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The Distribution of Tone in Shanghainese Monosyllables: An Optimality Theory Approach

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by

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ABSTRACT

This paper aims to create an Optimality Theory ranking of tonal phonology constraints in Shanghai Chinese (Shanghainese) monosyllables. Previous research on tonal phonology in Shanghainese preceded the more recent research on Optimality Theory which may provide new principles to justify the language's tonal phonology system. I use inputs composed of High (H) and Low (L) tone combinations and 8 constraints, (3 faithfulness and 5 markedness constraints) to motivate the distribution of tones in Shanghainese monosyllable in four environments: KV, GV, KVʔ, GVʔ. The faithfulness constraints include DEP, MAX, and IDENT. The markedness constraints include $*K^{L}$, $*G^{H}$, POLARITY, [AGREE]ʔ, and *L/ʔ. The [AGREE]ʔ constraint is undominated which produces solely level tone outputs in the KVʔ and GVʔ environment. Contour tone sequences emerge as winners in the KV and GV environment due to the high ranking of POLARITY. The interaction of tone-specific constraints produces 3 languages that correctly correspond to the tone outputs of Shanghainese monosyllables. Shanghainese is metrically sensitive at both the moraic and the syllable level which enriches its tonal phonology analysis. Further research can be conducted on connected speech at the polysyllabic level.

ACKNOWLEDGEMENTS

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1. Introduction

1.1 Background on Shanghainese

The estimated number of native speakers of Shanghai Chinese (Shanghainese) ranges greatly. Ethnologue lists Shanghainese as a dialect of Wu Chinese in the Sino-Tibetan language family with 83 million speakers (Ethnologue). Wikipedia states that the dialect has 14 million speakers. No information is available on Shanghainese (SHAN 1293) in Glottolog (Wikipaedia). Regardless, Shanghainese is not mutually intelligible with the more widely spoken Mandarin Chinese. Both Mandarin and Shanghainese are tone languages, meaning the pitch of a syllable can create grammatical and lexical differences. Shanghainese uses a 5 tone system whereas Mandarin Chinese uses a 4 tone system (Duanmu 1999). This paper will analyze the distribution of tones in Shanghainese motivated by an Optimality Theory approach.

1.2 Tonal System of Shanghainese

There are 5 recognized tone sequences of Shanghainese monosyllables said in isolation (Chao 1930). Figure (1) displays the distribution of monosyllabic tone sequences where H represents a High tone, M' represents a Mid-high tone, M represents a Mid tone, and L represents a Low tone (Lu 1987). The tone sequences can be categorized in four environments: KV, GV, KVʔ. and GVʔ. Two critical dimensions determine the environment the tone is distributed in: voicing of the onset and the presence of a ʔ in the coda position. Pertaining to onset voicing, Shanghainese monosyllabic tones either fall in voiceless initial or voiced initial environments. As seen in figure (1), tones HL, MM', and M' occur in voiceless initial environments while LM' and LM occur in voiced initial environments. Beyond onset voicing, the presence of ʔ at the end of the monosyllable creates distinct environments. Tones HL, MM', and LM' occur in environments without glottal stop codas whereas tones M’ and LM occur in environments with glottal stop codas (Xu and Tang 1988). The mora is assumed to be the tone-bearing unit (TBU).

(1)

The five Shanghainese tones arranged by voicing and glottal stop environments

	Non-glottal	Glottal
Voiceless	**KV** HL, MM’	**KVʔ** M’
Voiced	**GV** LM’	**GVʔ** LM

As seen in figure (1), the KV environment is particularly interesting because it is the only environment where more than one tone sequence can be found: both HL and MM’. Additionally, because there are so few phonologically distinct categories pertaining to Shanghainese monosyllabic tones, only two tones, H and L, are necessary in the underlying form. The H and M’ tone can be simplified to an H tone and the M and L tone can be simplified to an L tone as demonstrated in figure (2) (Lu 1987). Phonological constraints treat H and M’ as H tones and M and L tones as L tones.

(2)

Simplified Shanghainese tone voicing system

H	H
	M’
L	M
	L

When the information from figure (2) is taken into account, figure (1) can be simplified to consist only of L and H tones as displayed in figure (3).

(3)
The five Shanghainese tones arranged by voicing and glottal stop environments (simplified)

	Non-glottal	Glottal
Voiceless	**KV** HL, LH (previously MM')	**KVʔ** H[1] (previously M'**)**
Voiced	**GV** LH (previously LM')	**GVʔ** LL[2] (previously LM)

1.3 The Historical Role of Tone
It has been postulated that tone's purpose in a language is to create contrast (Yip 2002). The most well-known source of tonal contrast due to voicing can be seen in obstruents, where voiced obstruents lowers the fundamental frequency of preceding vowels and voiceless obstruents raise fundamental frequency of preceding vowels (Hombert 1979). Phonetically, this appears to be the case because voicing leads to slacker vocal folds and therefore lowers the larynx whereas voiceless pronunciation requires tense vocal folds which raises the larynx.

Another example of tone creating phonological distinction is in Danish. In Danish, the stød, a creaky voice laryngeal feature, acts as a manifestation of the tonal distinction of a neighboring Swedish spoken in Eskilstuna, Sweden (Riad 2009). Phonetically, both the stød in Danish and the HL tone in Eskilstuna Swedish share a sharp drop in F0.

Historical linguistics can explain how tonal contrast occurs in vowels. When consonants lose voicing contrast, the burden of tone contrast falls onto the vowel's fundamental frequency. An example can be seen in Mon- Khmer, an indigenous language of Cambodia. Where Southern dialects have the contrast of voiceless and voiced onsets, Northern dialects have the contrast of H and L tones illustrated in figure (4) respectively (Svantesson 1983, Dell 1985). Interestingly,

1 A motivation for including HH in this environment will be included in further discussion

2 A motivation for including L in this environment will be included in further discussion

Shanghainese may represent an intermediary transition where the burden of contrast has shifted to the vowel but the voicing contrast in the onset still exists.

(4)

A figure demonstrating tonal versus voicing contrast in Kammu dialects (Svantesson 1983, Dell 1985) from Yip 2000

Kammu dialects		
South	*North*	
klaaŋ	kláaŋ	‘eagle’
glaaŋ	klàaŋ	‘stone’

<u>2. The Optimality Theory Constraints, Inputs, and Outputs</u>

2.1 The Constraints

The constraint set used in my analysis is detailed below. CON consisted of 8 constraints: 5 were markedness constraints and 3 were faithfulness constraints. The constraints were used for the FACTYPE function in the OT workplace software (Prince and Smolensky 1993). The tone patterns I aimed to reproduce were those of Shanghainese monosyllables shown in figure (5) with slight modification. Outputs allowed in the KVʔ and GVʔ environments can be expanded because I argue that the outputs H and HH as well as L and LL are interchangeable. Although they differ in the amount of tones, a single tone such as H associates with two moras in the output just as HH associates one H tone per mora in the output. Regardless of the number of tones, they link to the same two moras in the output creating an equal tone sequence value. GEN creates bimoraic outputs with H and L tones in each position and is not concerned with mora faithfulness. Therefore, the possible outputs in the KVʔ environment are revised to H and HH and the possible outputs in the GVʔ environment are revised to L and LL. The output tone drawings in section 2.3 will further demonstrate this concept.

