Consonant and lexical tone interaction: Evidence from two Chinese dialects

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Chapter 6 General discussion and conclusion

6.1 Main findings

The main goal of this dissertation was to investigate the interaction of consonant and lexical tone (C-T interaction hereafter) in two Chinese dialects, namely Lili Wu and Shuangfeng Xiang Chinese. To achieve this goal, the property-based approach was highlighted. As discussed in Chapter 1, two biases (i.e., methodological and typological) were identified in the existing literature, which motivated the current study.

Chapter 2 presented a comprehensive description of the sound system of Lili Wu Chinese. A number of methodological/analytical innovations and new perspectives with regard to not only lexical tones but also segmental features have been proposed. First, there are eight lexical tones in Lili Wu Chinese. A clear fundamental frequency (*f0*) lowering effect in syllables with voiceless aspirated onsets in certain tonal contexts (i.e., non-*Ping* Middle Chinese [MC] tonal categories) has been observed. This lowering effect, seemingly a split of the same tone into two as a function of voiceless unaspirated vs. aspirated onsets, is known as the 'aspiration-induced tonal split' (ATS) phenomenon. The co-occurrence pattern (i.e., voiceless onsets co-occurring with high-register tones, while voiced onsets with low-register ones) commonly observed in most Northern Wu dialects, falls apart in Lili Wu Chinese where voiceless aspirated onsets can co-occur with low-register tones. Second, voicing contrasts in fricatives such as /f/ vs. /v/ can be signaled via their durational differences. The percentage of the frication duration of voiceless onsets is significantly higher than that of their voiced counterparts. Third, the two high front vowels have been proposed to be better transcribed as /i/ (e.g., /ti^{3}/ 'dot') and /ɻ/ (e.g., /tɻ^{3}/ 'bottom') with more anterior constriction for /ɻ/. Fourth, there are two syllabic

approximants in Lili Wu Chinese. /ɻ̟̈/, as in /sɻ̟̈¹/ 'book', is produced with a more laminal articulation combined with a lip rounding gesture in contrast to /ɻ̟/, as in /sɻ̟¹/ 'silk'.

Chapter 3 focused on the issue of C-T interaction in Lili Wu Chinese. Controlled experiments were designed to examine two long-standing debates on ATS in previous literature. They are i) Is ATS an ongoing change or a completed change? and ii) Is aspiration or breathiness synchronically related to ATS? The present results suggest that ATS in Lili Wu Chinese is a completed sound change but that it is conditioned by certain tonal contexts (i.e., MC tonal categories). This pattern is quite consistent across generations. Regarding the second debate, the results suggest that neither aspiration nor breathiness is synchronically related to ATS. One ongoing sound change that is observed is that the breathiness of vowels after voiced onsets is disappearing among the young generation of Lili speakers. This is probably due to its superfluous role in cueing the three-way laryngeal contrast: it is therefore not a robust cue for the laryngeal contrast in Lili Wu Chinese.

Chapter 4 provided a comprehensive description of the sound system of Shuangfeng Xiang Chinese. There are four main findings. First, the voiced consonant has multiple laryngeal realizations: modal voiced, voiceless unaspirated, and implosive. Second, /n/ and /l/ contrast only before three high segments (i.e., /i ɤ j/) and are neutralized before the other segments. Third, Shuangfeng Xiang Chinese has an interesting and rarely observed three-way contrast in high back vowels, as illustrated by the triplet of /bo²/ 'to climb' vs. /bu²/ 'old woman' vs. /bu̟²/ 'calamus'. In addition to their formant differences, the three back vowels can be distinguished via strong visual cues, i.e., their distinct lip gestures. Both /o/ and /u/ differ from /u̟/ in having more rounding and protruding lip constriction, whereas /u̟/ is produced with greater lip compression and less lip protuberance than /o/ and /u/ are. Fourth, relative to the sonorant baseline, *f*0 is lowered after voiced and voiceless aspirated onsets but is

unaffected (or minimally affected) after voiceless unaspirated onsets. This pattern seems to be consistent across all tonal contexts.

