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Sociolinguistic motivations in sound change: on-going loss of low tone breathy voice in Shanghai Chinese

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Abstract

This study focuses on the on-going disappearance of low tone breathiness in Shanghai Chinese. In the change from a voicing contrast to a tone register contrast in Sinitic languages, the ancient voiced series was characterised by a breathy voice quality, which remained as a secondary and redundant cue of low tones in Shanghai Chinese. This study, using transversal production data from 12 young and 10 elderly speakers, shows that low tone breathiness is better preserved by elderly than young speakers, and by male than female speakers. We predict a future loss of this secondary cue, which is speeding up due to the interference with Standard Chinese. We also found that the disappearance is more advanced in female speakers, which might be explained by female speakers' stronger adherence to Standard Chinese as the prestigious form. Indeed, our young female speakers reported more frequent usage of Standard Chinese than Shanghai Chinese and higher competence in Standard Chinese than in Shanghai Chinese, whereas young male speakers were more confident in their usage of Shanghai Chinese.

1 Background

1.1 Tone split in Middle Chinese

There have been at least two principal tonal development waves in Chinese dialects (Haudricourt 1954; 1961). The first tonal development, or the tonogenesis *per se*, occurred in Early Middle Chinese (by the end of the sixth century CE) and consisted in a transphonologisation from a three-way coda contrast into a three-way tone contrast, as shown in (1), where <V> stands for any vowel, <N> for any sonorant, <-> for any segment and <.> for a syllable boundary.

(1) *-V(N). > 平 *ping* 'level tone'
*-ʔ. > 上 *shang* 'rising tone'
*-s. > *-h. > 去 *qu* 'departing tone'

There was another coda type, *-p|t|k., which is preserved in Middle Chinese and some Modern Chinese varieties such as Cantonese, and which forms another category that is traditionally counted as a fourth tonal category 入 *ru* 'entering tone'.

The second tonal development, which occurred around 1000 CE, and which is known as the 'tone split' process, consisted in a transphonologisation from a two-way onset voicing contrast into a two-way tone register contrast, as shown in (2), where <P> stands for any voiceless stop onset and <B> stands for any voiced stop onset.

(2) *.P- > 陰 *yin* 'high register'
*.B- > 陽 *yang* 'low register'

It is very likely that the voicing contrast in early Middle Chinese was accompanied by a voice quality difference: voiced stop onsets were produced with breathy voice while voiceless ones were produced with modal voice. It was probably the combined effect of voicedness and breathy voice that led to perceptible pitch lowering before its phonologisation.

Evidence of a voiced breathy series in Middle Chinese can be found in historical records of descriptions of consonants and tones of that time. Voiced stops are traditionally labelled as 濁 *zhuo* 'muddy', in contrast to voiceless ones that are labelled as 清 *qing* 'clear', which might convey an impression of different voice qualities. According to a description of Chinese tones from the early eighth century composed by Annen, a Japanese monk, "the level tone was level and low, with both the *light* and the *heavy* [allotones]" (cited in Mei 1970, 98) my emphasis). According to Pulleyblank (1978), 'heavy' and 'light' described originally different voice qualities associated to tones, as far as the level tone was concerned, at least. Furthermore, as suggested by Annen's descriptions, voice qualities, originally associated with onsets, were later associated with tones when the voicing contrast was replaced with the tone register contrast.

Other evidence can be found in present-day languages, in which breathy phonation is retained in one or another form. In Beijing Mandarin, the original low-register level tone with 'muddy' stop onsets has evolved to a rising tone with voiceless aspirated stop onsets. In

Thai, which has also undergone 'tone split', voiced stop onsets evolved to today's voiceless aspirated ones. Aside from aspiration, acoustic data show that some Central and Southern Chinese dialects still retain breathy phonation in the original voiced series, such as Wu, Xiang, Gan, and Yue dialects (Zhu 2010).

Meanwhile, it is worth noting that while Chinese dialects took the path of 'tone split' (as did Vietnamese and Thai), some languages took a different evolutionary path following a merger of their voicing contrast. In Mon, an onset voicing contrast was replaced with a voice quality contrast, with today's breathy phonation derived from an originally voiced onset (Shorto 1967). This might suggest that voiced onsets were originally accompanied by lower pitch and breathy phonation in these languages, and afterwards, either pitch or voice quality was phonologized. In Khmer (Henderson 1952; Wayland & Jongman 2003) and Southern Yi (Kuang & Cui 2016), the breathy vs. modal voice contrast further evolved into a vowel quality contrast, with lax vowels derived from breathy voice.

1.2 Tone, voicing, and voice quality in Shanghai Chinese

Among the Chinese dialects cited in 1.1 that retain breathy phonation, Wu dialects are often used as a model example. Wu dialects still retain a voicing contrast in word-medial position (Cao & Maddieson 1992), but this is not the focus of this study. In Northern Wu dialects, word-initial 'voiced' obstruents are described by linguists as 清音濁流 *qingyin zhuoliu* 'clear sound with muddy flow', following the descriptions of Liu (1925, 60ff) and (Chao 1928).[1]

It is generally agreed that this 'muddy flow' indicates a breathy phonation in a broad sense. It is termed 'breathy voice' or 'murmur' by many linguists including Ramsey (1987, 21), Sherard (1972), Cao & Maddieson (1992), and Zhu (1999). It is termed 'slack voice' by Ladefoged & Maddieson (1996, 57), arguing that slack voice has a smaller degree of glottal aperture and lower airflow rate than plain breathy voice, as found in, for example, Hindi. For the sake of simplicity, I will use 'breathy voice' to describe the 'muddy flow' in Shanghai Chinese in this study.

