Third Tone Sandhi and the Prosodic Structure of Mandarin Chinese

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Generative phonology originally viewed the phonological and syntactic components as distinct entities related to each other in limited ways (Chomsky & Halle 1968, Selkirk 1972). Subsequently, however, various researchers (Kaisse 1977, Clements 1978, Odden 1982) have proposed that some phonological processes are best accounted for by referring to syntactic structure. Selkirk (1972, 1974, 1978) and Nespor and Vogel (1979, 1982), among others, have examined the relationship between prosodic and syntactic structure, concluding that prosodic structure is projected from syntactic structure but not isomorphic to it.

This paper applies the findings of these studies to the third tone sandhi (henceforth 3TS) process in Mandarin Chinese (henceforth MC). The account proposed here revises Nespor and Vogel’s algorithms for building prosodic structure to fit MC parameters; observed variability in the application of 3TS is accounted for in terms of the options offered by prosodic structure.

PRELIMINARIES

3TS occurs when two lexical third (low-falling-rising) tones occur adjacent to one another: the leftmost tone becomes phonetically identical to the second tone (mid-rising). The following phrases (from Cheng 1973) are examples of two-word sequences in which 3TS occurs:

(1) a. /mai³ ma²/ -/ [mai² ma³] 
   buy horse
   "to buy a horse"

b. /fen³ chang³/ -/ [fen² chang³]
   flour factory
   "flour factory"

For the purposes of this discussion, all syllables will appear with their lexical tone. The application and non-application of 3TS will be indicated graphically: if the first of two adjacent third tones undergoes 3TS, the syllables are linked by the symbol "*"; if two adjacent third tones do not undergo 3TS, they are separated by an oblique stroke "/". Consider this

-1-
sentence:

(2) wo³/maì³*mi³
    I buy rice
    "I am buying rice"

This sentence has the surface tone melody [3 2 3]: only the second syllable has changed from its lexical tone. The symbol "*" between two words indicates that both application and non-application of 3TS are attested in that environment.

THE SYNTACTIC ACCOUNT

Since 3TS occurs between words, one might propose that it occurs in a syntactic environment. Cheng (1973) makes such a proposal. He combines a cyclic solution and the "syntactic depth" hypothesis proposed by Wang (1966, cited by Cheng). Cheng's solution accounts for many examples by deriving tone melodies directly from syntactic structure; however, there are many sentences which cannot be generated within this framework. Consider (3):

(3) wo³ * yun³*xu³ / xiao³ * Mei³
    I allow little Mei
    "I let little Mei (do it)"

The melody attested should be impossible: under Cheng's hypothesis, wo³ should be in a context for 3TS with the verb only if the rate of speech is sufficiently fast to make the entire sentence the domain of the rule. The entire VP should be the 3TS domain before the subject NP comes into the picture.
Numerous other examples show that 3TS often contradicts syntactic structure in its application. The rule operates, at least in some respects, independently of syntax. In the rest of this paper, I will develop an account of 3TS based on prosodic as well a syntactic information.

**THE PROSODIC ACCOUNT**

The task of this paper, then, is to set up a workable framework of prosodic structure for MC. Selkirk (1978) proposes that there is a hierarchy of prosodic structure consisting of the syllable (s), the foot (F), the word (W), the phonological phrase (P), the intonational phrase (I) and the utterance (U). This general model will be applied to MC. First, the lower levels of phonological structure are established, and it is noted that at the word (W) level, which is defined syntactically, 3TS is obligatory. Next, the phonological phrase (P) is discussed: 3TS is obligatory within P under certain circumstances. Finally, P-restructuring rules proposed by Nespor and Vogel (1982) are revised parametrically to account for further MC data.

Yip (1980) proposes that in MC each tone-bearing syllable represents a foot, with neutral toned syllables joined as weak sisters in a right-branching structure. Following Selkirk, all lexical entries are dominated by W when they leave the lexicon. There are several syntactic constructions consisting of two tone-bearing syllables in which 3TS is obligatory:

\[
\begin{align*}
(4) & \quad \text{a. adjective-noun} & \quad \text{b. adverb-adjective} \\
& \quad \text{xiǎo}^3 \times \text{gōu}^3 & \quad \text{hēn}^3 \times \text{lào}^3 \\
& \quad \text{"little dog"} & \quad \text{"very old"} \\
& \quad \text{c. verb-noun} & \quad \text{d. preposition-noun} \\
& \quad \text{mǎi}^3 \times \text{mǐ}^3 & \quad \text{wáng}^3 \times \text{nà}^3 \\
& \quad \text{"buy rice"} & \quad \text{"towards where?"}
\end{align*}
\]
e. number-classifier    f. subject-predicate
wu³ * zhong³        wo³ * mai³
"five kinds"        "I buy (it)"

g. compounds¹      h. names
fen³-chang³         Li³ Mei³
"flour factory"