Chapter 5 focused on C-T interaction in Shuangfeng Xiang Chinese. The question concerns the phonetic properties shared by voiced and voiceless (i.e., unaspirated and aspirated) onsets that condition the low-rising *f0* contours. In the existing literature, *f0* contours after different onsets are usually treated as an identical low-rising tone (i.e., T2) which is associated with syllables with laryngeal contrast in voicing (e.g., Chao, 1935 [Yang, 1974]). This phenomenon is termed 'initial-associated tonal merger' (ITM). However, Zhu and Zou (2017) argue for a two-way phonatory distinction of the laryngeal contrast which co-occurs with two separate low-rising tones (i.e., modal – /24/ vs. breathy – /13/). The results suggest that neither voicing contrast nor phonation contrast could explain all findings. Furthermore, the phonetic properties that condition the low-rising *f0* contours have been undergoing changes. Specifically, there seems to be a trading relationship between voice onset time (VOT) and contact quotient (CQ) across generations. When a low-rising-contour-carrying syllable has a voiced onset, the old-generation speakers produce predominately negative VOT without significant breathiness (indicated by CQ) in the following vowel. The young-generation Shuangfeng Xiang speakers, however, produce fewer negative-VOT tokens as well as shorter negative-VOTs. But in contrast to the old-generation speakers, they enhance breathiness over the following vowel (over the first half).

6.2 Typological significance

Typologically speaking, what light can the results of Lili Wu and Shuangfeng Xiang Chinese shed on the topic of C-T interaction across the world's languages? In general, three points are of particular interest.

6.2.1 Tonal depression and [voice]

The most striking finding of this study is a comparable lowering effect on *f0* after aspirated and voiced onsets in both Lili Wu and Shuangfeng Xiang Chinese. A similar phenomenon of tonal lowering associated with a particular class of initial consonants has been reported in some studies of Nguni, Shona, and Khoisan languages spoken in Africa (see a recent review in Mathes & Chebanne, 2018). This lowering effect is called 'tonal depression' (e.g., Traill et al., 1987; Strazny, 2003) and is argued to be triggered by a series of consonants referred to as 'depressors' (Lanham, 1958: 66). The class of depressors may vary among African languages, but it usually includes both voiceless (i.e., unaspirated plosives and affricates) and voiced (i.e., clicks, fricatives, velar nasal, and nasal-voiced stop sequences) sounds (see a comprehensive review in Downing, 2018).

In her dissertation, Bradshaw (1999) makes a strong claim for a single-source approach for accounting for the depressor effects. Bradshaw's claim consists of at least two aspects. One is of the privative correlation between low tone and [voice] ([L/voice]) (pp. 43). The other, more phonetically, is that the central characteristics of the feature [voice] are associated with vocal fold vibration (pp. 163). However, with the extension of new data, both aspects face considerable challenges (also see previous criticisms in Tang, 2008; Downing, 2009, 2018).

As to the first aspect, cross-linguistic reports have shown that phonological [voiceless] consonants can also interact with low tones. The [voiceless] category mainly refers to voiceless aspirated/fricative consonants. For example, in Lili Wu Chinese, lexical tones with voiceless aspirated onsets have merged with tones with voiced onsets in certain tonal contexts. In another three-way-contrast language – Ikalanga (a Bantu language of the Shona group) – some voiceless aspirated obstruents also behave like depressor consonants, which can further block 'High Tone Spread' (Mathangwane, 1998). In Nambya, a Southern Bantu language closely related to Ikalanga, Downing and Gick (2001) show that a

set referred to as 'depressor /f/', i.e., phonetically voiceless fricatives can also act as tonal depressors. Very recently, the acoustic data of Mathes and Chebanne (2018) show a quite comparable *f0* pattern following aspirated obstruents as opposed to the voiced counterparts in Tsua, a Khoisan language. All cases are further confirmed to have no historic source for voicing and grow out of historically voiceless segments. Interested readers are referred to Tang (2008: 26, Table 2) for more examples.

The second aspect, namely the correlation between vocal fold vibration and the phonological feature [voice], is more problematic. The studies of Lili Wu and Shuangfeng Xiang Chinese clearly suggest that the so-called voiced category of obstruents in both dialects fails to show stable voicing (indicted by lead VOT). In initial position, the voiced category is never realized with negative VOTs in Lili Wu Chinese; while in Shuangfeng Xiang Chinese, it is partially realized with negative VOTs. However, regardless of dialects, the so-called voiced category of obstruents is consistently correlated with a lowering of *f0*, contrasting with the *f0* contour after the voiceless unaspirated category. These observations are basically in accord with the study by Kingston and Diehl (1994), which has already shown that the [voice] distinction is not consistently realized with voicing lead through much or all of its closure (i.e., consequently lead VOT). However, *f0* is consistently depressed in vowels adjacent to [voice] onsets, regardless of their VOT values. In addition, Zulu and Xhosa Bantu have been reported to present a voicing-absent realization of the depressor onsets (Jessen & Roux, 2002; Chen & Downing, 2011).

