Phonemic Distinction between Vowels and Glides in Sinvaudjan Paiwan*

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ABSTRACT

This paper shows that it is necessary to posit a phonemic distinction between the high vowels /i u/ and the glides /j w/ in Sinvaudjan Paiwan, although the latter are usually taken to be alternants of the former in phonological theory, conditioned by syllabic or metrical position. I provide evidence in support of this distinction and offer a unified account which is in accord with the established evidence from stress and morphophonemic alternations. The contrast between the vowels and glides is reflected in the segments' moraic status and the internal structure of syllables, including the syllabic affiliation and distribution of phonemic vowels and glides. The confusion made by surface glides is also explained: phonemic glides, which are true consonants, pattern with consonants, whereas derived glides, which come from vowels, are mostly vowel-like.

Key words : vowel/glide distinction, derived glide, stress, syllabification, Austronesian language, Paiwan

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1. Introduction

The status of the segment type “glide” has long been a hotly debated issue in phonological theory. Glides are highly similar to vowels phonetically, and thus whether one is distinct from the other at the phonemic level has drawn much attention. Some scholars treat glides as allophones of vowels (Steriade 1984; Levin 1985; Rosenthall 1994; among others) while others argue that underlying glides are phonemically independent of vowels (Hume 1995; Levi 2004, 2008; Padgett 2008; among others).[1] In Paiwan, an Austronesian language spoken in the mountain area of southern Taiwan, similar segment sequences involving surface glides show conflicting patterns. Some words with [CVG] (Consonant-Vowel-Glide) in word-final position receive default penultimate stress (e.g. [kú.ʌaw] ‘to roast’), but others do not (e.g. [ʃi.káw] ‘net-bag’). When preceding a vowel-initial suffix, some stem-final surface glides are clearly resyllabified as onsets (e.g. [ma.ku.ʌa.**w**á.ŋa] ‘has already roasted’), while other are not (e.g. [san.ʃi.ka**w.w**á.ŋa] ‘already made net-bags’). This asymmetry in the behavior of surface glides strongly suggests the need for a phonemic contrast between vowels /i u/ and glides /j w/. Thus, some surface glides are phonemic (true) glides and others come from underlying vowels. This paper not only provides new evidence in favor of the existence of the vowel/glide distinction in Paiwan, but also offers an analysis that accounts for previously mentioned data. The perplexing nature of surface glides can therefore be attributed to this underlying contrast. Additionally, this study delineates the predictions regarding Paiwan syllable structure made by such a contrast.

Ho (1977) first proposes the necessity of a vowel/glide contrast in Paiwan based on stress and morphophonemic alternations as shown in (1a) and (1b), respectively, but without explaining some key details and issues related to this contrast. This paper offers syllabification and reduplication data as new evidence in favor of the contrast, and further analyzes relevant patterns including the data in Ho (1977). With a different perspective on the syllable, the established data regarding stress and morphophonemic alternations is reexamined and accounted for.[2] The different patterns resulting from the two types of surface glides (phonemic and derived glides) will be clarified, and the behavior of

1. It is important that whether a vowel/glide distinction is needed depends on the phonological behaviors of those segments of the specific language.
2. This paper probes into the patterns based on the author’s first-hand data gathered from speakers in the Sinvaudjan village, who differ from Ho’s (1977) in terms of both generation and communalect.

phonemic vowels and glides, together with the syllable structure of Paiwan, will be elaborated on. (The triangular brackets < > refer to infixes, such as *-əm-*/*-ən-* 'Agent voice' or *-in-* 'perfective/Patient voice'.)

(1) Ho's data supporting the V/G contrast

a.	[kái]	'language'	[kúkaj]	'swing'	(Ho 1977:599)
b.	s<əm>ənaw	'wash'	sənav-i	'wash (IMP)'	(Ho 1977:613)

This paper is organized as follows. Section 2 introduces the Paiwan language and previous studies' views of vowels and glides. In Section 3, new evidence from syllabification and reduplication which supports the V/G contrast is presented and discussed. Section 4 reexamines the evidence favoring the need for such contrast from a different viewpoint, specifically taking into account morphophonemic alternations and stress, and displays relevant patterns. This paper emphasizes the phonological evidence for the vowel/glide distinction, but it also provides a brief Optimality-Theoretic analysis regarding stress, which involves vowel clusters and their resolution. Section 5 seeks a formal representation of phonemic vowels and glides, and explains the complex nature of surface glides in Sinvaudjan Paiwan. Section 6 concludes.

2. A Sketch of Paiwan and its Glides

2.1 The Paiwan language

Paiwan is spoken in the southernmost mountain areas of Taiwan, mainly in the Pingtung (屏東) and Taitung (臺東) counties. The data in this paper is based on synchronic data from Sinvaudjan Paiwan, which is a communalect of Paiwan spoken in the Mudan village (牡丹村) (known as Sinvaudjan [ʃin.váw.ɟan] in the Paiwan language) of the Mudan township (牡丹鄉) in Pingtung county (屏東縣). Its phoneme inventory is comprised of 23 consonants,[3] as shown in (2), in addition to the four vowels /i u ə a/.

3. Pharyngeal /h/, which occurs only in loanwords, is not listed in this inventory.

(2) Phoneme inventory of Sinvaudjan Paiwan

	Bilabial	Alveolar	Retroflex	Palatal	Velar	Uvular	Glottal
Stop	p b	t d	ɖ	c ɟ	k g	q	ʔ[4]
Fricative	v	s z				ʀ	
Affricate		t͡s					
Nasal	m	n			ŋ		
Liquid			ɭ	ʎ			
Glide	w			j			

2.2 Discussions of the vowel/glide distinction

The reasons for establishing a phonemic contrast between vowels and glides in Paiwan can be detailed in terms of the theoretical debates regarding whether glides are distinct from phonemic vowels in various languages. Previous studies of Paiwan have centered on other aspects, such as documentation, general grammar or morpho-syntax (Chang 1992, 1998, 1999, 2000, 2006; Chen and Ma 1986; Early and Whitehorn 2003; Egli 1990, 2002; Ferrell 1982, Hua and Zeitoun 2005; C. L. Li 2004; Lin 1992; Ogawa 1930; Ogawa and Asai 1935; Sung 2005; Tang 2002a, 2002b, 2004; Tang et al. 1998; Wang 2004; Wu 2004; among others). In comparison, studies spotlighting Paiwan phonology (Chen 2006, 2009a, 2009b; Ho 1977, 1978, 1995; Tseng 2003) are few, and most of them made a phonemic distinction between vowels and glides without further explanation. Ho (1977) first points out the need for discriminating the vowels /i u/ from the glides /j w/ based on stress and morphophonemic alternations.[5] In concordance with Ho (1977), other studies of Paiwan (Ferrell 1982; Chen and Ma 1986; Egli 1990; Chang 2000, 2006; Tseng 2003; Chen 2006, 2009a, 2009b; among others) posit a phonemic contrast between vowels and glides, though without elaboration due to the focus of the studies. Chen (2006) points out the phonemic vowel/glide contrast, and the glide

4. In Sinvaudjan Paiwan and possibly other southern village dialects as well (such as Butanglu in Ho (1978:567)), glottal stop /ʔ/ occurs in limited word categories (e.g. personal pronouns and prefixes). The sound correspondence between /k/ in other dialects and /ʔ/ in Sinvaudjan is treated as the split of the proto-Paiwan phoneme *k conditioned by morphology (Ho 1978:575). As can be seen, /ʔ/ corresponds with /k/ (Ferrell 1982) in affixes such as *-a**ʔ**ən* 'NOM.1S' (cf. *-a**k**ən*) and ***ʔ**i-paiz* 'fan oneself ' (cf. ***k**i-paiz*); but not in content words such as ***k**əḍi* 'small' (cf. ***k**əḍi*) and *vaik* 'go' (cf. *vai**k***).

5. Ho (1977, 1978, 1995) uses /y/ to represent the palatal glide. This paper uses the IPA palatal approximant /j/ in its place.

formation process which derives some surface glides from underlying vowels; however, an illustration of the crucial phonological change and its relation to the status of surface glides is still needed. Also, Wu (2002) examines the status of glides in three Formosan languages, Tsou, Bunun, and Amis, using acoustic evidence, such as duration.[6] As will be seen, this paper elaborates on these points, showing the evidence for the vowel/glide contrast in Paiwan as well as the advantages of positing such a contrast.

In phonological theory, the segment type "glide" has long been problematic (Hyman 1985) due to its varied behavior — sometimes glides behave as vowels but sometimes as consonants. Glides are treated as alternants of vowels in many languages such as Lenakel and Kimatuumbi (Rosenthall 1994); the surface realization of an underlying vowel is either a syllabic vowel or a non-syllabic glide, as in the different realizations of /u/ in /a**u**l**u**/ → [a**w**.l**u**] 'to persuade' in Lenakel. The distribution of vowels and glides in these languages is subject to syllabic, metrical, or prosodic factors, though the details could be more complicated (see Steriade 1984; Levin 1985; Guerssel 1986; Waksler 1990; and Rosenthall 1994; among others). In these cases, only a set of vocoids (namely the high vowels /i/ and /u/) is necessary in the underlying representation. However, problems may arise in many other languages if vowels and glides are treated as the same phoneme. Hume (1995) observes the dual behavior of glides and differentiates them from vowels in terms of their syllabic status and the [±consonantal] feature. This type of phonological contrast between vowels and glides also appeals to the difference in constricted degree (Padgett 2008). Additionally, Levi (2004, 2008) mentions that one problem raised by distinguishing phonemic glides from derived glides (which are underlying vowels) is the lack of a clear phonetic difference. Therefore, she argues for the vowel/glide distinction based on language-internal data, which converges on the fact that vowels and glides are phonemically different. For example, true glides block nasal harmony but derived glides do not in Sundanese; phonemic and derived glides behave differently in terms of syllabification and alternation at morpheme boundaries in Karuk. In other words, the phonological difference between these two types of surface glides lies in their underlying difference. Following Levi, I argue for a phonemic contrast between vowels and glides on the basis of phonological evidence from Sinvaudjan Paiwan. In correlating various

6. The focus of Wu's (2002) work differs from this study in many respects. This paper argues for the need for a vowel/glide contrast, mostly in post-vocalic position, based on phonological evidence, while Wu (2002) investigates pre-vocalic glides using phonetic information. Therefore, the analysis of particular instances of these segments in this paper may not correspond exactly to the analysis of the same segments in Wu (2002), though a phonetic study on Paiwan post-vocalic glides is needed in the future.

phonological patterns with the vowel/glide distinction, this paper also clears up the confusion regarding surface glides. It is shown that some surface glides are derived from underlying vowels, while others are phonemic glides.

