

Tone 3 Sandhi in Mandarin Chinese: Phonological Rule or Process?

Nian Liu¹

ABSTRACT

The phenomenon of third tone (T3) sandhi in Mandarin Chinese has long been noticed: underlying full T3s may be modified under the influence of their tonal phonetic environment. By discussing in detail from the perspectives of perception, historical development and phonological domain, this paper argues that it is more convincing to take T3 sandhi as a phonological process rather than a morpho-phonological rule resulting from historical residue. This study corrects the long-time misunderstanding of Chinese tone sandhi—that all of it has originated because of historical change of tones by showing that T3 sandhi is a special phenomenon that distinguishes itself from other sandhi. Also, the conclusion has pedagogical implications which can help language learners in studying Chinese tone systems—the sandhi is

¹ Nian Liu, Ph.D., E-mail:Nin.liu@ou.edu; Lecturer, University of Oklahoma.

not to be mechanically memorized, but can be naturally acquired. This research has implications in teaching Chinese as a second language.

Keywords: *Mandarin Chinese, tone sandhi, phonological process, morpho-phonological rule*

The phenomenon of tone sandhi (TS) has long been noticed in almost all Chinese dialects (e.g. Chao 1946, 1968): underlying full tones may be modified under the influence of their tonal phonetic environment. In this paper, I would like to review the most widely found and studies tone sandhi phenomena in Chinese, with special focus on Tone 3 (or T3) sandhi.

Various studies have been conducted on the T3 sandhi. Most of them concerned with the tone sandhi domain (e.g. Shih 1986, Zhang 1988, M. Chen 2000). Some other studies have examined the acoustic features of the sandhi rising tone (Speer, Shih, & Slowiaczek 1989, Peng 2000, Kuo, Xu, & Yip, 2007). However, there is few study focus on the nature of the T3 sandhi phenomenon as what exactly is T3 Sandhi?

The T3 sandhi has mostly been described as a phonological rule results from historical changes rather than a phonological process as a response to the difficulty in pronunciation. But this assertion contrasts with native speakers intuition and observation. Naive native speakers of Chinese are usually not aware of the tone shifting they made; besides, second language learners also subconsciously apply the T3 sandhi rule in their casual speech. The discrepancy in linguistics research and everyday experience motivates this paper and it intends to explore whether the T3 sandhi is a phonological rule or process.

By going through the perception and domain of T3 sandhi, and by comparing it to some other sandhi phenomena of relatively more ancient Chinese dialects, I find out that the following argument is more convincing: T3 sandhi in Chinese is contextual change, which is the response to the difficulty in pronouncing two dipping tones on two contiguous syllables. So it is more like a phonological process rather than an arbitrary rule.

I. The Phonetic Descriptions and Perception of T3 Sandhi

To study the cause of T3 sandhi and to further discuss its domain, it is necessary to take a look at the phonetic properties of Chinese tones first. Standard mainland Mandarin Chinese has four main tones: level high [55], mid-rising [35], low falling-rising [214]², and high falling [51], traditionally termed Tones 1,2,3, and 4, respectively. (The numbers in the square brackets indicate the pitch values of these tones on a five level scale. And Figure 1 is the graphic representations of those pitch values, termed Chao's tone letters, see Chao 1948& 1968.) There is also a “fifth” tone (valued 0), namely the inherent neutral tone, whose pitch value varies dependent on its preceding full tone.

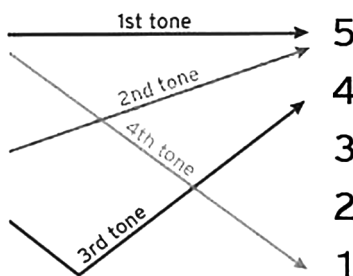


Figure 1. Schematic representation of Chinese Mandarin tones

² In Cheng (1973), T3 is described as having the value [315].

As described in Chao (1948, 1968), the third-tone sandhi happens when the dipping tone T3 (-valued 214) becomes T2 (-valued 35) when immediately followed by another T3, in other words, T3T3 becomes T2T3. Some studies (e.g., Chen & Yuan, 2007) have reported that the sandhi rising tone (T2 in T2T3 sequence) and the underlying rising tone (T2) are acoustically different in certain conditions, however, it has been widely accepted that speakers do not distinguish the T2T3 and T3T3 pairs (Wang & Li, 1967). As a result, this paper will not discuss the differences in acoustic features between sandhi and underlying T2 in detail as that is not the focus of current research.

