1): the nasal effects are examined in both generations.

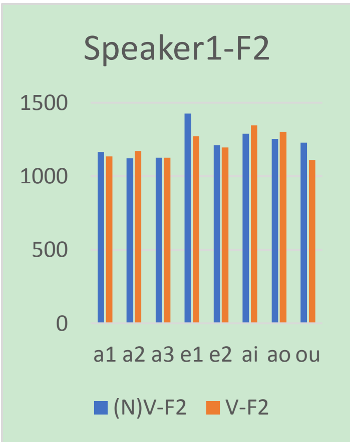
A question may be further asked: what is the socio-variationist factors, related to the generational differences in Zhengding dialect? Is this relevant to the dialect contact with Mandarin Chinese, the dominant official language, spoken in China. The following experiment will mainly focus on this issue.

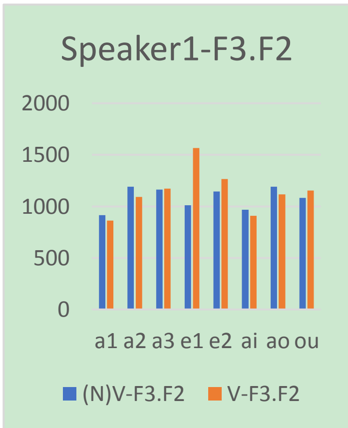
### *5.3 Experiment III: Dialect Contact in Young Patterns*

In this section, 60 items with vowel realizations [ʌ, a, ɑ, ɤ, ə, ai, ɑo, ou] are respectively produced by the young speakers in Zhengding dialect and Mandarin. The goal is to investigate whether the younger Zhengding dialect has the same speech pattern in Mandarin, and finally contributes the generational variation in Zhengding dialect. The frequencies of F1, F2 and velar pinch (F3-F2) are compared in (18), with the *pinyin* labels “a1, a2, a3, e1, e2, ai, ao, ou” between two contexts.

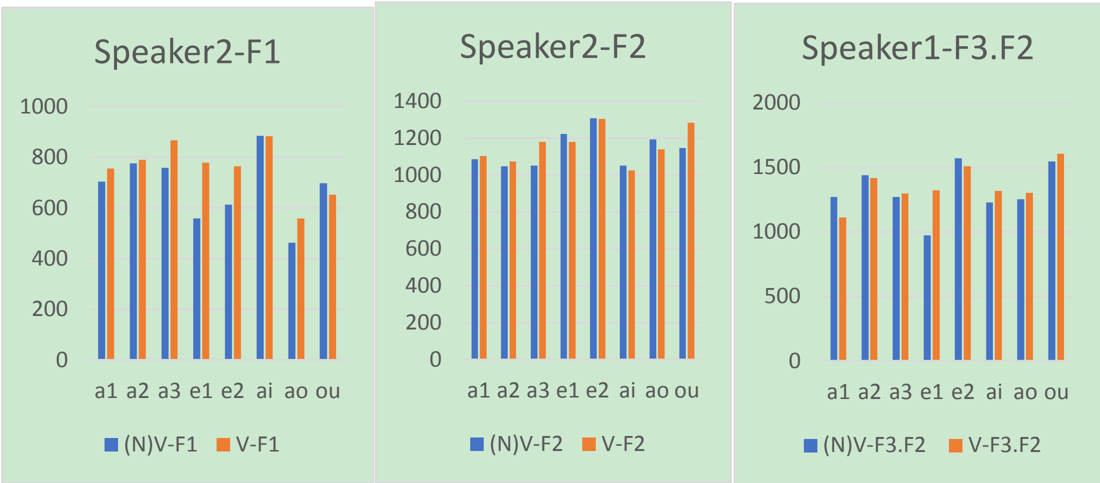
(18)a Formant values in young (male) speaker 1



