Formal and empirical issues in phonological typology*

Paul Kiparsky
Stanford University

1 Lexical representations

1.1 Problems with phonemes

Typological generalizations and universals are explicanda for linguistic theory, but they are themselves theory-dependent, for in order to be intelligible and falsifiable they must adhere to some explicit descriptive framework. This mutual dependency comes to a head at the margins of typological space, where reconciling typologies with descriptive frameworks and the analyses dictated by them can involve a labyrinth of choices. I explore a few of the tangled paths through it in the realm of syllable structure and vowel systems.

Phonological typology has been based on three distinct levels of representation: phonemic, phonetic, and morphophonemic (underlying, "systematic phonemic"). Most work on segment inventories is framed in terms of phonemic systems in the tradition of Trubetzkoy (1929, 1939), Jakobson 1958, and Greenberg (1978). A major resource is the UPSID collection of phonemic systems (Maddieson 1984, 2013, Maddieson & Precoda 1990), which has the virtue of being genetically balanced (to the extent possible), carefully vetted, and to some extent normalized to conform to a standard set of analytic principles.[1] The same resource has also been used by phoneticians to investigate the typology of speech sound inventories (Schwartz et al. 1997). Proponents of Dispersion Theory have attempted to model the UPSID vowel systems, even though the theory is strictly speaking about the phonetic realization of phonemes (maximization of perceptual distance and minimization of articulatory effort). A growing body of typology crucially relies on underlying representations (phonemes in the generative phonological sense), such as Dresher 2009 and Casali 2014. The analysis of Arrernte syllable structure that Evans & Levinson (2009: 434) cite as part of their argument that universals are "myths" is based on abstract underlying representations (section 2.1 below).

Throwing abstract morphophonemic, phonemic, and phonetic inventories in the same bin is unlikely to produce coherent typologies and universals. So what kinds of categories and representations should typologists look at? At least two criteria follow from the nature of typology

*Special thanks to Byron Bender for sharing his beautiful work on Marshallese, and to Larry Hyman for lively discussion and comments on a draft.

[1] This useful work is often somewhat misleadingly called a "database" of "sound inventories". It contains phoneme inventories, which can be at considerable remove from the primary data. Really they are theories, just as grammars are not primary data but theories of languages.

itself. We want typological categories that correlate with each other and show some historical stability. And we want the categories to be based on independently justified linguistically significant representations.

It is not obvious that the phonemic level satisfies either of these criteria. There is persuasive evidence for *some* level between abstract underlying representations and phonetics at which phonology is accessed in language use, including the classic "psychological reality" or "external evidence" diagnostics such as versification and language games, as well as language change, including sound change and phonologization, analogy, and borrowing. But phonemic theories do not converge on this level. Depending on how such fundamental issues as biuniqueness, invariance, linearity, and morphological conditioning ("grammatical prerequisites", junctures), are resolved, phonemic analyses diverge for all but the simplest textbook cases, and quite drastically for typologically challenging outlier systems of the sort I'll focus on here. For example, if we require linearity (a phoneme cannot correspond to a sequence of sounds) Kabardian has seven vowel phonemes. If we don't require linearity, but do require biuniqueness, it has three vowel phonemes; otherwise it has two. Each of these phonemic analyses is currently advocated by researchers on Kabardian (section 3.2).

I shall argue that what language users actually access, and what language change reveals, is not exactly the classical phonemic level, but the level of representations that emerges from the lexical phonology (in the sense of Lexical Phonology and Stratal OT). I'll refer to this as the level of LEXICAL REPRESENTATIONS and to its elements as L-PHONEMES. I will argue first that the classic diagnostics fit lexical representations rather than phonemic representations, where they differ, and then that the typology of syllable structure and phonological systems is best served by lexical representations. At this level phonological systems converge on significant common properties, and some important phonological near-universals turn exceptionless. The global factors of dispersion, symmetry, and naturalness, to the extent that they shape phonological systems, appear to take effect at this level.

Although I concentrate on unusual syllabification and vowel systems, these just highlight some inherent tensions between phonemics and typology that arise less conspicuously in most languages. They are due to the SPARSENESS and SEGMENTALISM of phonemic representations.