Why then does the first T3 in T3T3 sequences simplify to T2 but not T1 or T4, the other two “simpler” tones in Mandarin Chinese? Steriade (2001) proposes that this may be a case of perceptually tolerated articulatory simplification. That is, T2 is selected as the sandhi form because it is perceptually more similar to T3 than T1 or T4 is, which makes the change relatively hard to detect in perception. Kiriloff (1969) found that syllables with Tone 2 and Tone3 may be perceptually confusable. Huang (2001)

examines the confusability of T3 and T2 by carrying out a perceptual experiment of monosyllabic tonal pairs, in which he recorded both the “same/different” judgment made by the participants and their reaction time during response latency. The scientific method and analysis of this experiment provide better understanding of this sandhi process and prove that the sandhi process is allowed to take place because such a change is relatively hard to detect and that the selection of T2 as the output of the sandhi may be perceptually conditioned.

Furthermore, Huang’s (2001) experiment provides scientific perception evidence for my observation, because it proved that the altered sound sequence (T2T3) is not perceived as distinct from the unaltered form (T3T3)—T2 and T3 are the most similar tone pair. So it provides a piece of evidence that T3 sandhi is probably a Phonological process, not an arbitrary rule.

II. The Trigger and Origin of T3 Sandhi

The first documented statement on the T3 sandhi by westerners is found in a grammar book of Chinese written by Francisco de Varo, O.P. in 1682, showing that the T3

sandhi came into being in the mid 17th century at the latest.

Mai, en tercera tonada es comprar...mas
juntandola con otra tercera, como *mai ping*,
pronunciandolas juntamente el mail ba quasi a
ser primera [“*mai*, in the third tone, means ‘to
buy’... but next to another third tone, as in *mai
ping*, it nearly becomes the first tone³ when
pronounced together”; tr. MYC] (Francisco de
Varo, 1682, Arte de la Lengua Mandarina, p.9)

We may then ask what brings about the T3 sandhi?
Is it because of certain historical change in the tone or the
articulatory constraint of human vocal capacity? Shin
(1997) agrees with the latter explanation based on the
perception that T3 surfaces as a low (falling) tone in most
cases. He argues that the trigger of T3 sandhi seems to be
the “lowness” of T3. C.C.Cheng (1968, cited in Shin 1997)
reported that, even when Mandarin speakers code-switch
between Chinese and English, a T3 would change into T2

³ It is not clear why the first T3 in the sequence is described as T1 instead of T2. But because the realization of tones have probably underwent changes since the time the book was written and we do not have access to what the tones exactly sound like, we may just focus on the fact that the first T3 was altered in a T3T3 sequence.

when the first syllable of the following English word is unstressed –i.e. bearing a low tone:

Underlying form	Surface form	Meaning
/hao ²¹⁴ pro`fessor/	[hao ³⁵ pro`fessor]	“good professor”
/hao ²¹⁴ `student /	[hao ²¹⁴ `student]	“good student”
/mai ²¹⁴ re`frigerator/	[mai ³⁵ re`frigerator]	“buy refrigerator”
/mai ²¹⁴ `flower/	[mai ²¹⁴ `flower]	“buy flower”

And the native speakers are totally unaware of the adjustment they made. This shows that simplification seems to be the correct analysis in that both native intuition and vocal physiology support the theory that it is hard to produce two dipping T3 in a row. Shin’s observation is convincing because he adopts a novel perspective for T3 sandhi and shows that T3 sandhi affects novel situations that the speakers could not have learned. This could be a piece of evidence to prove that T3 sandhi is a phonological process.