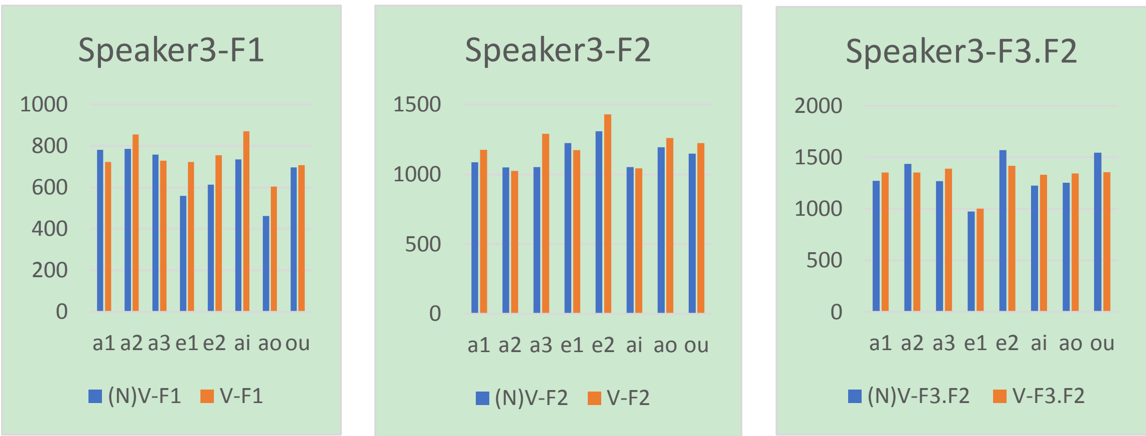



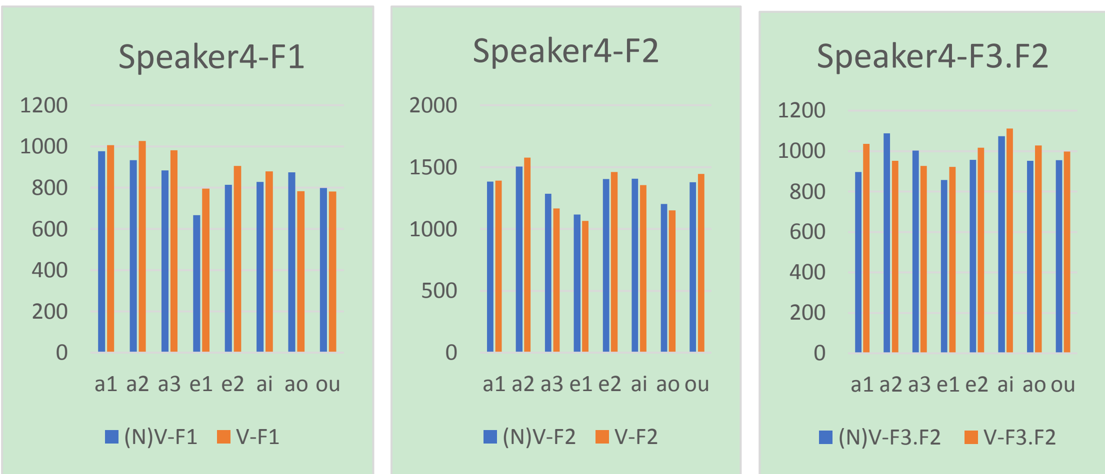
(18)b Formant values in young (male) speaker 2




(18)c Formant values in young (female) speaker 3




(18)d Formant values in young (female) speaker 4




For F1, it seems no obvious difference between the zero-initial in Mandarin and the traditional '[ŋ]-V' context in Zhengding dialect (i.e., deleted-initial as argued in Experiment

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II). The multiple paired t-tests do not indicate significant differences between these two contexts, with p>0.05, as seen in (19). A deviation is found in [ɤ] (labelled e1), in which the mean differences between contexts are 164 HZ (p=0.0337) for speaker 1, 219 HZ (p=0.0366) for speaker 2, 164 HZ (p=0.0493) for speaker 3, and 128 HZ (p=0.0402) for speaker 4. To sum up, a similar pattern between contexts are largely tested, except for [ɤ].