The point of phonemic representations is that they should be stripped of all predictable information. In Jakobson's words (1958 [1962]: 525): "A typology of either grammatical or phonological systems cannot be achieved without subjecting them to a logical restatement which gives the maximum economy by a strict extraction of redundancies." I'll defend the opposite view, that a specific class of redundant information is phonologically relevant,[2] and that its omission can lead typology astray – namely just that increment of information which accrues from the phonological computation in the lexical module. In particular, lexical representations include word stress, if the language has it, and word-level syllable structure, regardless of whether these things are predictable in the language, or relevant to any phonological processes in it.[3] Lexical representations include this information for principled reasons, as we'll see directly. But they exclude postlexical

[2]UPSID's convention of representing phonemes by their most frequent allophone, rather than by an invariant feature bundle, could be seen as a partial acknowledgment of this.

[3]I am thus compelled to reject the CONTRASTIVE HYPOTHESIS, according to which phonological generalizations can only refer to constrastive features (Currie-Hall 2007, Dresher 2007).

feature specifications from sandhi processes and phonetic implementation rules. In this respect lexical representations are thus more like Praguian *Wortphonologie* than like *Satzphonologie*.

Besides sparseness, a second source of trouble for structural phonemics is its segmentalist commitment (criticized in Scobbie & Stuart-Smith 2008). It requires that a multiply associated feature be associated with exactly one contrastive segment in its span. Segmentalism is implied by such concepts as minimal pairs, the commutation test, and the view of a phonemic system as an inventory of abstract contrastive segments. Structural phonemics has no place for Harris' long components, Firthian prosodies, or Goldsmith's autosegments, not even those versions of it that take distinctive features as the basic units of phonology, such as Jakobson's. OT phonology has inherited segmentalism in its descriptive practice, and formalized it in correspondence theory, but nothing about OT inherently requires it. OT is a theory of constraint interaction, not a theory of representations. Lexical representations differ from phonemic representations in that they record the full cumulative effect of the stem-level and word-level phonological computation, including any redundant features assigned in those two lexical submodules, with one-to-many association of prosodies to segmental slots where appropriate, while still excluding allophones introduced in the postlexical module and phonetic implementation. This additional information turns out to be important for phonological typology and significant universals can be formulated over representations that incorporate it.

An example will help make these points clear. Gravina (2004: 90-94) describes Moloko (Central Chadic) as having a single underlying vowel /a/, and a second vowel /ə/ which does not appear in underlying forms and is predictably inserted where syllable structure requires.[4] In addition, a word may have one of two prosodies, palatalization and labialization (notated as ^{y}, ^{w}), which color its vowels to yield six surface vowels altogether:

(1)

	No Prosody	Palatalization	Labialization
/a/	a	ɛ	ɔ
/ə/	ə	ɪ	ʊ

The prosodies spread leftward across a word, from suffix to stem and stem to prefix, but they do not cross word boundaries (e.g. (2g)).[5]

(2)

a.	/mdga/	[mədəga]	'older sibling'
b.	/matabaɬ/	[matabaɬ]	'cloud'
c.	/mababak^{y}/	[mɛbɛbɛk]	'bat'
d.	/gva^{y}/	[gɪvɛ]	'game'
e.	/gza^{w}/	[gʊzɔ]	'kidney
f.	/talalan^{w}/	[tɔlɔlɔŋ]	'chest'
g.	/na zm^{w} ɗf/	[na zʊm ɗaf] (*[nɔ]…, *…[ɗəf])	'I eat food'
h.	/aɬaɬaɗ^{y}/	[aɬɛɬɛɗ] (*[ɛɬɛɬɛɗ])	'egg'
i.	/ma-ɮr-ak^{w}/	[mɔɮʊrɔk^{w}]	'we (excl.) kicked'

[4]Moloko allows as medial codas only the most sonorous consonants, the non-nasal sonorants /r/, /l/, /w/ or /j/. Violations are eliminated by inserting /ə/.

