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Voicing and Devoicing Rules in East and Southeast Asian Languages

Siyu Crystal Zhang

I. INTRODUCTION

Languages are composed of sounds that are produced by the vocal organs. These sounds can be split into two categories, voiceless and voiced, depending on whether or not the vocal cords are stretched apart or not. In general, based upon the International Phonetic Alphabet, there are more voiced sounds possible than voiceless sounds, with vowels, nasals, and approximants inherently voiced. After analyzing the separate phonetic inventories of 9 Asian languages representative of the major Asian language families (Arabic, Burmese, Japanese, Korean, Malay, Mandarin Chinese, Tamil, Turkish, Vietnamese), it was found that all of them except Mandarin Chinese had far more voiced sounds than voiceless sounds as well. In order to analyze voiced and voiceless sounds in languages more objectively, all naturally voiced sounds were eliminated, leaving only stops and affricates that can be both voiced and voiceless. After isolating only stops and affricates, all the Asian languages were found to have more voiceless phonemes than voiced. Now that a clear picture of the phonetic characteristic of the languages has been painted, voicing and devoicing rules of these languages were analyzed.

II. THE PHYSIOLOGY OF VOICED AND VOICELESS SOUNDS

In languages, almost all speech sounds are produced when the respiratory system pushes air out of the lungs.¹ Air from the lungs goes up the trachea, into the larynx, and then passes between the vocal cords. When breathing out normally, the vocal cords are apart and thus air from the lungs will pass relatively freely into the pharynx and mouth. However, if the vocal cords are adjusted, resulting in only a narrow passage between the vocal cords, the airstream will cause the cords to vibrate. Voiced sounds are those produced when the vocal cords are closer apart and vibrating.

¹ Some stops are produced in reverse.

Voiceless sounds are those produced when the vocal cords are farther apart and not vibrating. All vowels are naturally voiced, but consonants can be either voiced or voiceless. Under certain circumstances, voiced and voiceless sounds can become voiceless or voiced sounds, respectively (Ladefoged 1993). Voicing and devoicing are distinctive characteristics of languages and have very specific conditions when they occur. In this paper, an analysis of the frequency of voiced and voiceless phonemes possible for all languages (based upon the 2005 International Phonetic Alphabet (IPA) found in the Appendix A) and also for nine specific Asian languages represent the major language families of Asia (Arabic, Burmese, Japanese, Korean, Malay, Mandarin, Tamil, Turkish, and Vietnamese) will be conducted. A further analysis of only stop and fricative voiced and voiceless phonemes will also be done. Finally, a summary of voicing and devoicing rules in the nine Asian languages will be given followed by a discussion of noted voicing and devoicing patterns and conclusions.

III. ANALYSIS OF THE PHONETIC INVENTORIES OF LANGUAGES

In the IPA Chart (Appendix A), there are 105 total phonemes with 77 consonants/nasals/approximants and 28 vowels. There are 27 voiceless phonemes and 78 voiced phonemes if all the vowels, which are all voiced, are counted as voiced phonemes. If the vowels are eliminated from the counting, there are 27 voiceless phonemes and 50 voiced phonemes. From this data, it is clear that there are more voiced than voiceless sounds, especially if the naturally voiced vowels are included in the count. This phenomenon can be logically explained through human physiology. Human vocal cords are naturally close together when relaxed, so it is easier to pronounce voiced sounds because the vocal cords do not need to be pulled apart like they have to be for voiceless sounds. Thus, due to the close nature of the relaxed vocal

cords, voiced sounds are easier to pronounce than voiceless sounds, explaining the existence of more voiced than voiceless phonemes.

After analyzing the phonetic inventories of the nine Asian languages (Appendix B), it is apparent that the majority of them (8 out of 9) have a significantly greater number of voiced sounds than voiceless sounds. This can be supported by the fact that children produce voiced sounds before voiceless sounds since they are easier to produce. The inherent voicing of vowels, nasals, and approximants is mainly responsible for this phenomenon. However, Mandarin Chinese is an exception and actually has more voiceless than voiced phonemes (17 voiceless, 7 voiced). Korean is also unique in that it has almost equal voiceless and voiced phonemes (15 voiceless, 16 voiced). This can be explained by lack of voiced stops and fricatives and the different pronunciations of the voiceless stops and fricatives. Specifically, Mandarin Chinese and Burmese distinguish aspirated and unaspirated voiceless stops and fricatives and Korean has lax, aspirated, and tensed stops and fricatives, which double and triple their voiceless phonetic inventories, respectively. Aspiration is a “period of voicelessness after the stop articulation and before the start of the voicing for the vowel” (Ladefoged 1993). Tensed phonemes are usually articulated with greater distinctiveness and pressure and are considered geminates or double consonants (Choi 1995).