(19) Frequencies of F1 in Zhengding younger dialect and Mandarin

| *Pinyin* Labels | IPA | Token Count | Lower in traditional NV | Traditional NV in dialect (HZ) | V in Mandarin (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 603 | 710 | 107 | 0.0512 |
| a2 | [a] | 9 | 44.44% | 902 | 862 | 40 | 0.06142 |
| a3 | [ɑ] | 4 | 50% | 821 | 847 | 26 | 0.0602 |
| **e1** | **[ɤ]** | **10** | **100%** | **697** | **861** | **164** | **0.0337** |
| e2 | [ə] | 6 | 83.33% | 731 | 752 | 21 | 0.0657 |
| ai | [ai] | 8 | 75% | 682 | 707 | 25 | 0.0606 |
| ao | [ɑo] | 11 | 81.82% | 778 | 782 | 2 | 0.0511 |
| ou | [ou] | 9 | 77.78% | 745 | 762 | 17 | 0.0108 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 33.3% | 703 | 754 | 51 | 0.0601 |
| a2 | [a] | 9 | 88.89% | 775 | 789 | 14 | 0.0558 |
| a3 | [ɑ] | 4 | 25% | 757 | 866 | 109 | 0.0504 |
| **e1** | [ɤ] | 10 | **80%** | **558** | **777** | **219** | **0.0366** |
| e2 | [ə] | 6 | 83.33% | 613 | 764 | 151 | 0.0621 |
| ai | [ai] | 8 | 62.5% | 884 | 883 | 1 | 0.1917 |
| ao | [ɑo] | 11 | 63.64% | 462 | 558 | 96 | 0.0535 |
| ou | [ou] | 9 | 55.56% | 696 | 651 | 45 | 0.0933 |
| Speaker3 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 781 | 722 | 59 | 0.0624 |
| a2 | [a] | 9 | 66.67% | 785 | 855 | 70 | 0.0843 |
| a3 | [ɑ] | 4 | 0% | 757 | 729 | 28 | 0.1074 |
| **e1** | [ɤ] | 10 | **50%** | **558** | **722** | **164** | **0.0493** |
| e2 | [ə] | 6 | 66.67% | 613 | 755 | 142 | 0.0502 |
| ai | [ai] | 8 | 87.5% | 734 | 870 | 136 | 0.0555 |
| ao | [ɑo] | 11 | 81.82% | 462 | 603 | 141 | 0.0658 |
| ou | [ou] | 9 | 77.78% | 696 | 706 | 10 | 0.0855 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 976 | 1006 | 30 | 0.0512 |
| a2 | [a] | 9 | 77.78% | 993 | 1026 | 33 | 0.0645 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a3 | [ɑ] | 4 | 25% | 884 | 981 | 97 | 0.0589 |
| **e1** | [ɤ] | 10 | **80%** | **667** | **795** | **128** | **0.0402** |
| e2 | [ə] | 6 | 66.67% | 814 | 906 | 92 | 0.0853 |
| ai | [ai] | 8 | 75% | 827 | 879 | 52 | 0.1204 |
| ao | [ɑo] | 11 | 72.73% | 874 | 783 | 91 | 0.0947 |
| ou | [ou] | 9 | 77.78% | 798 | 781 | 17 | 0.0843 |

For F2, if the younger dialects are influenced by Mandarin, then I expect the same pattern between these two contexts. This is true, and has been supported by multiple paired t-tests. The mean differences between contexts do not have any significant differences in [ʌ, ɑ, a, ə, ai, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou), with p>0.05, in (20). However, a significant (p<0.05) higher tendency is found in [ɤ] (labelled e1) in Zhengding dialect. The mean difference between contexts are 155 HZ (p=0.0471) for speaker 1, 48 HZ (p=0.0326) for speaker 2, 148 HZ (p=0.0365) for speaker 3, and 251 HZ (p=0.0463) for speaker 4. Based on this observation, we can say a similar F2 is widely observed between these two contexts, although there is a deviation in [ɤ].

