Phantom stress in tone sandhi: evidence from Shaoxing Wu Chinese

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CHAPTER 5

General discussion and conclusion

This dissertation aims to investigate the interaction between tone sandhi and stress in Shaoxing Wu Chinese, a dialect exhibiting complex tone sandhi patterns. Through a series of controlled acoustic experiments, we examined whether stress can account for tonal realizations across various domains, from disyllabic words (Chapter 2) to trisyllabic compounds (Chapter 3) and to phrasal structures of varying lengths (Chapter 4). In the following sections, we summarize the main findings of each chapter, discuss their theoretical implications, and suggest directions for future research.

5.1 Main findings

Chapter 2 investigated complex disyllabic tone sandhi at the word level in Shaoxing Wu and its potential interaction with stress. Two research questions were addressed: whether left- and right-dominant sandhi patterns coexist at the word level, and whether these patterns are stress-conditioned. The results confirm that both sandhi dominance patterns coexist. Specifically, words starting

with Rising tones exhibit left-dominant patterns, with the final syllable's underlying tone neutralized; in contrast, words starting with Falling tones display right-dominant characteristics, with the initial syllable surfacing as level-ish contour, and the final syllable potentially preserving its underlying contour. Nonetheless, no durational evidence was found to support a stress-based account of this distinction: the final syllable was consistently longer than the initial one regardless of sandhi dominance pattern. These findings offer a more nuanced picture of the left- vs. right-dominant sandhi distinction by providing new evidence of their coexistence in the same dialect, and establish a solid foundation for subsequent investigations as reported in Chapters 3 and 4. More importantly, the absence of compelling durational evidence for stress in dialects with complex sandhi calls for a more scrutinized approach to stress-based accounts of tone sandhi across Sinitic varieties.

Chapter 3 extended the investigation of the relationship between tone sandhi and stress to trisyllabic compounds in Shaoxing Wu. The primary goal was to examine whether stress systematically conditions both tonal realization and the sandhi domain formation across disyllabic words and trisyllabic compounds, even in the absence of overt acoustic correlates. Two research questions were addressed: whether trisyllabic compounds of different structures (2+1 vs. 1+2) vary in their sandhi domain formation, and whether both initial and non-initial tones condition the tonal realizations as the stress-based account predicts. Experimental data suggest that all 2+1 and the vast majority of 1+2 compounds form one single sandhi domain, within which the f0 contours are primarily conditioned by the tonal identity of the initial syllable. The results were incompatible with a straightforward stress-based account, demonstrating that stress is not as effective in explaining complex tone sandhi patterns as it is for typical left- or right-dominant patterns. Furthermore, trisyllabic sandhi patterns show notable similarity with their disyllabic counterparts, suggesting an alternative analysis whereby sandhi contours extend from a substituted tonal melody; the apparent preservation of non-initial tones in disyllables might result from coinciding with part of that melody. These find-

ings contribute to a more comprehensive understanding of complex sandhi patterns, and highlight the importance of investigating less-studied dialects with complex sandhi patterns in larger domains.

Chapter 4 examined the phrasal-level tonal realizations in Shaoxing Wu, focusing on the alleged distinction between verb-object (VO) and subject-predicate (SP) structures. While differences in tonal realizations between phrases and words/compounds have often been cited as supporting evidence for tone-stress interaction, the VO-SP distinction is not predicted by stress-based accounts and is rarely documented in other dialects. Through controlled experiments, we confirmed that disyllabic VO and SP structures in Shaoxing Wu differ in the tonal realizations of their initial syllables (Experiment 1). Specifically, they display different patterns of tonal contour neutralization, contrary to stress-based predictions. However, the distinction between disyllabic VO and SP does not carry over to quadri-syllabic cases (Experiment 2). These findings demonstrate an interaction between syntactic structure and constituent size in conditioning phrasal-initial tonal realizations, which cannot be adequately explained by stress-based accounts and instead favors an end-based alternative. Notably, all examined cases except for disyllabic VO structures exhibited an f0 converging pattern towards a higher tonal target at the end of the initial constituent, suggesting the presence of a boundary-induced high tone. To account for its distribution, we proposed that in addition to syntax-prosody correspondence constraints, prosodic constituent formation in Shaoxing Wu is conditioned by size constraints on both Prosodic Words and Intonation Phrases. In line with the overall findings of this dissertation, this chapter advocates for a cautious approach to the presumed role of stress at the phrasal level and highlights the necessity of investigating a broader range of structures.