3. Syllabification and Reduplication as New Evidence

This study provides two phonological patterns as new evidence of the vowel/glide distinction in Paiwan: syllabification and reduplication. Though not mentioned in previous studies, syllabification and reduplication augment the evidence in Section 4, that is, morphophonemic alternations and stress. When morphophonemic alternations and stress fail to distinguish phonemic vowels from glides under certain conditions, syllabification and reduplication serve as crucial diagnostics. The new phenomena are strongly supportive of an underlying contrast between vowels and glides.

3.1 Syllabification

Every Paiwan syllable must begin with a consonant, as per the onset requirement.[7] A stem-final consonant is resyllabified as the onset of the following syllable when preceding a vowel-initial suffix, as in /sa-səkə**z**-an/ → [sa.sɨ.kə́.**z**an] 'the place to rest'. However, a glide on the surface sometimes plays the role of the onset as in (3), but sometimes spans over syllable boundaries as in (4), being a coda and an onset at the same time. The reason for this variation is made clear with the assumption that post-vocalic surface glides in word-final position have two possible sources though they are phonetically similar: either an underlying glide or an underlying vowel. An underlying glide, just like a consonant, is unsurprisingly syllabified as the onset, as in (3c) /puvaʌa**w**-aŋa/ [pu.va.ʌa.**w**á.ŋa] 'already married'. In contrast, a derived glide in the same position both remains a coda for the preceding syllable and extends to the following onset, creating an ambisyllabic or geminate segment,[8] such as (4b) /man-sika**u**-aʔən/ [man.ʃi.ka**w**.**w**á.ʔən] 'I make net-bags'. The difference between stems ending in phonemic (underlying) glides in (3) and in derived glides in (4) are clear.

7. Paiwan does have some vowel-initial words, in which the onset requirement is violated. These exceptions are noted and accounted for in Section 5.2.

8. The terms geminate and ambisyllabic glide are here used interchangeably to describe a glide that spans a syllable boundary. This paper does not imply that there exists a phonemic contrast between geminates and single segments in Paiwan.

(3) Syllabification for underlying glides

	Underlying Glides	*Phonetic form*	*Gloss*
a.	/t͡s<in>akaw-aŋa/	[tʃi.na.ka.**w**á.ŋa]	'steal (COS)'[9]
b.	/ma-kuʎaw-aŋa/	[ma.ku.ʎa.**w**á.ŋa]	'roast (COS)'
c.	/pu-vaʎaw-aŋa/	[pu.va.ʎa.**w**á.ŋa]	'marry (COS)'
d.	/pu-aʀaj-aŋa/	[pwa.ʀa.**j**á.ŋa]	'cast a net (COS)'
e.	/ma-vavuj-aŋa/	[ma.vu.**j**á.ŋa]	'crawl (COS)'
f.	/k<in>əlaj-aʔən/	[ki.nə.la.**j**á.ʔən]	'I hung.'

(4) Syllabification for derived glides

	Underlying Vowels	*Phonetic form*	*Gloss*
a.	/ʔi-pau-aw/	[ʔi.pá**w**.**w**aw]	'to pick Macaranga Tanaruis'
b.	/man-sikau-aʔən/	[man.ʃi.ka**w**.**w**á.ʔən]	'I make net-bags'
c.	/ʔi-kai-aŋa/	[ʔi.ka**j**.**j**á.ŋa]	'talk (COS)'
d.	/ma-qiu-aŋa/	[ma.qi**w**.**w**á.ŋa]	'scorched (COS)'
e.	/ma-ɟui-aʔən/	[ma.ɟu**j**.**j**á.ʔən]	'I'm stabbed'

Following the syllabification generalization above, stem-final glides are resyllabified as onsets in (3), while those in (4) instead are geminate or ambisyllabic. The contrast between (3) and (4) can be attributed to their underlying difference: phonemic glides are consonant-like but derived glides are not. Thus, without a phonemic V/G distinction, it is impossible to predict the correct syllabification after affixation.

3.2 Reduplication

Reduplication is common in Formosan languages (Zeitoun and Wu 2006; Lee 2007), such as Thao (M. Chang 1998), Amis (Lu 2003; Yeh 2003), Paiwan (Chang 2000; Tseng 2003; Lu 2003; Chen 2006), and Pazih (Li and Tsuchida 2001), Bunun (M. Yeh 2000), among others. One type of partial reduplication in Paiwan, suffixal reduplication, serves as new evidence for the existence of a phonemic contrast between /i u/ and /j w/, based on

9. The marker COS, change of situation, refers to an action which has already happened.

which segments are copied.[10]

In Paiwan, suffixal reduplication, which is a kind of root reduplication, generally copies the last two syllables of the stem minus the final consonant if one exists.[11] For coda-less words, it copies two syllables from the right edge as in (5.i), i.e. $C_1V_1C_2V_2C_3V_3$ → $C_1V_1C_2V_2C_3V_3$-$\underline{C_2V_2C_3V_3}$. (The underlined portion is the reduplicant in this analysis.) For words ending in a consonant without word-medial coda, the two syllables at the right edge are copied except for the final consonant as shown in (5.ii), i.e. $C_1V_1C_2V_2C_3V_3C_4$ → $C_1V_1C_2V_2C_3V_3$-$\underline{C_2V_2C_3V_3}$-C_4. For CVCCVC words, the final open CV and the coda of the preceding syllable are copied as in (5.iii), i.e. $C_1V_1C_2C_3V_2C_4$ → $C_1V_1C_2C_3V_2$-$\underline{C_2C_3V_2}$-C_4. The detailed analysis of this reduplication (including the final, uncopied consonant, the size of reduplicants, and the copying direction) will not be elaborated because it falls outside the scope of this paper. The crucial point is the fact that the stem-final consonant (never a stem-final vowel) is always excluded from the copying process.

(5) Suffixal reduplication in Paiwan

		Base	*Gloss*	*Reduplication*	*Gloss*
i.	a.	/kəḍi/	‘small’	/kəḍi-kəḍi/	‘somewhat small’
	b.	/v<ən>əl̪i/	‘buy’	/v<ən>əl̪i-vəl̪i/	‘be buying’
	c.	/t͡s<əm>apa/	‘dry by fire’	/t͡s<əm>apa-t͡sapa/	‘be drying’
	d.	/ʔi-tul̪u/	‘learn’	/ʔi-tul̪u-tul̪u/	‘be learning’
	e.	/t͡s<əm>əpə/	‘weave’	/t͡s<əm>əpə-t͡səpə/	‘be weaving’
	f.	/k<əm>əʎava/	‘wait for someone’	/k<əm>əʎava-ʎava/	‘be waiting’
ii.	a.	/siʎup/	‘to sip’	/si-siʎu-siʎu-p/	‘straw’
	b.	/mintul̪uq/	‘run’	/mintul̪u-tul̪u-q/	‘be running’
	c.	/t<əm>əkəl̪/	‘drink’	/t<əm>əkə-təkə-l̪/	‘be drinking’
	d.	/t͡s<əm>əvas/	‘mow’	/t͡s<əm>əva-t͡səva-s/	‘be mowing’

10. This reduplicative pattern (that is also called root, full, partial, rightward, or suffixal reduplication) is analyzed as suffixal reduplication in this paper and many others (Chang 1998; Tseng 2003; Lu 2003; Yeh 2003).

11. In terms of meaning, suffixal reduplication of noun stems denotes a facsimile, diminutive, or plurality interpretation. Reduplicated stative verbs are given an intensified meaning, while reduplicated dynamic verbs either acquire a continuity/repetition denotation, or, in the case of reciprocals, refer to the plurality of participants (Zeitoun and Wu 2006).

	e.	/qaʎəts͡əqəts͡/	‘sour’	/qaʎəts͡əqə-ts͡əqə-ts͡/	‘somewhat sour’
iii.	a.	/ʔiɭaŋda/	‘listen’	/ʔiɭaŋda-ŋda/	‘be listening’
	b.	/vaŋt͡suɭ/	‘odor’	/vaŋt͡su-ŋt͡su-ɭ/	‘somewhat stinky’
	c.	/quŋvuʎ-an/	‘dust’	/quŋvu-ŋvu-ʎ/	‘powder’
	d.	/vaŋsaʀ/	‘handsome’	/vaŋsa-ŋsa-ʀ/	‘somewhat handsome’

The non-reduplication of the stem-final consonant serves as a diagnostic to clarify the true colors of surface glides. The prediction based would be that a phonemic glide in stem-final position should not participate in the process, while a derived glide, which is underlyingly a vowel, should be part of the reduplicant. As expected, the surface glides (in bold-face) in (6a-g) are excluded from the reduplicative process, but those in (6h-k) are copied.

