A two-level take on Tianjin tone

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Abstract

The tonal alternations of Tianjin Mandarin are investigated. The data, which have been problematic for rule-based approaches, receive an analysis in a declarative two-level setting. Formal differences between certain tonal alternations are conjectured to bear on speech production but not on acquisition.

Tianjin Mandarin tones

In the variety of Mandarin spoken in the city of Tiānjīn 天津, each syllable bears one of the following four contour tones:*

low	falling	[21]	as in	吃 *chī* ‘eat’
high	rising	[45]		甜 *tián* ‘sweet’
low	rising	[(2)13]		咬 *yǎo* ‘chew’
high	falling	[53]		脆 *cuì* ‘crisp’

These phonetic contrasts represent four phonemic contrasts:

toneme	a.k.a.	surfaces in isolation as	and in certain environments as
first	/A1/	[21]	[213]
second	/A2/	[45]	–
third	/B/	[213]	[45]
fourth	/C/	[53]	[21], [45]

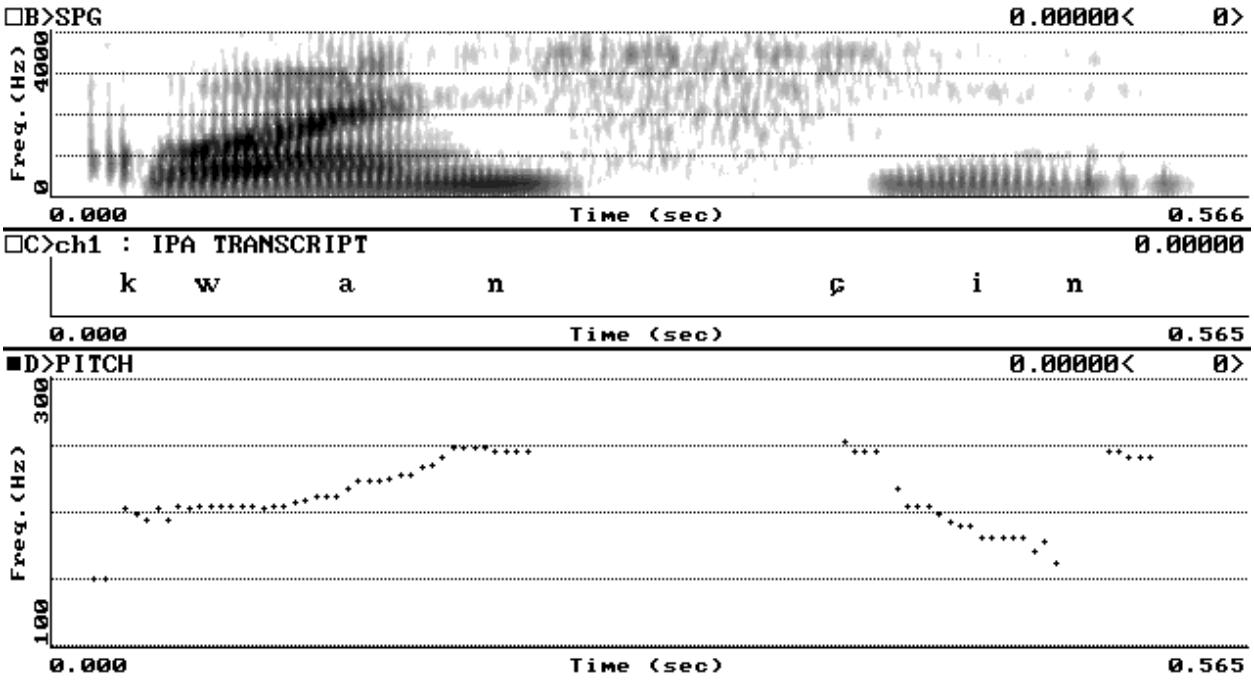
What are the conditions on allotonic variation?