5.2 Theoretical implications

5.2.1 Tone sandhi and stress

Our findings consistently demonstrate that stress cannot adequately account for the complex sandhi patterns observed in Shaoxing Wu. Specifically, we reveal two limitations of stress as an explanatory mechanism in this dialect.

First, we found no independent acoustic correlates of stress beyond tonal patterns themselves. Through a durational analysis of disyllabic words, we examined a cross-linguistically robust phonetic correlate of stress, and found no evidence for different stress placement that would align with the observed sandhi patterns. This stands in contrast to most languages exhibiting tone-stress interaction, where stress is marked by overt acoustic cues (e.g., Gruber, 2011; Potisuk et al., 1996), allowing for independent verification of its presence and location. Although our analysis was limited to disyllabic words in isolation and would benefit from further investigation with carrier sentences to control for potential final lengthening effects, our findings raise doubts about the role of stress in conditioning sandhi dominance of Shaoxing Wu.

Second, stress fails to provide a coherent account of tonal realizations across different domains in Shaoxing Wu. Even setting aside the absence of phonetic evidence, the patterns observed at word, compound, and phrasal levels resist unified stress-based explanations. This failure is particularly revealing when contrasted with dialects such as Shanghai Wu, where stress, though phonetically elusive, nonetheless offers consistent explanations for tonal realizations across different domains (e.g., M. Y. Chen, 2000; Duanmu, 1993).

It bears repeating that identifying tone-stress interaction requires verifying the existence of stress through independent evidence, whether phonetic correlates or consistent phonological patterning across multiple domains, rather than inferring it circularly from the very tonal patterns it seeks to explain. Without such evidence, stress-based accounts become unfalsifiable and risk obscuring

alternative mechanisms that may better account for the observed phenomena. Taken together, our findings reveal no such independent evidence for stress in Shaoxing Wu, challenging its explanatory adequacy for complex sandhi patterns.

These findings raise further questions about the generalizability of stress-based accounts across Sinitic varieties. A prevailing view in the literature holds that all Sinitic varieties share a unified stress system that underlies foot formation and shapes tonal phenomena (e.g., Duanmu, 2005). However, our data demonstrate that this assumption is at least not straightforward, if not untenable, for Shaoxing Wu, which exhibits complex sandhi patterns. It should be noted that our findings do not preclude the validity of stress-based accounts in other contexts. For instance, stress has been shown to provide a systematic cross-domain account of tonal realizations in Shanghai Wu (see Chapters 1 to 4), and offers an analytical perspective for understanding the contrast between full and neutral tones in Mandarin (e.g., Chao, 1968; C.-C. Cheng, 1973; W. Li, 1981). Nonetheless, its explanatory success does not necessarily extend to similar or neighboring varieties. Before attributing tonal phenomena to stress, therefore, it is necessary to seek evidence for the presence of stress within each dialect individually, rather than generalizing any observed tone-stress interaction to Sinitic varieties as a whole.

One might go further and argue, following Feng (2025a), that tone and stress are in fact manifestations of the same metrical phenomenon: both the L-H alternation constituting a tone and the strong-weak alternation constituting a foot can be regarded as organized by a single principle of relative prominence, differing only in the level at which this principle applies. We do not have direct evidence to rule out this possibility, which provides an elegant account of the parallels between tonal and metrical structures. Adopting such a view, however, does not eliminate the need for independent empirical evidence. Demonstrating the existence of a higher-level metrical structure still requires evidence beyond a reinterpretation of the very tonal phenomenon it is intended to explain. Otherwise, analyzing tone and stress within a unified metrical framework risks be-

coming a notational shift rather than an empirically motivated analysis, leaving the concern of circularity unresolved in a different form.

Overall, throughout this dissertation, we advocate for a more cautious and empirically grounded approach to attributing tone sandhi to stress in Sinitic varieties. While stress-based accounts have proven valuable for dialects with typical left- or right-dominant sandhi patterns, our findings from Shaoxing Wu demonstrate that such accounts cannot be extended without direct evidence.