For the purpose of analyzing devoicing and voicing in languages, a simplified IPA Chart (Appendix B) of voiced and voiceless phonemes has been constructed that eliminates all the voiced phonemes by default (vowels, nasals, approximants), which leaves only the fricative and stop consonants. Coincidentally, the majority of devoicing and voicing rules in Asian languages usually only involve fricative and stop consonants as well. From this simplified chart, it can be concluded that there are 21 voiceless

consonants and only 19 voiced consonants. Other than the voiceless epiglottal and glottal stops, all other stops and fricatives have both voiced and voiceless sounds for each of the possible places of articulation. Using the simplified IPA Chart as a template, nine Asian languages were mapped out in the same fashion for voiced and voiceless stop and fricative consonants. Surprisingly, analysis of the simplified IPA Chart shows all nine languages having more voiceless than voiced stop and fricative consonants, with Mandarin Chinese and Korean having no voiced phonemes. This is a result of many of the languages not having a voiced counter part for some of the voiceless stops and fricatives. In the case of Korean, Burmese, and Mandarin Chinese, their voiceless phonemes are also multiplied due to the contrast in pronunciation of aspirated, unaspirated, and tensed (only Korean) consonants.

IV. VOICING AND DEVOICING RULES IN NINE ASIAN LANGUAGES

After studying the voiceless and voiced phonetic inventories of nine Asian languages, devoicing and voicing rules from each language were determined and analyzed. Interestingly, the number of devoicing rules is greater than that of voicing rules for these nine languages, with 7 and 4, respectively.² Based upon this data, a valid conclusion cannot be made because there is not enough data collected to determine if there are equal or unequal devoicing and voicing rules. However, it is still interesting to analyze the rules and draw parallels between the languages. No voicing or devoicing rules for Mandarin were found in this analysis. Thus, of the 8 Asian languages with devoicing and voicing rules, 6 of them have devoicing rules. In standard Arabic, /b/ tends to become devoiced if it proceeds a voiceless consonant, e.g. /habs/

² Burmese also has an assimilation rule that involves voicing and devoicing. When the first syllable of two is a minor one, the initial of the minor syllable often harmonizes with the voicing of the following consonant either becoming devoiced or voiced, e.g. /təhkàn/ is realized as [təkhã] with both stops voiceless or /səpwè/ is most often pronounced [zəbwè] with voicing throughout.

→ [haps] ‘imprisonment’ or /hibs/ → [hips] ‘dam.’ A unique devoicing rule occurs in Japanese, which unlike other languages allows the devoicing of vowels. The high vowels /u/ and /i/ are devoiced in a voiceless environment, which means they cannot be contiguous to a voiced sound, initial, nor accented, e.g. /kʷtsu/ → [kʷ̥tsu] ‘shoe,’ /hafi/ → [hafi̥] ‘chopstick,’ /sʷsʷuki/ → [sʷ̥sʷ̥uki] ‘eulalia’ with the open circle diacritic indicating voicelessness. Since voiced stops cannot occur in the final position, loanwords with voiced consonants are devoiced, e.g. /jawab/ → [jawap] ‘answer (Arabic),’ /masjid/ → [masjit] ‘mosque (Arabic),’ /zig-zag/ → [siksak] ‘alternating left and right turns (English).’ Tamil follows Caldwell’s Law, which states that stops are voiceless when they occur initially or geminated, e.g. /bāvam/ ‘facial expression’ and /pāvam/ ‘sin’ are both pronounced as [pāvã] with a nasalized vowel (Comrie 2009). In Turkish, stops and affricates are devoiced in the syllable-final position, e.g. /sebep/ ‘reason’ has the voiceless /p/ since the /p/ is in the syllable-final position, but in the possessive case, /sebebi/, the voiced /b/ is present because it does not occur syllable-finally and thus, is not devoiced to /p/ (Lombardi 1990). Another unique devoicing rule that does not involve stops and fricatives occurs in Turkish where word final liquids are devoiced, e.g. /kar/ → [kaɾ̥] ‘snow,’ /bakir/ → [bakiɾ̥] ‘copper,’ /kel/ → [keɻ̥] ‘bald’ (Comrie 2009). Finally, Vietnamese devoices syllable final /b/ stops to /p/.