These phrases all consist of two non-branching monosyllabic words. For example, (4-f) above has the following syntactic and phonological structure:

```
S
 / \ syntactic structure
NP  VP
 /   /
wo  mai
|   |
F   F
|   |
W   W phonological structure
```

The phrases in (4) share an important syntactic property. Employing the convention of pruning (cf. Ross 1967), deleting all non-branching preterminal nodes from the branching syntactic structure of each phrase, all of them are of the form

```
X
 / \ mutual c-command" (Chomsky 1982). C-command is defined as follows:
 Y   Z
```

In such a structure, the relationship between Y and Z is defined as one of "mutual c-command" (Chomsky 1982). C-command is defined as follows:

In a][b, a c-commands b if and only if neither one dominates the other and the first phrasal node which dominates a also dominates b (Manzini 1983, pg.3).

Manzini (1983) looks at data from French (Selkirk 1974) and Ewe (Clements 1978) and concludes that the application of external sandhi is dependent on the notion of c-command. She proposes a universal condition for the application of phonological rules:

In a][b or b][a
a and b c-command each other (obligatory)
a c-commands b (optional).

C-command holds between a lexical head and the elements within the maximal projection on its non-recursive side. Applying Manzini's proposal to the Mandarin data, in any two-footed phrase with the structure shown above, the condition of mutual c-command is met, and 3TS is obligatory.

I propose that mutually c-commanding members of two-footed phrases be joined or lexicalized under the node W'. This is obligatory if the condition of mutual c-command is met. A phrase like (4-f), then, has the following phonological structure:

```
       wo * mai
       /     /
      /     /
     W     W
    /     /
W'     W'
```

Incorporating the notion of lexicalization, a generalization can be made regarding the environment for the application of 3TS: it occurs obligatorily within W or W'.

3TS is obligatory within W'. However, if one constituent of a syntactic phrase branches at the W-level, 3TS over the entire phrase is not obligatory:

(5) da³ jing³-chuan³
hit police dog
"to hit a police dog"

```
       VP
       /   /
      V   NP
     /   /    
   da jing-chuan
   /   /     
  /   /      
W W W W W'
```

Here, 3TS between the verb and the object NP is optional. Furthermore, if both
W's within a syntactic phrase branch, 3TS is even less likely.

(6) mai³-hao³ jing³-chuan³
    buy-ASP police-dog
    "bought a police dog"

In this case, 3TS applies obligatorily within each W', but only in fast speech would the rule have the entire VP as its domain.

While 3TS must occur within W', it can also apply between W's. Evidently, then, 3TS cannot be defined only in terms of the word; reference to a higher prosodic level is necessary. The phonological phrase, P, is the highest strictly defined level of prosodic structure (Selkirk 1978, Nespor and Vogel 1982). In an analysis of "raddoppiamento sintattico" (RS), a gemination rule in Italian, Nespor and Vogel (1982) propose algorithms for building P on the basis of syntactic structure. 5

a. P-construction.
Join into P any lexical head (X) with all items on its non-recursive side within the maximal projection and with any other non-lexical items on the same side (e.g. prepositions, complementizers, conjunctions, copulas...).

b. P-constituency.
P branches in the same direction as the syntactic trees.

c. Optional P-restructuring.
A non-branching P which is the first complement of X on its recursive side loses its label and is joined to the P containing X under a new node labelled P' (pp.228-9).

Although prosodic structure is mapped from syntactic structure and dependent on
the core grammar notion of recursiveness (cf. Chomsky 1965), the domains for
external sandhi cannot be satisfactorily described purely in terms of syntactic
categories. The phonological phrase, for example, "extends over the left side
of a phrase and not the right side" (Nespor and Vogel 1982, pg. 254). RS can
be elegantly described as an external sandhi process occurring within P.
Nespor and Vogel go on to show that phenomena like French liaison and
intervocalic flapping in English can be explained simply within this framework.
It will be argued below that 3TS can also be accounted for if P is considered.

(7) is an example of a MC sentence analyzed according to Nespor and
Vogel's proposal.