5.2.2 Tone sandhi across Northern Wu: General tendencies

Although initially motivated by questions about tone-stress interaction, our study revealed systematic sandhi patterns that align Shaoxing Wu with other Northern Wu. These convergent phenomena suggest more general tendencies in tone sandhi across Northern Wu that operate independently of metrical structure, and prompt reconsideration of how we interpret seemingly complex sandhi patterns.

Pattern extension following pattern substitution

First, pattern extension may be a more general tendency across Northern Wu, even in dialects that appear to exhibit complex sandhi patterns. In Shaoxing Wu, sandhi contours do not directly spread from the initial syllable's underlying tone, and are further complicated by other conditioning factors, particularly in disyllables. Still, through comparison of sandhi contours across different domain lengths, we observed pattern extension analogous to the typical left-dominant sandhi, though from a substituted tone conditioned by the initial underlying tone (and occasionally the historical tonal categories of non-initial syllables, which will be discussed later).

Notably, pattern extension preceded by substitution has also been reported in Wuxi Wu (Chan & Ren, 1988), and our data provide corroborating evidence for the broader applicability of this process. Given that observing pattern extension clearly requires examining larger domains, especially when pattern substi-

tution is involved, a question naturally arises: might other Wu dialects currently analyzed as having irregular or complex sandhi systems actually exhibit pattern extension, which has gone undetected due to insufficient data from longer sequences?

This speculation finds support in observations from other Wu dialects with complex tone sandhi. In Xiangshan Wu, for instance, trisyllabic sandhi patterns mirror their disyllabic counterparts, even though not directly extended from the initial syllable's underlying tone (Y. Shi et al., 2023). What makes these patterns particularly noteworthy is that several sandhi contours bear striking resemblance to those documented in Shaoxing Wu. With underlying LHL.LHL.HH or LHL.LHL.LHL tonal combinations, trisyllabic compounds in Xiangshan Wu display three tone sandhi variants[1]: in one variant, the first syllable surfaces with a low level contour, the second with a rising contour, and the third with a falling contour, remarkably similar to trisyllables starting with low falling tones in Shaoxing Wu; in another variant, the first syllable surfaces with a low level-ish rising contour, the second as level, and the third as falling, resembling those starting with low rising tones in Shaoxing Wu.

It should be noted that all trisyllabic compounds of Xiangshan Wu presented in Y. Shi et al. (2023) exhibit a 2+1 structure, which was analyzed as involving cyclic application of tone sandhi: the initial disyllabic constituent undergoes sandhi first, after which the second syllable's sandhi tone extends to the third syllable. Nonetheless, similar sandhi contours were observed in both 1+2 and 2+1 compounds of Shaoxing Wu, which cannot be adequately analyzed with cyclic application of tone sandhi. Currently available acoustic data from Xiangshan Wu remain limited regarding tonal combinations and compound structures in trisyllables, precluding comprehensive comparison with the Shaoxing patterns. Nevertheless, the similarities in the documented cases invite the hypothesis that Xiangshan Wu may involve similar substitution-and-

[1] As noted in Y. Shi et al. (2023), the choice of these sandhi variants is not correlated with the tone of the non-initial syllables, speakers, items, or other factors; they are therefore treated as a set of free variants.

extension process as proposed for Shaoxing Wu, though what conditions the substituted tone remains to be further investigated.

Jinshan Wu presents another suggestive case. Rose and Yang (2024) documented that disyllables with underlying falling.falling or falling.level tonal combinations undergo substantial tonal changes: the first syllable surfaces with either high level-ish rising or low rising pitch depending on its original register, while the second syllable surfaces with a high falling contour. To account for these patterns, Rose and Yang (2024) proposed a series of derivational rules. However, these sandhi contours closely resemble those of disyllables starting with rising tones in Shaoxing Wu. An alternative interpretation is that they reflect pattern extension from a substituted tone, which might offer a more parsimonious account, though this hypothesis needs to be tested with data from longer sequences in Jinshan Wu.