On the other hand, only four of the eight languages have voicing rules. In Burmese, successive major syllables in *close* juncture can have preservative voicing on the internal velar stop /k/, e.g. /lè-hkàn/ → [lègã] ‘four rooms.’ In /θòn-hkăn/ ‘three rooms’ there is a final nasal in anticipation of the velar stop with the same preservative voicing as the previous example which results in [θõũŋgã]. *Rendaku*, “sequential voicing,” is a voicing rule of Japanese that ensures the second element of a compound word is voiced, basically the consonant is voiced by the preceding vowel, e.g. /yu/ ‘hot

water' + /toofu/ 'tofu' → [yudoofu] 'boiled tofu,' /de/ 'leave' + /kuchi/ 'mouth' → [deguchi] 'exit.' Not surprisingly, Korean, which only has voiceless stops and fricatives, has a voicing rule. Voiceless stops and affricates become voiced when they occur between two voiced sounds, e.g. /aka/ → [aga] 'baby.' Tamil obeys Caldwell's Law, which states that stops are voiced when they occur intervocallically or after nasals, e.g. /atu/ → [aðu] 'it' and /aŋkē/ → [aŋgē] 'there' (Comrie 2009).

V. CONCLUSIONS

From this analysis of voicing and devoicing rules in Asian languages, a few possible explanations and conclusions can be drawn. It seems that some languages follow Caldwell's Law, which states stops are voiceless when they occur initially or geminated, and voiced when they occur intervocallically or after nasals. Surprisingly, stops and fricatives are not the only voiced and devoiced phonemes, vowels and liquids can be as well. Many languages have similar voicing and devoicing rules as well. Vietnamese, Turkish, and Japanese all have syllable-final devoicing. Japanese and Tamil, on the other hand, both have intervocalic voicing rules.

The data shows that there are more devoicing rules than voicing rules, which might be explained by the fact that most languages have more voiced phonemes, so naturally in order for a change in voicing to occur, it would be more likely for the larger number of voiced sounds to become devoiced, simply by probability. In addition, since languages possess more voiced than voiceless sounds, it would make sense to have more devoicing rules in order to create a voiced and voiceless alternation in order to avoid misinterpretation of sounds. These conclusions may not be valid because the sample size of the data is too small and a more thorough analysis of voicing and devoicing rules in Asian languages would need to be conducted. Due to this fact, the larger number of devoicing rules may be misleading and inconclusive. From a logical

perspective, it would make sense for there to be more voicing rules because voiced sounds are easier for the vocal cords to produce. Thus, it is possible that there are more voicing rules than devoicing rules. A further and more comprehensive study of voicing and devoicing rules would be needed in order to draw more valid and supported conclusions about the voicing and devoicing trends in Asian languages.

APPENDIX B. IPA Chart for Nine Asian Languages

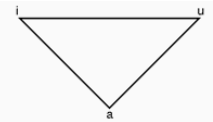
All IPA charts were obtained from *The World's Major Languages*, Comrie, Bernard, 2009

Arabic (Afroasiatic)

Table 33.1 Arabic Consonant Phonemes

	Bilabial	Labio-dental	Inter-dental	Dental	Emphatic	Palatal	Velar	Uvular	Pharyngeal	Laryngeal
Stops	b			t d	ɾ ɽ		k	q		ʔ
Affricates						ʃ				
Fricatives		f	θ ð	s z	ʂ ʐ (z)	ʃ		x ɣ	ħ ʕ	h
Nasals	m			n						
Laterals				l	ɭ					
Trill				r						
Approximants	w					y				

Vowels



6 total vowels (each of the three vowels above have long and short pronunciations)

36 total phonemes: 23 voiced, 13 voiceless

Burmese (Tibeto-Burman)

Table 43.1 Burmese Phonological Oppositions

	Stops and affricates				Fricatives		Nasals		Resonant					
C _i Aspirate	hp	ht	hc	hk	hs		hm	hn	hp	hɟ	hl	hy	hw	h
Plain	p	t	c	k	s θ		m	n	ɲ	ŋ	l	y	w r	ʔ
Voiced	b	d	j	g	z ð									
V Syllable type														
Open (-∅)	i	e	ɛ	a	ɔ									o u
	(-n)	ɪ	eɪ	a	aɪ	aʊ	oʊ	u						
Closed	(-ʔ)	ɪ	eɪ	ɛ	a	aɪ	aʊ	oʊ	u					
Transcribed as:														
	i	e	ɛ	a	ɔ	aɪ	aʊ	o	u					
C _m -y-, -w-					C _f -n, (-ʔ)									
T	ˀ (creaky),	∅ (low),	ˀ (high),	-ʔ (checked)										