The presence of breathy voice associated with low tones in Shanghai Chinese has been demonstrated experimentally by acoustic measures (Cao & Maddieson 1992; Chen 2011) and fiberoptic

[1] As mentioned in 1.1, 'clear' refers to 'voiceless' and 'muddy' refers to 'voiced' in modern Chinese linguistic terminology.

transillumation observation (Ren 1988; but see negative results from physiological data in Gao et al. 2011).

Several of the original eight tone categories have been merged in Shanghai Chinese. Modern Shanghai Chinese has five lexical tones: tone 1 (52 ˥˨), tone 2 (34 ˧˦), tone 3 (23 ˨˧), tone 4 (55 ˥) and tone 5 (12 ˩˨), referred to here as T1, T2, T3, T4 and T5, respectively (tone values from Xu & Tang 1988), as shown in Figure 1. T1, T2 and T4, which originated from voiceless onsets, are high tones; T3 and T5, which originated from voiced onsets, are low tones and are typically described as breathy. In prosodic words, tone values are modified by tone sandhi rules, which are beyond the scope of this study.

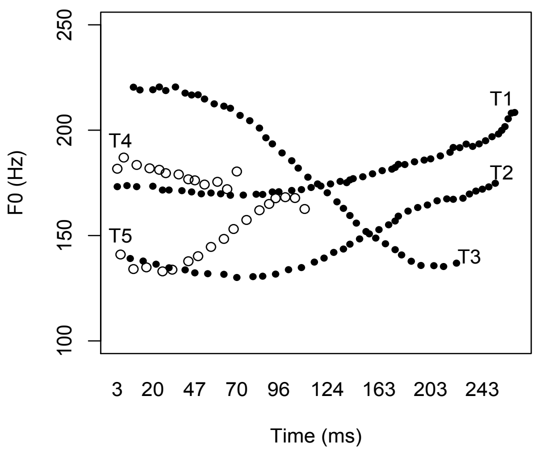

Figure 1: F0 contours of the five lexical tones of Shanghai Chinese.

1.3 Language contact and evolution of Shanghai Chinese

Shanghai Chinese, as spoken in the urban area of Shanghai, has undergone extremely rapid change since Shanghai became a treaty port, and thus a linguistic 'melting pot,' more than one and a half centuries ago. The contact with diverse migrant languages, especially neighbouring Wu dialects, has contributed to the evolution of Shanghai Chinese, at phonological, lexical and syntactic levels. In textbooks and dictionaries on Shanghai Chinese, linguists usually define three generational varieties: the Old variety for speakers born before the 1930s, the Middle variety for speakers born between the 1940s and the 1960s, and the New variety for speakers born between the 1970s and the 1990s (Xu & Tang 1988; Qian 2003).

Since the 1950-60s, the promotion of Standard Chinese as a *lingua franca* in China has been playing an important role in the recent evolution of Shanghai Chinese. The New variety has been most influenced by Standard Chinese, but this 'New variety' is somewhat outdated. We might expect that speakers born after the 1990s, (who speak — let's call it — the 'New new variety'), have even greater interference from Standard Chinese. For example, the /ŋ/ onset, a licit onset in at least the Old and Middle varieties but illicit in Standard Chinese, has been lost in most young speakers' speech. For example, 外 'outside', [waj˥˩] in Standard Chinese, is pronounced as [ŋa˨˧] in the Old variety but [a˨˧] in the new new variety.

1.4 Goal of the present study

Sound change in Shanghai Chinese has attracted linguists' attention for quite some time. Impressionistic descriptions have reported on generational differences in the consonantal, vocalic and tonal systems (Qian 2003; Chen 2003).

The present study does not focus on the evolution of the Shanghai phonological system, but rather on that of its phonetic realization. Breathy phonation, considered here as a redundant cue of low tones, has not disappeared even though it has no distinctive function.

The main goal of this study is to experimentally investigate low tone breathiness in Shanghai Chinese, using data from two age groups, so as to complement previous studies with data from younger speakers. These transversal data will therefore provide insights on the possible evolution of low tone breathiness. In order to study the possible link to contact with Standard Chinese, the recorded participants were also asked to self evaluate their competence and frequency of usage in both Standard and Shanghai Chinese.

2 Experiment

The experiment consisted of (i) a production test of high vs. low tone syllables in Shanghai Chinese and (ii) a survey of the linguistic biography of the same speakers.

2.1 Methods

2.1.1 Participants

22 native speakers of Shanghai Chinese participated in the recordings and also in a survey of their linguistic biography. They are divided into two age groups: 12 young (aged 20-30, 6 male) and 10 elderly (aged 60-80, 4 male) speakers. None reported hearing or reading disorders.