(20) Frequencies of F2 in Zhengding younger dialect and Mandarin

| *Pinyin* Labels | IPA | Token Count | Higher in traditional NV | Traditional NV in dialect (HZ) | V in Mandarin (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 66.67% | 1166 | 1134 | 32 | 0.1051 |
| a2 | [a] | 9 | 44.45% | 1122 | 1172 | 50 | 0.0605 |
| a3 | [ɑ] | 4 | 50% | 1126 | 1026 | 100 | 0.0647 |
| **e1** | **[ɤ]** | **10** | **90%** | **1426** | **1271** | **155** | **0.0471** |
| e2 | [ə] | 6 | 66.67% | 1210 | 1195 | 15 | 0.0854 |
| ai | [ai] | 8 | 25% | 1288 | 1345 | 57 | 0.0703 |
| ao | [ɑo] | 11 | 27.27% | 1253 | 1301 | 48 | 0.0627 |
| ou | [ou] | 9 | 77.78% | 1227 | 1110 | 117 | 0.0557 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 0% | 1085 | 1103 | 18 | 0.0893 |
| a2 | [a] | 9 | 11.11% | 1048 | 1074 | 26 | 0.1603 |
| a3 | [ɑ] | 4 | 25% | 1052 | 1180 | 128 | 0.0671 |
| **e1** | [ɤ] | 10 | **100%** | **1224** | **1179** | **45** | **0.0326** |
| e2 | [ə] | 6 | 50% | 1307 | 1303 | 4 | 0.0521 |
| ai | [ai] | 8 | 87.5% | 1050 | 1025 | 25 | 0.0641 |
| ao | [ɑo] | 11 | 81.82% | 1194 | 1139 | 55 | 0.0746 |
| ou | [ou] | 9 | 33.33% | 1146 | 1284 | 138 | 0.0955 |
| Speaker3 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 1085 | 1176 | 91 | 0.0621 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a2 | [a] | 9 | 77.78% | 1048 | 1024 | 24 | 0.1002 |
| a3 | [ɑ] | 4 | 25% | 1052 | 1289 | 237 | 0.0734 |
| **e1** | [ɤ] | 10 | **50%** | **1224** | **1372** | **148** | **0.0365** |
| e2 | [ə] | 6 | 33.33% | 1307 | 1428 | 121 | 0.0684 |
| ai | [ai] | 8 | 75% | 1050 | 1042 | 8 | 0.0975 |
| ao | [ɑo] | 11 | 27.27% | 1194 | 1259 | 65 | 0.1534 |
| ou | [ou] | 9 | 44.44% | 1146 | 1222 | 76 | 0.0699 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 33.33% | 1381 | 1389 | 8 | 0.0756 |
| a2 | [a] | 9 | 33.33% | 1504 | 1575 | 71 | 0.0902 |
| a3 | [ɑ] | 4 | 75% | 1284 | 1166 | 118 | 0.1678 |
| **e1** | [ɤ] | 10 | **20%** | **1115** | **1366** | **251** | **0.0463** |
| e2 | [ə] | 6 | 33.33% | 1402 | 1459 | 57 | 0.0573 |
| ai | [ai] | 8 | 87.5% | 1404 | 1355 | 49 | 0.0805 |
| ao | [ɑo] | 11 | 81.82% | 1201 | 1150 | 51 | 0.0774 |
| ou | [ou] | 9 | 44.44% | 1377 | 1455 | 78 | 0.0924 |

After analyzing the F1 and F2, let us turn to the frequencies of pinch values (F3-F2). If the younger dialect shows the contact influence of Mandarin, then the similar pinch values are expected. The multiple paired t-tests confirm with this expectation. The pinch values in [ʌ, ɑ, a, ə, ai, ɑo, ou] (labelled a1, a2, a3, e2, ai, ao, ou) do not show any significant differences across four younger speakers, with p>0.05 in (21). However, significant (p<0.05) lower pinch values are found in [ɤ] (labelled e1) in speaker 1, speaker 2, speaker 4 (see the bold rows), but not in speaker 3.