[5]I include the labial prosodies ^{y} and ^{w} within the phonemic representation, but they are not phonemically attached to the last segment.

There are three special cases. The vowel of a pre-pausal syllable is neutralized to /a/, realized as [a], [ɛ], [ɔ] depending on the prosody, e.g. (2g)). Labialized consonants /w/ and color adjacent [a] to [ɔ], [ə] to [ʊ], and [ɛ] to [œ] (the only source of [œ]), and /j/ colors adjacent [ə] to [ɪ]. Finally, a word-initial vowel is always [a], regardless of the prosody, e.g. (2h).[6]

So how many vowel phonemes does Moloko have? Just /a/, for the epenthetic vowel is predictable, and the color prosodies are suprasegmental? Or six, since there are in principle six-way surface contrasts like CaCaC : CɛCɛC : CɔCɔC : CəCəC : CɪCɪC : CʊCʊC? The puzzle is that the epenthetic vowel is noncontrastive, therefore allophonic, but it is the bearer — in some cases the *only* bearer — of the phonologically unpredictable and contrastive prosodies, therefore phonemic.

From the Stratal OT point of view, both answers are right. In this theory of grammar, three levels of representation naturally emerge from the phonological computation: *(1)* The STEM LEVEL is the innermost layer of morphology and phonology. Its constraint system characterizes the form of simple and derived stems, and derivatively via lexicon optimization the form of the roots and affixes from which they are built, so that there is no structural difference between underlying and derived representations at this level. *(2)* The WORD LEVEL constraint system generates words, and comprises constraints that apply in the span of a word, which in Moloko includes the spread of the palatalization and labialization autosegments to eligible slots. *(3)* The POSTLEXICAL PHONOLOGY applies to phrases and sentences syntactically generated by combining words, generating PHONETIC REPRESENTATIONS, the interface to speech production and perception.

At the stem level (whose representations I'll put between braces) Moloko has one vowel segment {a} and the autosegments {^{y}} and {^{w}}, formally the feature bundles [–consonantal, –back] and [–consonantal, +back] (hence mutually incompatible and compatible only with vowels). Epenthesis and the spread of the prosodies at the word level produce a system of six vowels /a/, /ɛ/, /ɔ/, /ə/, /ɪ/, /ʊ/. Assuming the structure-insensitive local assimilation processes apply across word boundaries, they are postlexical add a seventh vowel [œ] to the repertoire. This is also where prepausal neutralization of height takes effect.

Now we have to settle a terminological matter. What shall we call the elements at the stem and word levels? The term "phoneme" is too handy to give up, but it becomes ambiguous now that we have two significant abstract levels of representation above the phonetic level, not just one as in generative phonology. Should we use it for input segments (as in Gravina 2014) or for lexical output segments, such as the six vowels of Moloko (as Gravina 2010: 153 does for the similar Mbuko language)? To avoid confusion I'll refer to the underlying elements as M-PHONEMES (morphophonemes) and to elements in lexical representations (the output of the word phonology) as L-PHONEMES, or LEXICAL PHONEMES. Phonemes in the traditional structuralist sense, not part of the proposed setup, are then S-PHONEMES.

L-phonemes are at once more concrete and more abstract than s-phonemes. As noted above, they are more concrete in that they incorporate redundant features and prosodic properties that are assigned in the lexical phonology. Consider syllable structure. Jakobson (1958) pointed out that all languages have CV syllables.[7] But in most languages syllabification is entirely predictable from the segmental chain, which means that it is not s-phonemic. At the s-phonemic level, such languages

[6]Perhaps through merger with an *a*-colored consonant inserted to satisfy ONSET.

[7]See below for a defense of Jakobson's generalization against claims that some languages have only VC(C) syllables (section 2.1) and that some languages have no syllables (section 2.2).

therefore have *no* syllables, and in particular no CV syllables. More pointedly, some languages have completely predictable and unremarkable CV syllable structure that cannot be assigned at the s-phonemic level, even redundantly, because its segmental substrate is not present there. For example, Kalam words can contain long sequences of consonant phonemes, of which all but the word-final one are automatically syllabified with an epenthetic [ɨ] (for details, see (3.1)) below), e.g. /pttt/ [ɸɨ́rɨrɨ́r] 'quivering' (Pawley & Bulmer 2011). In reality this language has a very strict syllable structure; indeed it is a textbook illustration of syllabic universals and preferences, but it violates almost all of them at the s-phonemic level, and a fortiori at the m-phonemic level.