A more interesting and detailed study of tone sandhi was done by Pan in the year 1982. If Shin (1997) only provides indirect support of my hypothesis, Pan’s (1982) conclusion in his paper “Several problems in the

development of Chinese tones” could be viewed as direct and strong evidence. In his work of studying tone shape-merge hypothesis, Pan Wuyun made a very important claim that: “Chinese tone sandhi is of two types. The first type is contextual change, in which if there is difficulty in pronouncing the tones on two contiguous syllables, the tone in one of the syllables is changed. The second type is that found in Xiamen dialects, where so-called changed tones in syllables are not determined by the tones of contiguous syllables. (Pan, 1982: 359-360)”. This claim corrects the long-time misunderstanding of Chinese tone sandhi—that all of it has originated because of historical change of tones. And T3 sandhi is a special phenomenon that distinguishes itself from other sandhi as it is obviously the former one, although it also happens in southern dialects which preserve more information related to medieval Chinese tones.

Chen (2000) also points out in detail that in Mandarin Chinese it is the tone on the second syllable in a pair that undergoes the tone sandhi; however, in Xiamen dialect, it is the first one which is changing. And this difference reflects a different origin of tone sandhi

phenomena:

“In fact, it is the second syllable in a pair that reflects more recent historical change than in the citation tone; the tone in the preceding syllable conserves older values. Only by recognizing the difference between these two kinds of sandhi is it possible to systematically and scientifically study the complications of sandhi phenomena.” (Pan, 1982)

Applying this general statement to the T3 sandhi we are discussing, T3 sandhi is not triggered by historical tone change, because if it was, it would be hard for us to explain why the changing tone is on the first syllable instead of the second one considering the enormous data found in various Chinese dialects.

Pan’s study is based on wide yet detailed observation of more than 20 dialects and on finding evidence from historical materials. It is not a study using statistics or scientific tools, but all of its deductions are step by step and based on rigorous proof, which leads to clear and convincing conclusion. This paper was published

in a “pre-technology” period for Chinese linguists (1982), and I believe it is not only necessary but also desirable to have further study employing experimental and quantitative methods to test several hypotheses proposed by the author later on.

III. The Domain of T3 Sandhi

The domain of T3 sandhi is another crucial factor to decide whether it is a phonological rule or process. Previous studies on the T3 sandhi have mainly concerned with the formation of tone sandhi domain (Shih, 1986; Zhang, 1988; M. Chen, 2000, among others). In his book specified to Chinese tone sandhi phenomena, Chen (2000) talked about the issue of domain in detail and provides support to my point of view.

In discussing the topic of stress-foot in sandhi domain, Chen (2000) considers the metrical foot, “which entails the notion of stress, the linguistically significant prominence around which the metrical unit is organized” (Chen, 2000: 286), as the domain of tone sandhi. Shanghai dialect and other Wu dialects are chosen to be analyzed to explain the interplay of the stress foot and the complex

sandhi phenomenon. However, these two chapters do not shed much light on the special T3 sandhi as no substantial T3 sandhi examples are cited. But this does imply that the criteria proposed by him are not applicable to T3 sandhi, as some other scholars do believe that metrical foot has something to do with the T3 sandhi domain. For example, Yip (1980) and Zhang (1988) mentioned that T3 sandhi is conditioned by the metrical pattern of the utterance and that the T3 that undergoes the sandhi has to be in the weak branch of the stress matrix, i.e. the syllable bearing the sandhi tone must not be linked to a node at the highest/primary stress level. Thus, it is predicated that the first T3 in /xiao²¹⁴jie²¹⁴/ “Miss” (with a weak-strong pattern) would undergo the T3 sandhi and surface as [xiao³⁵jie²¹⁴], whereas that in /jie²¹⁴jie²¹⁴/ “elder sister” (with a strong-weak pattern) would not, yielding the surface form [jie²¹⁴jie⁰].

In contrast, Shin (1997) holds that the stress does not play a role in the sandhi processes. I choose not to commit myself to any phonological framework because these two solutions cannot fully explain the complicated sandhi phenomenon, especially when there are intervening

structure factors. If it is the case that only metrical pattern and stress determines T3 sandhi, it implies that T3 sandhi should be restricted within a word boundary, which is contrary to some observations as will be discussed in a moment.