(5)

The five Shanghainese tones arranged by voicing and glottal stop environments with revisions

	Non-glottal	Glottal
Voiceless	**KV** HL, LH (previously MM')	**KVʔ** H and <u>HH</u> (previously M'**)**
Voiced	**GV** LH (previously LM')	**GVʔ** <u>L</u> and LL (previously LM)

(6)

The following faithfulness constraints were considered:

Faithfulness constraints:

1. IDENT: Assign a violation for every H input tone that changes to an L output tone at the corresponding index and vice versa (McCarthy and Prince 1999).
2. MAX: Assign a violation for every element that is present in the input that is not present in the output.
3. DEP: Assign a violation for every element that is present in the output that is not present in the input.

The faithfulness constraints only assign violations relating to tone faithfulness. As section 2.3 will show, GEN only changes tones. The indexing system referenced in IDENT is a corresponding positional index that relates the element in the first position of the input with the first position of the output and so forth.

The following markedness constraints were considered:

Markedness constraints:

4. $*K^L$: Assign a violation for every L tone that immediately follows a voiceless consonant.

5. $*G^H$: Assign a violation for every H tone that immediately follows a voiced consonant.

6. [AGREE]ʔ: Assign a violation for every tautosyllabic tone sequence immediately preceding a glottal stop that has different tone values such as HL or LH.

7. *L/ʔ: Assign a violation for every L tone that immediately precedes a glottal stop.

8. POLARITY: Assign a violation for every tautosyllabic tone sequence that is level such as HH, H, LL, and L.

Of the markedness constraints, the constraints $*K^L$ and $*G^H$ pertain to the initial tone. The constraints [AGREE]ʔ and *L/ʔ pertain to the tone immediately preceding a glottal stop in glottal stop coda environments. The constraint POLARITY pertains to the entire tone contour. A violation of POLARITY is assigned to single tone outputs such as L and H because the two sequential moras share the same tone value in the output. Examples of outputs that violate markedness constraints are shown below in figure (7) and will be further detailed in section 3.2.

(7)

Example outputs that violate markedness constraints

	$*K^L$	$*G^H$	*L/ʔ	[AGREE]ʔ	POLARITY
KL	*				*
KHH					*
GH		*			*
KLʔ	*		*		*
KLH	*				
GLʔ			*		*
GHLʔ		*	*	*	

2.2 The Inputs

The following inputs were used in OT Workplace. Inputs include null, single tone, and dual tone inputs. Recall that the indexing system used in the inputs and outputs is a corresponding positional index system where L1 refers to a low tone in the first position of the input, L2 refers to a low tone in the second position of the input, and so forth. How these positions correspond to the output will be detailed in section 2.3.

(8)

Inputs as represented in OT Workplace for Shanghainese monosyllables

Inputs in KV	**Inputs in GV**	**Inputs in KVʔ**	**Inputs in GVʔ**
K	G	Kʔ	Gʔ
KH1	GH1	KH1ʔ	GH1ʔ
KH2	GH2	KH2ʔ	GH2ʔ
KH3	GH3	KH3ʔ	GH3ʔ
KL1	GL1	KL1ʔ	GL1ʔ
KL2	GL2	KL2ʔ	GL2ʔ
KL3	GL3	KL3ʔ	GL3ʔ
KH1H2	GH1H2	KH1H2ʔ	GH1H2ʔ
KH1L2	GH1L2	KH1L2ʔ	GH1L2ʔ
KL1H2	GL1H2	KL1H2ʔ	GL1H2ʔ
KL1L2	GL1L2	KL1L2ʔ	GL1L2ʔ

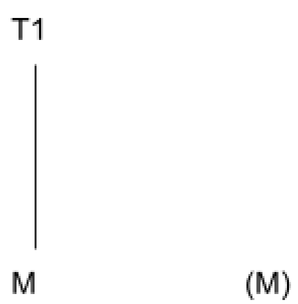
In Metrical Structure and Tone: Evidence from Mandarin and Shanghai (Daunmu 1999), the Richness of the Base Hypothesis (Smolensky 1993) was violated through a minimal word requirement of two moras in the input. However, I make the same assumption for the inputs for all languages in my typology and I obtain my outputs without assuming extra restrictions on the input. The inputs do not have a minimal word requirement and can be null, monomoraic, or bimoraic as opposed to solely bimoraic. Although the input is not specified, the output has a requirement for all syllables to be bimoraic, as seen in the natural output of most Shanghainese syllables.

2.2.1 Input Tone Drawings

The following figures demonstrate how single tone inputs were represented in OT workplace. An instance where no tone is linked to the moras in the input is considered a null input however. Examples include K, G, Kʔ, and Gʔ. They are not depicted.

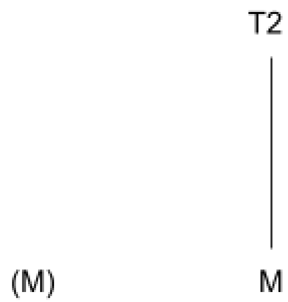
An example of a single tone input, T1, where T represents either H or L, is shown below. T1 corresponds to the first mora of the input. Examples include KL1, KH1, GL1, GH1, KL1ʔ, KH1ʔ, GL1ʔ, GH1ʔ.

(9)



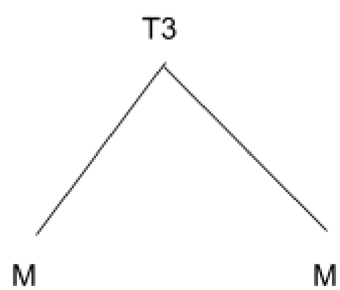
An example of a single tone input, T2, where T represents either H or L, is shown below. T2 corresponds to the second mora of the input. Examples include KL2, KH2, GL2, GH2, KL2ʔ, KH2ʔ, GL2ʔ, GH2ʔ.

(10)



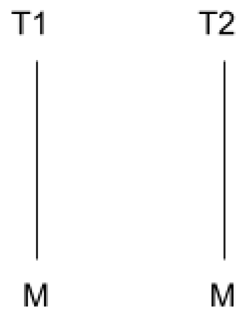
Another example of a single tone input, T3, where T represents either H or L, is shown below. Here, T3 is dually linked to both the first and second mora of the input.

(11)



The following figures demonstrate how dual tone inputs are represented. An example of a dual tone input, T1 and T2, where T represents either H or L, is drawn below. T1 corresponds to the first mora of the input and T2 corresponds to the second mora of the input. Examples include KH1H2, GH1H2, KH1H2ʔ, GH1H2ʔ, KH1L2, GH1L2, KH1L2ʔ, GH1L2ʔ, KL1H2, GL1H2, KL1H2ʔ, GL1H2ʔ, KL1L2, GL1L2, KL1L2ʔ, and GL1L2ʔ.

(12)



2.3 The Outputs

The following figure represents how the outputs were represented in OT Workplace. Each output, including single tone outputs, are critically assumed to be bimoraic. In outputs with a single tone, the tone is linked to both moras. The assumptions is that GEN varies the tone value and the position of the tone, but do not make changes to the voicing of the consonant or consider insertion or deletion of the glottal stop.