In the face of such examples, one might consider framing syllabic typology at the phonetic level instead, where the regular syllable structure of a language such as Kalam is patent. But this is not a promising solution in general, for syllables are in general not phonetically characterizable. They are only definable over sequences of discrete phonological segments (see section 2.2 below).

Similarly, if stress falls predictably within words, it has no place in redundancy-free phonemic representations unless it plays a demarcative role at the level of the sentence. For example, if secondary stresses fall predictably on alternating syllables, they are absent from phonemic representations even if they play a role in morphophonology and selection of affix allomorphs. A consequence is that the theory and typology of stress (Hyde 2002, Alber 2005, Kager 2007, and many others) simply cannot be defined on s-phonemic or m-phonemic representations.

Conversely, l-phonemes are more abstract than s-phonemes in other respects. They do not register postlexical sentence-level processes, even when these neutralize contrasts or introduce new derived ones. In particular, the lexical form of a word is not necessarily the same as its isolation form, as we have just seen in Moloko. A better-known example is French, where final consonants, present in the output of the word level since they surface in liaison contexts, are dropped prepausally. Postlexical operations can mask word phonology with respect to syllable structure, lexical stress, and tone, to the point of altering its typological character. Ancient Greek is lexically a tone-to-stress system, while the post-lexical component is a stress-to-tone system (Blumenfeld 2004). In preclassical Sanskrit, accent is culminative at the word level: a word has one and only one pitch accent. Postlexically, as a result of deaccentuation and glide formation across word boundaries, a word may be unaccented or have more than one accent. It is the culminative accentuation in the lexical phonology that is the phonologically important property because it is driven by constraints that lie at the core of the accentual phonology. Its loss in the postlexical phonology is the extraneous result of various processes that have no intrinsic connection to each other.

How do we identify the lexical representations of a language? The bottom line is that we have to work out its phonology and morphology. But there are some diagnostic shortcuts. Let us say that a constraint is ACTIVE at a given level if it ranked in such a way that it is visible in at least some derivation, i.e. that the output would be different if it were removed entirely. A constraint that is active at the word level has the following properties: (A) Its domain includes the entire lexical word, not only stems.[8] (B) It interacts transparently with all other word-level constraints. (C) It is asymmetrically bled and fed by stem-level constraints, and hence can render them opaque. (D) It can be rendered opaque by postlexical operations, resulting in derived surface contrasts. (E) It is sensitive to word-level morphology; when words are built recursively, it applies cyclically at each

[8]Lexical words should be distinguished from postlexical words formed by syntactic processes such as cliticization, which are only subject to the postlexical phonology.

stage, which can lead to derived surface contrasts. (F) It is not sensitive to stem-level morphology. (G) Like all of lexical phonology, it operates on binary feature values rather than gradient feature values, and its phonological context is defined in terms of binary feature values. Naturally not all these properties can be positively instantiated for every case, but whichever ones can be checked in a language should yield mutually consistent results.

The properties (A)-(G) are not stipulated arbitrarily. They are consequences of the principles of Stratal OT (Kiparsky, 2000, to appear, Bermúdez-Otero 2012, 2015). (A) follows because the natural way of restricting a process to the word domain is to restrict the constraints that drive it to the word level ("level 2"). The interaction and non-interaction patterns (B)-(F) are implied by the architecture of the theory and basic OT. Binarity of feature specifications (G) is a property of the entire lexical phonology. Enhancement by new features is possible because Stratal OT has no principle of Structure Preservation, as originally adopted in Lexical Phonology, but soon abandoned in the face of a barrage of counterevidence (Harris 1987, 1990, 1991, MacMahon 1991, Borowsky 1993, Hall 1993, Martínez-Gil 1993, Kim 2001, Roca 2005). Structure-preservation in the lexical phonology was an attempt to reconstruct certain structuralist assumptions, with tenuous empirical support and no connection to the rest of the theory.[9] Finally, OT phonology has no constraints that prohibit syllabification. That is, building syllable structure does not incur faithfulness violations.[10] The empirical reason is that such faithfulness constraints would expand the factorial typology to predict nonexisting phonological systems, such as languages with arbitrary phonotactics. In particular, it would defeat the derivation of Jakobson's generalization that CV syllables are universal (Prince & Smolensky 1993).