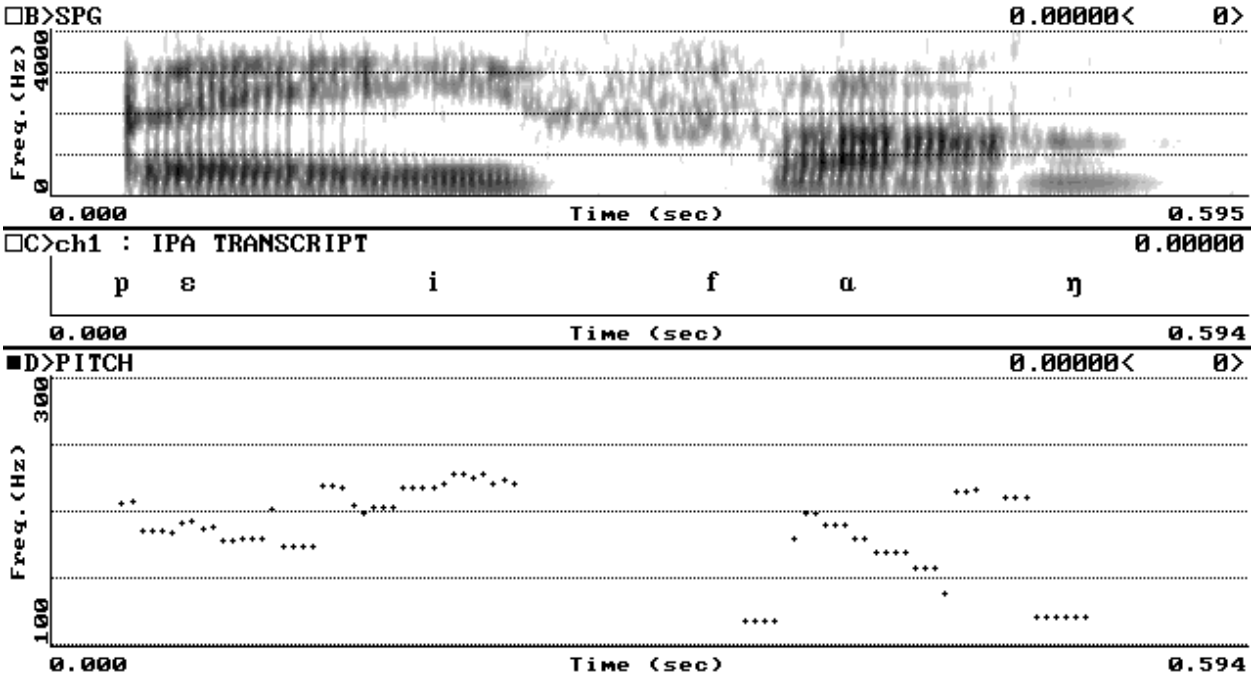
*See 李行健、劉思訓, 天津方言的連讀變調, 中國語文 184, 1985.
Additional data from 韓根東, 天津方言, 北京燕山出版社, 1993.

Allotones of the first toneme

The monosyllabic morphemes 關 *guān* ‘to concern’ and 心 *xīn* ‘mind’ appear as isolated syllables with tone [21]. Underlyingly they therefore belong to the first toneme category /A1/.

When they combine to form 關心 *guānxīn* ‘to be concerned about’, the first syllable does not bear tone [21], but instead [213], just as an isolated third tone syllable.



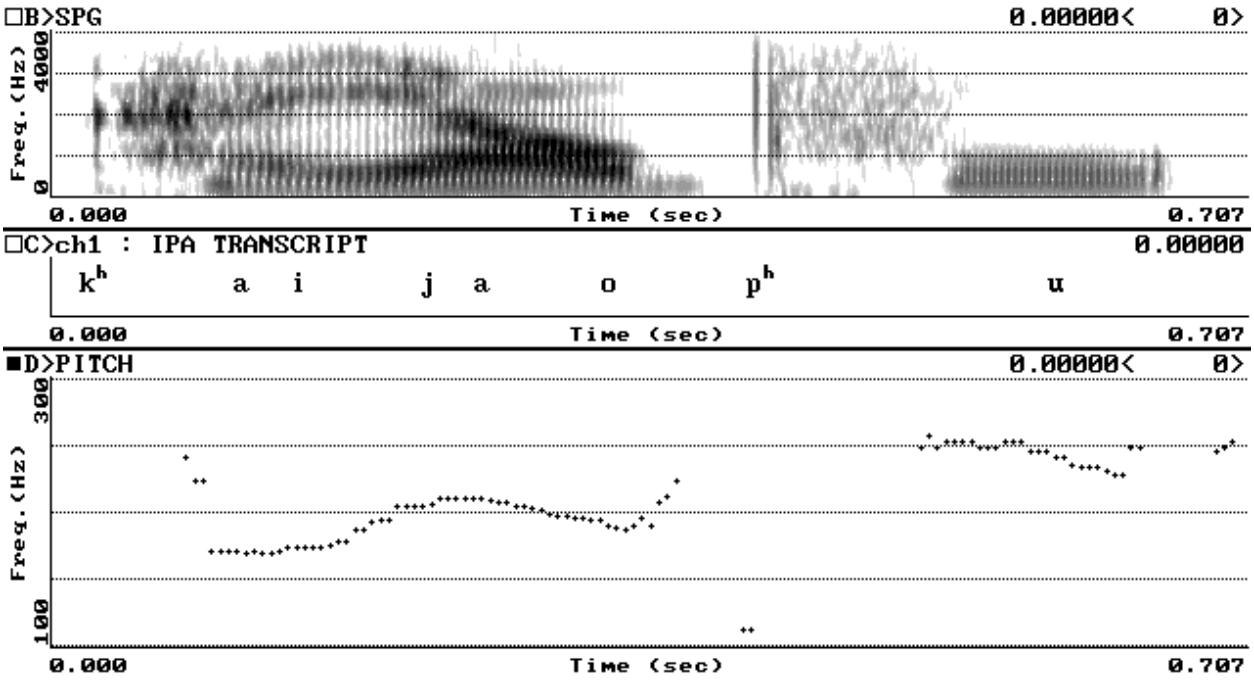


The word 北方 *běifāng* ‘the North’ is made up from the monosyllabic morphemes 北 *běi* /B/ ‘north’ and 方 *fāng* /A1/ ‘region’. In the compound, both syllables appear in their isolation tones.