(21) Frequencies of velar pinch (F3-F2) in Zhengding younger dialect and Mandarin

| *Pinyin* Labels | IPA | Token Count | Smaller in traditional NV | Traditional NV in dialect (HZ) | V in Mandarin (HZ) | Mean Difference (HZ) | p-values |
|---|---|---|---|---|---|---|---|
| Speaker1 | | | | | | | |
| a1 | [ʌ] | 3 | 0% | 916 | 862 | 54 | 0.1057 |
| a2 | [a] | 9 | 22.22% | 1192 | 1091 | 101 | 0.1623 |
| a3 | [ɑ] | 4 | 100% | 1161 | 1172 | 11 | 0.0723 |
| **e1** | **[ɤ]** | **10** | **100%** | **1010** | **1566** | **556** | **0.0454** |
| e2 | [ə] | 6 | 50% | 1143 | 1265 | 122 | 0.0985 |
| ai | [ai] | 8 | 0% | 968 | 910 | 58 | 0.0736 |
| ao | [ɑo] | 11 | 0% | 1192 | 1115 | 77 | 0.1225 |
| ou | [ou] | 9 | 77.78% | 1083 | 1154 | 71 | 0.0748 |
| Speaker2 | | | | | | | |
| a1 | [ʌ] | 3 | 0% | 1270 | 1109 | 161 | 0.0712 |
| a2 | [a] | 9 | 55.56% | 1436 | 1415 | 21 | 0.0763 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a3 | [ɑ] | 4 | 75% | 1269 | 1296 | 27 | 0.1128 |
| **e1** | [ɤ] | 10 | **100%** | **972** | **1321** | **349** | **0.0416** |
| e2 | [ə] | 6 | 33.33% | 1569 | 1507 | 62 | 0.0515 |
| ai | [ai] | 8 | 100% | 1226 | 1317 | 91 | 0.0746 |
| ao | [ɑo] | 11 | 100% | 1251 | 1301 | 50 | 0.0124 |
| ou | [ou] | 9 | 100% | 1544 | 1603 | 59 | 0.0642 |
| Speaker3 | | | | | | | |
| a1 | [ʌ] | 3 | 66.67% | 1170 | 1351 | 181 | 0.1925 |
| a2 | [a] | 9 | 88.89% | 1236 | 1351 | 115 | 0.0683 |
| a3 | [ɑ] | 4 | 25% | 1269 | 1389 | 120 | 0.0758 |
| e1 | [ɤ] | 10 | 50% | 1072 | 1003 | 69 | 0.0555 |
| e2 | [ə] | 6 | 0% | 1469 | 1416 | 53 | 0.0848 |
| ai | [ai] | 8 | 75% | 1251 | 1329 | 78 | 0.0842 |
| ao | [ɑo] | 11 | 100% | 1126 | 1342 | 216 | 0.0915 |
| ou | [ou] | 9 | 22.22% | 1444 | 1355 | 89 | 0.0849 |
| Speaker4 | | | | | | | |
| a1 | [ʌ] | 3 | 100% | 896 | 1035 | 139 | 0.1123 |
| a2 | [a] | 9 | 0% | 1088 | 951 | 137 | 0.0836 |
| a3 | [ɑ] | 4 | 0% | 1003 | 926 | 77 | 0.0763 |
| **e1** | [ɤ] | 10 | **90%** | **857** | **1021** | **164** | **0.0484** |
| e2 | [ə] | 6 | 33.33% | 956 | 1016 | 60 | 0.0746 |
| ai | [ai] | 8 | 62.5% | 1074 | 1127 | 53 | 0.1924 |
| ao | [ɑo] | 11 | 81.82% | 951 | 1027 | 76 | 0.1623 |
| ou | [ou] | 9 | 77.78% | 955 | 997 | 42 | 0.0659 |

**Summary of Experiment III:** when considering the frequencies of F1, F2 and pinch values (F3-F2) between Mandarin and younger dialect, we have found only [ɤ] (labelled e1) is statistically ($p<0.05$) different between these two dialect contexts. All the rest seven vowel realizations show the similar patterns between these two contexts. The multiple paired t-tests suggest that the younger Zhengding dialect has the same speech pattern with Mandarin, except in [ɤ]. It might suggest that the dialect contact between Mandarin and younger dialect related to the generational differences in Zhengding dialect.