1.2 Contrastiveness and distinctiveness

The basic concept of classical phonemics is that of phonological contrast, or opposition. A phoneme is defined as a class of non-contrasting sounds. Contrastiveness has been understood in two different ways. In American structuralism, it had to do with CONTRASTIVE DISTRIBUTION. Two sounds were held to contrast in a given phonological environment if they are neither in complementary distribution nor in free variation in that environment, i.e. if the occurrence of either of them in a given context neither excludes nor implies the occurrence of the other in that context (Bloch 1953). Functional approaches (Trubetzkoy 1939, Martinet 1964) equated contrast with phonological RELEVANCE, or DISTINCTIVENESS, the potential of distinguishing utterances as revealed by minimal or near-minimal pairs and the commutation test. In Martinet's formulation (1964: 53), the function of "phonic elements of a language" ... "is distinctive or oppositional when they contribute to the identification, at one point of the spoken chain, of one sign as opposed to all the other signs which could have figured at that point if the message has been a different one." The semiotic grounding of this view of the phoneme is apparent.

It has been clear for some time that the distributional and semiotic concepts of contrast don't converge. Two empirical insights led to this conclusion. One is that sounds which contrast in the distributional sense are sometimes perceptually indistinguishable. Labov (1994) documented the

[9] At the stem-level, on the other hand, structure-preservation is a theorem of Stratal OT, because the phonological inventory and stem structure of a language derives from its stem-level constraint system. No special structure-preservation principle is needed. Note further that with the equivalent update, rule-based Lexical Phonology can provide essentially the same kind of rich word phonology as Stratal OT.

[10] *Removing* it by syllabification and desyllabification does; this will become important below.

phenomenon of NEAR-MERGER, where speakers produce an instrumentally measurable contrast that they cannot perceive, either in the speech of other such speakers or when their own speech is played back to them. An example is the *source : sauce* opposition in some U.S. dialects (Labov 1994, ch. 12).[11] Independently of this work, it was found that contextual neutralization can be incomplete (Port & O'Dell 1985, Port & Crawford 1989, Dinnsen 1985, Piroth & Janker 2004, Kleber & Harrington 2010). For example, some German speakers pronounce underlying voiced and voiceless obstruents differently in word-final position, but not differently enough to enable hearers to distinguish them reliably. Port and his collaborators showed that German speakers can guess correctly whether a given instance of German [bunt] corresponds to /bund/ 'league' or /bunt/ 'colorful', with more than chance accuracy though far less well than a normal distinctive minimal pair. Berber speakers consistently articulate initial and final geminate voiceless stops longer than singletons, as in *ttut* 'forget him' : *ttutt* 'forget her' : *tut* 'she hit', even though this articulatory difference has no audible effect (Ridouane 2007). These are non-distinctive contrasts.

The second reason for separating contrastiveness and distinctiveness is that distributionally non-contrastive, redundant features can contribute to signaling phonemic distinctions ("the identification of signs" in Martinet's words) and are in that sense phonologically distinctive and relevant. Russian front /i/ and back /ɨ/ are allophones respectively triggered by palatalized and non-palatalized consonants. But Jakobson, Fant & Halle (1952) observed that the phonemic opposition between the consonants is more effectively cued by the vowel allophones that they condition than by the consonants themselves; in a noisy channel only the vocalic cues may be perceived. Moreover, the backness distinction between [i] and [ɨ] is phonologically relevant also in the sense that it actively participates in phonological processes. In the lexical phonology, velars are palatalized before /i/, but postlexically the direction of assimilation is reversed and velars back a following /i/ to [ɨ] like all other [+back] consonants (Rubach 2000, Padgett 2010). Russian /ɨ/ is a non-contrastive but distinctive segment.