Thus in the absence of further conditioning factors, two syllables that are underlyingly /A1 A1/ surface exactly like two syllables with tonemes /B A1/.

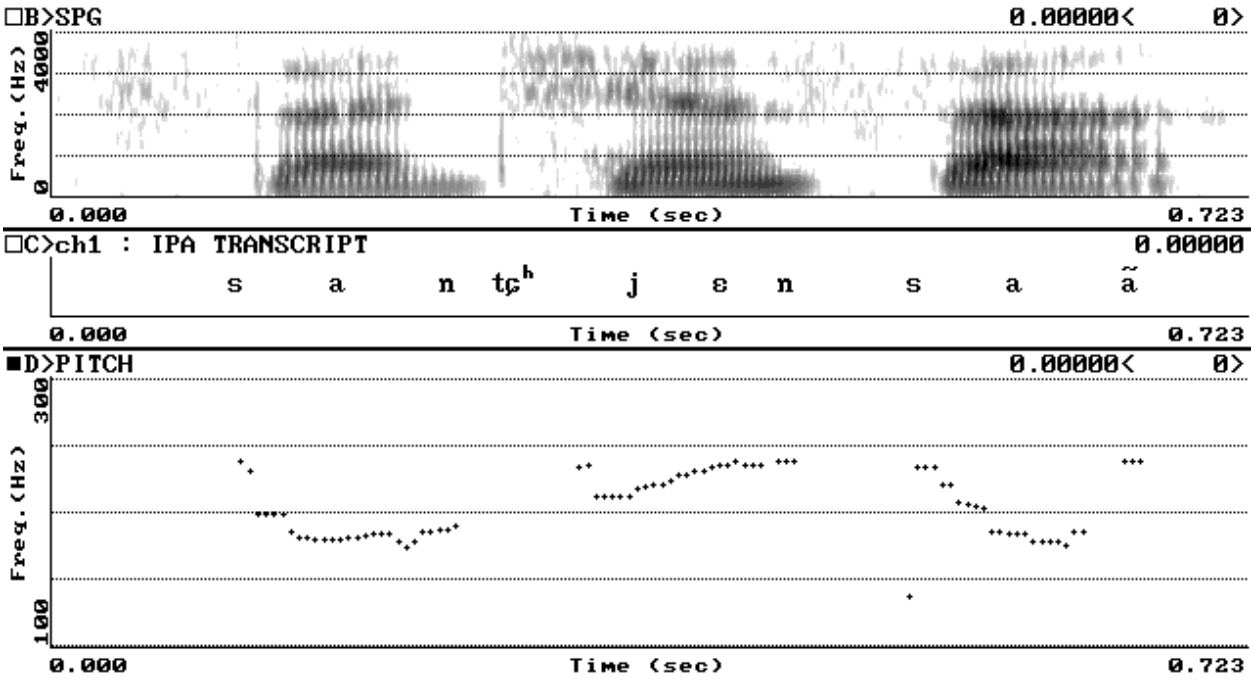
Toneme A1 also surfaces as tone [213] before a tone [21] that stems from an underlying toneme C.

The morpheme 開 *kāi* ‘to operate’ bears an isolation tone [21], and thus is underlyingly /A1/. However, it has tone [213] when followed by 藥舖 *yàopù* ‘drugstore’, whose surface tones [21 53] result from underlying tonemes /C C/ by another alternation not discussed here.



Toneme A1 does not always surface as tone [213] when it precedes another /A1/ syllable.

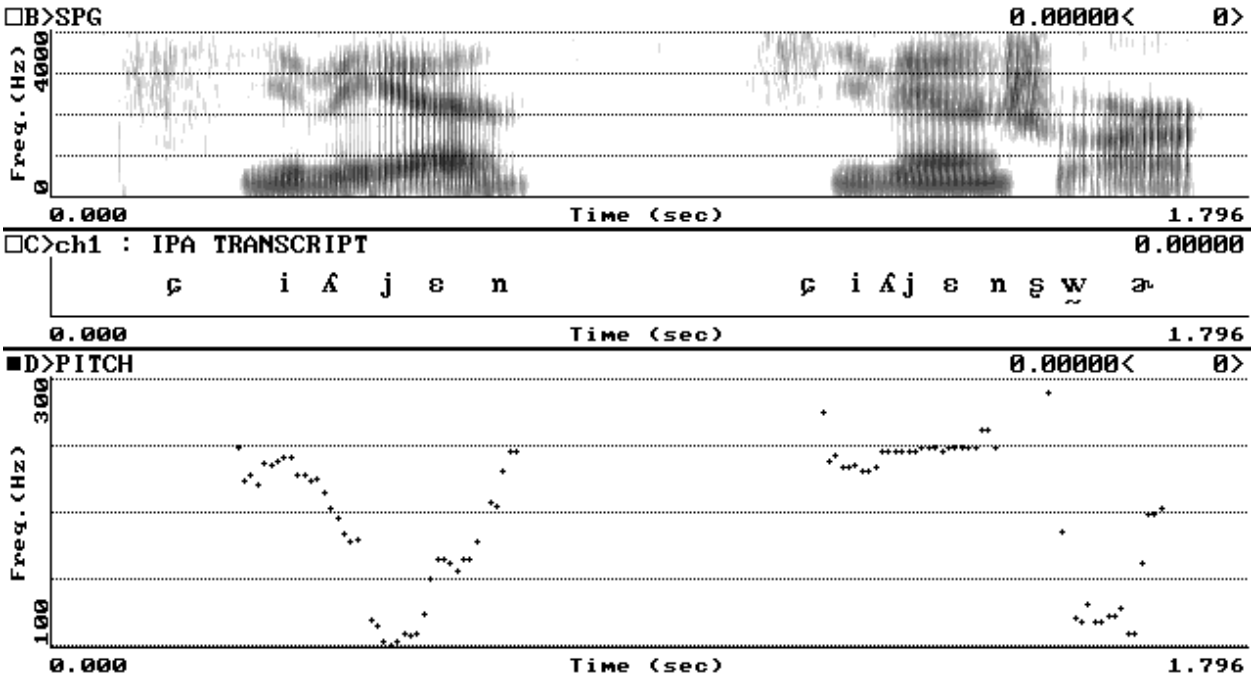
The word 三千三 *sānqiānsān* ‘3300’ is composed of the morphemes 三 *sān* ‘three’ and 千 *qiān* ‘thousand’, each of which are lexically specified as /A1/. The compound appears with tones [21 213 21] with only the middle syllable appearing in altered form.