Still in Chen's (2000) book, reasonable analysis of sandhi domain specifically for T3 sandhi phenomenon was found in the discussion about minimal rhythmic unit and phonological phrase as sandhi domain. These parts of the book in detail discusses a central proposal of the author that the domain of T3 sandhi is a new prosodic category called the minimal rhythmic unit (MRU) rather than the lexical word as many linguists have claimed before. Then the author shows what constitutes an MRU and how MRUs are formed: he argues that the MRU is not a syllabic foot, as it was previously called, because every full Mandarin syllable is already a moraic foot (assuming that each language has only one kind of foot). In addition, in the prosodic hierarchy theory a foot is a constituent of the phonological word, but in Mandarin a MRU can be a *phonological phrase*, such as /mai²¹⁴ ma²¹⁴/ "buy a horse" and /ni²¹⁴ hao²¹⁴/ "how are you?" Obviously, the T3 sandhi

domain should not be confined by morpheme or word boundaries. A more recent study (Wang, Schmitt and Lin, 2012) about the acquisition of T3 sandhi employing experimental methods also support the idea that children and adults do not confine the domain of T3 domain to binary foot, in other words, T3 domain can be larger than word boundaries.

An exciting part of the two studies cited in the previous paragraph is that although linguists have devoted no small amount of ink to T3 sandhi in Mandarin Chinese, I haven't found much other reference which adequately explains how this phenomenon might apply to a string of three or more syllables in the third tone so far. But the two works, especially that by Chen (2000), gives a clear account of this problem by proposing a different sandhi pattern determined by different complement structures, for example, a carefully analyzed example is /zhao²¹⁴ dan²¹⁴ xiao²¹⁴ gui²¹⁴/ "find the coward" and /zhi²¹⁴ lao²¹⁴ hu²¹⁴ pao²¹⁴/ "paper tiger runs". Nevertheless, the author also analyzes the concept of the word and the lexical status of the modifier+noun and verb+resultative complement constructions to further examine the domain of T3.

Underlying Form	Surface Form	Meaning
a. /hao ²¹⁴ mi ²¹⁴ /	[hao ³⁵ mi ²¹⁴]	“good rice”
modifier head noun		
b. /mi ²¹⁴ hao ²¹⁴ /	[mi ³⁵ hao ²¹⁴]	“The rice is good”
subject predicate		
c. /mai ²¹⁴ mi ²¹⁴ /	[mai ³⁵ mi ²¹⁴]	“buy rice”
verb object		

And based on this distinction, we see a new proposal that T3 sandhi must apply in two steps, first at the word and compound level, and then at the phrase level. Chen (1998) has thoroughly compared the analysis he proposed with three other alternative accounts: the prosodic hierarchy, syntactic juncture, and meaning-based prosodic structures delimiting the scope of tone sandhi. This opinion is consistent with his former research addressing the application of Optimality Theory to tone sandhi. “Far from being arbitrary rewrite rules, tone sandhi processes function

as competing repair strategies, a synchronic analog of competing sound change. (Chen, 1998: 191)”

Chen (2000) also contrasts the T3 Sandhi domain in Mandarin Chinese to other sandhi phenomena in various Chinese dialects. He suggests that there is an even larger sandhi domain than prosodic unit, which does not apply to Mandarin Chinese T3 sandhi, but to another well-known dialect, Xiamen, where sandhi domains are determined by marking the right end of each syntactic phrase (XP). Other factors affecting phonological phrases include whether an XP is an adjunct, the c-command relation in the constituents, and the effects of rhythm. In a word, sandhi domains in different dialects are determined by different levels of the prosodic hierarchy: it is the foot in Shanghai, the MRU in Mandarin, the phonological word in Wenzhou, and the phonological phrase in Xiamen.

It is interesting that Chen’s (2000) analysis of sandhi domain verifies the conclusion Pan (1982) had drawn before: tone sandhi in Mandarin Chinese is different from that of Xiamen dialect. Chen provides syntactic analysis, whereas Pan contributes from historical study. Putting these pieces of evidence together we now find strong

support from different aspect that T3 sandhi may not be a phonological rule.