46 total phonemes: 33 voiced, 13 voiceless

Japanese

Table 44.2 Segmental Phonemes of Japanese

Vowels	i	u	
	e	o	
	a		
Consonants	p	t	k
	b	d	g
	s		h
	z		
		r	
	m	n	
	w	j	N Q

21 total phonemes: 15 voiced, 6 voiceless

Korean

Table 45.2 Korean Consonants

	<i>Manner</i>	<i>Point</i>	<i>Labial</i>	<i>Dental</i>	<i>Palatal</i>	<i>Velar</i>	<i>Glottal</i>
Stops	voiceless	{ laxed aspirated tensed }	p	t		k	
			p ^h	t ^h		k ^h	
			p'	t'		k'	
Affricates	voiceless	{ laxed aspirated tensed }			c		
					c ^h		
					c'		
Fricatives	voiceless	{ laxed tensed }		s			h
					s'		
Nasals	voiced		m	n		ŋ	
Liquid	voiced			l			
Semi-vowels			w	y			

Table 45.1 Korean Vowels

	<i>Front</i> <i>Unrounded</i>	<i>Rounded</i>	<i>Back</i> <i>Unrounded</i>	<i>Rounded</i>
High	i	ü	ũ	u
Mid	e	ö	ə	o
Low	æ		a	

31 total phonemes: 16 voiced, 15 voiceless

Malay (Austronesian)

Table 47.1 Consonant Phonemes in Inherited Malay-Indonesian Vocabulary

	<i>Bilabial</i>	<i>Dental/Alveolar</i>	<i>Palatal</i>	<i>Velar</i>	<i>Glottal</i>
Voiced stops	b	d	ʃ	g	
Voiceless stops	p	t	c	k	ʔ
Nasals	m	n	ɲ	ŋ	
Liquids		l r			
Fricatives		s			h
Glides	w		y		

Table 47.2 Vowel Phonemes in Inherited Malay-Indonesian Vocabulary

	<i>Front</i>	<i>Central</i>	<i>Back</i>
High	i		u
Mid	e	ə	o
Low		a	

25 total phonemes: 18 voiced, 7 voiceless

Mandarin Chinese (Sino-Tibetan)

Table 5.9. Mandarin Chinese consonants, Beijing dialect (adapted from Li and Thompson 1981)

	Labial	Dental	Retroflex	Palatal	Velar	Uvular
Stops						
unaspirated	b [p]	d [t]			g [k]	
aspirated	p [p ^h]	t [t ^h]			k [k ^h]	
Affricates						
unaspirated		z [ts]	zh [tʂ]	j [tɕ]		
aspirated		c [ts ^h]	ch [tʂ ^h]	q [tɕ ^h]		
Fricatives	f	s	sh [ʂ]	x [ɕ]		h [χ]
Nasals	m	n			ŋ [ŋ]	
Liquid		l				
Rhotic			r [ʐ]			
Semi-vowels	w		y [j]			
Mandarin Chinese Vowels						
	Front		Central		Back	
High	i, y				u	
Mid					ʏ	
Low			a			

29 total phonemes: 12 voiced, 17 voiceless

Tamil (Dravidian)

Table 37.1 The Sounds of Modern Standard Tamil

	Stop		Fricative	Sibilant	Nasal	Lateral	Tap	Approximant	Glide
	<i>vls.</i>	<i>vd.</i>							
Labial	p	(b)	(f)		m				v
Dental	t	(d)			n	l	r		
Alveolar	R				[N]				
Retroflex	ʈ	(ɖ)		(ʂ)	ɳ	ɭ		ʐ	
Palatal	c	(j)		(ʃ)	ɲ				y
Velar	k	(g)			[ŋ]				(h)

		Front	Central	Back
High	long	ī		ū
	short	i		u
Mid	long	ē		ō
	short	e	(ə)	o
Low	long	(ā)	ā	(ō)
	short		a	
Diphthong		ai		au

Notes: (X), X is part of the peripheral phonology of Tamil. [X], X is graphemically, but not phonemically distinct.

42 total phonemes: 32 voiced, 10 voiceless

Turkish (Uralic)

Table 30.2 Turkish Consonants

		Bilabial	Labio-dental	Dental, Alveolar	Palato-alveolar	Palatal	Velar	Glottal
Stop	voiceless	p		t	ç		k	
	voiced	b		d	j		g	
Fricative	voiceless		f	s	ʃ			
	voiced		v	z	ʒ			
Nasal		m		n				
Lateral approximant				l				
Central approximant				r		y		h

Table 30.1 Turkish Vowels

	[−back]	[+back]		
	[−round]	[−round]	[+round]	[+round]
[+high]	i	ü	ɨ	u
[−high]	e	ö	a	o

28 total phonemes: 20 voiced, 8 voiceless

Vietnamese (Mon-Khmer)