Allotones of the third toneme

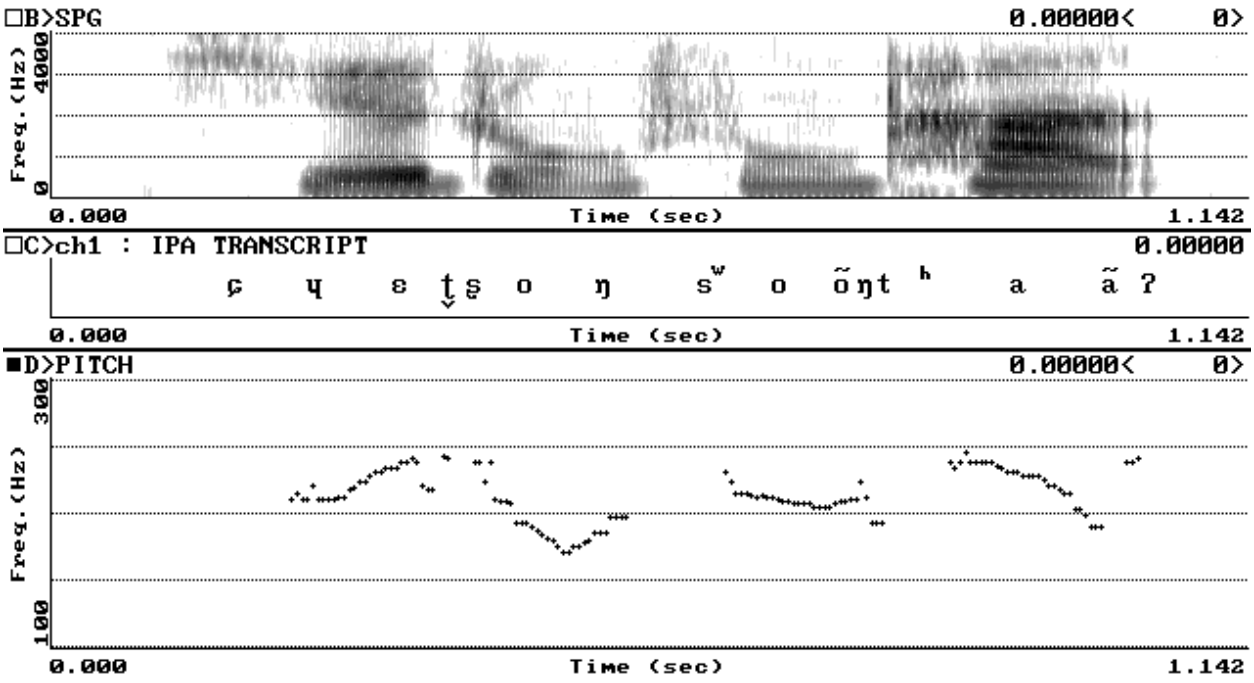
When the monosyllabic morphemes 洗 *xǐ* ‘to wash’, 臉 *liǎn* ‘face’, and 水 *shuǐ* ‘water’ appear in isolation they each bear tone [213], corresponding to an underlying third toneme /B/.

The phrase 洗臉 *xǐ liǎn* ‘to wash one’s face’ appears with tones [45 213]; and 洗臉水 *xǐliǎnshuǐ* ‘water for washing one’s face’ with tones [45 45 213].



The isolation tone of 中 *zhōng* ‘amid’ is [21], an instance of toneme /A1/. Its surface tone is [213] when followed by the phrase 送炭 *sòng tàn* ‘to send coals’, which has surface tones [21 53] arising from underlying /C C/.