2.1.2 Speech materials and design

The target syllables are 32 monosyllabic words with all five lexical tones (T1 to T5), with the following onsets [Ø (zero), p, t, f, s, m, n], and with an [ɛ] rime for tones T1–3 and an [aʔ] rime for tones T4–5 (T4 and T5 are checked tones which only co-exist with rimes ending with a glottal stop coda; T1–T3 are called unchecked tones here). There is no T2 /nɛ/ syllable, nor T4 /maʔ/ or /naʔ/ syllable. This made a total of 32 (= 7 onsets * 5 tones – 3) monosyllables. The target syllables were elicited in the following carrier sentence: /__ gə ə zz̩ ŋo nin tə ə/ (__ 迭个字/词我认得个。 '__ this character/word, I know it'). This sentence-initial position was designed to avoid potential intervocalic voicing of obstruents in low tone syllables. All sentences were repeated once, except for one young female speaker and one elderly male speaker who read the word list only once due to technical problems.

Simultaneous audio and electroglottographic (EGG) data were recorded. Speakers were recorded individually in a quiet room and asked to read each sentence on a laptop screen. The audio recordings were made with an AKG C520L headband microphone through an EDIROL external sound board connected to a laptop in stereo mode, using the Sound Studio software: one channel for the audio signal, and the other for the EGG signal. Both signals were coded in WAV format, sampled at 44.1 kHz, with 16 bit resolution.

2.1.3 EGG and acoustic analyses

We report here on the EGG data from 10 native speakers of Shanghai Chinese, including 6 young speakers (aged 24-25, 3 males) and 4 elderly speakers (aged 64-72, 3 males). The data of these speakers were retained because their EGG signals were the least noisy. The EGG signal represents an estimation of the degree of contact of the vocal folds. Consequently, it is possible to measure the proportion of time when the vocal folds are abducted during each glottal cycle (open quotient, or OQ). Higher OQ values indicate a longer open phase than closed phase, suggesting more abducted phonation, and thus breathier voice.

In order to measure OQ, we adopted the dEGG (derivative of the EGG signal) method (Henrich et al. 2004, Michaud 2005), using the Matlab program 'peakdet'.[2] The positive and negative peaks of the dEGG signal are found to correspond respectively to the instants when the vocal fold contact area increases and decreases with the greatest

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[2] Downloadable at http://voiceresearch.free.fr/egg (Henrich, Gendrot, & Michaud, 2004), and from COVAREP (Degottex et al. 2014): https://github.com/covarep/covarep/blob/f726176223c1cc808ece6ae1bfa5ee9ddd73cb48/glottalsource/egg/peakdet/peakdet.m

velocity, and are interpreted as the closing and opening instants of the glottis (Childers & Krishnamurthy 1985). 'Peakdet' computes the OQ value, which is the duration between the negative and the following positive peak divided by the duration of the entire glottal cycle.

Most acoustic measurements found to be good indicators of voice quality in the literature were used in this study, using Voicesauce (Shue et al. 2011): H1-H2 (amplitude difference between the first and second harmonics), H1-A1 (amplitude difference between the first harmonic and the first formant), H1-A2 (amplitude difference between the first harmonic and the second formant), CPP (Cepstral Peak Prominence), and F1 (value of the first formant).

2.1.4 Questionnaire on linguistic biography

In the questionnaire about background information on each participant, we included two questions about their linguistic performance in Shanghai Chinese and Standard Chinese.

One question was on their self-evaluated language skills, the other on the frequency of usage of each language spoken by the participant. They provided responses on a 1–5 scale.

(1) How do you evaluate your language skills
in Shanghai Chinese: listening __ speaking __ ?
in Standard Chinese: listening __ speaking __ ?
others ___ : listening __ speaking __ ?

(2) How often do you use Shanghai Chinese? Standard Chinese?
Others, please specify ___ ?

3 Results

3.1 Voice quality

3.1.1 Open quotient

Note that only a subset of the OQ data is reported in this paper (see 2.1.3). Figure 2 shows the averaged OQ contours over the rime according to syllable tone and speaker group. Higher OQ values suggest a breathier phonation. Only for the elderly male speaker group is OQ significantly higher for low tones (T3 and T5) than high tones (T1, T2, T4) at the first four time points. This suggests that elderly male speakers produce breathier voice on low tone than on high tone syllables. Furthermore, the voice quality difference between high and low tones is the largest at rime onset but diminishes towards rime offset.