(13)

Outputs as represented in OT Workplace for Shanghainese monosyllables

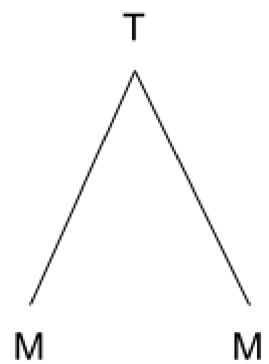
Outputs in KV	**Outputs in GV**	**Outputs in KVʔ**	**Outputs in GVʔ**
KH1	GH1	KH1ʔ	GH1ʔ
KL1	GL1	KL1ʔ	GL1ʔ
KH2	GH2	KH2ʔ	GH2ʔ
KL2	GL2	KL2ʔ	GL2ʔ
KL3	GL3	KL3ʔ	GL3ʔ
KH3	GH3	KH3ʔ	GH3ʔ
KH1H2	GH1H2	KH1H2ʔ	GH1H2ʔ
KH1H3	GH1H3	KH1H3ʔ	GH1H3ʔ
KH3H2	GH3H2	KH3H2ʔ	GH3H2ʔ
KH1L2	GH1L2	KH1L2ʔ	GH1L2ʔ
KH1L3	GH1L3	KH1L3ʔ	GH1L3ʔ
KH3L2	GH3L2	KH3L2ʔ	GH3L2ʔ
KL1L2	GL1L2	KL1L2ʔ	GL1L2ʔ
KL1L3	GL1L3	KL1L3ʔ	GL1L3ʔ
KL3L2	GL3L2	KL3L2ʔ	GL3L2ʔ
KL1H2	GL1H2	KL1H2ʔ	GL1H2ʔ
KL1H3	GL1H3	KL1H3ʔ	GL1H3ʔ
KL3H2	GL3H2	KL3H2ʔ	GL3H2ʔ

2.3.1 Output Tone Drawings

The following figures demonstrate how output tones were represented in OT workplace. Fully faithful output candidates perfectly replicate the structures of their respective inputs.

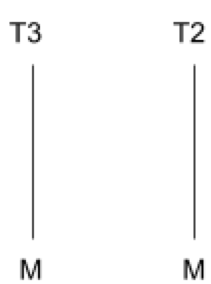
Single tone outputs are represented where one tone, T1, T2, or T3, is linked to both moras. Examples of single tone outputs include KH1, GH1, KH1ʔ, GH1ʔ, KL1, GL1, KL1ʔ, GL1ʔ, KH2, GH2, KH2ʔ, GH2ʔ, KL2, GL2, KL2ʔ, GL2ʔ, KL3, GL3, KL3ʔ, GL3ʔ, KH3, GH3, KH3ʔ, GH3ʔ.

(14)



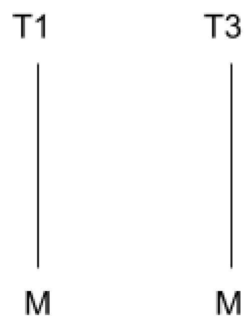
A T3, where T represents either H or L, may be epentheized initially. Examples where L3 is epenthesized initially in the output include: KL3L2, GL3L2, KL3L2ʔ, GL3L2ʔ, KL3H2, GL3H2, KL3H2ʔ, and GL3H2ʔ. Examples where H3 is epenthesized initially in the output include: KH3H2, GH3H2, KH3H2ʔ, GH3H2ʔ, KH3L2, GH3L2, KH3L2ʔ, GH3L2ʔ.
In figure (15), an example of T3 initial epenthesis is shown. T3 corresponds to the first mora and T2 corresponds to the second mora. T1 is always deleted to make room for T3.

(15)



A T3, where T represents either a H or L tone, may be epenthesized finally as well. Examples where L3 is epenthesized finally in the output include: KH1L3, GH1L3, KH1L3ʔ, GH1L3ʔ, KL1L3, GL1L3, KL1L3ʔ, and GL1L3ʔ. Examples where H3 is epenthesized finally in the output include: KH1H3, GH1H3, KH1H3ʔ, GH1H3ʔ, KL1H3, GL1H3, KL1H3ʔ, GL1H3ʔ. In figure (16), an example of T3 final epenthesis is shown. T1 corresponds to the first mora and T3 corresponds to the second mora. T2 is always deleted to make room for T3.

(16)



3. Constraint Violations

3.1 Examples of Faithfulness Constraint Violations

Figure (17) demonstrates faithfulness constraint violations. Faithfulness constraint violations can occur in any of the 4 environments: KV, GV, KVʔ, and GVʔ. In example 1, the input is identical to the output, therefore no faithfulness violations are assigned. In example 2, the tones in the input and the output have the same indices but the tone at index 2 has changed from L2 to H2. Therefore, an IDENT violation is assigned. In example 3, the input index L2 is missing in the output and a MAX violation is assigned. In example 4, the output index of L2 is missing in the input and a DEP violation is assigned. In example 5, L2 is deleted and H3 is epenthesized. Therefore, the output is both a MAX and DEP violation. In example 5, the combination of violations MAX and DEP looks very similar to the violation of IDENT in example 2. Therefore, the indices become crucial to distinguish an output that is a result of MAX and DEP (L1H3) violations or simply an IDENT (L1H2) violation.

(17)

Faithfulness Constraint Violation Examples

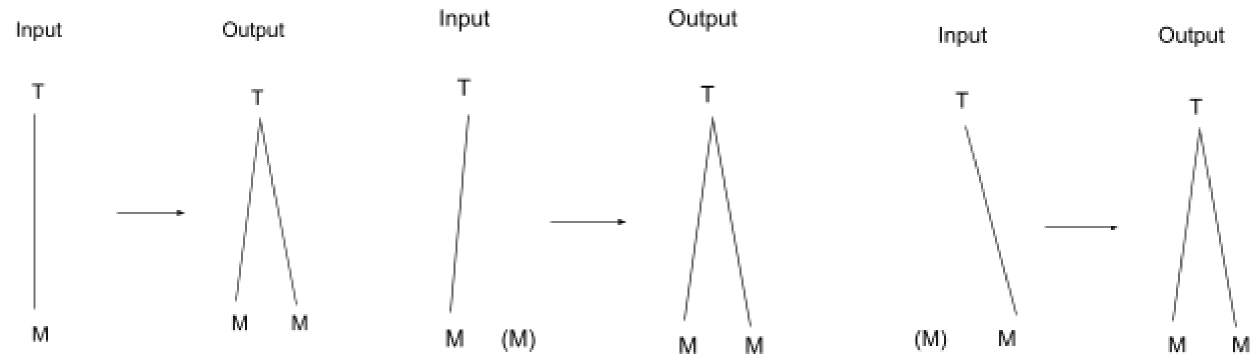
Example	**Input**	**Output**	**Violation**
1	L1L2	L1L2	N/A
2	L1L2	L1H2	IDENT
3	L1L2	L1	MAX
4	L1	L1L2	DEP
5	L1L2	L1H3	MAX and DEP

Critically, no faithfulness violations are assigned in the scenarios demonstrated in figure (18). In 18a when a monomoraic single tone input becomes a bimoraic single tone output, no faithfulness constraint violations are assigned. In 18b when an extra association line is created in the output to link the second mora to the tone, no faithfulness constraints are violated. Lastly, in 18c, when an extra association line is created in the output to link the first mora to the tone, no faithfulness constraint is violated. Although the monomoraic input becomes bimoraic in the output without faithfulness constraint violations, I still argue that Richness of the Base is not violated because there are no specific restrictions on the input.

(18)

Examples where faithfulness is not violated

a) b) c)



3.2 Examples of Markedness Constraint Violations

Figure (19) demonstrates some examples of markedness constraint violations. Because markedness constraints are assigned independent of the input, the input is irrelevant. Recall that not every markedness constraint is relevant in each environment.