In isolation 雪 *xuě* ‘snow’ bears tone [213], and thus toneme /B/. However in the idiom 雪中送炭 *xuězhōng sòng tàn* ‘to provide timely assistance’ the first syllable *xuě* appears with tone [45].



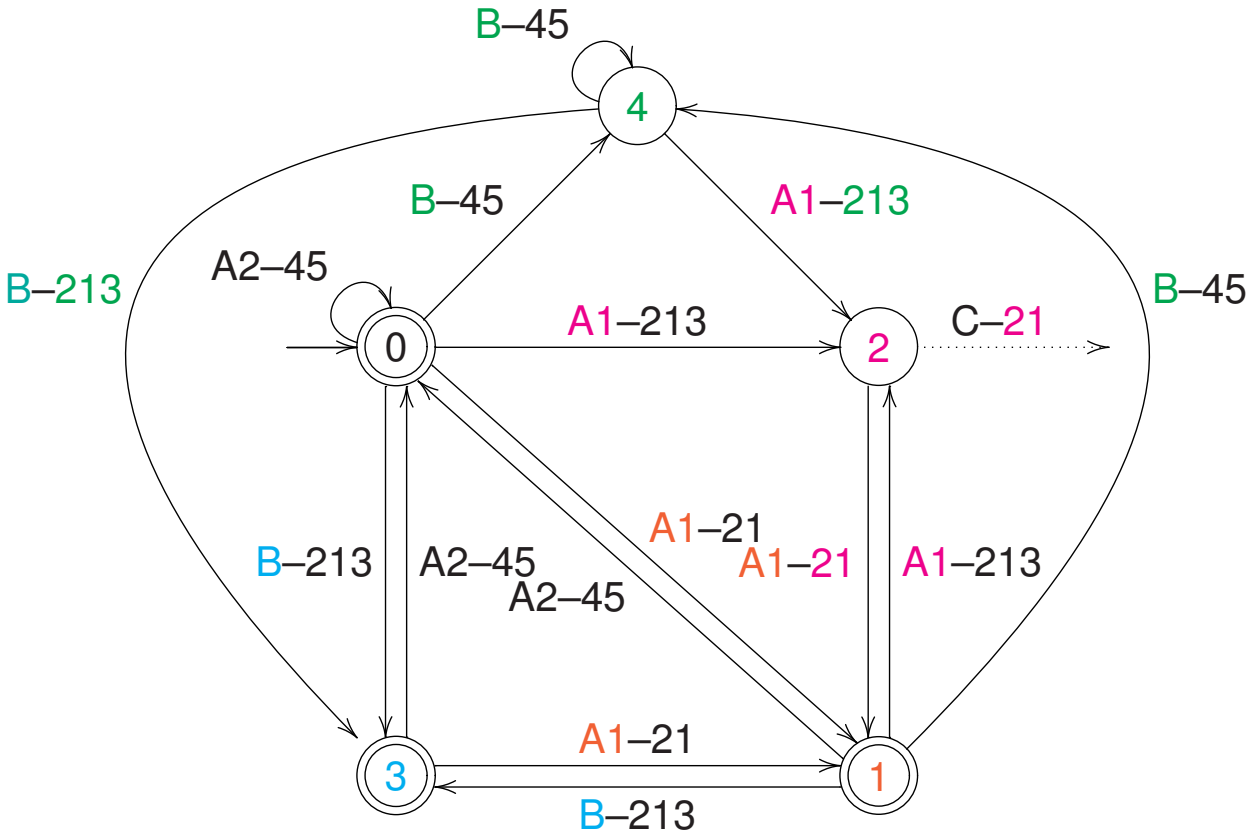
Summary of the facts discussed

- Toneme /A1/ has allotone
  - [213] (its *sandhi* tone) iff it precedes tone [21];
  - [21] (its isolation tone) iff it does not precede tone [21].
- Toneme /A2/ has allotone
  - [45] (its isolation tone) everywhere.
- Toneme /B/ has allotone
  - [45] (its *sandhi* tone) iff it precedes either toneme /B/ or tone [213] (or both);
  - [213] (its isolation tone) iff it neither precedes toneme /B/ nor precedes tone [213].