(7) lao³ Li² da³ ta¹-de xiao³ hai²
    old Li hit he-POSS little child
    "old Li beats his child"

The three P's in (7) are built over the lexical heads of the two NP's and the
VP. The NP's become part of multi-footed P's because all items within the
maximal projection on the non-recursive (left) side are incorporated. The verb
remains alone in a non-branching P because there is nothing within its maximal
projection on the left side. If, however, the object NP consisted of only one
foot, this foot would be joined with the V under P' in accordance with the
optional restructuring convention.

3TS will be defined by referring to P. However, the proposal that 3TS
simply occurs within P is not adequate:

(8) wo³ you³ wu³-ben³ xiao³ shuor¹
I have 5-volume little speak
"I have five novels"

ben³ and xiao³ are within the same P, yet 3TS between them is not obligatory.

On the other hand, 3TS between members of different P's is possible:

(9) wo³ ba³ bi³ ge³ ta¹
I take pencil give him
"I give him the pencil"
bi³ and gei³ here are in different P's but can still participate in 3TS. A valid explanation of 3TS must account for this.

The notion of P proposed by Nespor and Vogel must be revised to provide a framework which can handle the MC data. There are three main points in this revision:

(i) A condition on non-branching W's within P.

(ii) A revision which expands Nespor and Vogel's P-restructuring condition to make it more independent of syntactic structure.

(iii) A non-structure dependent rule which results in 3TS between two adjacent third tones
    (a) at utterance edge (obligatorily)
    (b) utterance-internally (optionally).

Non-branching W's within P

It has already been established that 3TS is obligatory within W' and optional within P. However, there are data indicating that 3TS is not always optional within P. When a non-branching W occurs with another branching W in one P, the former must enter into 3TS with its partner.
(10) a. \( \text{wu}^3-\text{zhong}^3 \text{ gou}^3 \text{ lai}^2 \)
5-M dog come
"five kinds of dogs came"

\begin{itemize}
  \item S
  \item NP VP
  \item CL N
  \item # CL
  \item wu-zhong gou lai
  \item F F F F
  \item W W W W
  \item W'
  \item P P
\end{itemize}

\([\text{wu*zhong * gou lai}]\)
\(*[\text{wu*zhong / gou lai}]\)

b. \( \text{zhei}^4-\text{ge hen}^3 \text{ zhun}^2-\text{shi}^2 \)
this-M very accurate
"this one is very accurate"

\begin{itemize}
  \item S
  \item NP VP
  \item DET CL ADV V
  \item zhei-ge hen zhun-shi
  \item F F F F
  \item W W W W
  \item W'
  \item P P
\end{itemize}

\([\text{zhei-ge hen * zhun-shi}]\)
\(*[\text{zhei-ge hen / zhun-shi}]\)

Renditions of these sentences in which the non-branching W does not participate in 3TS with the other W in its P are rejected as ungrammatical: this is the case whether the non-branching W is on the left or right side of P, and whether
or not the non-branching \( W \) is itself a phrasal head. On the other hand, two branching \( W \)'s within one \( P \) are not in an obligatory 3TS context:

\[
(11) \text{wu}^{3}\text{ben}^{3} \text{xiao}^{3} \text{shuo}^{1} \\
5-M \text{ little speak} \\
"five novels"
\]

In (11), 3TS between \( \text{ben}^{3} \) and \( \text{xiao}^{3} \) is optional even though they are both in the same \( P \).

The phonological status of a non-branching \( W \) differs depending on whether it is part of a branching \( P \) or the sole constituent of a \( P \); in the latter case, it does not obligatorily enter into 3TS with adjacent material.

\[
(12) \text{ta}^{1} \text{zhao}^{3} \text{xiao}^{3} \text{Bei}^{4} \\
\text{he invite little Bei} \\
"he invites little Bei"
\]

Here, 3TS between \( \text{zhao}^{3} \) and \( \text{xiao}^{3} \) is possible but not obligatory.
Another obligatory environment for the application of 3TS has been established on the basis of prosodic structure: a non-branching W within a multi-footed P must enter into 3TS with its neighbour. It has also been shown that 3TS between P's is not obligatory under all circumstances. It remains to examine and explain the cases where 3TS is optional. The explanation will be based on prosodic restructuring processes.

Restructuring

MC P-restructuring differs from that proposed by Nespor and Vogel in two important aspects:

(i) "Branchingness" of P is defined either at the P or W level: a non-branching P is one containing only one foot (F) (i.e., one tone-bearing syllable).

(ii) Restructuring in MC exploits both the recursive (right) and non-recursive sides; it is independent of syntax and need only have reference to existing phonological structure.

The comparison of (13) and (14) supports the claim that a P should be regarded as branching if it or the W within it branches.