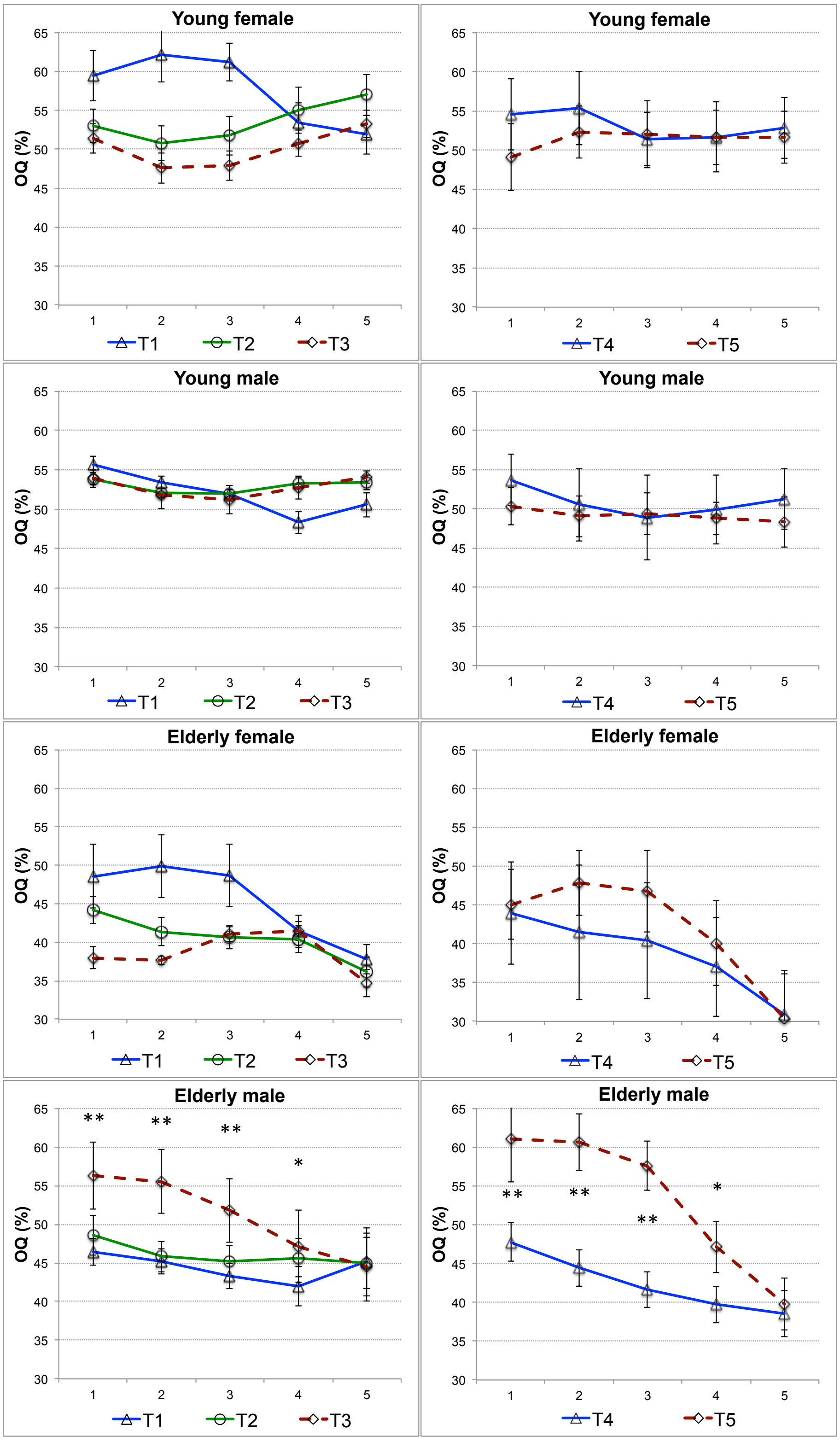

Figure 2: Averaged OQ contours according to tone, time point, and speaker group: left panels for T1–T3 and right panels for T4–T5, dashed lines in a 'muddy' colour show the low tones (significance level for greater OQ with low than high tones: *:p<.05; **:p<.01).

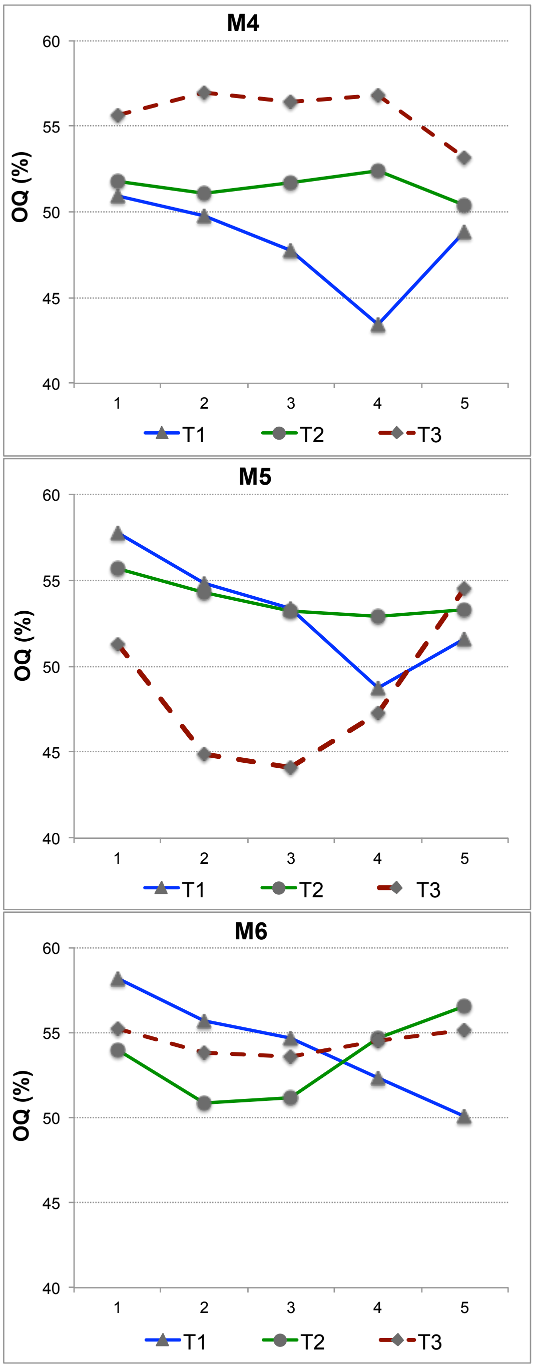

Figure 3: Averaged OQ contours according to tone T1-3, for the three young male speakers, dashed lines in the 'muddy' colour show T3.