Two-level morpho-phonology

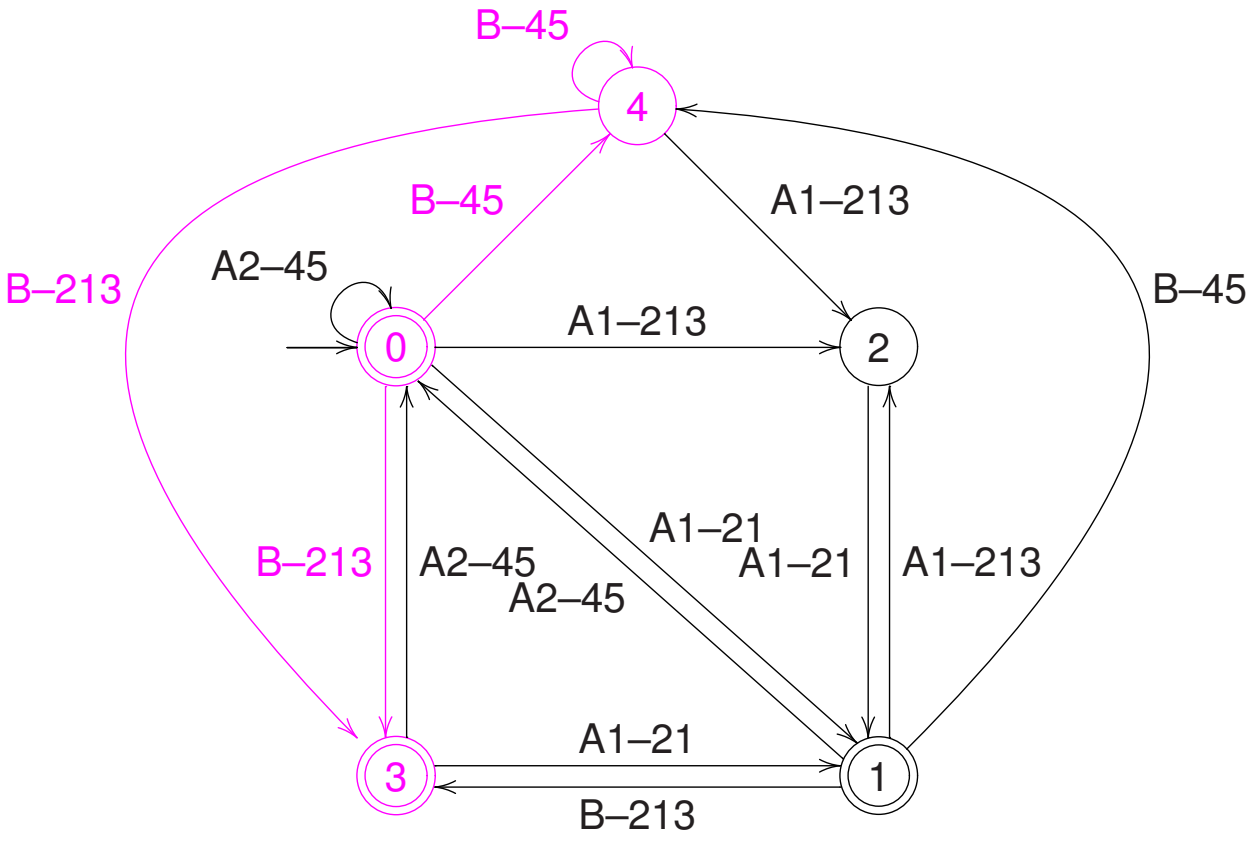
- two levels of representation, mediating relation
- finite-state constraints with finite-state transducers as models
- results in shallow, phenomenon-oriented analyses
- provides analogs of three tasks performed by speakers:
  - recognition, parsing
  - production, generation
  - acquisition, induction
- can address issues of task-specific resource requirements

Part of the transducer

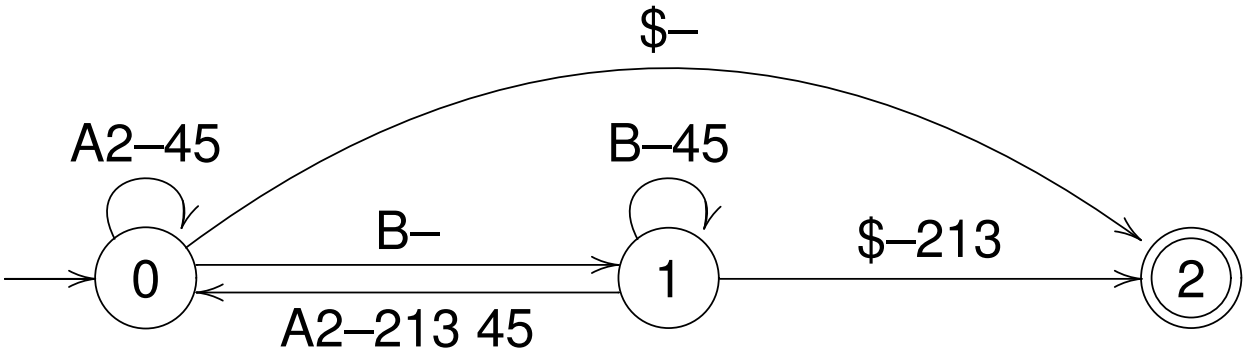


- /A1/ surfaces as [21] iff it does not precede [21];
- /A1/ surfaces as [213] iff it precedes [21];
- /B/ surfaces as [213] iff it neither precedes /B/ nor precedes [213];
- /B/ surfaces as [45] iff it precedes either /B/ or [213] (or both).