(6) Reduplication and the vowel/glide difference

	Stem	*Gloss*	*Reduplicated Form*	*Gloss*
a.	/k<əm>uʎaw/	‘roast in	/k<əm>uʎakuʎaw/	‘be roasting in
	[kə.mú.ʎaw]	fire’	[kə.mu.ʎa.kú.ʎa**w**]	fire’
b.	/kuɭavaw/	‘rat’	/k<əm>uɭavaɭavaw/	‘be gnawing’
	[ku.ɭá.va**w**]		[kə.mu.ɭa.va.ɭá.va**w**]	
c.	/t͡s<əm>akaw/	‘steal’	/t͡s<əm>akat͡sakaw/	‘be stealing’
	[t͡sɪ.má.ka**w**]		[t͡sɪ.ma.ka.t͡sá.ka**w**]	
d.	/ma-vavuj/	‘crawl’	/ma-vavuvavuj/	‘be crawling’
	[ma.vá.vu**j**]		[ma.va.vu.vá.vu**j**]	
e.	/buɭaj/	‘healthy’	/buɭabuɭaj/	‘very healthy’
	[bú.ɭa**j**]		[bu.ɭa.bú.ɭa**j**]	
f.	/kuŋaj/	‘dirty’	/kuŋakuŋaj/	‘somewhat
	[kú.ŋa**j**]		[ku.ŋa.kú.ŋa**j**]	dirty’
g.	/ɟuaj/	‘sticky’	/ɟuaɟuaj/	‘glutinous rice’
	[ɟwá**j**]		[ɟwa.ɟwá**j**]	
h.	/kai/	‘language’	/ʀu-kaikai/	‘talkative’
	[káj]		[ʀu.kaj.ká**j**]	
i.	/sikau/	‘net-bag’	/man-sikaukau/	‘be making net-
	[ʃi.káw]		[man.ʃi.kaw.ká**w**]	bag’

j.	/ɟui/	‘thorn’	/ʀu-ɟuiɟui/	‘thorny’
	[ɟúj]		[ʀu.ɟuj.ɟú**j**]	
k.	/qau/	‘bamboo’	/pu-qauqau-an/	‘the place of
	[qáw]		[pu.qaw.qá**w**.wan]	piling bamboos’

Although the words in (6) end in [(C)VG] on the surface, the asymmetry in their behavior suggests an underlying contrast between /i u/ and /j w/. Take (6g) /ɟuaj/ ‘sticky’ as an example; it is comprised of an initial consonant, a following vowel cluster, and a final underlying glide. This final underlying /j/ is excluded from copying, while the rest of the syllable, /ɟua/, is copied. The reduplicated form, /ɟuaɟuaj/, further undergoes glide formation, becoming [ɟwa.ɟwáj], and the final heavy syllable [ɟw$_{\mu}$a$_{\mu}$.(ɟw$_{\mu}$á$_{\mu}$j)] attracts stress. The following section shows that aside from syllabification and reduplication, the patterns of morphophonemic alternations and stress reinforce the necessity of a distinction between /i u/ and /j w/.

4. Reexamining Morphophonemic Alternations and Stress

This paper provides a unified account for the phonological phenomena regarding surface glides, reexamining morphophonemic alternations and stress in support of the need for a V/G distinction. Ho (1977, 1978) mentions morphophonemic alternations and stress as evidence. This paper is different from Ho’s (1977) analysis in assuming a stricter onset requirement, whereas Ho permits syllables without onsets on the surface. The essential discrepancy between this analysis and that of Ho, and the advantages of the former, is illustrated first. Then I explicate the recurrent dissimilarities between /i u/ and /j w/ in terms of morphophonemic alternations and stress respectively, along with a detailed analysis which captures the phonological interactions. Ho’s (1977) analysis, which allows some VV sequences, is then compared with the one proposed here.

4.1 The interpretation of the present data

The major difference between Ho (1977) and this study lies in the assumptions regarding syllables, which directly influence the analysis of other patterns. Because the treatment of syllable onsets in Ho’s and this analysis is not the same; what an underlying

VV may surface as also differs.[12] Ho allows certain non-identical vowel clusters /V_xV_y/ to surface with hiatus: falling sonority sequences (e.g. /a i/) are heterosyllabic, whereas rising sonority sequences (e.g. /i a/) are separated by homorganic glide insertion.[13] In other words, onset-less syllables are legitimate. A similar view can be found in Ferrell (1982), who also treats /VV/ as heterosyllabic on the surface. In this study, vowel clusters are analyzed as being compelled by the onset requirement[14] to be changed into tautosyllabic diphthongs: non-identical vowel clusters (e.g. /ai, ua, iu/) are mended by glide formation, while identical vowel sequences (e.g. /ii, uu, aa/) are modified by coalescence. Along these lines, words such as /Cau/ and /Cua/ would surface as [Caw] and [Cwa] in this study, but [Ca.u] and [Cu.wa] in Ho's (1977). The former is not an unusual analysis: similar to this study, Egli (1990:9) points out that /a i/ and /a u/ are like diphthongs in a shared syllable, rather than monophthongs in two distinct syllables. A recent work on Paiwan (Chen 2006) also seems to correspond with the analysis in this paper, pointing out that glide formation compels underlying VV to become a diphthong.

There are persuasive reasons in support of such an interpretation of the treatment of underlying hiatus: i) the onset requirement, and ii) the correlation between the syllable and the pitch implied by stress. First, the onset requirement, which is operative in this analysis, is straightforwardly present in Paiwan. It is observed applying across morphemes and phrases (as liaison) in which a vowel-initial morpheme drags a preceding consonant, if one exists, to fill the onset. This analysis generally does not allow for syllables without onsets (such as [Ca.**u**]), though onset-less syllables in word-initial position do exist, as detailed in Section 5.2.)

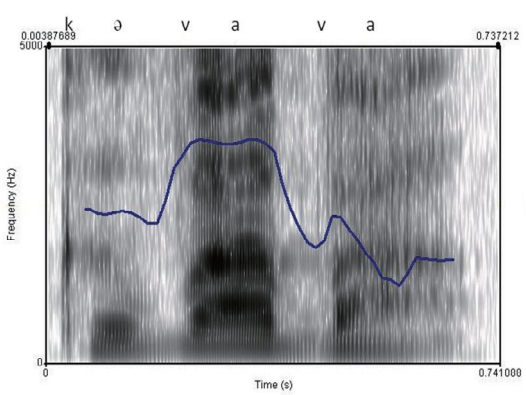
Second, this study relies on the correlation between syllable boundaries and pitch indicated by stress in a spectrogram to imply the syllabification of vowel clusters. Before moving on to this point, we first note the difficulty in distinguishing glides from vowels in Paiwan. Glides can differ from vowels in at least two ways, as summarized in Padgett

12. The difference could also be due to differences in speaker dialects and generations. Ho (1977) works on the Butanglu communalect of the 1970s, whereas this paper examines Sinvaudjan in the 2000s. Both of these communalects are treated as being part of the southern village group of Paiwan, and have great similarities.
13. Ho (1977, 1978) allows a range of vowel clusters (e.g. /au ai iu ui ii uu aa/). Ho (1977:606) also mentions that phonologically identical vowel clusters /ii, uu, aa/ exist, but only [ii] and [uu] are observed at the phonetic level.
14. The onset requirement is motivated by two main factors, among others: first, most syllables in Paiwan contains an onset based on examination of the data. Second, ease of perception (Côté 2000; Flemming 2005) makes syllables beginning with consonants (rather than vowels) more common cross-linguistically.

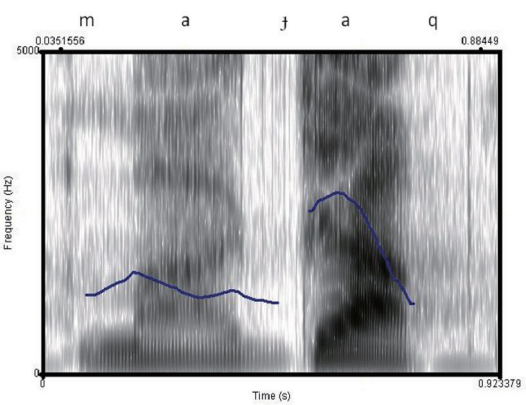
(2008): they can differ in i) dynamics, such as fast/slow formant transitions or changing/steady state, and ii) constriction degree, such as less/more intense formants, or no/possible frication.[15] However in Paiwan, the [aw] deriving from /au/ and the [aw] from /aw/ are both changing state: it is hard to separate the transitions from the preceding low vowel. Therefore it is not possible to distinguish glides from vowels by simply looking at the phonetic information. Because of the correlation between the phonetic cues with stress in words in which the syllabification is clear, we assume that /VV/ is tautosyllabic. As indicated by Chen (2009b), pitch is an important correlate of stress in Piuma Paiwan.[16] The same is true in Sinvaudjan Paiwan. When stress falls on a word-final syllable that is either a ($\acute{\sigma}_{\mu\mu}$) derived from an underlying VV or a monosyllabic stem such as *k<əm>án* 'eat (AV)' or *ma-ɟáq* 'have menses (AV)', the final syllable is realized with a steep falling pitch. Otherwise, stress is penultimate ($\acute{\sigma}_{\mu}\sigma_{\mu}$), and conveyed by high level pitch followed by a gentle fall. Based on the pattern of pitch in words in which the syllabification is clear, the final heavy syllable ([$CV_{\mu}G_{\mu}$] or [$CG_{\mu}V_{\mu}$]), which receives a steep falling pitch, is better considered tautosyllabic rather than heterosyllabic. As shown in (7), (a) /kəvava/ [kə.vá.va] 'wine' obtains penultimate stress. In terms of tone shapes, [va] in (a) has high tone, and that of the second [va] in (a) corresponds to a gentle fall. In contrast, (b) /maɟaq/ [ma.ɟáq] 'have menses' gets final stress, and [ɟaq] correlates to a steeply falling pitch.