Whereas the patterns are systematic in the elderly male and young female speaker groups (there was only one elderly female speaker), great individual variation can be observed in the young male group. Figure 3 shows the three young male speakers' OQ contours.

3.1.2 Acoustic measurements.

Figures 4–7 show the scatterplot matrices with the results of all acoustic measurements, that is, H1-H2, H1-A1, H1-A2, CPP and F1, for tones T1, T2, T3, with different colours representing different tones. (The same pattern obtained for T4 and T5.) The labels in the diagonal are the labels for both the Y axis of the plots in the same row and the X axis of the plots in the same column. For example, the plot in the top row, fourth column is a scatterplot of H2–H2 (Y axis) × CPP (X axis).

For the young speakers and elderly female speakers, the red points (low tone T3) are strongly overlapping with the blue (T1) and green (T2) points in all panels. However, for the elderly speakers, the red points are well apart from the blue and green points. Only T1–T3 (unchecked tones) are represented. T4–T5 (checked tones) show the same pattern as T1–T3. The acoustic analyses thus confirm that the voice-quality difference between high and low tones is better maintained by elderly male speakers than the other three speaker groups.

To substantiate this observation, we ran linear discriminant analyses (LDA) to determine which acoustic measures were the most efficient to discriminate breathy from modal phonation. We used the MASS package (Venables & Ripley 2002) and the klaR package (Weihs et al. 2005) in R (R Developement Core Team 2015). The factors included in the LDA were the five acoustic measures mentioned above, all pooled across the five time points in each vowel. Analyses were conducted separately for each speaker group and for checked and unchecked tones to discriminate between high and low tone syllables (unchecked tones: T1 and T2 vs. T3; checked tones: T4 vs. T5). In order to prevent the discriminant analysis from being affected by outliers, we removed the data beyond two standard deviations from the means, for each tone category and for each speaker group. Table 1 shows the overall Wilk's Lambda of the LDA model for each speaker group (lower values indicate higher significance), suggesting that the discriminant analysis combing the five acoustic measures is the most efficient for elderly male speakers, followed by elderly female, young male, and, lastly, by young female speakers.

	Young female	Young male	Elderly female	Elderly male
T1,2 vs. T3	0.88	0.74	0.59	0.28
T4 vs. T5	0.72	0.68	0.58	0.33

Table 1: Overall Wilk's Lambda of the LDA model for each speaker group (lower values indicate higher significance).

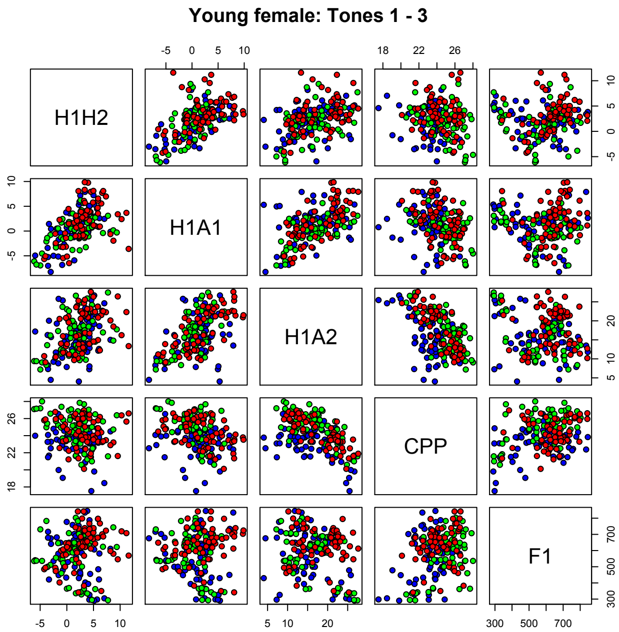

Figure 4: Scatterplot matrices with five acoustic measures of breathiness for young females: blue for T1, green for T2, and red for T3.

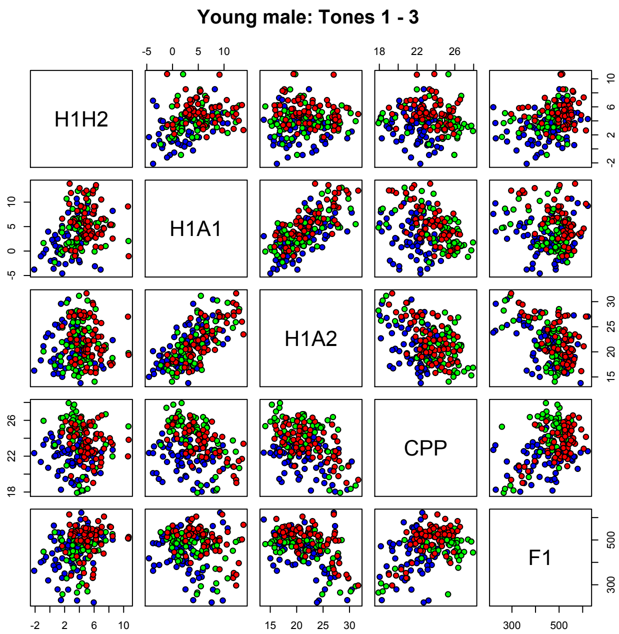

Figure 5: Scatterplot matrices with five acoustic measures of breathiness for young males: blue for T1, green for T2, and red for T3.