In a nutshell, neither the phonological [voice] category nor phonetic voicing should be inextricably or exclusively correlated with the low tone/tonal depression. Cross-linguistic reports have already shown that although most tonal languages abide by the [voiceless/H]-[voiced/L] pattern, there are more language-specific patterns that need to be uncovered to further our understanding of the C-T interaction.

6.2.2 The effect of aspirated onsets on *f0*

What has been consistently observed in this study is the lowering of *f0* contour after aspirated onsets. The effect of aspirated onsets on *f0* seems to be highly language-specific (Carne, 2008; Chen, 2011) and even speaker-specific (e.g., see studies of Korean, Kagaya, 1974; and Thai, Erickson, 1975). In terms of typology, as argued by Chen (2011: 622), '[i]n some, often non-tonal languages, voiceless aspirated stops tend to show comparable *f0* as voiceless unaspirated stops, while in others, mainly tonal languages or languages with a full-fledged system of phonation and aspiration contrast, a voiceless aspirated stop tends to introduce lower *f0* than a voiceless unaspirated one.' It is worth noting that an aspiration-induced *f0* lowering effect also seems likely to exist in languages where obstruents have more than a binary laryngeal contrast. Asian languages such as Lili Wu Chinese, Shuangfeng Xiang Chinese, Kam (Sanjiang 三江 variety, Donohue & Wu, 2013), Vietnamese (Northern Vietnamese, Carne, 2008), and Tibetan (Qiuji and Tiebu, Sun, 2003) have all been reported to have a three-way laryngeal contrast of obstruents. It is also true for African languages such as Ikalanga (Mathangwane, 1998) and Tusa (Mathes, 2015: 34). Taken together, these studies suggest that, unlike the clearly binary effect on *f0* after voiceless and voiced onsets, perturbation effects after aspirated onsets seem to be more complicated.

A subsequent issue is why aspirated onsets can co-occur with lower *f0* contours. Breathiness should play a crucial role in such a co-occurrence. This is because in Lili Wu Chinese, irrespective of whether tonal split occurred or not, aspiration has a consistent perturbation effect on the following vowel, as evident in the strong degree of breathiness. Similar effects have been observed in Shuangfeng Xiang Chinese. This relationship between aspiration and breathiness has been reported in some other languages, such as Swedish (Gobl & Chasaide, 1988), English (Löfqvist & McGowan, 1992), and German (Chasaide & Gobl, 1993). The observed increased breathiness has been attributed to a delayed laryngeal

adjustment after the release of an aspirated onset. Upon the release of an aspirated onset, the glottis may have a more abducted posture, which consequently causes the vocalis muscle's effect to be either weak or not as effective as after an unaspirated onset, as Chen (2011) argued for the mechanism of *f0* lowering in Shanghainese. In addition, aspiration-induced greater aperiodic noise may also be at play. It has been argued that aspiration is typically followed by considerably greater airflow (Stevens, 1971), which can result in a breathier transition between aspiration and vowel voicing (Sagart, 1981; Ren, 1992; Zhu & Xu, 2009).

In this way, breathiness transition, together with aperiodic noise of aspiration provides a possible pivot for linking onset aspiration to *f0* lowering. Aspirated onsets hence have the potential to behave like voiced onsets in introducing *f0* lowering. For example, similar lowering effects after aspirated and voiced onsets have been reported for Standard Thai (Gandour & Maddieson, 1976), Ikalanga (Mathangwane, 1998), and Tsua (Mathes & Chebanne, 2018). In Shanghainese, the perturbation effect of the aspirated category is similar to that of the voiced one in non-initial position (Chen, 2011). Moreover, lower *f0* and breathier phonation are found to correlate with both voiceless and voiced aspirated plosives in Nepali (Clements & Khatiwada, 2007; Khatiwada, 2008; Mazaudon, 2012) and Bengali (Mikuteit & Reetz, 2007). It is worth noting that in this current study, the breathier transition can be generally observed at the onset of the vowel after all aspirated onsets regardless of whether tonal split happened or not. This suggests that breathiness is not the direct trigger of lower *f0*. There should be no direct correlation between breathier voice and lower *f0*. As *f0* level is related to the degree of stiffness of the vocal cords while breathier voice is related to the glottal constriction and noise component, it is not difficult to imagine that the same glottal constriction and noise component can vary via different rates of vibration of the vocal folds (Ladefoged, 1973; Kuang, 2013b).