Note that we do not intend to challenge existing analyses of these dialects, but rather to draw attention to the cross-dialectal similarities in sandhi contours. It is worth investigating whether this similarity is purely coincidental, or pattern substitution and extension are indeed more widespread than previously assumed, potentially involving a limited set of "prototypical" contours or melodic templates. If the latter is the case, many seemingly irregular patterns might turn out to be systematic.

These considerations lead to a key insight from our studies: in dialects with complex tone sandhi, it may be helpful to treat the sandhi contour as a whole rather than to focus exclusively on the correspondence between surface and underlying tones. This perspective may be informative even for dialects where pattern extension is not readily detectable in disyllabic sequences. Evaluating these possibilities, of course, will require substantial new empirical work. More acoustic data are needed from dialects with complex sandhi, especially from larger domains, with attention to the sandhi contours rather than syllable-by-syllable tonal alternations.

The effect of historical tonal categories

Related to pattern extension is the second general tendency, namely the effect of the historical tonal categories of non-initial syllables on sandhi contours, which sometimes obscures the extension and makes it difficult to identify at first glance. Our findings demonstrate the effect of historical tonal categories on disyllabic tone sandhi, which has been frequently reported across Northern Wu (e.g., M. Y. Chen & Zhang, 1997; Kuang et al., 2018; Rose & Yang, 2024). Interestingly, we further observed that the effect diminishes in longer sequences. This aligns with the tendency of sandhi pattern simplification in Wuxi Wu (Chan & Ren, 1988): distinct sandhi contours conditioned by the historical tonal categories of the second syllable are observed in disyllables, but they tend to merge in tri- and quadri-syllabic sequences.

Although the diminished effect of historical tonal categories is less frequently reported in the literature, likely due to the scarcity of acoustic data from larger domains, impressionistic descriptions provide evidence on similar tendencies in other Northern Wu. Consider Chongming Wu, where historical tonal categories are vital in the description of tone sandhi behaviors (M. Y. Chen & Zhang, 1997). In disyllables, the specific Middle Chinese categories of non-initial syllables condition tone sandhi patterns, whereas trisyllabic sandhi patterns are comparatively simpler, with only the broader distinction between "even" (i.e., Middle Chinese Ping and Ru tones) and "oblique" tones (i.e., Middle Chinese Shang and Qu tones)[2] playing a role (M. Y. Chen & Zhang, 1997). Although the effect of historical categories does not disappear entirely as it does in Shaoxing Wu, both dialects demonstrate systematic diminishing of this effect as domain length increases, suggesting a cross-dialectal tendency.

Taken together, while the historical categories of non-initial syllables have been repeatedly reported to condition sandhi patterns across Northern Wu, its

[2]Traditionally, "even" tones (平声) refers to Middle Chinese Ping tones, while "oblique" (仄声) covers Shang, Qu, and Ru tonal categories. M. Y. Chen and Zhang (1997) redefined these terms in their description of tone sandhi in Chongming Wu, and we follow their usage here for clarity.

diminishing effect in larger domains may be equally widespread, though receiving considerably less scholarly attention. Assessing how general this tendency is requires additional acoustic data from larger domains in dialects where effects of historical category have been reported. In addition, the underlying mechanism driving the influence of the historical categories of non-initial syllables, as well as its tendency to diminish in larger domains, deserves further investigation. Chan and Ren (1988) propose that this may reflect an ongoing sound change toward simpler sandhi patterns, though more diachronic data would be helpful for evaluating this hypothesis.

f0 converging pattern

Third, our findings reveal that despite variations conditioned by the initial tone and occasionally the historical categories of non-initial syllables, f0 trajectories converge towards a low tonal target as domain length increases. This echoes findings previously reported in Shanghai (Y. Chen, 2008; Takahashi, 2019) and Suzhou Wu (F. Ling, 2011), adding to the existing body of evidence on f0 convergence in Northern Wu. Specifically, our data come from a dialect with more complex tone sandhi, suggesting that this phenomenon may be a more general tendency across Northern Wu.