(13) ta³ bu⁴ yun³ xu³ % wo² xue²-hao³
    he NEG let I study-ASP
    "he won't let me study well"
By far the most common rendition of this sentence shows 3TS occurring between yun\textsuperscript{3}-xu\textsuperscript{3} and wo\textsuperscript{3}. Using Nespors and Vogel's conventions, this is explained by restructuring which puts both these words in the same P':

Thus, the process of restructuring creates the environment for 3TS, which in this case has P' as its domain. However, (14) is different.

(14) wo\textsuperscript{3} % yun\textsuperscript{3}*xu\textsuperscript{3} % xiao\textsuperscript{3} Bei\textsuperscript{4} lai\textsuperscript{2}  
I let little Bei come  
"I allow little Bei to come"
Here, 3TS between \( yun^3 - xu^3 \) and \( xiao^3 \) is acceptable, but it is not preferred to the extent that it is in (13). This seems strange, when in both cases the NP to the right of the upper verb is a non-branching P. The explanation is that in (14) the NP in question does not branch at the W-level, whereas in (13) it does. The rule of restructuring must be able to "see" branching at the W-level even after the P-level has been built.

A rule's capacity to refer to other levels of metrical structure cannot be unconstrained. Hammond (1984) notes this and proposes the condition of "Metrical Locality":

\[
\ldots \text{a rule operating at level } n \text{ in the metrical hierarchy cannot refer to structure on level } m, \text{ where } m > n + 1 \text{ or } m < n - 1 \text{ (pg. 139)}.\]

Restructuring, which operates at the P-level, can refer to structure (in this case, branchingness) one level down, at the W-level. One would reject, based on Hammond's proposal, a rule which operated on the P-level but referred to structure on the F-level, which is two structural levels removed. Indeed, branchingness at the F-level is completely irrelevant to the application of 3TS.
MC restructuring is independent of syntax and may incorporate material to the left or right of X. This makes it a much more general rule than that proposed by Nespou and Vogel, where only complements on the recursive side may be incorporated. For example, there are five logical possibilities for the tone melody of (15) below.

(15) ta⁴ bu⁴ yun³-xu³ wo³ yang³ xiao³ ma³
  he NEG let I keep little horse
  "he won't let me raise a pony"

Each non-branching P could be joined to the adjacent non-branching P, resulting in this structure and the indicated pattern of 3TS application:

The two non-branching P's could join into one, producing this structure:
The first of the non-branching P's could join with the adjacent branching P, while the other remains alone:

The second non-branching P, rather than the first, could join with the adjacent branching P:

All four possibilities are in fact attested. Note that the requirement that non-branching W's enter into 3TS with adjacent material in the same P can be generalized to include P' as well.

The fifth logical possibility, in which no restructuring (and therefore no 3TS between P's) takes place, is judged ungrammatical by all informants. The
simplest explanation is that there is a constraint blocking the occurrence of
two consecutive non-branching P's. This would make it imperative that some
form of restructuring occur in a sentence like (15), while still allowing the
speaker to exercise any of the four options mentioned above.

The most striking aspect of this account of restructuring is its
simplicity compared to restructuring as proposed by Nespor and Vogel for
Italian. In MC, the restructuring process is apparently independent of syntax:
only reference to phonological structure is needed to determine the options
open to the speaker.

With the exception of two minor points which will be dealt with in the
next section, this concludes the account of 3TS. 3TS applies obligatorily
within W or W'. It is also obligatory between a non-branching W and any other
material which is in the same P. P-restructuring joins a non-branching P to
adjacent material on either side to form P'. As (15) above demonstrates, P'
and P are subject to the same constraints with respect to non-branching W's and
the application of 3TS.

Low-level rules

There remain some instances of 3TS application which cannot be explained
in terms of restructuring. It is observed at several points in the literature
(e.g. Cheng 1973) that sequences of two unchanged third tones do not occur at
the beginning or end of an utterance. Unfortunately, the prosodic account of
3TS outlined here does not provide a better explanation. One might be inclined
to propose that a non-branching initial or final P is joined to an adjacent P
obligatorily, rather than optionally, as is the case sentence-internally. But
this cannot be true, as (16) illustrates.
(16) wo³ yun³-xu³ Bei⁴ Duo²
I allow  Bei Duo
"I let Bei Duo (do it)"

If restructuring occurs here, the result is

In this case, wo³ is in a sandhi context with yun³-xu³, and the resulting melody is [2 2 3 4 2]. However, the non-restructured version of this sentence, which has the surface melody [3 2 3 4 2], is also possible.