In example 1, for any output with an L tone in a voiceless environment, (KV and KVʔ), a violation is assigned for $*K^{L}$. In example 2, for any output with an H tone in a voiced environment, (GV and GVʔ), a violation is assigned for $*G^{H}$. In example 3, for any output with two different tones in any environment with a glottal stop coda, (KVʔ and GVʔ), a violation is assigned for [AGREE]ʔ. In example 4, for any output with two identical tones in any environment (KV, GV, KVʔ, and GVʔ), a violation is assigned for POLARITY. Recall, a POLARITY violation is also assigned to single tone outputs such as KL1 because the single tone is the same tone value for two sequential moras in the output. In example 5, for any output with an L tone immediately preceding a glottal stop in glottal stop coda environments, (KVʔ and GVʔ), a violation is assigned for *L/ʔ.

(19)

Markedness Constraint Violation Examples

Example	**Output**	**Violation**	**Relevant Environment**
1	KL1L2 KL1H2 KL1 KL1ʔ	$*K^L$	KVand KVʔ
2	GH1H2 GH1L2 GH1L2ʔ	$*G^H$	GV and GVʔ
3	KL1H2ʔ GH1L2ʔ	[AGREE]ʔ	KVʔ and GVʔ
4	KL1L2 KH1H2 GL1L2 KL1L2ʔ GL1L3ʔ KL1	POLARITY	KV, GV, KVʔ, GVʔ
5	KL1L2ʔ GH1L2ʔ	*L/ʔ	KVʔ and GVʔ

4. Discussing the OT Workplace FACTYPE Results for Shanghainese monosyllables

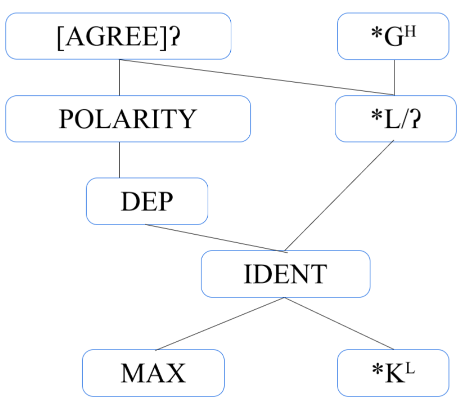
The constraints and inputs from section 2 were placed in the OT Workplace software. 652 languages were generated from the FACTYPE (Factorial Typology) function in OT Workplace. 3 languages of the 652 were identified as candidate output languages where the tones in the output correctly mapped to the tone distribution in the KV, GV, KVʔ, and GVʔ environments of Shanghainese. Note that language 553 had two possible rankings which will now be referred to as 553a and 553b. The only difference between 553a and 553b is that in 553a, MAX dominate $*K^L$ and in 553b, DEP dominates $*K^L$. Both 553a and 553b produce the same outputs. The constraint rankings of the three languages are shown in figure (20).

Several patterns emerge among the three languages. The difference between languages 513 and 516 is minimal. The only difference is that in language 513, IDENT >> MAX whereas in language 516, MAX >> IDENT. In all three languages, at least 2 faithfulness constraints always dominate *K^{L} where one of the constraints is always IDENT. In language 553a and 553b, IDENT >> DEP which is not the case in language 513 nor in 516. *L/ʔ ranks over IDENT in languages 513 and 516 but not in 553a nor 553b.

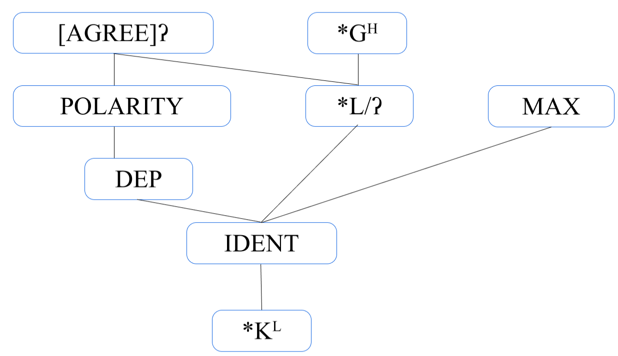
(20)

The Three Winning Output Languages from OT FACTYPE

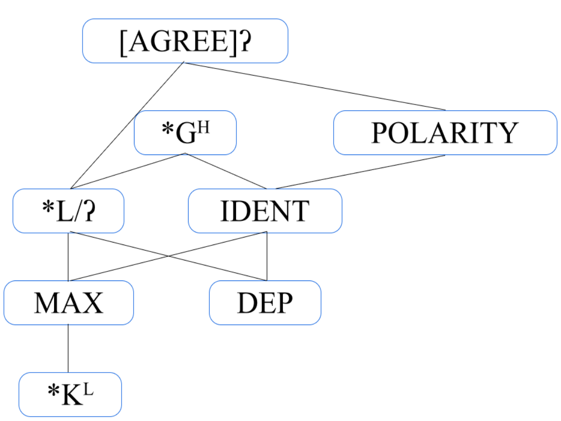
Language 513



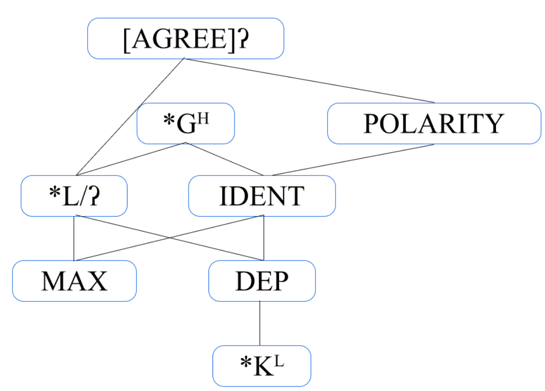
Language 516



Language 553: Option A



Language 553: Option B



The Support Comparative Tableau for each language is shown below in figure (21). The cell blocks highlighted in yellow represent resolved disjunction. Additionally, the X in the constraint titles AgreeX and starLX refers to a ʔ ([AGREE]ʔ and *L/ʔ).

(21)

Support Comparative Tableaus for each language

Language 513:

Support												
Residue#	ERC#	Input	Winner	Loser	6:starGH	8:AgreeX	4:Polarity	7:starLX	2:Dep	3:Ident	1:Max	5:starKL
L.513.8.4.2	34.2-4-6>1-3-5	GX	GL1X GL2X GL3X	GH1X GH2X GH3X	W			L				
L.513.6	34.2-4-6>9-13-17	GX	GL1X GL2X GL3X	GL1H2X GL3H2X GL1H3X		W	L	L	W			
L.513.6.8.7	1.8-12-16>1-3-5	K	KH1L2 KH3L2 KH1L3	KH1 KH2 KH3			W		L			
L.513.6.8.4.2	25.1>2	KL1X	KH1X	KL1X				W		L		W
L.513.6.8.4.7	8.8>16	KH1H2	KH1L2	KH1L3					W	L	W	
L.513.6.8.4.2.7	3.9-17>8-16	KL1	KL1H2 KL1H3	KH1L2 KH1L3						W		L
L.513.6.8.4.2.7	31.1>7	KH1L2X	KH1X	KH1H2X						W	L	

Language 516:

Support												
Residue#	ERC#	Input	Winner	Loser	1:Max	6:starGH	8:AgreeX	4:Polarity	7:starLX	2:Dep	3:Ident	5:starKL
L.516.6.8.4.2.7	31.7>1	KH1L2X	KH1H2X	KH1X	W						L	
L.516.1.8.4	34.2-4-6>1-3-5	GX	GL1X GL2X GL3X	GH1X GH2X GH3X		W			L			
L.516.1.6	34.2-4-6>9-13-17	GX	GL1X GL2X GL3X	GL1H2X GL3H2X GL1H3X			W	L	L	W		
L.516.1.6.8.7	1.8-12-16>1-3-5	K	KH1L2 KH3L2 KH1L3	KH1 KH2 KH3				W		L		
L.516.1.6.8.7	8.8>7	KH1H2	KH1L2	KH1H2				W			L	
L.516.1.6.8.4	25.1>2	KL1X	KH1X	KL1X					W		L	W
L.516.1.6.8.4.7	3.9-17>8-16	KL1	KL1H2 KL1H3	KH1L2 KH1L3							W	L

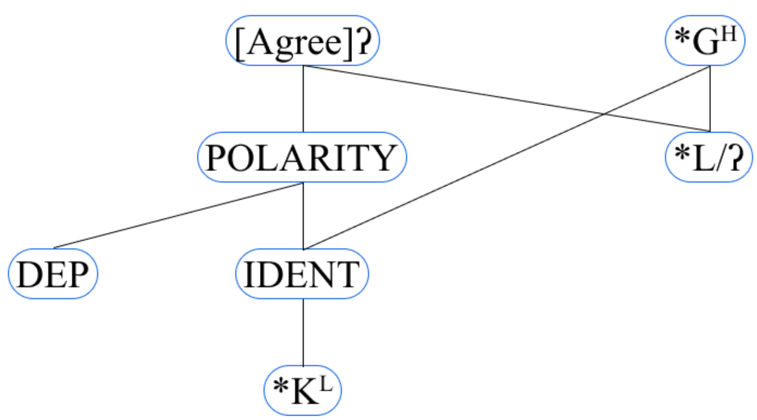
Languages 553a and 553b:

Support												
Residue#	ERC#	Input	Winner	Loser	6:starGH	8:AgreeX	4:Polarity	7:starLX	3:Ident	1:Max	2:Dep	5:starKL
L.553.8.4	20.13-17>8	GH1L2	GL3H2 GL1H3	GH1L2	W				L	L	L	
L.553.8.4	34.2-4-6>1-3-5	GX	GL1X GL2X GL3X	GH1X GH2X GH3X	W			L				
L.553.6	34.2-4-6>9-13-17	GX	GL1X GL2X GL3X	GL1H2X GL3H2X GL1H3X		W	L	L			W	
L.553.6.8.7	20.13-17>4	GH1L2	GL3H2 GL1H3	GL2			W		L		L	
L.553.6.8.4.3	25.3-5>2	KL1X	KH2X KH3X	KL1X				W		L	L	W
L.553.6.8.4.7	8.16>8	KH1H2	KH1L3	KH1L2					W	L	L	
L.553.6.8.4.3.7	3.9-17>12	KL1	KL1H2 KL1H3	KH3L2						W	W	L

The following rankings are always true across all three languages demonstrated in figure (22). The core trunk of the rankings is [AGREE]ʔ >> POLARITY >> IDENT >> $*K^L$. In addition, [AGREE]ʔ >> *L/ʔ, $*G^H$ >> IDENT, $*G^H$ >> *L/ʔ, and POLARITY >> DEP.

(22)

Constraint rankings that are true across all three output languages



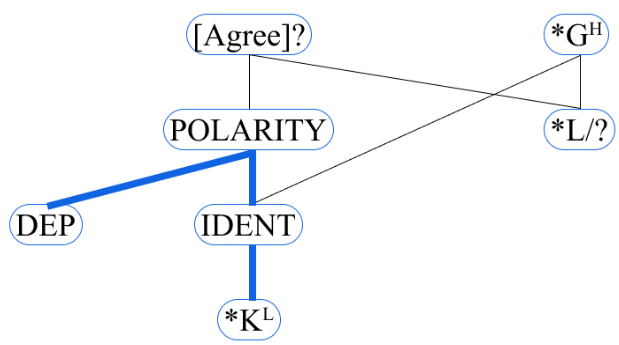
The rankings in figure (22) will be discussed in four sections, one for each environment. Each section will focus on the constraints that are most relevant in that environment.

4. 1 The KV environment

The following constraints, POLARITY, DEP, IDENT, and $*K^L$ are the key constraints in the KV environment. POLARITY >> IDENT >> $*K^L$ and POLARITY >> DEP are the two key rankings.

(23)

The key constraint rankings in the KV environment



Recall that in the KV environment, both the non-level HL and LH are possible output tone sequences while the level L, LL, H, and HH are not possible output sequences.

I begin by discussing the non-level HL output. There are no markedness constraints discouraging HL in the KV environment, so the input HL always emerges as HL under any ranking. The losers are all harmonically bounded by the faithful candidate. However, the ranking POLARITY >> DEP plays a crucial role in making the HL output optimal in other circumstances. For example, when the input is KH1, the ranking POLARITY >> DEP allows the non-level KH1L2 to emerge as optimal over the fully faithful candidate, KH1. The desired winner KH1L2 satisfies POLARITY but incurs a DEP violation. The fully faithful loser, KH1, satisfies DEP but incurs a POLARITY violation. Therefore, KH1L2 is optimal when

POLARITY dominates DEP. Recall that single tone candidates such as KH1 violate POLARITY because two adjacent moras have the same tone value in the output (both moras have an H value in this case). Only the winner-loser pair is shown below. Reference to the support comparative tableaus in figure (21) can be made for the full comparative tableau.

(24)

/KH1/	POLARITY	DEP
w. KH1L2		1
a. KH1	1 W	L

POLARITY >> IDENT is another important constraint ranking that leads to the emergence of HL. For example, when the input is KH1H2, the ranking POLARITY >> IDENT allows the desired non-level winner, KH1L2, to emerge as optimal over the fully faithful loser candidate, KH1H2. The desire winner, KH1L2, satisfies POLARITY at the expense of IDENT while the loser satisfies IDENT at the expense of POLARITY. For the desired winner to beat the loser, POLARITY must dominate IDENT. Together, the rankings POLARITY >> IDENT and POLARITY >> DEP excludes outputs such as H, HH, L, and LL, in favor of the H1L2 output.

(25)

/KH1H2/	POLARITY	IDENT
w. KH1L2		1
a. KH1H2	1 W	L

The markedness constraint $*K^L$ discourages the other possible candidate output, LH, from automatically emerging in the KV environment because $*K^L$ assigns a violation to L tones in voiceless environments. Rather, the output LH only emerges under two candidate input scenarios: The first is the fully faithful input, KL1H2, and the second is KL1, both of which will be discussed below.[3]

The emergence of LH using the fully faithful input, KL1H2, is shown below in figure (26). The desired winner, KL1H2, satisfies IDENT at the expense of $*K^L$. The loser, KH1L2, incurs two violations of IDENT while satisfying $*K^L$. (Two violations of IDENT are assigned at 22a because L1 has changed to H1 and H2 has changed to L2). Therefore, the desired winner, KL1H2, emerges as optimal when the ranking IDENT >> $*K^L$ is true. Overall, the information from figures (25) and (26) combine to give us the constraint ranking POLARITY >> IDENT >> $*K^L$ which is a key ranking in this environment.

(26)

/KL1H2/	IDENT	$*K^L$
w. KL1H2		1
a. KH1L2	2 W	L

Lastly, the KL1 input is the only other input that can produce KLH. The same constraint ranking discussed in figure (24), POLARITY >> DEP, can be applied to to the emergence of KLH from KL1. The desired winner, KL1H2, satisfies POLARITY and incurs one violation for DEP. The fully faithful single tone candidate output in 27a satisfies DEP but incurs one violation

3 In certain languages, the input KL2 also produces the output KLH.

of POLARITY. Therefore, the ranking POLARITY >> DEP must be true in order for the winner KL1H2 to emerge as the winner over the fully faithful input.