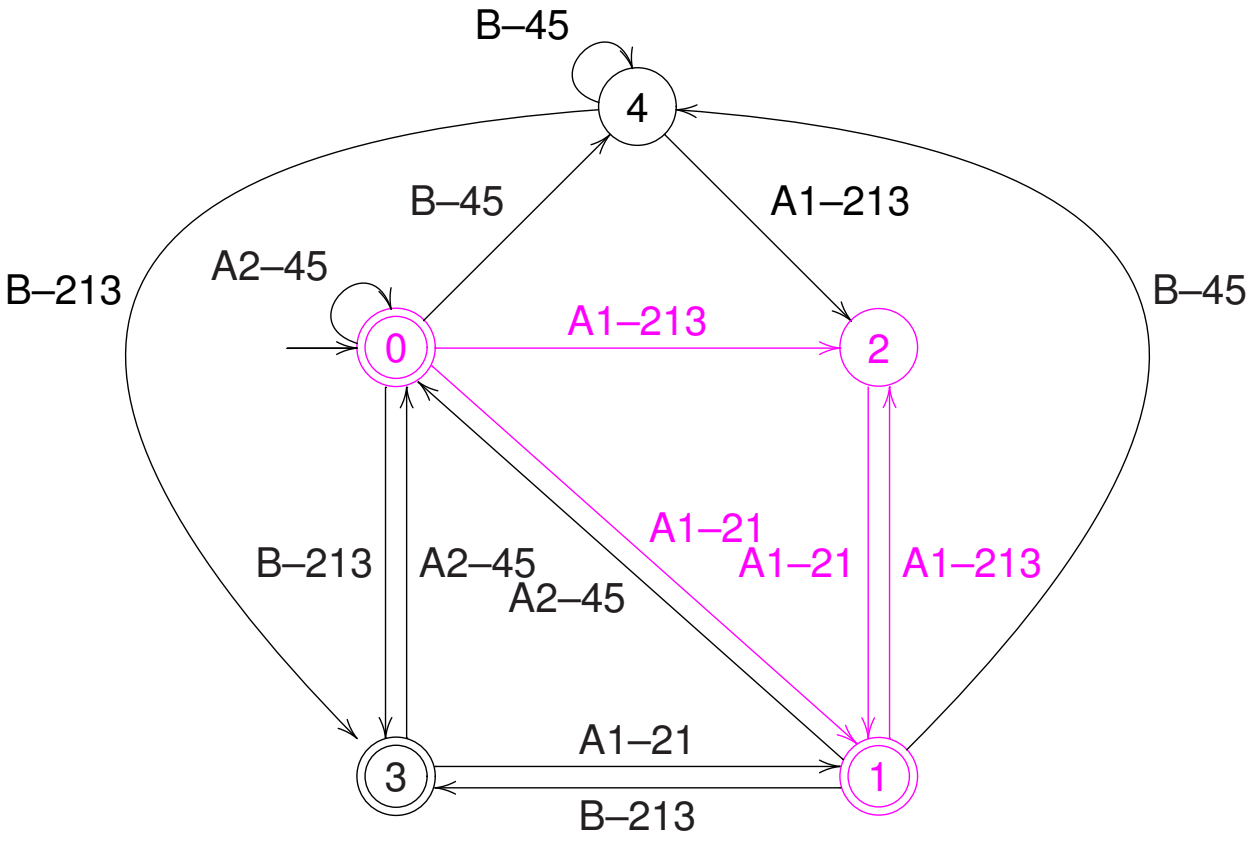
Complexity of the third tone sandhi



A mapping from /B B . . . B/ to [45 45 . . . 213] is deterministic given one token lookahead.