What makes this converging pattern intriguing is its potential to advance our understanding of tonal realizations on non-initial syllables in Northern Wu. The general consensus for dialects demonstrating typical left-dominant sandhi is that the first non-initial syllable re-associates with a tone decomposed from the initial tone, while the remaining associate with an inserted default low tone (e.g., M. Y. Chen, 2000). Nonetheless, the converging pattern, particularly the temporal dynamics of f0 lowering, motivates further discussion on the nature of the low tone. Observing that the f0 lowering already starts before the end of the first non-initial syllable and approaches near convergence at later syllables, Y. Chen (2008) and F. Ling (2011) proposed the existence of a low or mid tone target for all non-initial syllables. Specifically, its phonetic implementation is weak compared to underlying lexical tones and requires larger domains to man-

ifest, which is remarkably comparable to the neutral tone in Mandarin (e.g., Y. Chen & Xu, 2006). Along a different line, Takahashi (2019) attributed the converging pattern in Shanghai Wu to a boundary low tone at the right edge of a phonological word. This analysis, however, struggles to explain why f0 fails to reach target values by the end of disyllabic words in Shanghai Wu.

Regardless of which theoretical account ultimately proves more adequate across dialects, or whether different dialects require different analyses, it is clear that the nature of this low tone differs from lexical low tones and deserves further investigation. Our data suggest Shaoxing Wu as a valuable case for such inquiry, though we lack fine-grained measurements on the time course of f0 converging (since they were not originally collected to address this issue). Moreover, as discussed in Chapter 3, our stimuli were produced in isolation rather than embedded in carrier sentences, which might induce more pronounced f0 lowering due to the utterance-final position. Future studies should pay closer attention to the time course of f0 convergence and embed the stimuli in carrier sentences, which would allow for more direct comparison with previous studies in the literature. Beyond the aforementioned dialects, it would also be valuable to investigate whether other Northern Wu demonstrate similar convergence patterns. If so, bringing together cross-dialectal data might contribute to a more comprehensive understanding of the tonal realizations of non-initial syllables.

Overall, the general tendencies across Northern Wu demonstrate that the underlying sources of seemingly complex sandhi patterns can be manifold: potentially complicated by ongoing sound changes, the surface sandhi contours result from the extension of a substituted tonal melody on the initial syllable, which further interact with a low tonal target. This becomes clearer only with acoustic data from dialects exhibiting complex sandhi, particularly from larger domains. Recognition of these patterns further requires moving beyond the traditional analytical focus on whether individual syllables preserve or neutralize their underlying tones. While such underlying-to-surface comparisons prove valuable for certain dialects with typical left- or right-dominant sandhi patterns,

exclusive reliance on it risks becoming a theoretical hammer that shapes every seeming tonal alternation into a stress-related nail.

5.2.3 Syntax-prosody mapping

With controlled experimental data on phrasal-level tonal realizations in Shaoxing Wu, this dissertation further contributes empirical evidence to how morphosyntactic structure and constituent size interact in prosodic constituent formation, which is a central issue in syntax-prosody mapping studies.

While it is widely accepted that prosodic constituents map onto their corresponding syntactic constituents (e.g., Selkirk, 1986; Truckenbrodt, 1999), their formation is also constrained by phonological factors, among which size constraints play a well-attested role (e.g., Elordieta et al., 2005; Ghini, 1993). Our data revealed distinct tonal realizations between disyllabic VO and SP structures, likely reflecting different levels of prosodic boundaries, but the distinction disappears as the constituent size increases. This suggests that size constraints interact with syntax-prosody correspondence constraints in Shaoxing Wu, which adds to the growing literature on their interplay in prosodic constituent formation.

Specifically, we have proposed size constraints on both Prosodic Word and Intonation Phrase for Shaoxing Wu, the latter being a constraint less frequently reported. Though tentative and requiring further validation through more complex structures, our proposal suggests that Shaoxing Wu can serve as a test case for further investigating size constraints on higher-level prosodic constituents. Furthermore, given the proposed size constraints on Prosodic Word and Intonation Phrase, a question arises as to whether similar constraints also apply at the level of Phonological Phrase, which remains to be explored in future research.