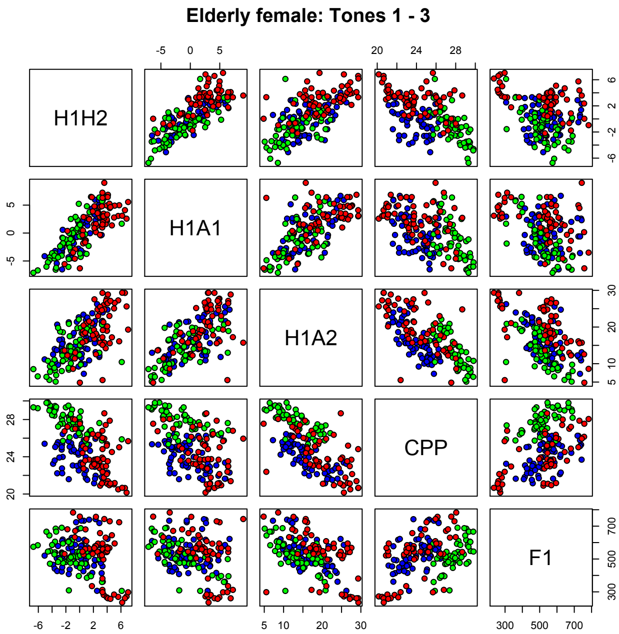

Figure 6: Scatterplot matrices with five acoustic measures of breathiness for elderly females: blue for T1, green for T2, and red for T3.

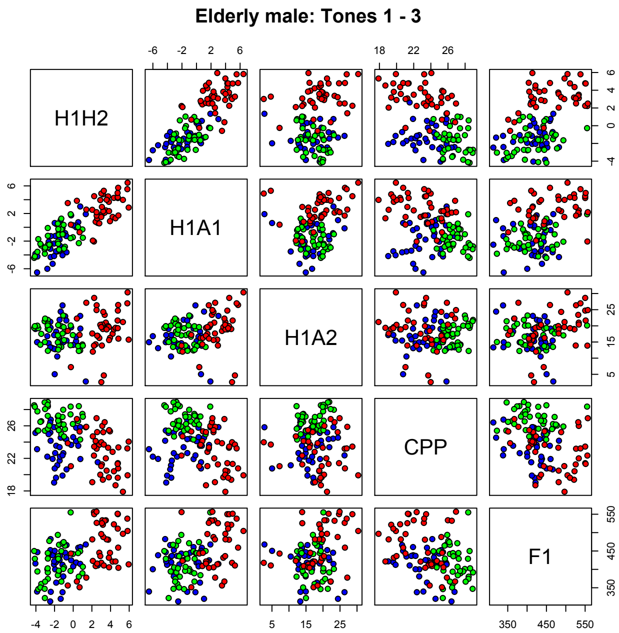

Figure 7: Scatterplot matrices with five acoustic measures of breathiness for elderly males: blue for T1, green for T2, and red for T3.

3.2 Frequency of usage and self-evaluation of Shanghai and Standard Chinese

Figure 8 shows the individual results of the survey on the frequency of usage and the self-evaluation of competence for Shanghai Chinese (SHC) and Standard Chinese (SC), the top two panels for young speakers, and the bottom two panels for elderly speakers, the left bars for female speakers (F1-6) and the right bars for male speakers (M1-6). The scores for self-evaluation are averaged scores over the scores for speaking and for listening.

For data visualisation, I use hatched bars when the score for Shanghai Chinese is lower than Standard Chinese, and plain-coloured bars when it is not lower.

Among the young speakers, female speakers have more hatched than plain-coloured bars, and male speakers have the opposite result, which means that more females than males use Standard Chinese more frequently than Shanghai Chinese, and more females than males judge themselves to be more competent in Standard Chinese than in Shanghai Chinese. As for the elderly speakers, all of them responded with the highest scores for Shanghai Chinese. Eight out of ten speakers did not give any response concerning Standard Chinese because they considered that they hardly use it and are not competent in this language. In sum, although I only investigated a small number of participants, the younger generation shows a tendency towards more frequent and skilled usage of Standard Chinese, sometimes at the cost of using less and 'worse' Shanghai Chinese. This tendency is strongest among young female speakers.