Last but not least, in comparison to voiceless unaspirated onsets, how should we understand those languages where voiceless aspirated

onsets produce a comparable *f0* pattern (or even a raising effect as in Khmer, Central Thai, and Northern Vietnamese [Kirby, 2018])? The opposite effect on *f0* may result from different mechanisms for producing voiceless aspirated sounds. In terms of the state of the vocal folds, in those languages, speakers may employ active tension in order to inhibit vocal-fold vibration triggered by a more abducted glottis after both kinds of voiceless onsets (Hanson & Stevens, 2002), which then produces comparable *f0* patterns. The breathier transition after voiceless aspirated onsets is inhibited and hence limited. Needless to say, more research, especially aerodynamic experiments, is needed.

To summarize, in Lili Wu and Shuangfeng Xiang Chinese, not only voiced onsets but also aspirated onsets can introduce *f0* lowering.

6.2.3 ATS reported in other languages

Except for Wu Chinese, ATS has also been documented in some other languages. For example, in many Kra-Dai languages spoken in China, similar tonal-split phenomena associated with onset aspiration have been reported (Ho, 1989; F. Shi, 1998). Xu (2014) further argues that ATS serves as evidence for the retention of a Kra-Dai substratum of the proto-Wu. However, unlike Lili Wu Chinese, where *f0* contours after aspirated onsets have merged with those after voiced onsets, a few studies have shown that *f0* contours produced with aspirated onsets are allotones of those produced with unaspirated onsets in some Southern Kam (Dong 侗 in Chinese literature) varieties (Donohue & Wu, 2013; Long, 2018). What makes the story more complicated is the patterns reported for the Rongjiang (榕江) variety. The acoustic results of Zhu et al. (2016) show that there is shorter VOT lag (30–60 ms) but longer maintenance of breathiness (around 100 ms) over the following vowels for syllables featuring the so-called ATS. More importantly, ATS in Kam languages seemingly can happen to high-level tones (e.g., Rongjiang) and its

historical condition is less clear-cut (F. Shi, 1998: 131). All these results are inconsistent with the findings observed in Lili Wu Chinese.

In addition, Gan Chinese (赣语) is another group where ATS has been reported in the existing literature. However, the historical condition of ATS in Gan Chinese is quite different from that observed in Wu Chinese. In Lili Wu Chinese, none of the aspirated onsets have a historic source for voicing and are known to grow out of historically voiceless segments. However, in dialects like Nanchang (南昌) Gan, ATS has been found to co-occur with aspirated onsets which developed from historically voiced obstruents (Xiong, 1979). A related question is whether the so-called ATS is the vestige of the low tones which co-occurred with voiced onsets in MC (Ho, 1989; F. Shi, 1998; Wang, 2010). A recent study of Zhajin (渣津) Gan Chinese (Zhou & Kirby, 2019) seems to indicate that the historical voiceless aspirated onsets first became voiced/breathy, and merged with MC voiced onsets. Synchronically speaking, VOT is no longer a robust cue to signal the laryngeal contrast of voiceless aspirated vs. voiced onsets. The merged category (covering MC voiceless aspirated and voiced onsets) is argued to further engage in the tone-developmental processes in Gan Chinese.

All evidence seems to point to a language-specific interpretation of the so-called ATS. To have a better understanding of ATS, two additional pieces of evidence are needed. One is the diachronic reconstructions on how the tonal inventories of proto-languages that existed in China evolved into those of modern Chinese dialects; and the other is more empirical data from under-documented languages, of which Kra-Dai languages especially.