(27)

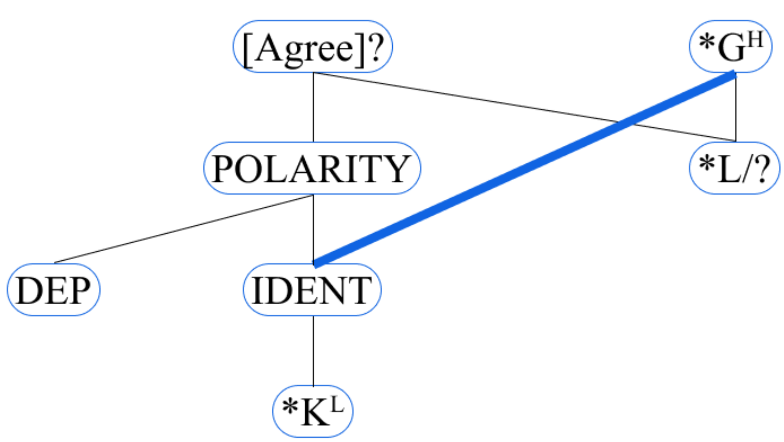
/KL1/	POLARITY	DEP
w. KL1H2		1
a. KL1	1 W	L

4. 2 The GV environment

The key constraints in the GV environment are $*G^H$ and IDENT. The key ranking that will be discussed in the GV environment is $*G^H$ >> IDENT. The previously established POLARITY >> IDENT ranking will also be discussed in this environment as to how it prevents level tone sequences. Recall, the counterpart to $*K^L$, $*G^H$, prohibits an initial H tone in voiced initial environments.

(28)

The key constraint rankings in the GV environment



The only tone output sequence allowed in the GV environment is LH. Under any ranking, the LH input emerges as LH in the output. The losers are harmonically bounded by the fully faithful candidate. Since the candidate input LH naturally emerges as LH in the output, I will discuss how the trickier input HL emerges as LH. Similar to the role $*K^{L}$ in the KV environment, the markedness constraint, $*G^{H}$, disfavors initial H tones input which assigns a violation for the HL input. Therefore, the candidate input HL requires the ranking $*G^{H}$ >> IDENT to be true for the output to emerge as LH. Additionally, just as POLARITY >> IDENT prevents level tones such as H, HH, L, LL from emerging in the KV environment, the same constraint ranking prevents level tones from emerging in the GV environment, making LH the optimal output.

In figure (29), the input is GH1L2 and the desired winner is GL1H2. The desired winner satisfies $*G^{H}$ at the expense of IDENT. It incurs two violations of IDENT because it changes the underlying H tone to an L tone at the first index and the underlying L tone to an H at the second index. The desired winner satisfies $*G^{H}$ because of the initial L tone. Contrastingly, the fully faithful loser, GH1L2, violates $*G^{H}$ and satisfies IDENT by retaining an H tone in the initial index. Thus, $*G^{H}$ >> IDENT is a key ranking that allows the winning LH tone sequence to emerge.

The desired winner, GL1H2, also wins over a second loser, GL1L2, which re-establishes the key ranking seen in the KV environment, POLARITY >> IDENT. The loser, GL1L2, satisfies $*G^{H}$ but incurs POLARITY and IDENT violations whereas the winner satisfies POLARITY and $*G^{H}$ at the expense of IDENT. The ranking plays a similar role as it did in the KV environment where it prevents level tone outputs, such as the loser in 29b, from emerging as optimal. The interaction of $*G^{H}$ >> IDENT and POLARITY >> IDENT demonstrates that

IDENT is easily violable relative to POLARITY and $*G^H$ which allows the LH tone sequence to emerge as optimal even when the input has different tones.

(29)

/GH1L2/	POLARITY	$*G^H$	IDENT
w. GL1H2			2
a. GH1L2		1 W	L
b. GL1L2	1 W		1 L

The constraint POLARITY prevents dual level tones from emerging as demonstrated above om 29b, and the ranking POLARITY >> DEP also prevents single level tones from winning in the GV environment. The tableau below demonstrates an example of a single tone input, GL1, losing against the desired winner, GL1H2. The desired winner satisfies POLARITY at the expense of DEP. The fully faithful loser candidate satisfies DEP at the expense of POLARITY. Thus, LH emerges as optimal when the ranking POLARITY>> DEP is true.

(30)

/GL1/	POLARITY	DEP
w. GL1H2		1
a. GL1	1 W	L

It is interesting to compare $*K^L$ and $*G^H$ because both are similar markedness constraints, however $*K^L$ is always dominated by faithfulness constraints whereas $*G^H$ is not. Further, $*G^H$ is undominated so it is always surface-true.

4.3. Glottal stop effect on tones: A preface to KVʔ And GVʔ environments

The distribution of tones in KVʔ and GVʔ environments requires a brief discussion about the effect of glottal stops on tones. Glottal stops have two effects on tone: the first is a leveling effect and the second is a heightening effect (DiCanio 2012, Mastiff 2003, Lee 2007, Haudricourt 1954). I represent the leveling effect with the markedness constraint [AGREE]ʔ and the heightening effect with the markedness constraint [*L/ʔ], both of which were described in section 2.1 figure (6). Their application in the KVʔ and GVʔ environments will be described in this section.

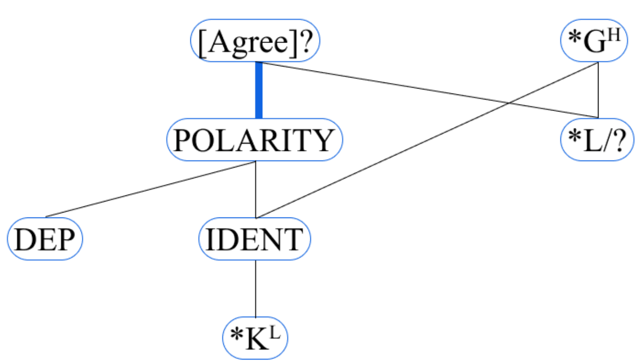
The leveling effect of glottal stops on tone is attested in the language San Martín Itunyoso Trique spoken in Oaxaca. The only time level tones surface is in glottal stop coda environments (CVʔ) while non-glottal final syllables have contour tones (DiCanio 2012). Both the leveling and heightening effect on tones in glottal stop final environments has been attested in Burmese. Burmese seems to neutralize to a high tone when syllables have creaky phonotation or a glottal stop coda (Lee 2007). Some literature distinguishes a full glottal stop which has a heightening effect on tones and creaky voice phonotation which has a lowering effect on tones (Haudricourt 1954). Nonetheless, there is evidence for heightened tones in the presence of a glottal stop coda. The next sections will demonstrate the effect glottal stop coda environments have on Shanghainese tones.

4. 4 The KVʔ environment

The following constraints, [AGREE]ʔ, POLARITY, IDENT, *L/ʔ, MAX, and DEP are key constraints in the KVʔ environment. The key ranking that exists across the three languages is [AGREE]ʔ >> POLARITY >> IDENT shown in figure (31). Recall that the ranking POLARITY>> IDENT was already established in the KV environment, so this section will focus on [AGREE]ʔ >> POLARITY. Additionally, some rankings particular to specific output languages will also be discussed. For example, the ranking *L/ʔ >> IDENT is specific to languages 513 and 516 (shown in figure 32) and *L/ʔ >> MAX, DEP (shown in figure 33) is specific to language 553a and 553b. The winning tone output sequences in the KVʔ environment are H and HH.