(7) Pitch difference in words with penultimate and final stress

a. [kə.vá.va]



b. [ma.ɟáq]

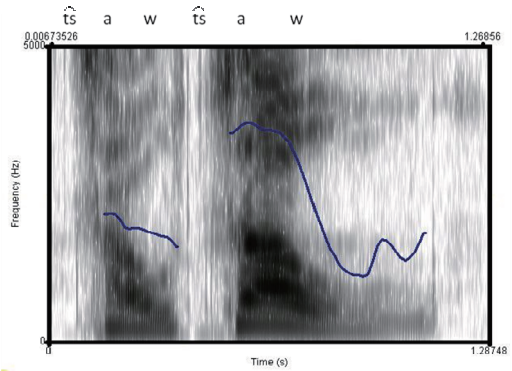


15. Descriptions may focus on the difference in either dynamics (Catford 1988) or constriction degree (Ladefoged and Maddieson 1996).
16. Piuma Paiwan is spoken in the communalect in Pinghe village (平和村), Taiwu Township (泰武鄉), Pingtung County (屏東縣). Apart from Sinvaudjan, the author does fieldwork in this village, too.

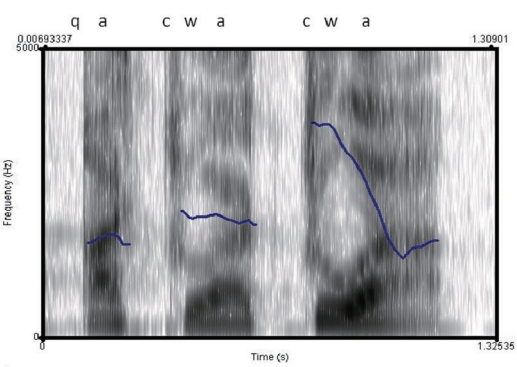
Regarding the crucial case in (8), (a) /t͡sau̯t͡sau/ [t͡saw.t͡sáw] 'human' and (b) /qacuacua/ [qa.cwa.cwá] 'sprout' obtain final stress because of the final diphthong. The pitch shape of the second [t͡sáw] in (8a) and that of the second [cwa] in (8b) correlate to a steeply falling pitch which implies that [t͡sáw] or [cwá] itself constitutes a single syllable.

(8) Pitch in words with final diphthong

a. [t͡saw.t͡sáw]



b. [qa.cwa.cwá]



If an underlying VV surfaces as heterosyllabic, the expected pitch form of (8) would be a high plateau on /t͡sa/ and a following gentle fall on /u/ in the word / t͡sau̯t͡sau / [t͡saw.t͡sáw]; but this contour is not observed. Therefore, underlying VV in this paper is considered tautosyllabic on the surface based on the correspondence between the syllable and the pitch contours that mark stress. A vowel sequence like /Cau/ thus becomes a diphthong [Caw] and receives falling pitch, rather than two separate syllables with a high pitch on the penultimate syllable [Ca] in [Ca.u].[17]

4.2 Morphophonemic alternations in Sinvaudjan Paiwan

Morphophonemic alternations in which the stem-final segment undergoes phonological changes after suffixation are common in Formosan languages (Li 1974), and Paiwan is no exception (Ho 1977; Ferrell 1982; Chang 2000, 2006; Chen 2006, 2009a). This subsection displays a clear distinction between /w/, /u/, and /v/ after suffixation, and points out the similarities between /w/ and /u/ in post-vocalic word-final position. Ho's (1977:612-4) analysis of a similar morphophonemic alternation is then examined, and the

17. The term 'diphthong' is used in this paper to refer to a syllable comprised of two moras. Thus a sequence consisting of a vowel plus a true glide has only one mora, and is not considered a diphthong.

data reanalyzed.

In Sinvaudjan Paiwan, the stem-final glide /w/ becomes a voiced labiodental fricative /v/ when preceding a vowel-initial monosyllabic suffix (Ho 1995:310), as shown in (9).[18] For example, in (9a) the stem-final *w* in [vadi**w**] 'mushroom' surfaces as [w] when unsuffixed, but as *v* in the suffixed form [ʔivadi**v**an] ('the place where mushroom are picked').

(9) *w*~*v* alternations

	Stem	*Gloss*	*With Suffixation*	*Gloss*
a.	/vadiw/	'mushroom'	/ʔi-vadiw-an/	'places where mushrooms
	[vá.diw]		[ʔi.va.ɗi.**v**an]	are picked'
b.	/k<əm>uʌaw/	'roast in	/kuʌaw-u/	'roast in coals (IMP)'
	[kə.mú.ʌaw]	coals'	[ku.ʌá.**v**u]	
c.	/t͡s<əm>akaw/	'steal'	/t͡sakaw-ən/	'steal (PV)'
	[t͡sɪ.má.kaw]		[t͡sa.ká.**v**ən]	
d.	/guʌaʌaw/	'dog-louse'	/ʔi-guʌaʌaw-i/	'to louse (IMP)'
	[gu.ʌá.ʌaw]		[ʔi.gu.ʌa.ʌá.vi]	

Thus, stem-final /w/ alternates with /v/ before vowel-initial suffixes. However, it is logically possible that the opposite could be the case, that is, for *v* to become *w* in word-final position but remain *v* elsewhere. This idea is soon discarded when we examine the data in (10): word-final *v* does not change after suffixation. Therefore, it is apparent that the stem-final /w/ becomes /v/ after suffixation, rather than the other way around.[19]

(10) /v/-final stem

	Stem	*Gloss*	*Suffixation*	*Gloss*
a.	/taqəv/	'daughter/son-in-	/pu-taqəv-i/	'have daughter/ son-in-
	[tá.qəv]	law'	[pu.ta.qɘ́.vi]	law (IMP)'

18. Ho (1995:310) specifically points out that monosyllabic suffixes trigger the alternations. Therefore, the disyllabic suffixes *-aʔən* (NOM.1S) and *-aŋa* (COS) will not activate the alternations, as can be seen in (3) and (4).

19. It is interesting to note that the stem-final /w/ in Sinvaudjan corresponds to /v/ in Piuma and several Paiwan dialects of the Central and Northern villages, such as *kasiw* vs. *kasiv* 'tree' and *t͡siqaw* vs. *t͡siqav* 'fish' (Ho 1978; Ferrell 1982; Chang 2000; Chen 2006, 2009a).

b.	/t͡saqəv/	‘to open’	/ʔu-sut͡saqəv-aj/	‘I’ll open for you
	[t͡sá.qəv]		[ʔu.su.t͡sa.qə́.vaj]	(SUBJ)’
c.	/ʔi-t͡sauv/	‘cover (oneself)’	/si-t͡sauv-an/	‘blanket’
	[ʔi. t͡sawv]		[ʃi.t͡sáw.van]	
d.	/pa-qədəv/	‘to take aim’	/pa-qədəv-an/	‘a target’
	[pa.qə́.dəv]		[pa.qə.də́.van]	
e.	/pa-kaiv/	‘to give supper’	/kaiv-ən/	‘an evening meal’
	[pa.kájv]		[káj.vən]	
f.	/q<əm>aqiv/	‘call’	/qaqiv-u/	‘call (IMP.)’
	[qə.má.qiv]		[qa.qí.vu]	

Phonemic glides and derived glides behave differently despite their phonetic similarity, in post-vocalic word-final position, with the *w*~*v* alternation only applying to underlying true glides. In contrast, a surface glide [w] which comes from /u/ remains intact under the same conditions, as seen in (11): the final derived [w] does not surface as [v] when preceding a monosyllabic vowel-initial suffix.

(11)

	Stem	*Gloss*	*Suffixation*	*Gloss*
a.	/sikau/	‘net-bag’	/san-sikau-i/	‘Let’s make net-bags
	[ʃi.ká**w**]		[san.ʃi.ká**w.w**i]	(IMP)’
b.	/qau/	‘bamboo’	/ʔa-qau-an/	‘Bambusa vulgaris’
	[qá**w**]		[ʔa.qá**w.w**an]	

This data answers the important question of why instances of the glides [w] such as those in (9b) [kuʌa**w**] and (11a) [ʃika**w**] have similar form but behave differently: they come from two distinct underlying phonemes. More specifically, the segments which undergo morphophonemic alternations are true glides in both the underlying and surface representations, while those which do not are phonemic vowels in the guise of surface glides. This distinction raises the question of why underlying vowels change into glides. The answer is that the onset requirement compels vowel clusters to be repaired to avoid creating onset-less syllables. One of the vowels therefore surfaces as a glide and forms a diphthong with the nearby vowel to evade onset-less syllables, e.g. /CVV/ → [CVG]. Thus, glide formation repairs vowel clusters, but as a result blurs the distinctions between

/w/ and /u/ on the surface, as in the boldfaced portion of [ʃik**aw**] (←/sikau/) and [kuʌ**aw**] (←/kuʌaw/).

The morphophonemic alternation between /w/ and /v/ has been noticed by many researchers (Ho 1977, 1978; Ferrell 1982; Chang 2000, 2006; Chen 2006, 2009a). However, a similar alternation of word-final /j/ before the *-i* suffix, as shown in (12), is only mentioned by Ho (1977), who posits that stem-final /j/ in (12a) is deleted when preceding the imperative suffix *–i*, while stem-final /i/ is retained in (12b) in the same environment (Ho 1977:612-3). Note that Ho (1977:605) allows adjacent high vowels in different syllables, e.g. /ɟui/ [ɟu.i] 'thorn'; therefore identical high vowel sequences are considered heterosyllabic.[20] The contrast between stem-final /i/ and /j/ is shown.