Another interesting study on tone sandhi domain is done by Ning Zhang (1997), exploring from the other end of the tunnel by studying the avoidance of the third tone sandhi. This study adopts the Optimality Theory analysis of tone sandhi domains of Mandarin, and proposes that to determine a Tone Sandhi domain, several constraints related to metrical factors, constituent strength, tone sandhi domain grouping direction, and output condition should all be brought into consideration. The novel idea of Zhang's (1997) study is that it distinguishes two situations where the avoidance of tone sandhi would occur, one is "category dependency" and the other is "structure dependency"—the former deals with how some categories in some situations resist T3 sandhi, and the latter one is about the certain syntactic structure that prevents T3 sandhi from happening. It is like providing counter examples and letting us see what is correct and how it is so. By doing this, it is possible to better analyze the domain of T3 sandhi. And by this method, some issues that Chen's analysis does not consider can be explained because

Zhang provides more subcategories than the two proposed by Chen (“modifier+noun” and “verb+resultative” complement constructions).

Therefore, it is clear that T3 Sandhi in Mandarin Chinese has a much bigger domain than most sandhi in other Chinese dialects, which is an indication that T3 sandhi is in nature different from other sandhi phenomena which based on historical rules.

IV. Discussion

After the detailed discussion, we come to the conclusion that it is a phonological process instead of a rule from the perspectives of perception, history and its domain. Most of the aspects of T3 sandhi meet with the criteria to distinguish phonological processes from morphological rules given below:

- (1) It originates as the response to the difficulty of producing two dipping tones in a row.
- (2) The altered tone sequence (T2T3) is not perceived as distinct from the unaltered form (T3T3) in that T2 and T3 are the most confusable tone pair in Mandarin Chinese.
- (3) The substitution is based entirely on features and

prosodic units as it applies to all of the T3 sequences, not only certain categories⁴.

(4) Processes may be optional or variable. It is possible for speakers to avoid T3 sandhi in very careful speech.

(5) Substitutions based on processes affect novel situations that the speakers could not have learned, as T3 sandhi happens in the code-switch case.

(6) The substitution does not depend on morphological information.

(7) The substitution may apply across a word boundary, as T3 sandhi works not only in word, but also in phrases and sentences.

(8) Substitutions do not have exceptional forms. The dipping tone T3 is changed into T2, but not any other tones or suprasegmental elements.

It is the common view that tones are suprasegmental of a language, but Chinese tones should be understood to include both suprasegmental and segmental features, and the historical development of Chinese tones has moved from the segmental to the suprasegmental. T3 sandhi in

⁴ This issue is not agreed on completely among scholars and definitive answer still needs further study.

Mandarin Chinese, for example, is tone suprasegmental, contrasting with many other tone sandhi phenomena in other Chinese dialects which originate because of diachronic reasons.

There are three crucial challenges in teaching Chinese as a second language: pronunciation, character writing, and verbal communication skills, with the teaching of pronunciation the foremost and more difficult, as the phonemes and tones cannot be seen. Being a natural phonological process that originated from effort saving in pronunciation, T3 sandhi should not pose special difficulty in learning Chinese as a second language. However, teachers need to bring this phenomenon to students' attention as early as possible. A brief introduction to the T3 sandhi process in our teaching is necessary and important. Moreover, teaching a language in the classroom improves significantly when technology complements and extends the functionality of the traditional methods. In this case, we can probably lead a language lab session. In this session, students can study tones and tone sandhi by computer and have hands-on experience with linguistic software such as Pratt. They can record their pronunciation

using the software and actually see the curves of different tones and tone sandhi from the diagrams (Figure 2).

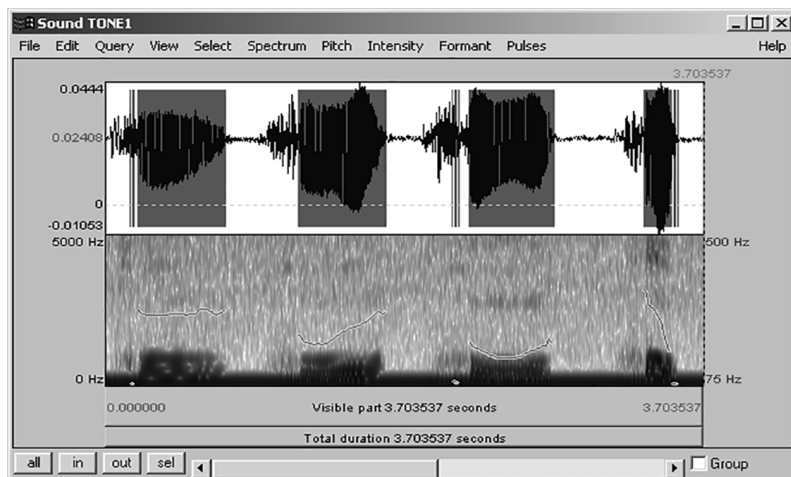


Figure 2: Visual cues of tone production
(blue dashes in the lower part showing all four tones in Chinese)

In this way, students can easily test if their tone and tone sandhi production is correct. Visually assisted learning can greatly help students to understand and master intangible suprasegmental information and change in Chinese sound inventories, hence improve students' performance in Chinese learning.