Our findings, once supported by additional data, might also contribute to the study of cross-dialectal variation in syntax-prosody mapping. The constraints involved in prosodic constituent formation and their ranking are known to vary across languages (e.g., Selkirk, 2011), though less attention has been paid to cross-dialectal variation in Sinitic varieties. With empirical data from

Shaoxing Wu, we observed a potential difference from the widely studied Northern Wu dialect, Shanghai Wu. To account for the observed patterns in Shaoxing Wu, we proposed a size constraint requiring an Intonation Phrase to dominate at least two Phonological Phrases, which outranks the syntax-prosody correspondence constraint mapping a Phonological Phrase onto a lexical XP. In contrast, previous studies on Shanghai Wu have reported no distinction between VO and SP structures, let alone further interaction with constituent size. A Phonological Phrase is typically analyzed as being directly mapped onto lexical XPs (e.g., Selkirk & Shen, 1990), suggesting that the size constraint we propose for Shaoxing Wu is either inactive or significantly lower-ranked in Shanghai Wu. It should be noted that existing syntax-prosody studies on Shanghai Wu are primarily based on impressionistic or limited acoustic documentation. Therefore, the observed difference may stem from the lack of controlled acoustic studies comparing VO and SP structures of varying lengths in Shanghai Wu. Direct acoustic comparison between the two dialects is thus essential to confirm this proposed cross-dialectal variation.

5.3 Limitations and future research

Despite the theoretical contributions and the future directions already mentioned in Section 5.2, several limitations of the current studies should be acknowledged.

First, as the data were collected in a fieldtrip during COVID-19, recording sessions had to be kept relatively short in order to accommodate participants' availability and health considerations. As a result, the number of tokens per condition was necessarily constrained, which limits statistical power of the current studies. Although the observed patterns were consistent and theoretically informative, a larger dataset would allow for more reliable modeling of interaction effects and greater confidence in subtle phonetic differences. In addition, the target stimuli were elicited in isolation rather than embedded in carrier sentences. As all items were produced in utterance-final position, the results may

have been influenced by prosodic boundary effects, including potential final lengthening and f0 lowering. Future studies could address this limitation by embedding target items in controlled carrier sentences.

Second, our discussion of tonal neutralization only concerns whether tonal contrasts are preserved or neutralized in speech production. Given that neutralization in production does not necessarily entail neutralization in perception, and vice versa, future research examining whether listeners can perceptually distinguish the allegedly neutralized tonal categories would provide a crucial complement to the current findings.

Third, several aspects of tone sandhi patterns in trisyllabic compounds examined in Chapter 3 remain open for future work. Although we observed interesting variation in these sandhi patterns and attributed the distinction between general and alternative patterns to differences in sandhi domain formation, our understanding of the alternative pattern remains limited. Specifically, its restricted distribution across certain tonal sequences and the tonal realizations of the initial syllable are not yet fully understood. Future research targeting the alternative pattern more directly would be highly valuable. In addition, compounds in both formal and informal registers were mixed in the stimuli of Chapter 3. Since the general and alternative patterns are each observed in both formal and informal compounds, register difference cannot fully account for the variation. Still, given the well-known register effects on speech variants in Sinitic varieties (see, e.g., Feng, 2025b, for recent discussion on Mandarin), more careful control of register in future studies would be helpful.

5.4 Conclusion

This dissertation investigates the interaction between tone sandhi and stress in Shaoxing Wu Chinese through a series of controlled acoustic experiments, across disyllabic words, trisyllabic compounds, and phrasal structures of varying lengths. This work leaves us with two key messages.

First, our findings highlight the importance of examining complex sandhi

patterns. The field's understanding of tone sandhi has been shaped largely by dialects with typical left- or right-dominant patterns. Yet, beyond the widely studied cases, there is considerably more left to discover. The complex patterns observed in Shaoxing Wu reveal more general tendencies across Northern Wu, and offer new insights to the underlying sources of seemingly complex surface contours. More investigations into dialects like Shaoxing Wu would further refine our understanding of tone sandhi.

Second, caution is warranted when invoking stress as the mechanism to account for tone sandhi. In Shaoxing Wu, we observed no independent acoustic correlates of stress beyond tonal patterns themselves, and stress fails to provide a coherent account of tonal realizations across different domains. This is not to deny the role of stress in tonal phenomena entirely. However, simply presuming a mechanistic account of stress for tone sandhi, without direct empirical evidence, risks hindering our further understanding of the more complex picture that dialects like Shaoxing Wu offer.

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