(12) j~∅ alternation (Ho 1977:612-3)[21]

	Present	*Imperative -u*	*Imperative -i*	*Gloss*
a.	qulivalivaj	pa-ʔa-qulivaj-u	pa-ʔa-qulivai (*pa-ʔa-qulivai-i)	'to yellow'
	ɟ-im-ilaj	ɟilaj-u	ɟilai (*ɟilai-i)	'to spit'
	k-əm-alaɖaj	kalaɖaj-u	kalaɖai (*kalaɖai-i)	'to carry'
b.	k-əm-ali	kali-u	kali-i (*kali)	'to dig'
	ɖ-əm-asi	ɖasi-u	ɖasi-i (*ɖasi)	'to sun'
	ma-cani	ʔa-cani-u	ʔa-cani-i (*ʔa-cani)	'to fall'

In contrast to Ho (1977), the analysis in this paper takes the onset requirement to be a more stringent obligation. For example, my transcription of the words in (13) slightly differs from Ho's of the same words given in (12): in (13), coalescence combines the two identical segments into a heavy syllable attracting stress to the ultima, e.g. /kali-i/ [ka.ɭí] (*[ká.ɭi], *[ka.ɭí.i]).[22] A consequence of this difference in analysis is that there is no need to posit a morphophonemic alternation between *j* and *Ø*: a stem-final /j/ is simply

20. Ho (1977:612-613) notes that the identical high vowel clusters /i i/ and /u u/ occur only when suffixing the imperative markers -i and -u. Moreover, the high vowel clusters may vary with a single vowel, e.g. /i i/→[i.i] or [i], which in this study is analyzed as the result of coalescence.

21. The data in (11) is copied from Ho (1977) without any modification. According to his descriptions, the data after *-i* suffixation in (11a) is the phonetic representation; that is, /pa-ʔa-qulivaj-i/ → paʔaqulivaji → [pa.ʔa.qu.li.vá.i].

22. Not mentioned in this paper, *kali-i* is analyzed as ka$_{\mu}$.(lí$_{\mu\,\mu}$), in which the bimoraic heavy syllable in word-final attracts stress based on the rule that stress falls on ($\acute{\sigma}_{\mu}\sigma_{\mu}$) or ($\acute{\sigma}_{\mu\,\mu}$) syllable.

syllabified as an onset when preceding the *-i* suffix to form a [ji] sequence in our analysis, which is disallowed in Ho (1977:613). Furthermore, here a stem-final /i/ and the suffix *-i* combine to form a single segment in order to avoid a vowel cluster. The coalesced heavy /i/ drags stress to the final syllable, as shown in (13b).

(13) The difference between glide /j/ and vowel /i/

	Agent Voice	*With imperative -i*	*Gloss*
a.	/ɟ<əm>ilaj/	/ɟilaj-i/	'to spit'
	[ɟə.mí.l̪aj]	[ɟi.l̪á.ji]	
	/k<əm>alaɖaj/	/kalaɖaj-i/	'to carry'
	[kə.ma.l̪á.ɖaj]	[ka.l̪a.ɖá.ji]	
b.	/k<əm>ali/	/kali-i/	'to dig'
	[kə.má.l̪i]	[ka.l̪í]	
	/ɖ<əm>asi/	/ɖasi-i/	'to sun'
	[ɖə.má.ʃi]	[ɖa.ʃí]	

Thus, not only do morphophonemic alternations between /w/ and /v/ in contrast with stem-final /u/ suggest the need for an underlying V/G distinction, but so does the behavioral difference between /j/ and /i/ in the same position. According to this analysis, a stem-final /i/ followed by an /i/-initial suffix undergoes coalescence, forming a word-final heavy syllable that attracts stress, while a stem-final glide /j/ is syllabified as the onset of the following syllable, just like other consonants in Paiwan. In contrast, Ho (1977, 1978) permits heterosyllabic vowel clusters (except /ua/ and /ia/) but is forced to posit a deletion rule especially to account for the supposed deletion of /j/ before the *-i* suffix. Thus, while Ho's analysis requires the addition of a special rule, the analysis presented in this paper captures the behavioral difference between /j/ and /i/ under *i*-suffixation using syllabic and metrical constraints that are already necessary to account for other phonological patterns in Paiwan.

4.3 Stress

Stress in Sinvaudjan Paiwan is predictable given the correct distinction between underlying vowels and glides. The interaction between stress and glide formation is explained to show the necessity of positing a V/G contrast. Section 4.3.1 illustrates how

vowel clusters are repaired, and the relationship between the resulting syllable form and stress. The presence of contrastive stress on the surface strongly suggests the need for an underlying V/G distinction. Section 4.3.2 provides an OT analysis of these patterns. In Section 4.3.3 I compare this approach to Ho's (1977) analysis.

4.3.1 Vowel clusters, heavy syllables, and stress

In Sinvaudjan Paiwan, vowel clusters with non-identical vowels are modified by glide formation.[23] This process creates a heavy syllable, which attracts stress when standing in word-final position. This interaction between glide formation and stress is observed not only at morpheme boundaries, but also within morphemes, as detailed below.

In glide formation, the less sonorous vowel in a heterorganic VV sequence changes into a homorganic glide on the surface, creating a diphthongized syllable, as shown in (14). Thus a high vowel surfaces as a glide if the adjacent vowel is a low vowel, e.g. /Cau/ → [Caw] or /Cua/ → [Cwa].[24] In a non-identical high-vowel sequence, either vowel could turn into a glide (e.g. /Cui/ → [Cwi] or [Cuj]).[25] The choice between [Cwi] and [Cuj] makes no difference phonologically since both vowels are assumed to be moraic and affiliated to the nucleus. Notice that the imperative suffixes *-i* (inclusive) and *-u* (exclusive) and the locative marker *-an* do not attract stress to the ultima.

(14) Glide formation in Sinvaudjan Paiwan

	Stem	*Phonetic form*	*Gloss*		*Suffixed Form*	*Phonetic form*	*Gloss*
a.	/kəvava/	[kə.vá.va]	'drink wine'	a'.	/kəvava-i/	[kə.va.váj]	'drink wine (IMP)'
b.	/pikuɭa/	[pi.kú.ɭa]	'wash feet'	b'.	/pikuɭa-u/	[pi.ku.ɭáw]	'wash feet (IMP)'
c.	/kəma͡tsu/	[kə.má.͡tsu]	'carry'	c'.	/ka͡tsu-i/	[ka.͡tsúj]	'carry (IMP)'
d.	/puɖu/	[pú.ɖu]	'sore'	d'.	/pinuɖu-an/	[pi.nu.ɖwán]	'have had sores'

23. The paper focuses on glide formation because it is closely related to the phonemic distinction between /i u/ and /j w/. Coalescence, which is the other strategy used in repairing identical VV, is not elaborated on due to its irrelevance to this issue.
24. According to the sonority hierarchy (Prince and Smolensky 1993), low vowels have higher sonority so that the hierarchy is *a* > *i*, *u*. High vowels easily become glides when preceding or following a low vowel /a/. The schwa /ə/, though part of the Paiwan phoneme inventory, is omitted here because it seldom occurs in vowel clusters.
25. Either [Cwi] or [Cuj] is observed. For the sake of consistency, this paper assumes that it is the second which becomes a glide, e.g. /Cui/ → [Cuj] and /Ciu/ → [Ciw].

e.	/vaʌi/	[vá.ʌi]	‘board’	e’.	/vaʌi-u/	[va.ʌíw]	‘plank (IMP)’
f.	/vuʀasi/	[vu.ʀá.ʃi]	‘sweet-potato’	f’.	/pu-vuʀasi-an/	[pu.vu.ʀa.ʃján]	‘sweet-potato fields’
g.	/təmaɭəm/	[tə.má.ɭəm]	‘plant’	g’.	/taɭəm-u/	[ta.ɭə́.mu]	‘plant (IMP)’
h.	/ʔi-qənəc/	[ʔi.qə́.nəc]	‘look’	h’.	/qənəc-i/	[qə.nə́.ci]	‘look (IMP)’
i.	/ʌavək/	[ʌá.vək]	‘sea’	i’.	/ʌəmavək-an/	[ʌə.ma.və́.kan]	‘along the sea’

As we see in examples (14g’-i’), words get penultimate stress after suffixation when no /VV/ is involved. On the other hand, words with underlying vowel sequences, as in (14a’-f ’), receive final stress.[26] The correct placement of stress is thus dependent on the assumption that a vowel does not shed its mora when changing to a glide.[27] The final syllables in (14a’-f ’) in the shape of CVG(C) or CGV(C) thus each carry two moras, making them heavy. Stress is then attracted to the final heavy syllable because Paiwan forbids a heavy syllable from standing in the non-head position of a foot.

The interaction between glide formation and stress is also found in non-affixed forms: though identical on the surface, the word-final glides in (15.i) are phonemic, non-moraic glides, while those in (15.ii) are derived from underlying vowels via glide formation. Stress consequently falls on the penultimate syllable of the word in (15.i), e.g. /quʌaw/ → [(qú$_{\mu}$.ʌa$_{\mu}$w)], but on the final syllable—which has a second mora from the underlying vowel and is therefore heavy—of those in (15.ii), such as /sikau/ → [ʃi$_{\mu}$.(ká$_{\mu}$ w$_{\mu}$)]. To correctly predict stress assignment, making a distinction between phonemic vowels and glides is therefore indispensible.