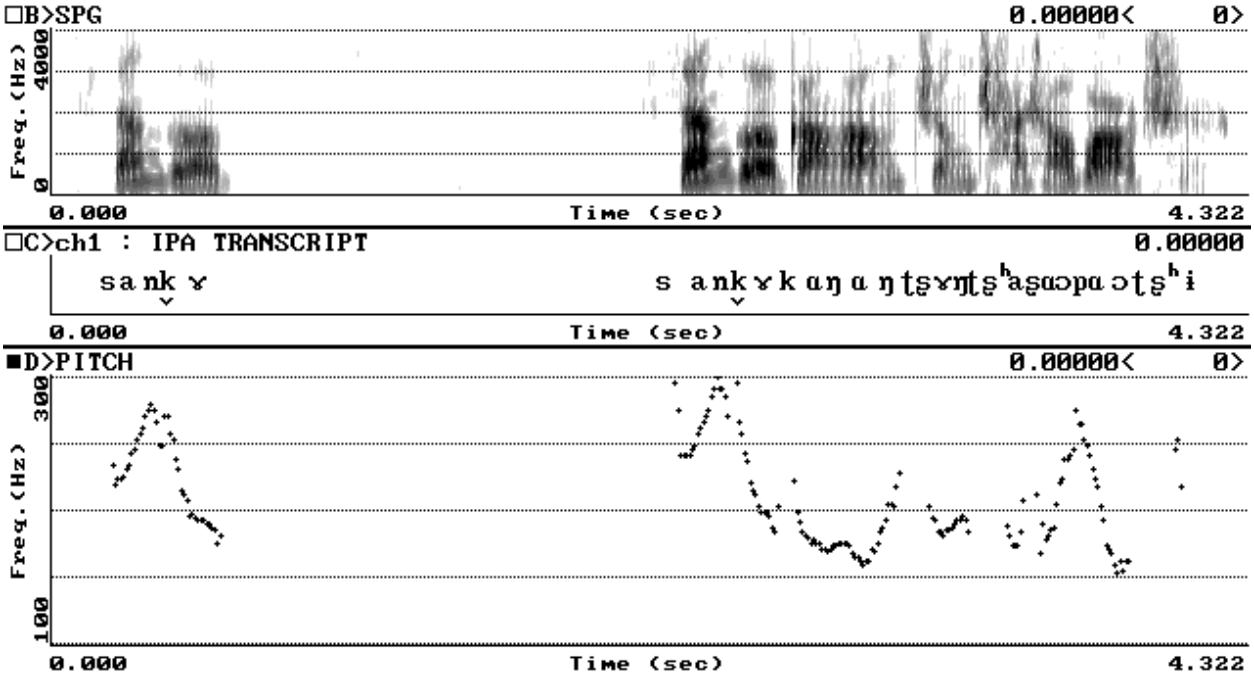


Complexity of the first tone sandhi



Mapping /(A1) (A1 A1)^n A1/ to [(213) (21 213)^n 21] is an inherently nondeterministic process and cannot be determinized with any fixed amount of lookahead.

三哥剛剛蒸叉燒包吃。



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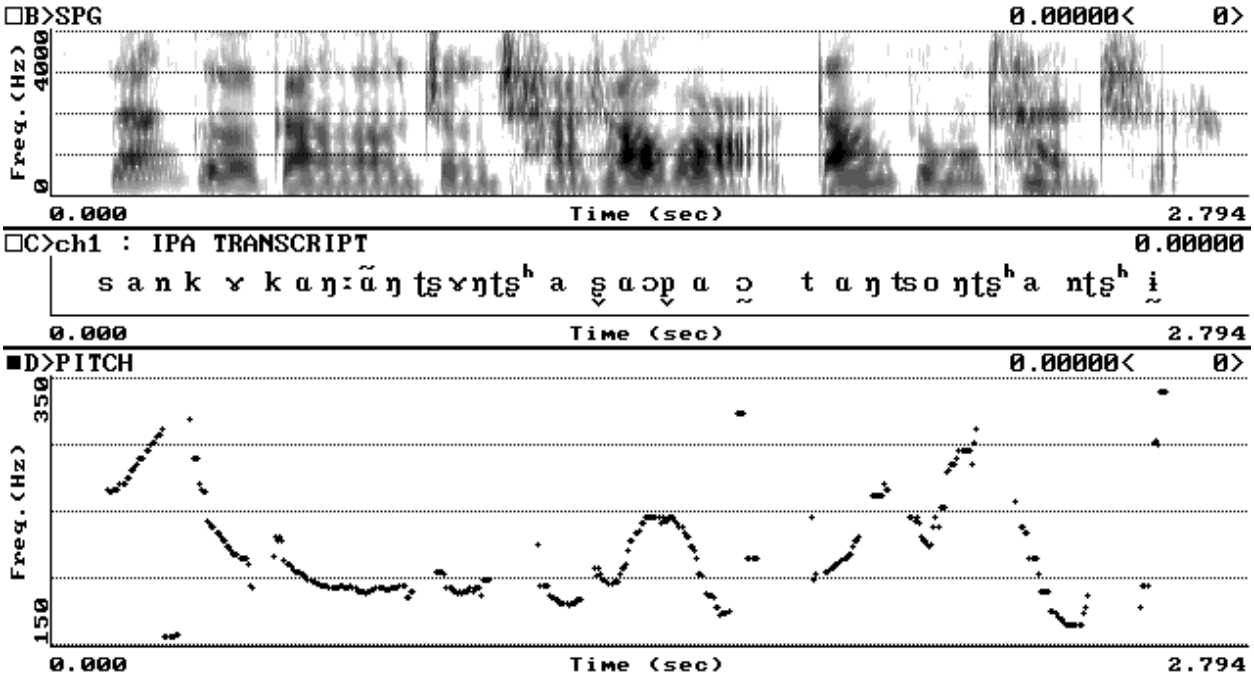

Conclusion

- A straightforward formal account of the Tiānjīn tone sandhi has been presented.
- The tonal alternation affecting a certain toneme can be processed easily during production, while another alternation requires working memory that grows linearly with the length of the input.
- Hypothesis: This formal difference should be reflected in an actual performance difference in speech production tasks.
- If this is true, the diachronic stability of the less costly alternation has a simple explanation.
- The difference between the two kinds of tone sandhi goes away for the induction task, which operates on input–output pairs. Thus neither alternation is more difficult to learn than the other.

Directions for further research

- empirical:
  - what are the sandhi domains?
  - is there a difference between the domains of the first and third tone sandhi?
  - is there variation with respect to tone sandhi across generations?
- psycholinguistic:
  - design and carry out an experiment that tests the current hypothesis
- historical/comparative:
  - when and how did the Mandarin third tone sandhi come into existence?
  - a *diachronic* survey of tone sandhi in Mandarin dialects is needed
- computational:
  - how can the non-(sub)sequential transducer be induced efficiently from positive data?