Table 40.4 Vietnamese Consonants

	Labial	Labio-dental	Alveolar	Retroflex	Palatal	Velar	Laryngeal
Voiceless stop	p		t	tr	ch	c	
Aspirated stop			th				
Voiced stop	b		ɗ				
Voiceless fricative		ph	x	s		kh	h
Voiced fricative		v	d	r	gi	g	
Nasal	m		n		nh	ng	
Lateral			l				

Table 40.2 Vietnamese Vowels

	Front	Central	Back	
			Unrounded	Rounded
i, y			ɨ	u
ê			ɔ	ô
e	ă		â	o
a				

35 total phonemes: 24 voiced, 11 voiceless

APPENDIX C. Simplified IPA Chart (Stops and Fricatives)

THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

	LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʕ	ʔ
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	ħ ʕ	h ɦ
Lateral Fricative				ɬ ɮ								

Where symbols appear in pairs, the one to the right represents a voiced consonant and the one to the left represents a voiceless consonant.

40 total phonemes: 19 voiced, 21 voiceless

APPENDIX D. Simplified IPA Chart for Nine Asian Languages (Stops and Fricatives)

All IPA charts were simplified from the original IPA charts in Appendix B originally from *The World's Major Languages*, Comrie, Bernard, 2009

Arabic

	LABIAL		CORONAL					DORSAL			RADICAL		LARYNGEAL	
	Bilabial	Labiodental l	Dental		Alveolar		Postalveolar	Retroflex x	Palatal	Velar	Uvular	Pharyngeal l	Epiglottal	Glottal
			Plain	Emphatic	Plain	Emphatic								
Stop	b				t d	tʕ dʕ				k q				ʔ
Fricative		f	θ ð	ðʕ	s z	sʕ zʕ	ʃ			x ɣ		ħ ʕ		h

<ʕ> indicates pharyngealized consonants

22 total phonemes: 9 voiced, 13 voiceless

Burmese (Tibeto-Burman)

	LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL	
	Bilabial	Labiodental l	Dental	Alveolar		Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal l	Epiglottal	Glottal
				Plain	Emphatic								
Stop	Plain	p b		t d			c ɟ	k g					ʔ
	Aspirate	pʰ		tʰ			cʰ ɟʰ	kʰ gʰ					
Fricative	Plain		θ ð	s z									h
	Aspirate			sʰ zʰ									

<h> indicates aspirated consonants

19 total phonemes: 6 voiced, 13 voiceless

Japanese

	LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop	p b			t d				k g				
Fricative				s z								h

9 total phonemes: 4 voiced, 5 voiceless

Korean

		LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
		Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop	Laxed	p			t			c	k				
	Aspirated	p ^h			t ^h			c ^h	k ^h				
	Tensed	p ^ˀ			t ^ˀ			c ^ˀ	k ^ˀ				
Fricative	Laxed				s								
	Tensed				s ^ˀ								h

^h indicates aspirated consonants. <ˀ> indicates tensed consonants.

15 total phonemes: 0 voiced, 15 voiceless

Malay (Austronesian)

		LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
		Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop		p b			t d			c ɟ	k g				ʔ
Fricative					s								h

11 total phonemes: 4 voiced, 7 voiceless

Mandarin Chinese (Sino-Tibetan)

		LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
		Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop	Unaspirated	p			t				k				
	Aspirated	p ^h			t ^h				k ^h				
Affricate	Unaspirated				ts		tʂ	tɕ					
	Aspirated				ts ^h		tʂ ^h	tɕ ^h					
Fricative		f		s		ʂ	ɕ		x				

^h indicates aspirated consonants.

17 total phonemes: 0 voiced, 17 voiceless

Tamil (Dravidian)

		LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
		Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop		p b		t̪	t d		ʈ ɖ	c ɟ	k g				
Fricative		f					ʂ z	ɕ					h

^h indicates aspirated consonants. <̪> indicates aspirated consonants.

16 total phonemes: 6 voiced, 10 voiceless

Turkish (Uralic)

	LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop	p b			t d			c ɟ	k g				
Fricative		f v		s z	ʃ ʒ							h

15 total phonemes: 7 voiced, 8 voiceless

Vietnamese (Mon-Khmer)

	LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epiglottal	Glottal
Stop	p b			t _h d		tʂ~t	c~tɕ	k				
Fricative		f v		s z		ʂ z~ʐ	ç~j	x ɣ				h

<h> indicates aspirated consonants. <A~B> indicates A being the pronunciation syllable initially, and B being the pronunciation syllable finally, but counted as one when determining the number of voiced and voiceless phonemes.

18 total phonemes: 7 voiced, 11 voiceless

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