(17) gives further evidence that obligatory 3TS at the utterance edge is not attributable to restructuring.

(17) wo³ da³ ting¹
I make listen
"I listen"
As in (16), restructuring cannot be obligatory here, according to its present definition. However, if 3TS does not apply, the resulting melody, *[^3 3 1]*, is ungrammatical. The situation at the righthand edge of an utterance is identical.

(18) bau₁–guo³ háo³
package-pass good
"parcel post is fine"

Again, restructuring must be optional, but the only permissible tone melody is [1 2 3]. It appears, then, that although restructuring at utterance edge is possible, it is not obligatory, and a low-level phonetic implementation rule is necessary to block sequences of unchanged third tones at utterance edge.

It has also been noted that adjacent utterance–internal third tones frequently undergo 3TS even though prosodic structure does not dictate its
application.

(19) wo³ na² bi³ gei³ ta¹
    I take pen give him
    I pick up the pen and give it to him

Simple adjacency, rather than phonological structure, is the only possible explanation for 3TS between bi³ and gei³: the restructuring rule as it has been proposed here would never account for 3TS application, since both P’s involved are branching. It appears that, as in the case of sequences of third tones at the edge of an utterance, a low level process is occurring. The difference is that it is not an obligatory rule utterance-internally: it is simply a tendency for two adjacent third tones which reach surface form unchanged to undergo 3TS regardless of their syntactic or prosodic relationship.

SUMMARY

The account of 3TS within the framework of prosodic categories is simple. First, feet (F) and words (W) are built in the lexicon. In the syntax, non-branching, mutually c-commanding W’s also become phonological words under
Within W or W', 3TS is obligatory if its structural description is met.

The next level of prosodic structure, the phonological phrase, is built according to Nespor and Vogel's (1982) conventions. A non-branching W is in an obligatory sandhi context with other material in the same P. A restructuring rule more general than Nespor and Vogel's allows a P consisting of only one F to be joined to an adjacent P under P'. Sequences of two one-footed P's are not permissible and are eliminated through restructuring.

Finally, a low-level rule blocks sequences of two third tones at utterance edge. Such sequences must undergo 3TS. There is also an optional tendency for utterance-internal sequences of two third tones to undergo 3TS regardless of their syntactic or prosodic relationship.

**CONCLUSIONS**

This study has taken the framework for prosodic categories developed by Selkirk (1972, 1974, 1978) and by Nespor and Vogel (1982) and applied it to Mandarin Chinese. Although the framework was first set up using evidence only from romance languages, it appears that it can be adapted to Southeast Asian tone languages with considerable success.

Possible domains for third tone sandhi in Mandarin Chinese can be defined on the basis of prosodic categories which are projected from syntactic structure but not isomorphic to it. Generally, prosodic structure requires only a small amount of the detail present in the syntax. Nonetheless, certain levels of prosodic structure (W, P) are built on the basis of syntactic structure and depend crucially on the notions "head of a category", "maximal projection", and "recursive side".

The system initially proposed by Selkirk and modified by Nespor and Vogel allows an account of the Mandarin Chinese facts. However, the revisions
necessary to the restructuring rules make it clear that, while phonological phrasing may be defined universally, restructuring must be based on language specific parameters.
FOOTNOTES

1. This is a highly condensed version of a longer paper dealing with this problem (see bibliography).

2. Tones are indicated by numerical superscripts. The four lexical tones in MC are high-level (1), mid-rising (2), low-falling-rising (3), and high-falling (4). In addition, a number of MC morphemes bear no lexical tone (or "neutral" tone): their relative pitch depends on the tone of the preceding syllable.

3. Yip's specific proposals for phonological structure at levels higher than the foot are rejected for various reasons in the longer version of this paper.

4. The implicit claim that compounds are formed in the syntax rather than in the lexicon is arguable. It appears, however, that compounds which have not lost any of their lexical tones through tone reduction (Yip, 1980) are identical to the syntactic phrases mentioned here with respect to sandhi processes.

5. Beattie (1985) provides detailed arguments for establishing the W' level.

6. It is actually Selkirk (1978) who originally specifies how the phonological phrase is built:
   a. An item which is the specifier of a syntactic phrase joins with the head of the phrase.
   b. An item belonging to a non-lexical category (cf. Chomsky 1965) such as Det, Prep, Comp, Verb(AUX), or Conjunction joins with its sister constituent (pg. 20).

7. Wright's (1983) account of Fuzhou tone sandhi shows some striking similarities to the account of MC tone sandhi set out here.
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