6.3 The relationship between Wu and Xiang: from the perspective of C-T interaction

6.3.1 Unicity of Wu–Xiang?

The existence of a three-way laryngeal contrast in obstruents, labeled as voiceless unaspirated, voiceless aspirated, and voiced, is the most prominent feature shared by Wu (e.g., Lili) and Old Xiang Chinese (e.g., Shuangfeng) (Zhou & You, 1986). This shared phonological trait, therefore, has been adopted as an overarching criterion to assume that the Wu and Old Xiang dialect groups are much more closely related to each other in historical classification than either of them is with other dialect groups. This assumption seems to be first raised in Yuan (1960: 102) and is later more firmly established in Hashimoto (1978/1985). Given the shared three-way contrast in obstruents, Hashimoto (1985: 31) points out that the Wu and Xiang dialect groups once constituted a unified dialect phylum. This view was later called the 'Unicity of Wu–Xiang' (吴湘一体) in Chang (1999).[40] Given the shared phonological trait of the voiced category of obstruents, this phylum is further called the 'Corridor of voiced sounds' (浊音走廊) in Chen (2004). The assumed historical relatedness of the Wu and Old Xiang dialect groups, however, is not unproblematic. The challenges come from at least two aspects.

First, in terms of historical reconstruction, the three-way contrast of obstruents is *not* shared innovation but shared retention, which cannot be used as evidence to argue for the close relatedness of the Wu and Old Xiang dialect groups. It has long been established in historical linguistics that shared innovation is the only criterion for subgrouping (e.g., Trask, 1996: 182; Campbell, 2013: 197). Given the widespread consensus on the reconstruction of the three-way-contrast system in MC (e.g., Karlgren,

[40] Chang (1999) further includes some Jianghuai dialects, assuming a so-called 'Dialect Continuum of Wu–Chu–Jianghuai' (吴楚江淮方言连续体).

1915–1926), this single common phonological trait in the Wu and Old Xiang dialect groups is merely a trait inherited from the proto-language. Similar manipulation of subgrouping based on shared retentions seems to be a common fallacy in some studies of the classification of Chinese dialects, which has been sharply criticized by Sagart (2002, 2011). While it is reasonable to employ the *development* of the three-way-contrast system as a criterion to subgroup Chinese dialects (Ting, 1982; Li, 2005), the so-called close relatedness of the Wu and Old Xiang dialect groups postulated based on their shared retention of the three-way contrast of obstruents is unlikely to be tenable. Similar doubts have been raised in Guo (2015).

Nevertheless, no shared innovation relating to the development of the three-way-contrast system can be identified. Instead, the results of this current study show that the development of the three-way-contrast system is quite complicated. Two points are of particular note. First, although the aspirated onset in both dialects can co-occur with low tones, the condition that is responsible for this co-occurrence is different. In Lili Wu Chinese, the condition is more historical (i.e., MC tonal categories). Regardless of the tonal contours at present, this condition seems to take effect across all its neighboring dialects showing the same phenomenon (Wang, 2008; Yue Xu, 2013). However, the *f0*-lowering effect of the aspirated onset in Shuangfeng Xiang Chinese is more related to the synchronic tonal contexts, irrespective of its historical origin. The lowering effect of the aspirated onset is more prominent in the two rising tonal contexts (i.e., low–rising and high–rising) compared to the other contexts (i.e., high–level and falling). Such a context-dependent condition is in line with some previous findings. For example, in Standard Chinese (Xu & Xu, 2003), the aspirated onset introduces a greater perturbation effect for the rising tone than for high and falling tones. In Southern Standard Kam (Tang, 2008) and Northern Standard Vietnamese (Carne, 2008), both languages show an affinity for a prominent *f0*-lowering effect on the rising tone after an aspirated onset. This rising context can even

extend beyond one syllable. For example, in Shanghainese (Chen, 2011), more salient perturbation effects on onset *f0* have been observed for syllables after low-rising tones than that after high-falling tones. However, the greater lowering effect of the aspirated onset in the rising context is not universal. Opposite cases can also be found. For example, in Cantonese (Francis et al., 2006), the perturbation effect after the aspirated onset presents a greater magnitude in the falling (/21/) tone than that in the level (/55/) and rising (/25/) tones. In a nutshell, the development of the aspirated category in the two dialects is not consistent.

More importantly, the development of the voiced category is also incongruent. This is mainly reflected by the realization of the voiced category in the two dialects. As shown in Table 6.1, the realization of the voiced category varies greatly between dialects. In Shuangfeng Xiang Chinese, negative VOT is partially realized to a higher degree among older speakers. In Lili Wu Chinese, none of the voiced onsets is realized with negative VOT. Furthermore, speakers of different generations within a dialect show differences. In Shuangfeng Xiang Chinese, speakers of the old generation produce less breathiness (indicated by higher CQ) than those of the young generation, while in Lili Wu Chinese, the relationship is reversed. Voiced onsets, however, are consistently realized with lower *f0* contours across dialects and generations. Given these characteristics of the phonologically voiced category in both dialects, it is questionable if the three-way laryngeal contrast of obstruents in the two dialects can be treated in a uniform way.