(15) Stress and vowel/glide distinction

	Phonemic	*Gloss*		*Phonemic*	*Gloss*
	i.		ii.		
a.	/k<əm>uʌaw/ [kə.mú.ʌaw]	‘roast in coals’	a.	/sika**u**/ [ʃi.káw]	‘net-bag’
b.	/quʌa**w**/	‘color’	b.	/ʔi-qa**u**/	‘pick bamboo’

26. Glide formation as a repair for VV clusters is described not only in Paiwan (Chen 2006:71-72, 75), but also in other Formosan languages such as Takituduh Bunun (Huang 2002), Isbukun Bunun (Huang 2006), and Squliq Atayal (Huang 2006). Furthermore, how glide formation interacts with stress is also characterized by Huang (2008) for Isbukun Bunun and by Tseng (2009) for Thao.

27. This analysis implies that underlying vowels do not lost their moraicity even when they do not surface as the most prominent segment within a syllable. But like other consonants, underlying glides are non-moraic.

	[qú.ʎaw]			[ʔi.qáw]	
c.	/kuɭava**w**/	‘rat’	c.	/ʔi-t͡sa**u**v/	‘cover (oneself)’
	[ku.ɭá.vaw]			[ʔi.t͡sáwv]	
d.	/ŋaɟa**j**/	‘saliva’	d.	/ʔi-pa**i**z/	‘fan (v.)’
	[ŋá.ɟaj]			[ʔi.pájz]	
e.	/mat͡sa**j**/	‘dead’	e.	/ʀu-kai-ka**i**/	‘talkative’
	[má.t͡saj]			[ʀu.kaj.káj]	
f.	/sapu**j**/	‘fire’	f.	/ɟ<əm>u**i**/	‘stab’
	[sá.puj]			[ɟə.mújˌ]	
g.	/kasi**w**/	‘tree’	g.	/ma-qi**u**/	‘scorched’
	[ká.ʃiw]			[maqîw]	

It might also be noted that the words in (15.ii) can be further decomposed into a monosyllabic root (surface [CVG(C)] from underlying /CVV(C)/) plus a prefix/infix, such as /si-kau/ in which /kau/ is considered the root. For this subset of the data, stress falls on the only syllable of the root, namely the ultima, even though the full word contains more than one syllable. If the data is analyzed in this way, it is possible to disregard the V/G distinction. Nevertheless, the data in (15.ii) patterns in parallel to that in (14a’-f ’), wherein stress is attracted to the final heavy syllable formed at the morpheme boundary. It would be inelegant to give two explanations for essentially the same pattern by saying that final stress is due to vowel clusters in (14a’-f ’) but lexical assignment in (15.i). But with an underlying vowel/glide contrast, the fact that stress falls on the final syllable in both (14a’-f ’) and (15.ii) is explained on the grounds that both undergo glide formation, resulting in a heavy syllable that attract stress in word-final position. Thus differing stress patterns on the same surface segmental sequences as shown in (15) reflect the need for a contrast between phonemic high vowels /i u/ and glides /j w/ in Sinvaudjan Paiwan.

If the same data is approached from a rule-based perspective, the analysis would be that stress falls on the final syllable because penultimate stress is assigned after syllabification and before glide formation, as shown in (16). The generalization that stress falls on the penultimate syllable holds at an intermediate level in derivations.

(16) A rule-based analysis

a. Rules:

i. Stress assignment: stress the penultimate syllable

ii. Glide formation: [V, +high, αplace] → [-syllabic] / { ____ [V, -αplace] ; [V, -αplace] ____ }

b. Derivations:

	/ta⌊əm-u/	/ku⌊avaw/	/piku⌊a-u/
Syllabification	ta.⌊ə.mu	ku.⌊a.vaw	pi.ku.⌊a.u
Stress	ta.⌊ə́.mu	ku.⌊á.vaw	pi.ku.⌊á.u
Glide formation	-----	-----	pi.ku.⌊áw
	[ta.⌊ə́.mu]	[ku.⌊á.vaw]	[pi.ku.⌊áw]

The next section outlines a constraint-based analysis of the data and shows that it better captures the interaction between glide formation, syllabification and stress, though a rule-based analysis also deals with the patterns.

4.3.2 An OT analysis

Stress in Sinvaudjan Paiwan interacts with vowel clusters and their repairs. The crucial force in this interaction is the Weight-to-Stress Principle (WSP), which disallows heavy syllables in a prosodically weak position (Prince 1983, 1990; Prince and Smolensky 1993), prohibiting forms with final heavy syllables from receiving penultimate stress.

Regular penultimate stress (Ho 1977; Ferrell 1982; Chang 2000; Chen 2006, 2009b), as shown in (17), is analyzed as the result of parsing a disyllabic foot, which is also bimoraic, from the right edge of the prosodic word, e.g. $_{\text{PrWd}}[\sigma_{\mu}\sigma_{\mu}(\acute{\sigma}_{\mu}\sigma_{\mu})]$. This pattern reflects the high ranking of FTTYPE and ALL-FT-RIGHT. The consequence is that only one foot is parsed in the prosodic word in Paiwan.

(17) General penultimate stress in Paiwan

a.	[cú.ʎa]	‘eel’	e.	[váŋ.saʀ]	‘handsome’
b.	[qá.did]	‘bitter’	f.	[sa.ví.ki]	‘betel nut’
c.	[pá.naq]	‘bow & arrow’	g.	[t͡sa.⌊í.ŋa]	‘ear’
d.	[ŋú.ɟus]	‘nose’	h.	[qə.ʀə́.pus]	‘cloud, fog’

However, marked final stress emerges under some circumstances. One of the factors focused on here is the creation of heavy syllables by glide formation, which modifies onset-

less syllables.[28] As shown in (14) and (15.ii) above, glide formation modifies VV, creating a bimoraic heavy syllable, which is disallowed in the non-head position of a foot. In this OT analysis, the pressure to avoid onset-less syllables comes from ranking ONSET over V-NUC, which penalizes the change from a vowel to a glide. WSP is undominated, ruling out unstressed word-final heavy syllables.[29] These constraints are defined in (18).

(18) a. WSP: Heavy syllables must stand in foot-head position.
b. FTTYPE=TROCHAIC: feet have initial prominence.
c. ALL-FT-RIGHT: Every foot stands at the right edge of the prosodic word.
d. FT-BIN: Feet are binary under syllabic or moraic analysis.
e. ONSET: Syllables must have onsets.
f. V-NUCLEUS (V-NUC): Every [-consonantal] segment must be associated to the nucleus without sharing it with other elements. (Huang 2008:12)

In combing syllabic and metrical constraints, the tableaux illustrate the interaction between stress assignment and the repair of onset-less syllables. In tableau (19), V-NUC is unviolated since both outputs are well-formed in terms of syllable structure. Therefore, candidate (a) with penultimate stress wins by satisfying all the constraints listed in (18). Candidate (b) is ruled out because it parses a monosyllabic foot, incurring a violation of FT-BIN.

(19)

/saviki/	ALL-FT-R	FTTYPE	WSP	ONSET	FT-BIN	V-NUC
a. ☞ $sa_{\mu}.(v\acute{i}_{\mu}.ki_{\mu})$						
b. $sa_{\mu}.vi_{\mu}.(k\acute{i}_{\mu})$					*!	

28. Other conditions under which final stress surfaces in Sinvaudjan Paiwan are (i) monosyllabic words and (ii) stressless prefixes/infixes: as prefixes/infixes cannot carry stress, a disyllabic word consisting of a prefix plus a monosyllabic root obtain the marked final stress.

29. A similar case is observed in Isbukun Bunun (Huang 2008): Huang shows the interaction between stress and syllable in which stress is attracted to the ultima after glide formation or coalescence repairs a VV. The major difference between Bunun and Paiwan is that all surface glides derive from underlying vowels in Bunun while glides contrast with vowels in Paiwan.

The ranking expresses that words with a final heavy syllable never obtains penultimate stress. In (20), candidate (a) is optimal, with stress assigned to the word-final heavy syllable, even though the non-correspondence of the final segment between the input and output violates V-NUC. Candidate (b) forms a disyllabic foot, but because the heavy syllable is not stressed, a fatal violation of WSP is incurred. Candidate (c) satisfies all the stress-related constraints, but violates undominated ONSET by having an onset-less syllable. The conditions in which penultimate and marked final stress could occur are shown in the correlation between metrical and syllabic constraints.

(20)

/kəvava-i/	ALL-FT-R	FTTYPE	WSP	ONSET	FT-BIN	V-NUC
a. ☞kə$_{\mu}$.va$_{\mu}$.(vá$_{\mu}$j$_{\mu}$)						*
b. kə$_{\mu}$.(vá$_{\mu}$.va$_{\mu}$j$_{\mu}$)			*!			
c. kə$_{\mu}$.va$_{\mu}$.(vá$_{\mu}$.i$_{\mu}$)				*!		

This analysis has two advantages. First, it clearly captures the interaction between stress and glide formation as a repair for vowel clusters. The occurrence of marked final stress is due to the combination of undominated WSP and the formation of a final heavy syllable via glide formation. Second, the prevalent foot forms in Paiwan are trochaic (**Ĺ**L) or (**H́**), conforming to the foot types in languages.[30] This pattern also implies that Paiwan stress is sensitive to a moraic contrast between light (mono-moraic) and heavy (bimoraic) syllables: thus it can parse either (σ́$_{\mu}$σ$_{\mu}$) or (σ́$_{\mu\mu}$) at the rightmost word-edge, resulting in an apparent stress shift between the penultimate and final syllable. In terms of stress, V differs from VG or GV, as long as the glide in [V$_{\mu}$G$_{\mu}$] and [G$_{\mu}$V$_{\mu}$] comes from underlying vowels; otherwise, V patterns together with VG when the glide is underlyingly consonantal.