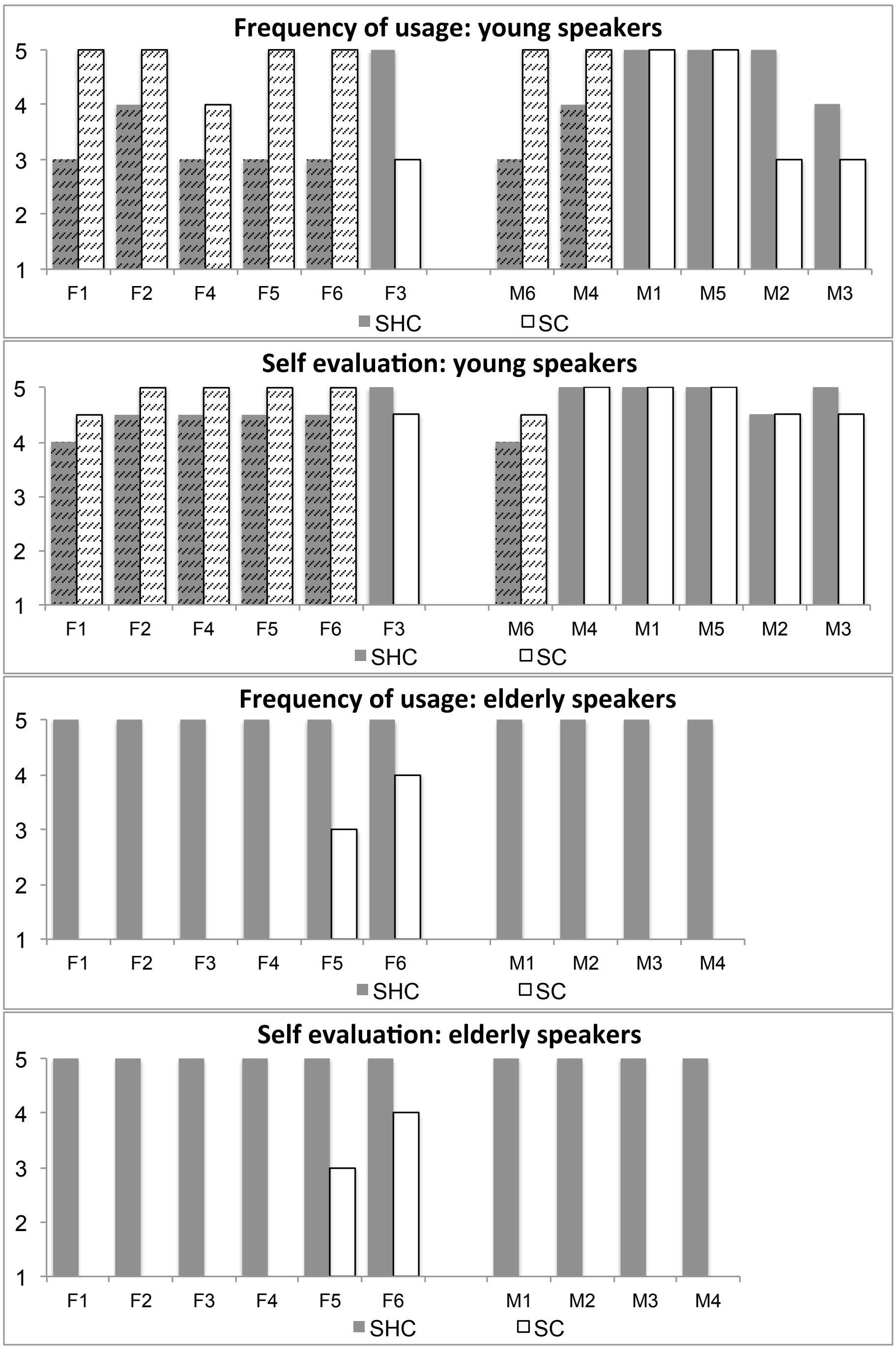

Figure 8: Individual results of frequency of usage and self-evaluation in Shanghai Chinese (SHC) and Standard Chinese (SC).

4 Discussion

4.1 Cross-age difference and on-going loss of breathiness

The results from our EGG analyses show higher OQ for low tone than high tone syllables in Shanghai Chinese only for elderly male speakers. The Wilk's Lamba of the LDA model show that acoustic measures for voice quality better distinguish high from low tone syllables for elderly than for young speakers. Thus, overall, both analyses show that low tone breathiness is better maintained in elderly than in young speakers' production. This cross-age variation might suggest an on-going change, in which low tone breathiness is disappearing.

Recent studies have shown that in many languages, tones are complex features, including not only pitch features, but also other cues than pitch, which might even play primary roles in tone identification, for example in Northern Vietnamese (Brunelle 2009) and Black Miao (Kuang 2013).

In Shanghai Chinese, pitch is undoubtedly the primary cue of tones, as described in textbooks for Shanghai Chinese written by linguists, on both an impressionistic and experimental basis (Chao 1928, Xu & Tang 1988, Chen & Gussenhoven 2015), but also as shown by the distinctive role of pitch in tone perception (Gao & Hallé 2013). However, secondary cues are not always doomed to disappear, especially when they serve as enhancing features (Stevens & Keyser 2010). Breathiness has probably existed in Wu dialects for a thousand years and still contributes to low tone perception in Shanghai Chinese (Gao & Hallé 2015). In fact, breathiness is lost especially when the original low tone becomes high (see examples in Tamang dialects, Mazaudon 2012).

Is it, then, possible, that the loss of breathiness in Shanghai Chinese is related to contact with Standard Chinese? In the next section, we will discuss the gender difference in the production of breathiness and in the attitudes toward Shanghai Chinese.

4.2 Cross-gender difference

The Wilk's Lamba of the LDA model also show that high and low tone syllables are better distinguished overall by female than by male speakers. The open quotient results derived from the dEGG signals also show that, while young male speakers do not produce breathier low tone syllables on average, one speaker (M4) still does. Although the number of our participants was limited, the results show a better preservation of low tone breathiness by males than by female speakers. In other words, female speakers seem to have started to lose lone tone breathiness before male speakers.