References:

- Blicher, D.L., Diehl, R.L., & L.B. Cohen, (1990). Effects of syllable duration on the Perception of the Mandarin Tone 2/Tone 3 distinction: evidence of auditory enhancement. *Journal of Phonetics*, 18(1).
- Chao, Yuen Ren. (1948). *Mandarin Primer*. Cambridge, MA: Harvard University Press.
- _____. (1968). *A Grammar of Spoken Chinese*. Berkeley: University of California Press.
- Chen, Matthew Y., (1998). Competing Strategies & Deviational Economy. *Journal of Chinese Linguistics*. 26(2), 191.
- _____. (2000). *Tone Sandhi patterns across Chinese dialects*. Cambridge, UK: Cambridge University Press.
- Chen, Yiya & Jiahong Yuan, (2007). A corpus study of the 3rd tone sandhi in Standard Chinese. In *Proceedings of Interspeech 2007*, ed. H. van Hamme and R. van Son, 2749–2752. Bonn: ISCA.
- Cheng, Chin-chuan. (1973). *A Synchronic Phonology of Mandarin Chinese*. The Hague: Mouton.
- Fon, J., Chiang W.-Y., & H. Cheung et al., (2004).

- Production and perception of the two dipping tones (Tone 2 and Tone 3) in Taiwan Mandarin. *Journal of Chinese Linguistics*. 32(2), 249-281.
- Huang, Tsan, (2001). The interplay of perception and phonology in Tone 3 Sandhi in Chinese Putonghua. *OSU Working Paper in Linguistics* 55, 23-42.
- Kiriloff, C, (1969). On the auditory perception of tones in Mandarin. *Phonetica* 20: 63-67.
- Kuo, Y.-C., Xu, Y., Yip, M., (2007). The phonetics and phonology of apparent cases of iterative tonal change in Standard Chinese. In Gussenhoven, C., Riad, T. (eds.), *Tones and Tunes, vol. II, Phonetic and Behavioural Studies in Word and Sentence Prosody*. Mouton de Gruyter, Berlin, pp. 211–237.
- Pan, Wuyun. (1982). Several problems in the development of Chinese tones. *Journal of Chinese Linguistics*, vol. 10, 359-385.
- Shen, X.S. & Lin, M., (1991). A perceptual study of Mandarin Tone 2 and 3. *Language and Speech*, 34(2), 145-156.
- Shin, Chi-lin, (1989). The Prosodic Domain of Tone Sandhi in Chinese, PhD dissertation, University of

California, San Diego.

- _____. (1997). Mandarin third tone sandhi and prosodic structure. In Wang Jialing and Norval Smith (eds.) *Studies in Chinese Phonology*. Berlin & New York: Mouton de Gruyter, 1997.
- Steriade, D. (2001). A perceptual account of directional asymmetries in assimilation and cluster reduction. In E. Hume & K. Johnson (eds.) *The Role of Perception in Phonology*. New York: Academic Press.
- Wang, Chiung-Yao, Cristina Schmitt & Yen-Hwei Lin. "Children's Acquisition of Mandarin Tone 3 Sandhi in Flat Structures." Paper presented on *the 6th International Conference on Speech Prosody*, Shanghai, China May 22-24, 2012.
- Yip, M. (1980). The Tonal Phonology of Chinese. Ph.D. dissertation. MIT.
- Zhang, Ning, (1997). The avoidance of the third tone sandhi in Mandarin Chinese. *Journal of East Asian Linguistics* 6, 293-338.
- Zhang, Zheng-Sheng, (1998). Tone and Tone Sandhi in Chinese, Ph.D.dissertation, The Ohio State University.