The three experiments in this study have suggested generational variation in the phonological speech patterns regarding the initial [ŋ] in Zhengding dialect. This study belongs to the emerging field of experimental sociolinguistics, and it might be the first step in a larger project, related to the sociolinguistic variation with the phonetic and experimental advances of laboratory phonetics. One of the main issues in this project is to "understand the nature of the relationship between linguistic features and the dimensions of the social world they evoke" (Eckert et al 2011: 9). Eckert et al discuss the linguistic features that index gender and sexuality, arguing that both laboratory phonologist and sociolinguists are interested in how the dynamism of context influences perception (Eckert et al. 2011). So the analysis on

Zhengding generational variation is expected to be part of the experimental sociolinguistics, allowing the sociolinguists and laboratory phonologists to study correlation between the social contexts and the language perception.

## 6. Conclusion

In this paper, three acoustic experiments have been conducted, showing that the younger generation in Zhengding dialect has been influenced by Mandarin, and they have largely lost the traditional initial-[ŋ] nowadays. Experiment I has defined and calculated three phonetic characteristics in the traditional [ŋ]-V context: a lower F1, a higher F2, and a smaller pinch value (F3-F2). Experiment II suggests that different patterns are produced by the younger generation, who have largely deleted the initial [ŋ]. A deviation is observed in [ɤ] (labelled e1), and a hypothesis on the fused vowel [ɤ̃] (labelled e1) is proposed. The assumption is based on two major observations: (a) no obvious low-frequency of initial nasal is visually perceived in the spectrogram trajectories; (b) three established nasal effects are attested on this vowel. Experiment III further explores the correlation between the younger Zhengding dialect and Mandarin. Multiple paired t-tests suggest that the younger Zhengding dialect is correlated to Mandarin Chinese, both having the deleted-initials (i.e., zero-initial).

From the socio-variationist perspective, the pronunciation with the initial nasal [ŋ] is a partial variation in Zhengding dialect. Not all natives speak with this sound. The older generation largely remains this traditional variant, but the younger generation preferred the deleted-initial, which might be correlated with the dialect contact, especially when the younger generation starts to learn Mandarin.

For the limitation of this study, the data base for this acoustic analysis is not large enough. Only 8 native speakers are recruited for the participation. The recording is conducted in one-time reading, although participants are allowed to pre-read and practice in advance. All of the limitations might cause the analyses not very precise to some extent. These limitations need to be improved for the future investigation.

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## References

Anderson, G. (2005). *Areal and Phonotactic Distribution of ŋ*. The Internal Organization of Phonological Segment, edited by Marc Van Oostendorp, Jeroen an de Weijer. For Publication Holland, 217.

Anderson, G. (2013). *The Velar Nasal* (Wals.info/chapter/9). Dryer, M. S., & Haspelmath, M. (Eds.).

International Journal of Linguistics
ISSN 1948-5425
2021, Vol. 13, No. 5

Baker, A., Mielke, J., & Archangeli, D. (2008). More Velar than /g/: Constant coarticulation as Cause of Diphthongization. In C. B. Chang, & H. J. Haynie (Eds.), *Proceedings of the 26th West Coast Conference on Formal Linguistics* (pp. 60-68). Somerville, MA: Cascadilla Proceedings Project.

Beddor, P. S. (1983). Formant Integration and the Perception of Nasal Vowel Height. *PhD dissertation*. Distributed by the Indiana University Linguistics Club.

Blevins, J., & Kaufman, D. (2012). Origins of Palauan Intrusive Velar Nasals. *Oceanic Linguistics*, *51*(1), 18-32.

Bloch, B. (1958). Studies in Colloquial Japanese IV: Phonemics. In Martin Joos (Ed.), *Readings in Linguistics* (pp. 329-348). New York: American Council of Learned Societies.