Why, again, are women leading the sound change, in line with the findings of a great number of (although certainly not all) sociolinguistic studies (for a review, see Labov 2001, chapter 8)? We will argue that, in the case of Shanghai Chinese, young women's adoption of the prestigious norm plays an important role.

Two types of linguistic change are classically distinguished in sociolinguistic studies (Labov 2001, 274ff): 'change from above', caused by the adoption of well-known language variables, which can be prestigious or stigmatised forms, accomplished at a high level of social awareness, and 'changes from below', the primary form of linguistic change within the system, accomplished below the level of social awareness. In 'changes from above', women, more often than men, tend to adopt prestigious linguistic forms, while in 'changes from below', women, again more often than men, tend to use more innovative forms. In fact, the apparent women's leading role comes from a paradox with respect to conformity, a 'Gender Paradox' or a 'Conformity Paradox': "Women conform more closely than men to sociolinguistic norms that are overtly prescribed, but conform less than men when they are not." (Labov 2001, 293).

How then, should we understand women's stronger tendency in the loss of one phonetic cue, breathiness, in this study? It is certainly not a change at the level of speakers' social awareness, since naïve Shanghai speakers are generally insensitive to the hardly perceptible breathiness, not to mention to a 'prestigious' connotation of modal rather than breathy voice. (They are also insensitive to tones, unless they have learned tone descriptions from Shanghai Chinese textbooks.) If the loss of breathiness can be considered as a change from below, we can hardly define the usage of modal voice (an unmarked phonation) instead of breathy voice as an innovative form, which could be a form of novelty sought by women. It would be more conceivable that female speakers are tempted by a more marked phonation, such as creaky voice, popular among young American females (Yuasa 2010).

When defining changes from above, Labov talks about a single language with prestigious vs. stigmatised varieties. If changes go beyond one single language and cover the influence from other languages, the picture is different and the case of loss of breathiness may fall into the 'change from above' category. An obvious influential language in this case is indeed Standard Chinese.

In a non-Mandarin-speaking Chinese region, Standard Chinese and local dialects do not simply co-exist as language varieties of different levels of prestige. Rather, the situation is closer to that of language contact, although these languages (so called 'dialects') share many common features.

The adoption of Standard Chinese forms is not limited to a number of overtly prescribed sociolinguistic norms such as lexical items, but extends to the integration of the entire system of the prestigious Standard Chinese. Shanghai speakers have the general feeling of a global impact of Standard Chinese on Shanghai Chinese, and young speakers judge themselves speaking a 'degraded' dialect. This is reflected by our young participants' overall lower self-evaluation of linguistic competence and frequency of usage in Shanghai Chinese than in Standard Chinese. While elderly speakers reported frequently using and speaking 'good' Shanghai Chinese, young female speakers were less confident than young male speakers in their competence in Shanghai Chinese compared to the presumably more prestigious Standard Chinese. Whether or not these female speakers were truly less competent in Shanghai Chinese remains to be verified, although we rather believe their judgments were biased by an underestimation of their competence in their native language and an overestimation of their competence in Standard Chinese, which is regarded as more prestigious. At any rate, Shanghai female speakers seem more willing than male speakers to accept, perhaps non-consciously, the prestigious Standard Chinese linguistic system as a whole, in which breathy voice does not play any phonological role. This being said, we must also add that our production experiment was a reading task, which not only induces a formal style by itself, but also is an activity practiced far more often with Standard Chinese than with Shanghai Chinese. Previous studies did indeed show that gender interacts with speech style and social class, in that women are more sensitive than men to prestigious forms only or especially in formal style, and especially in the lower middle class (Labov 1966, 313, Shuy, Wolfram & Riley 1967). It would be interesting to study breathiness in Shanghai Chinese by varying social classes and speech styles in the future, but the second task would be challenging since acoustic and physiological measurements of voice quality require well-controlled contexts, which is difficult to achieve in casual speech.

All this is not to say that women conform to prestigious forms by nature. As Eckert & McConnell-Ginet (2003) point out, gender may be a significant factor in statistical analyses, but it should not simply be regarded as a cause. Prestigious forms are not directly related to the female category, but to a refined and obedient personality that women try to construct, or are told to construct. This kind of personality in a woman is indeed highly valued in the Chinese society, even in the modern and westernised city of Shanghai.

5 Concluding remarks

Beijing Mandarin has completed the evolution from segmental (coda and voicing of onset) contrasts to tonal contrasts and has changed into what we might call a 'pure' tonal language. Wu dialects, which have also become tonal, present a more complex interplay between pitch cues and other laryngeal and supralaryngeal cues. This study focused on the relation between tone and voice quality in Shanghai Chinese. The results from acoustic and electroglottographic investigations confirm previous descriptions of breathy voice on low tone syllables in Shanghai Chinese. However, an on-going loss of breathy voice as a secondary cue to low tones, apparently driven by female speakers, can also be observed. This sound change may be related to contact with Standard Chinese.

What remains to be understood is the complex interaction between different laryngeal cues and their role in sound change in general. This *zhuoliu* 'muddy flow', well-known in Wu dialects, has also been reported in other Chinese dialect families. It would be insightful to collect quantitative and comparative phonetic data from these non-Wu dialects, especially those that are less influenced by Standard Chinese, so as to unravel the different causes of sound change, and tease apart internal and contact-induced developments.

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