Table 6.1 The realization of the voiced category in Shuangfeng Xiang and Lili Wu Chinese.

Dialect	Generation	VOT	CQ	*f0* contour
Shuangfeng	Old	negative (82%)	higher	low
	Young	negative (59%)	lower	low
Lili	Old	positive (100%)	lower	low
	Young	positive (100%)	higher	low

In summary, it is reasonable to argue that both Wu (e.g., Lili) and Old Xiang (e.g., Shuangfeng) dialect groups have inherited the phonological trait of the three-way laryngeal contrast of obstruents from MC. However, in terms of the development of the three-way-contrast system, no shared innovation can be identified. Instead, the two dialects behave quite differently and have developed their idiosyncratic features in the three-way laryngeal contrast of obstruents. Currently, there is no obvious evidence to support the 'Unicity of Wu–Xiang' assumption.

6.3.2 Today's Shuangfeng, tomorrow's Lili?

How can this study shed light on the relationship between the Wu and Old Xiang dialect groups? The most prominent finding is that the voiced category of obstruents is experiencing an ongoing change in both dialects (see Section 3.5.2 and Section 5.5.2). In general, an obvious trading relationship has been found between VOT and CQ. In Shuangfeng Xiang Chinese, the old-generation speakers produce predominately negative VOT without significant breathiness (indicated by CQ) in the following vowel. The young-generation Shuangfeng Xiang speakers, however, produce fewer negative-VOT tokens as well as shorter negative-VOTs. Furthermore, they enhance breathiness over the following vowel but only over the first half. In Lili Wu Chinese, a different cue-trading relationship has been observed. The old-generation speakers produce all 'voiced' obstruents with positive-VOTs but with a significantly higher level of breathiness over the first half of the following vowel. The young-generation speakers also produce positive-VOTs over the 'voiced' obstruents but with decreased breathiness over the first half of the following vowel. The four different relationships between VOT and CQ seem to imply a developmental trajectory of the voicing contrast varying from the old-generation Shuangfeng Xiang speakers to the young-generation Lili Wu speakers.

To sum up, VOT and CQ have started to show flexibility to signal the voicing contrast across dialects. The current situation in the two dialects, in terms of sound change, might give rise to two predictions. First, with the loss of phonetic voicing but the enhancement of breathiness among younger speakers of Shuangfeng Xiang Chinese, there seems to exist a chance that the current younger speakers of Shuangfeng Xiang Chinese today will speak like the current older speakers of Lili Wu Chinese in the future. Further longitudinal surveys are needed to test this possibility. Additionally, if no strategy of enhancement is taken by the younger speakers of Lili Wu Chinese, the loss of breathiness can potentially weaken the distinctness of voiced obstruents, leading to the neutralization of the voicing contrast. Such a tendency has already been observed in some of the young female speakers of Shanghainese (Gao, 2016) and in some speakers of Tamang dialects (Mazaudon, 2012).

The different trading relationships between laryngeal timing (in terms of VOT) and phonatory state (in terms of CQ) to signal voicing contrast in the two Chinese dialects highlight possible pathways for changes of cue weighting in the phonetic implementation of voicing contrasts in Asian tonal languages.

6.4 Conclusion

In the existing literature, C-T interaction generally concerns the [voiceless/H]-[voiced/L] co-occurrence pattern. However, largely because of the high level of homogeneity in the languages sampled, and the lack of access to portable articulatory and up-to-date statistical techniques, this [voiceless/H]-[voiced/L] pattern has veiled the full picture of C-T interaction across the world's languages.

There are two key findings in this dissertation that contribute to our understanding of the diversity in C-T interaction. First, voiceless aspirated onsets can also co-occur with low tones. This finding is antagonistic to the [voiceless/H]-[voiced/L] pattern which posits that

only contrastively voiced onsets can be in favor of low tones. Second, the realization of C-T interaction is not only specific between languages but also within languages. Speakers of different generations of a given language can utilize phonetic cues differently to signal the same phonological contrasts.

Last but not least, I hope to highlight the importance of the property-based approach for exploring phonological contrasts. In doing so, I believe that it would be beneficial to incorporate more cross-linguistic data into the perspective of phonological typology.