4.3.3 Comparison to Ho's analysis

Though Ho (1977) and this paper both use stress as evidence for a phonemic

30. Aside from (**Ĺ**L) and (**H́**), the predicted foot forms also include (**H́**L), as in /paisu/ [páj.su] 'coin', though this form is less common. A mono-moraic foot (**Ĺ**) as in /vat/ [vát] 'rice', which is predicted to be forbidden, does sometimes occur in Paiwan in order satisfy the minimal word requirement. In contrast, a disyllabic foot such as (**H́**H) is never found because it would violate WSP.

distinction between vowels and glides, the analyses differ with regard to syllabification. First, Ho (1977:605) allows vowel clusters with falling sonority /au ai/ or equal sonority /iu ui/ to surface intact, leaving them adjacent but heterosyllabic. For VV sequences with rising sonority /ua ia/, he posits a glide insertion rule that inserts a homorganic glide [j] or [w] between the high vowel and a following low vowel (e.g. /quaj/ → [qu.**w**aj] 'rattan').[31] Thus vowel clusters always remain heterosyllabic, with or without an inserted glide depending on contexts, so there is no need for glide formation in his analysis.[32] The words /kəvava-i/ and /pinuɖu-an/ would surface as [kə.va.vá.i] and [pi.nu.ɖú.**w**an], in which stress would regularly fall on the penultimate syllable from Ho's point of view. The same would apply in the words in (21a). Ho accounts for stress in (21b) by stating that these words' final segments are phonemic glides.

(21) Vowel/glide contrast and stress (Ho 1977:599)

a.	[kái]	'language'	b.	[kúkaj]	'swing'
	[šikáu]	'net'		[t͡sɨmákaw]	'steal'

Ho offers a possible alternative analysis that dispenses with the underlying V/G contrast using the glide formation rule in (22). However, if [j] and [w] in (21b) are derived by the rule in (22), stress must be lexical in these forms (e.g. (21b) /t͡səmákau/ → [t͡sɨ.má.kaw] in contrast with (21a) /sikáu/ → [ši.ká.u]). Thus, this possibility is quickly rejected by Ho.

(22) [u, i] → [w, j] / V́(C)V___# (Ho 1977:599)

There, given the principles that (i) stress is always penultimate and (ii) underlying vowel clusters always surface as heterosyllabic, the stress patterns in (21) suggest the need for an underlying distinction between high vowels and glides in Ho (1977).

The analysis proposed in this study gives a different account for the facts, but one

31. The glide insertion rule is also described in other previous studies (Chang 2000, 2006; Chen 2006). In fact, we do observe the glide insertion rule in the Sinvaudjan dialect, but only in careful or slow speech. The data presented in this paper are from a more casual or commonly used speech style, in which glide formation can easily be found. The presence of glide formation in fast speech and glide insertion in slow speech is not unique to Paiwan; similar cases can be found in languages such as Korean (Kang 1999).

32. Ho allows clusters of identical high vowels but not low vowels in phonetic forms (Ho 1977:608,610-611). He also mentions that *uu* alternates with *u* in the imperative (Ho 1977:612).

that still demonstrates the need for a vowel/glide contrast: glide formation repairs non-identical vowel clusters and results in a heavy syllable, which must be stressed. Because of this, final stress occurs in words with final heavy syllables, despite the fact that stress is generally penultimate. Thus, the phonemic vowel/glide contrast is reflected in stress assignment: a stressed final [CVG]/[CGV] syllable is derived from an underlying [CVV], while an unstressed final [CVG] syllable must contain a phonemic glide.

In summary, morphophonemic alternations, reduplication, stress, and syllabification all converge on the need for a phonemic vowel/glide contrast. This paper offers an integrated analysis of all the observed phenomena via this distinction, and in doing so explains the inconsistencies in the behavior of surface glides.

5. Discussions on Phonemic Versus Derived Glides

Now that extensive evidence has been presented supporting the need for a phonemic contrast between /i u/ and /j w/ in Sinvaudjan Paiwan, the theoretical question remains: what are the positions of derived versus phonemic glides within a syllable? This section first explains the importance of the new evidence, and then illustrates the syllabic position of vowels and glides and explains how their structural affiliation influences their differing distributions. Finally, the shape of the canonical syllable in Paiwan is considered, and the existence of word-initial onsets is discussed.

5.1 The importance of the new evidence – syllabification and reduplication

The evidence from syllabification and reduplication introduced in Section 3 serves as a useful diagnostic for phonemic versus derived glides, especially when morphophonemic alternations and stress are unable to distinguish them under some conditions. For example, the word for ‘give’, is transcribed /pavai/ ‘give’, with a final underlying vowel cluster but a surface vowel-glide sequence, with final stress: [pa.váj]. However, syllabification under suffixation and reduplication both suggest that the final syllable of this word should actually be an onset /v/ along with a low vowel /a/ followed by a true glide /j/ (rather than a vowel /i/), as shown in (23a.i). As mentioned in Section 3.1, a stem-final, post-vocalic true glide is resyllabified as an onset, while a derived glide spans the syllable boundary when preceding a vowel-initial suffix. In (23a.ii), /j/ is resyllabified to the next syllable, unlike the underlying vowel in (23b.ii). Also, Section 3.2 has shown that reduplication excludes a stem-final consonant (including true glides) from copying, and

while the post-vocalic true glide is excluded from copying in (23a.iii), the phonemic vowel is not in (23b.iii).

(23)

		Glide-final	*Phonetic*	*Gloss*
Word	a.i	/pavaj/	[pa.váj]	‘give’
Syllabification	a.ii	/pavaj-aŋa/	[pa.va.já.ŋa]	
Reduplication	a.iii	/pavavaj/	[pa.va.váj]	
		Vowel-final	*Phonetic*	*Gloss*
Word	b.i	/ʔikai/	[ʔi.káj]	‘talk’
Syllabification	b.ii	/ʔikai-aŋa/	[ʔi.kaj.já.ŋa]	
Reduplication	b.iii	/ʔikaikai/	[ʔi.kaj.káj]	

This leaves us with the problem of how to deal with the final stress in [pa.váj] ‘give’ if it does not end in an underlying vowel. Recall that though stress is generally penultimate, it avoids prefixes and infixes. Thus words comprised of a prefix/infix and a monosyllabic root, surface with final stress even though the prosodic word as a whole contains two syllables. The syllable /vaj/ can be treated as a monosyllabic root and /pa/ in /pavaj/ as a prefix. Therefore stress falls on the final syllable to avoid a stressed prefix. In contrast, (23b.i) /kai/ [káj] ‘language (n.)’ itself is a bimoraic stem, and gets final stress due to WSP.

(24) Reduplication of monosyllabic root

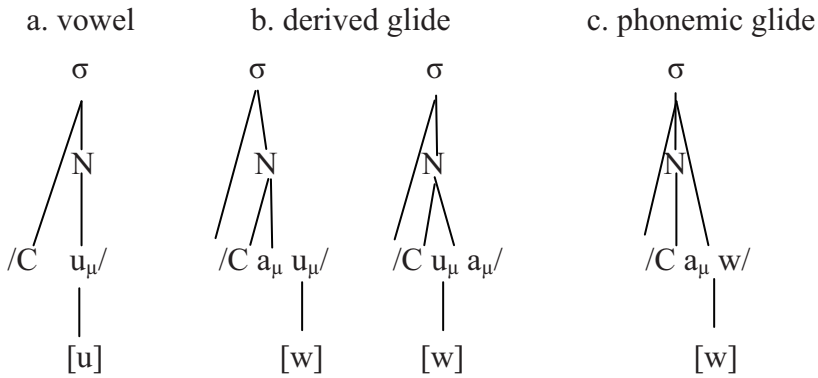
	Root	*Gloss*	*Reduplication*	*Gloss*
a.	/kan/ [kán]	‘to eat’	/ma-kakan/ [ma.ka.kán]	‘(animals) eat/bite each other’
b.	/su͡ts/ [sú͡ts]	‘net-bag’	/s-əm-usu͡ts/ [sə.mu.sú͡ts]	‘is binding the net-bag’

As for the reduplicated form, it is apparent that /pavaj/ does not pattern like /ʔikai/ but rather is parallel to the monosyllabic (and also monomoraic) words in (24): the root-final consonant is excluded and the remaining CV segments are copied. This comparison suggests that /pavaj/ is better treated as a word ending in a true glide /j/. Thus the new evidence provided in this paper from syllabification and reduplication is instrumental in differentiating vowels from glides.

5.2 Syllabic positions and syllable structure

In the internal structure of a Paiwan syllable, underlying vowels are assumed to affiliate to the nucleus node regardless of their surface form (whether a vowel or a derived glide), and every segment dominated by the nucleus node carries a mora. In contrast, underlying glides always occupy syllable margins and are non-moraic, just like other consonants. The syllabic positions of vowels, derived glides and phonemic glides are illustrated in (25).[33]

(25)



As can be seen in (25a) and (25c), both a single vowel and sequences of a single vowel followed by a phonemic glide surface unchanged, as they violate no constraint. Underlying vowel clusters like those in (25b) are repaired by glide formation, in which the less sonorous vowel changes into a surface glide.

This syllable-internal structure also predicts the distributions of derived and phonemic glides. Derived glides can occur both before and after the syllable peak, as in (26a-b) and (26c-d), respectively. However, underlying glides can only follow the syllable peak, as in (26e-f), as we assume that Paiwan disallows complex syllable margins, including onset consonant clusters and coda consonant clusters. In this way, a true glide following an onset and preceding the nucleus, as in *C**G**V$_{\mu}$C, is easily ruled out, as is a phonemic glide occurring after the nucleus with a following consonantal coda, as in *CV$_{\mu}$**G**C. Supporting evidence for the latter comes from the fact that we do not observe such syllable form in final position unless it also receives final stress (e.g. *CV́$_{\mu}$.CV$_{\mu}$GC).