Boersma, P., & Weenink, D. (2012). Praat: Doing Phonetics by Computer [Computer Program]. Version 5.3.32. Retrieved from http://www/praat.org

Carol, K. S. (2015). Phonetic Variations and Sound Changes in Hong Kong Cantonese: Diachronic review, synchronic study and implications for speech sound assessment. *Clinical Linguistics & Phonetics*, *29*(5), 333-353.

Chang, K. (1971). Phonological Aspects of Chinese Dialectology. *Tsing Hua Journal of Chinese Studies new series*, *9*, 192-215.

Chen, H. C., & Wang, M. J. (2013). An Acoustic Analysis of Chinese and English Vowels. *CALR Linguistic Journal*, *1*, 1-19.

Chen, M. Y. (1997). Acoustic Correlates of English and French Nasalized Vowels. *The Journal of Acoustics Society of America*, *102*(4), 2350-2370.

Chen, M. Y. (2000). Acoustic Analysis of Simple Vowels Preceding a Nasal in Standard Chinese. *Journal of Phonetics*, *28*, 43-67.

Crowley, T., & Bowern, C. (2010). *An Introduction to Historical Linguistics* (4th ed.). Oxford University Press.

Cutting, J. E. (1973). *Levels of Processing in Phonological Fusion*. Haskins Laboratories and Yale University, New Haven, Conn.

Duanmu, S. (2005). Phonology of Chinese (Mandarin). *For Encyclopedia of language and linguistics* (2nd ed.). Elsevier Publishing House.

Eckert, P. (2000). *Linguistic Variation as Social Practice: The Linguistic Construction of Identity in Belten High*. Massachusetts, Blackwell.

Eckert, P., & Podesva, R. (2011). Sociophonetics and Sexuality: toward a Symbiosis of Sociolinguistics and Laboratory Phonology. *American Speech*, *86*(1).

Flege, J., Nohn, O., & Jang, S. (1997). Effectives of Experience on Non-native Speakers' Production and Perception on English Vowels. *Journal of Phonetics*, *25*, 437-470.

Goodman, J. S. (1968). The Velar Nasal in Japanese: Phoneme or Allophone. *The Modern Language Journal*, *52*(3), 153-156.

Halle, M., & Clements, G. N. (1983). *Problem Book in Phonology*. Cambridge, MA: MIT Press.

House, A. S. (1957). Analog Studies of Nasal Consonants. *Journal of Speech and Hearing Disorders*, *22*, 190-204.

House, A.S., & Stevens, K. N. (1956). Analog Studies of the Nasalization of Vowels. *Journal of Speech and Hearing Disorders, 21*, 218-232.

Jorden, E. H. (1955). The Syntax of Modern Colloquial Japanese. *Language Dissertation*, *52*, Language Supplement.

Key, M. (2008). *The Phonology and Phonetics of Coalescence.*

Krakow, R. A., Beddor, P. S., Goldstein, L. M., & Fowler, C. A. (1987). Coarticulatory Influences on the Perceived Height of Nasal Vowels. *Status Report on Speech Research.*

Labov, W. (1966). The Social Stratification of (r) in New York City Department Stores. *The Social Stratification of English in New York City*. Cambridge University Press, pp. 168-178.

Labov, W. (1972). *Sociolinguistic Patterns*. Philadelphia: Pennsylvania University Press.

Ladefoged, P. (1993). *A Course in Phonetics*. Orlando. FL: Harcourt Brace & Company.

Li, C., & Thompson, S. (1981). *Mandarin Chinese: a Functional Reference Grammar.* Los Angeles, CA: University of California Press.

Liljencrants, J., & Lindblom, B. (1972). Numerical Simulation of Vowel Quality System: The Role of Perceptual Contrast. *Languag*e, *48*(4), 839-862.

Liu, N. (2010). *The Chinese language and language planning in China.* Heritage Briefs Collection.