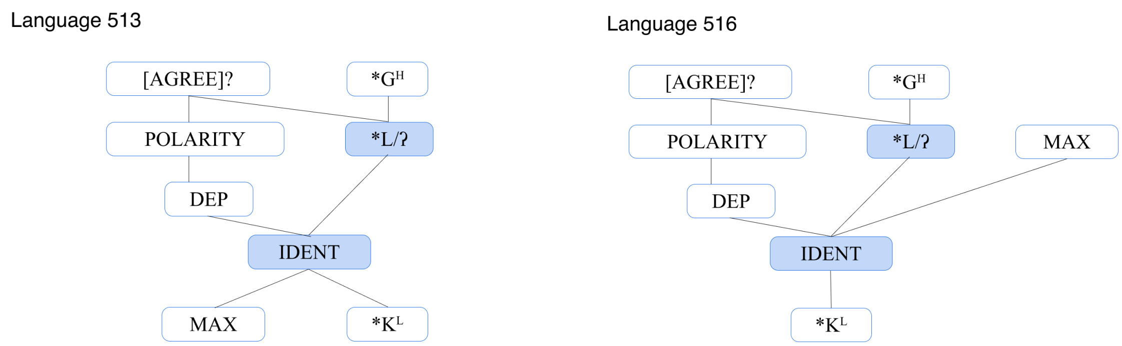
(31)

The key constraint rankings in the KVʔ environment



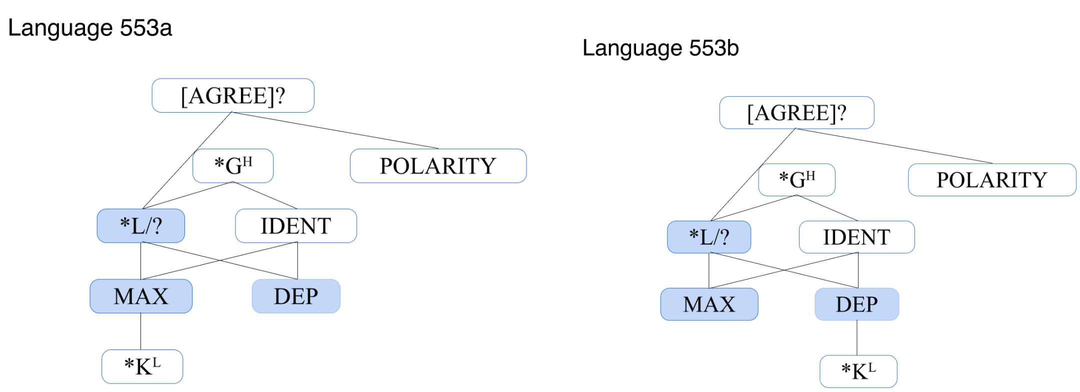
(32)

Figure demonstrating *L/ʔ >> IDENT in languages 513 and 516



(33)

Figure demonstrating *L/ʔ >> MAX, DEP in language 553a and 553b



[AGREE]ʔ is a key constraint that allows the tone sequences H and HH to emerge in the KVʔ environment. The outputs H and HH are interchangeable as they both give level high tone patterns. The only difference is that H has two moras linked to a single tone whereas HH has one mora linked to each H tone. Recall that the constraint [AGREE]ʔ requires an agreement in tone value preceding a glottal stop. The constraint [AGREE]ʔ motivates the leveling effect observed in glottal stop coda environments as mentioned in section 4.3. The figure below details the [AGREE]ʔ constraint (Bakovic 2000).

(34)

Figure from Bakovic 2000 detailing the constraint [AGREE]ʔ

(5) Satisfy AGREE[F] — Violate AGREE[F]

a.	*x*	*y*		c.	*x*	*y*
	[–F]	[–F]			[–F]	[+F]
b.	*x*	*y*		d.	*x*	*y*
	[+F]	[+F]			[+F]	[–F]

[AGREE]ʔ >> POLARITY is a crucial ranking that allows H and HH to emerge in the KVʔ environment. In the tableau below, the input is KH1H2ʔ and the desired winner is the fully faithful candidate KH1H2ʔ. The loser candidate is KH1L2ʔ. The desired winner, KH1H2ʔ, satisfies [AGREE]ʔ because two level H tones precede the glottal stop. However, the [AGREE]ʔ directly conflicts with POLARITY which requires a tonal contrast in the sequence. In the winner, POLARITY is sacrificed. The loser, KH1L2ʔ, achieves POLARITY by having a tonal contrast but violates [AGREE]ʔ in the process. Therefore, for the desired winner to emerge, the ranking [AGREE]ʔ >> POLARITY must be true. Recall earlier in the KV environment that POLARITY >> IDENT >> $*K^L$ was established. [AGREE]ʔ can appended to this constraint ranking as [AGREE]ʔ >> POLARITY >> IDENT >> $*K^L$.

Additionally, the constraint ranking [AGREE]ʔ or IDENT dominates POLARITY is gleaned from the support comparative tableaus. However, from the KV environment, it was established that POLARITY >> IDENT. Therefore, the ranking [AGREE]ʔ >> POLARITY must be true by process of elimination. The constraint IDENT is shown in figure (35) to show that it does not affect the winner and that [AGREE]ʔ does in fact dominate POLARITY.

(35)

/KH1H2ʔ/	[AGREE]ʔ	POLARITY	IDENT
w. KH1H2ʔ		1	
a. KH1L2ʔ	1 W	L	1 W

*L/ʔ >> IDENT is a pattern in languages 513 and 516 that does not exist across all three languages but still deserves discussion because it describes the emergence of the viable output sequence KH1ʔ in those languages. The ranking, *L/ʔ >> IDENT, reinforces the heightening effect that glottal stops produced detailed in section 4.3. When the input is KL1ʔ, the desired winner, KH1ʔ, wins over the fully faithful loser, KL1ʔ. The desired winner satisfies *L/ʔ but violates IDENT by changing the tone at the first index to H. The faithful loser candidate satisfies IDENT but violates *L/ʔ. Therefore, the ranking *L/ʔ >> IDENT must be true for KH1ʔ to emerge as the winner.

(36)

/KL1ʔ/	*L/ʔ	IDENT
w. KH1ʔ		1
a. KL1ʔ	1 W	L

Additionally, in languages 553a and 553b, the ranking *L/ʔ>> MAX, DEP is true which demonstrates how two H tones with any indices can emerge as the winning output. In the example below where the input is KH1L2ʔ, the desired winner, KH1H3ʔ, incurs one MAX and one DEP violation when L2 is deleted and H3 is epenthesized. Although two faithfulness violations are incurred, the winner satisfies *L/ʔ. Additionally, the winner satisfies [AGREE]ʔ which is an undominated constraint according to figure (22) so it is preferred over the loser that violates [AGREE]ʔ. The loser, although faithful, does not satisfy *L/ʔ. Therefore, the constraint ranking *L/ʔ>> MAX, DEP must be true for the level tone desired winner to rank over the loser.