33. Notice that it makes no difference whether a phonemic glide links to the syllable node or the upper prosodic node at present; the only crucial point is that phonemic glides are outside of the nucleus node.

The maximal syllable form is thus /CVVC/, in which the nucleus surfaces as either [C**G**$_{\mu}$**V**$_{\mu}$C] or [C**V**$_{\mu}$**G**$_{\mu}$C].[34] Consequently, derived glides freely occur before or after the syllable peak, as in (26d) /qatia/ [qa$_{\mu}$.t**j**$_{\mu}$á$_{\mu}$] 'salt' and (26b) /ʔi-paiz/ [ʔi$_{\mu}$.pá$_{\mu}$**j**$_{\mu}$z] 'fan', but like consonants, underlying glides are confined to post-vocalic (or coda) positions and have no influence on stress assignment.

(26) Distributions of derived and phonemic glides

		Derived Glides	*Gloss*		*Underlying Glides*	*Gloss*
Post-vocalic	a.	/sikau/ [ʃi.káw]	'net-bag'	e.	/quʌaw/ [qú.ʌaw]	'color'
	b.	/ʔi-paiz/ [ʔi.pájz]	'fan(AV)'	f.	/ŋaɟaj/ [ŋá.ɟaj]	'saliva'
Pre-vocalic	c.	/ma-guat/ [ma.gwát]	'hoarse(AV)'		(unattested)	
	d.	/qatia/ [qa.tjá]	'salt'			

A surface glide seldom occupies the position of syllable onset, with the exception of a few Japanese loanwords, such as [wara] 'dried rice-straw' and [jasi] 'coconut' (Ferrell 1982:357). This scarcity of onset glides is here attributed to a phonotactic restriction on phonemic glides, the Sonority Dispersion Principle (SDP) which disfavors them as onsets except in loanwords. The SSP requires a rise in sonority from the onset toward the nucleus, and a fall from the nucleus to the coda (Steriade 1982; Selkirk 1984). As the sonority distance between a glide and a nucleus vowel is minimal, glides are generally dispreferred as onsets. However, a few native words with onset glides can be found, such as [ʔi-**j**á**j**a] 'pick (fruits/vegetables)' or [páj.**w**an] 'Paiwan'. These cases are analyzed here as phonemic onset glides,[35] showing that while SDP is a strong tendency, it is violable. In this way, a CV containing a glide onset and a vowel is still in accord with the syllable

34. The maximal syllable in Paiwan posited in Chen (2009:205) is of the shape CVVC, in which the vowels are linked to the nucleus node and the nucleus plus the final C constitutes a rhyme node. The difference in this study is that the post-nucleus consonant is directly associated to the syllable node or the higher prosodic node, rather than falling under the rhyme node.

35. In [ʔi.jája] 'pick', the surface glide is not considered to be an underlying vowel because the high vowel in a suffixed-induced /aia/ sequence does not surface as a syllable onset, but an ambisyllabic glide.

structure requirements of Sinvaudjan Paiwan.

Although phonemic glides do exist as syllable onsets, some onset glides are apparently derived from underlying vowels, when there is no consonant available: when many vowels line up next to each other at the phrasal level, such as /u a u a/ in (27), and there is no consonant to fill the onset positions, an underlying vowel (marked in boldface) must become a surface onset glide to meet the onset requirement, and as a result of its re-association to a position external to the nucleus, loses its mora.

(27)

	Phonemic forms and gloss	*Phonetic forms*
a.	/ɖaɖua-**u** a qacuvi/. meddle-IMP NOM snake '(Go) meddle with the snake!'	[ɖa.ɖwa.**w**a.qa.cú.vi]
b.	/lua-**u** a su-s<in>itavaʌ/. make.space-IMP NOM 2S.GEN-planted.seedlings 'Widely space your planted seedlings!'	[l̩wa.**w**á.su si.ni.tá.vaʌ]

This discussion regarding onset glides leads to another question: do vowel-initial words actually exist in Sinvaudjan Paiwan? If ONSET is so far undominanted, an onset-less syllable could never surface intact. However, several words are indeed underlyingly vowel-initial, as shown in (28).

(28) Vowel-initial words in Sinvaudjan Paiwan

a.	/iku/	'tail'	e.	/uquʌ/	'back'	i.	/aʌu/	'sugar'
b.	/ini/	'no'	f.	/uɟuj/	'masculine name'	j.	/aʌis/	'tooth'
c.	/ita/	'one'	g.	/umaq/	'lair'	k.	/aŋaʌ/	'mouth'
d.	/idaj/	'hundred'	h.	/umuq/	'pus'	l.	/ada/	'onion'

In citation form, the onset-less syllable surfaces unchanged in word-initial position.[36] The addition of a new constraint requiring input-output correspondence of word-edges is needed, to allow for ONSET to be violated word-initially only. The constraint ANCHORING-L expresses this motivation by saying that the element standing at the left

36. Sometime a glottal stop is found in word-initial position though the consultants deny the existence of the phonetic glottal stop. For some times, [ji] and [wu], which seems to be a longer version of [i] and [u], occurs, especially when the consultants intend to emphasize the word-initial vowel.

periphery of the input must have a correspondent at the left periphery of the output. This approach is similar to that used in the case of Axininca Campa (McCarthy and Prince 1993), in which consonant epenthesis, which otherwise repairs onset-less syllables, fails to apply word-initially because it is dispreferred to alter word edges by insertion. Such an analysis allows for correct predictions regarding underlying word-initial onset-less syllables, as well as still fitting in with the central proposal of this paper with regard to the need for a phonemic distinction between glides and vowels.

6. Concluding Remarks

This paper has argued for the necessity of a phonemic distinction between vowels and glides by providing new evidence, and offering a unified analysis for relevant patterns in Sinvaudjan Paiwan. More importantly, this paper has clarified the apparently inconsistent surface behavior of true glides versus derived glides, and posits a structure for the syllable in Paiwan. New evidence from syllabification and reduplication was presented in Section 3 to reinforce the legitimacy of the claim. A reanalysis of stress and morphophonemic alternations in Section 4 has also supported the claim for the phonemic distinction. Finally, section 5 demonstrated the implications of such a distinction on the behavior of surface glides, their syllabic affiliation, moraicity, and phonotactic distribution. Furthermore, the data has implications for phonological theory, as it supports the argument put forth by Levi (2004, 2008) and subsequent researchers (i.e., Padgett 2008) that some languages do need a phonemic vowel/glide contrast, in opposition to the view that all glides are derived from underlying vowels (Levin 1985; Rosenthall 1994).

In the analysis presented here, the distinctions between derived and underlying glides in various positions were explained. First, a phonemic /w/ alternates with /v/ while followed by a vowel-initial monosyllabic suffix, while derived [w] do not. Second, a final [VG] sequence derived from underlying /VV/ attracts stress to the ultima because of its bimoraicity, while the monomoraic combination of an underlying glide following a vowel does not attract stress. Third, a stem-final phonemic glide is resyllabified as an onset when followed by a vowel-initial suffix, while a derived glide geminates or is ambisyllabic. Finally, suffixal reduplication excludes phonemic glides along with all other stem-final consonants, but not derived glides. These patterns are summarized in (29).

(29) Underlying vowels and glides at final post-peak positions

Situations	underlying vowels: /sikau/ ‘net-bag’	underlying glides: /kuʃaw/ ‘to roast in fire’
a. Word-finally	derived glides: (11a) [ʃika**w**]	no change
b. Before a suffix	no morphophonemic change	/w/ becomes /v/: (9b) [ku.ʃa.**v**-u]
c. Stress	final syllable: (15.ii.a) [ʃi.káw]	penultimate syllable: (15.i.a) [kə.mú.ʃaw]
d. Syllabification	become ambisyllabic: (4b) [man.ʃi.ka**w**.**w**á.ʔən])	become onsets: (3b) [ma.ku.ʃa.**w**á.ŋa]
e. Reduplication	participate in reduplication: (6i) [man.ʃi.kaw.ka**w**]	are excluded from reduplication: (6a) [kə.mu.ʃa.ku.ʃa**w**]

Thus, an underlying vowel/glide contrast is essential to a principled analysis of the seemingly disparate behavior of surface glides in Sinvaudjan Paiwan, as has been shown by both a reanalysis of old data and the presentation of new evidence from syllabification and reduplication. Such a contrast supports Levi’s (2004, 2008) view that derived glides are vowel-like while phonemic ones are consonant-like. An added complexity in the Paiwan data is that a few vowels in predictable positions—usually the onset—surface as consonant-like under more complicated circumstances.

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排灣語元音和滑音的音位對比

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摘 要

在衍生音韻學理論中，滑音常被視為元音因受制於音節或韻律規則所產生的變體，但本文提出新證據再次確立排灣語元音與滑音之間的音位對比。本文以音節劃分及重疊詞為新證據，重新分析過去文獻指出的現象，即重音分布與詞素音位交替，皆同時指出排灣語牡丹方言對於元音／滑音音位對比的需求。此研究除了提出一個全面的分析，釐清底層滑音和衍生滑音在表層形式所造成的混淆，更進一步討論元音和滑音於音節內部結構的歸屬，以及音段分布上的差異。此外，排灣語的底層滑音顯現輔音的特質，而衍生滑音則表現了元音的特性。

關鍵詞：元音滑音對比，衍生滑音，重音，音節劃分，南島語，排灣語

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