MacKay, D. G. (1987). *The Organization of Perception and Action: A Theory for Language and Other Cognitive Skills.* Springer Verlay New York Inc.

Mackenzie, L, Johnson, K., & Dicanio, C. (2007). The Acoustic and Visual Phonetic Basis of Place of Articulation in Excrescent Nasals. *UC Berkeley phonology lab annual report*.

Martin, S. E. (1952). *The Morphophenemics of Standard Colloquial Japanese.* Language Dissertation, 47, Language Supplement.

Matthews, S., & Yip, V. (1994). *Cantonese: A Comprehensive Grammar*. London: Routeledge.

Ohala, J. J. (1975). Phonetic Explanations for Nasal Sound Patterns. In C. A. Ferguson, L. M. Hyman, & J. J. Ohala (Eds.), *Papers from symposium on nasals and nasalization* (pp. 289-316). Standford: Language Universals Project.

Ramsey, S. R. (1987). *The Languages of China.* Princeton, NJ: Princeton University Press.

Rogers, H. (2000). *The Sound of Language: An Introduction to Phonetics* (1st ed.). Pearson Education ESL.

Song, W. H. (1999). Phonolocial Introduction of Zhengding Dialectology. *Journal of Sichuan University* (S1), 103-106.

Stevens, K. N. (1998). *Acoustic Phonetics.* Boston: The MIT Press.

Styler, W. (2008). On the Acoustic and Perceptual Features of Vowel Nasality. *PhD dissertation.* University of Colorad.

The World Atlas of Language Structures Online. (2015). Leipzig: Max Planck Institute for Evolutionary Anthropology. Retrieved June 15, 2015, from http://wals.info/chapter/9

Trask, R. L. (1996). *A Dictionary of Phonetics and Phonology.* London: Routledge.

Trudgill, P. (1986). *Dialects in Contact.* New York: Basil Blackwell, viii, 174.

Winford, D. (2003). *An Introduction to Contact linguistics.* Malden, Ma: Blackwell Publishers.

Wong, W. Y. P. (2006). Syllable Fusion and Speech Rate in Hong Kong Cantonese. *PhD dissertation.* Ohio State University.

Wong, S. Y. (2005). Phonological Variation: the Case of the Syllable-final Velar Nasal in Cantonese. *MA thesis.* University of Hongkong.

Wright, J. T. (1986). The Behaviour of Nasalized Vowels in the Perceptual Vowel Space. In J. J. Ohala, & J. J. Jaeger (Eds.), *Experimental Phonology* (pp. 45-67).

Zhengding County Annals. (1992). *Compilation Committees of Zhengding Annals* (eds.). China City Press.

Zhu, X. (2007). Ancient-Modern Phonetic Variations in Shijiazhuang Urban Dialect. *Chinese Studies*, *2*, 46-48.

## Notes

Note 1. The word *dialect* in this study is used in a broad sense, referring to the regional variety in particular areas.

Note 2. Based on Song's (1999) argument that there are 37 syllabic finals in Zhengding dialect, I summarize 9 vowel inventories in Zhengding dialect, which includes the allophonic realizations.

Note 3. In Mandarin, two nasal initials are licensed: [m, n]; in Zhengding dialect, three nasal initials are allowed: [m, n, ŋ]. The initial [ŋ] in Zhengding dialect is corresponding to the zero-initial in Mandarin.

Note 4. The Arabic numerals after the phonetic alphabet indicate the tone value. 55, 35, 214 and 51 are corresponding with the first, second, third and fourth tone in Mandarin Chinese.

Note 5. It is noticed that no significant difference between the fused [ɤ̃] and [g]-[ɤ] in the younger generation in experiment II. However, a significant difference is tested between [ŋ]-[ɤ] and [g]-[ɤ] in the senior group in experiment I: a lower F1, a higher F2, and a smaller F3-F2. The contrast shows the overt initial [ŋ] is more velar than the initial [g], but the fused nasal effect does not seem more velar than the velar plosive [g]. This may indicate a weak or deficient velar/nasal effect on the fused vowel, but this hypothesis needs further investigation.

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