(37)

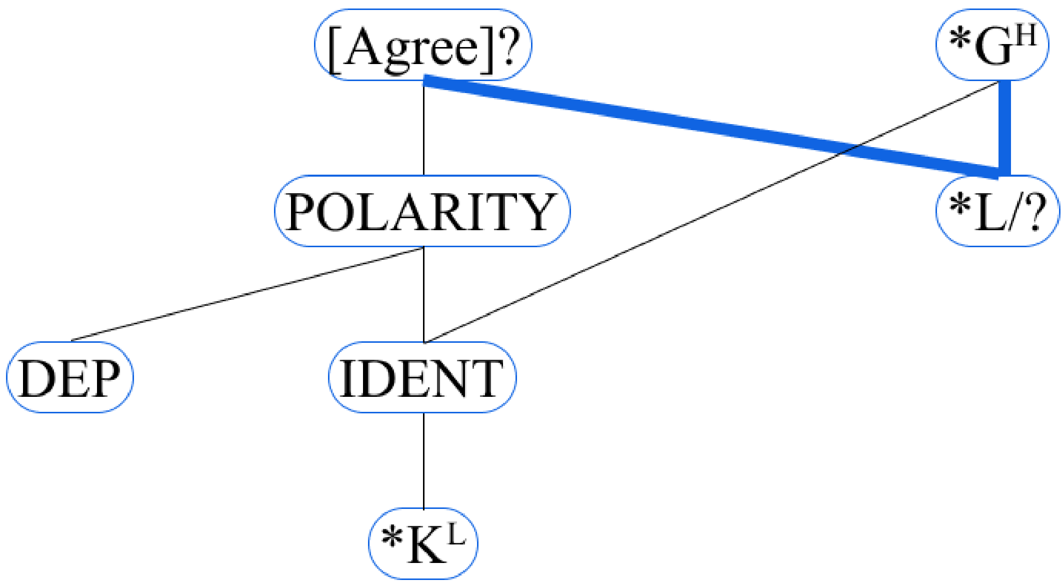
/KH1L2ʔ/	*L/ʔ	MAX	DEP
w. KH1H3ʔ		1	1
a. KH1L2ʔ	1 W	L	L

<u>4. 5 The GVʔ environment</u>

Lastly, in the GVʔ environment, [AGREE]ʔ, *L/ʔ, and $*G^H$ are key constraints. The key rankings in this environment are $*G^H$ >> *L/ʔ and [AGREE]ʔ >> *L/ʔ. The winning output sequences in the GVʔ environment are L and LL.

(38)

The key constraint rankings in the GVʔ environment



For L and LL to emerge as the winning outputs in the GVʔ environment, the key constraint ranking $*G^H >> *L/ʔ$ plays a crucial role in the emergence of the level tone output sequences. Figure (33) demonstrates $*G^H >> *L/ʔ$ with the winner-loser pair, GH1ʔ-GL1ʔ. The previously established ranking of $*G^H >>$ IDENT shows that $*G^H$ dominates both *L/ʔ and IDENT. In figure (39), the desired winner, GL1ʔ, satisfies $*G^H$ at the expense of *L/ʔ and IDENT.The loser does the opposite and satisfies *L/ʔ and IDENT while violating $*G^H$. Therefore, in order for the desired winner to dominate the fully faithful candidate, the ranking $*G^H >> *L/ʔ$ must be true.

(39)

/GH1ʔ/	$*G^H$	*L/ʔ	IDENT
w. GL1ʔ		1	1
b. GH1ʔ	1 W	L	L

Given the combination of $*G^H$ and *L/ʔ, a low tone initial and high tone final candidate such as GL1H2ʔ might be expected to win. However, when the highly ranked constraint [AGREE]ʔ is considered, GL1HLʔ becomes the preferred winner, not GL1H2ʔ. The constraint *L/ʔ, which disprefers L tones preceding a glottal stops, interacts with [AGREE]ʔ to produce a desired winner that is both level and one that contains H tones exclusively. The combination of these constraints also satisfies the leveling and heightening effect of glottal stop codas mentioned in section 4.3.

The ranking [AGREE]ʔ >> *L/ʔ and MAX is also important to the emergence of the tone sequence L. In the tableau below, the input is the level and high tone sequence GH1H2ʔ. The desired winner is GL1ʔ and the loser is GL1H2ʔ. The winner, GL1ʔ, satisfies [AGREE]ʔ at the expense of *L/ʔ by having a level L tone output. The winner also incurs a MAX violation by deleting the H tone at the second index. The loser, GL1H2ʔ, violates [AGREE]ʔ and while satisfying *L/ʔ and MAX. For GL1ʔ to beat the loser, [AGREE]ʔ >> *L/ʔ and MAX. The rankings discussed in this section also give rise to the other viable output in the GVʔ environment, LL.

(40)

/GH1H2ʔ/	[AGREE]ʔ	*L/ʔ	MAX
w. GL1ʔ		1	1
d. GL1H2ʔ	1 W	L	L

4.6 Conclusion

Under the definitions of GEN and CON outlined in the sections above, 3 output languages are possible for Shanghainese monosyllable tone patterns. Among the 3 winning languages, the following key constraints were identified: [AGREE]ʔ >> POLARITY >> IDENT >> $*K^L$, [AGREE]ʔ >> *L/ʔ, $*G^H$ >> IDENT, $*G^H$ >> *L/ʔ, and POLARITY >> DEP. In the KV environment, the rankings POLARITY >> IDENT >> $*K^L$ and POLARITY >> DEP played crucial roles in the emergence of the output candidates LH and HL. In the GV environment, $*G^H$ >> IDENT was a critical ranking for the emergence of LH. Transitioning to the glottal stop environments, the ranking [AGREE]ʔ >> POLARITY was crucial to the emergence of level tones such as H, HH, L, and LL in their respective environments. In the KVʔ, the winning outputs were H and HH. The leveling effect was motivated by [AGREE]ʔ >> POLARITY and the heightening effect of glottal stops was further solidified by the ranking *L/ʔ >> IDENT which changed an input L tone into an output H tone where necessary. The aforementioned critical rankings in the glottal stop environments ([AGREE]ʔ >> POLARITY and *L/ʔ >> IDENT) as well as the constraint rankings $*G^H$ >> *L/ʔ and [AGREE]ʔ >> *L/ʔ motivated the emergence of L and LL in the GVʔ environment.

4.7 Additional considerations

The inputs and outputs do not consider floating tones or multiple tones per mora. Initially, a FACTYPE was created in which toneless moras were allowed in the output. This resulted in over 3000 potential language candidates which was too wide of a scope. Thus, the output were adjusted so that no toneless moras were allowed. Every mora that surfaces in the output requires tones. Although this limited the scope of my research, I was able to make generalizations about the application of Optimality Theory to Shanghainese tones in monosyllables.

A subject of potential interest is the constraint ranking *L/ʔ >> *K^{L} in all three languages. Although it may be incidental, the ranking is interesting as *L/ʔ ranks above a faithfulness constraint, IDENT, while *K^{L} ranks below it. The two constraints are not in direct conflict with one another, but it is interesting that a markedness constraint dominates a faithfulness constraint, which then dominates a similar markedness constraint.

For future research, it is imperative that the study of tones in monosyllables using an Optimality Theory approach is expanded to disyllables, trisyllables, and beyond. This field of study is referred to as tone sandhi which considers the behavior of tonal stress in connected speech. It is already known that Shanghainese is a left-headed language where the pitch shape of words and phrases, especially the first couple of words, is heavy informed by the tone of the initial (the leftmost) syllable. The importance in tone value of the left-most syllable would make for interesting Optimality Theory constraint interactions.

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