One way of thinking of non-contrastive distinctive segments is that they ENHANCE lexical feature contrasts by redundant features, beyond what world result just from coarticulation (Stevens & Keyser 1989, Keyser & Stevens 2006). The enhancements can appear on the contrastive segments themselves or — what is more relevant here — on neighboring segments. They can be more saliently distinctive than the structurally contrastive segments they supplement, and historically more stable, often being precursors of new contrasts that arise by phonologization. Just as the realization of Russian /i/ as [i] or [ɨ] is a cue to the palatalization or velarization of the preceding consonant, English vowel quantity and its diphthongal reflexes (such as "Canadian Raising") are cues to the voicing distinction of coda consonants, Arabic vowel backing and lowering are cues to the pharyngealization ("emphasis") of consonants, etc. Such allophones have been called QUASI-PHONEMES (Ebeling 1960, Korhonen 1969, Liberman 1991, Janda 2003, Scobbie & Stuart-Smith 2008) or QUASI-CONTRASTIVE (Ladd 2006).[12]

Stratal OT separates the distributional property of contrastiveness from the perceptual/functional

[11] Such near-mergers had been reported in the earlier dialectological literature, though their significance remained unappreciated. For example, DeCamp (1958) notes near-merger of *four* and *for* in what was then old-fashioned San Francisco speech; since then replaced by complete merger.

[12] These terms have also been used to refer to contextually restricted contrasts, such as Spanish [ɾ]:[ɾ] intervocalically (Hualde 2005), or Italian [ɛ]:[e] (only stressed syllables), as well as to marginal, "fuzzy" contrasts (Scobbie & Stuart-Smith 2008). Currie-Hall 2013 sorts out these various uses.

property of distinctiveness in the following way. Contrastiveness can be characterized at the input. Phonological derivations cannot differentiate identical inputs: they can enhance, neutralize, and displace contrasts, or translate prosodic or morphological differences into segmental oppositions, but they cannot create distinctness from identity. Featural contrastiveness is characterized by the dominant faithfulness constraints at the stem level, the innermost layer of the lexicon. These determine the availability of contrasts in lexical entries, and the extent to which markedness constraints affect the shapes of morphemes and of morpheme combinations at the stem level. Complexity and redundancy are minimized at this level. The sparseness of the input representations and the invariant underlying form of morphemes presumably serve to facilitate the recognition, acquisition, and retrieval of the lexicon by making it easier to recognize morphological relationships among words.

The distinctiveness of a contrast, on the other hand, is dependent on the derivational level. At the word level, distinctiveness is characterized by the available stem-level inputs (no "freedom of analysis" here anymore!) and by the ranking of faithfulness constraints with respect to the markedness constraints at that level. The promotion of markedness constraints can optimize phonology for perception by enhancing lexical contrasts with redundant features that help the hearer identify them, or neutralize stem-level contrasts, or transpose them by a combination of contextual enhancement and neutralization of the original source of the contrast. Cyclic application or morphological conditioning can create new DERIVED feature contrasts which are not present in lexical representations, e.g. Belfast *winṇer* vs. *printer* (Wells 1982:431, Borowsky 1993, British *holey* [hɒʊ.li:] vs. *holy* [hʌʊ.li:] (Harris 1990, MacMahon 1991, Borowsky 1993). The interface between the word level and postlexical phonology is in principle analogous. Reduction and coarticulation in phonetic implementation minimizes effort in speech production at the cost of distinctiveness. Cases of near contrasts and incomplete neutralization probably arise here.

1.3 The argument from dispersion

We have seen that Moloko has one m-phonemic vowel and six l-phonemic vowels. *All* very sparse vowel systems appear to have a larger, typologically unremarkable symmetrical system of l-phonemic vowels due to the spread of vocalic features from prosodies or from adjacent consonants. The evidence will be laid out in section 3. The l-phonemic systems usually resemble the reconstructed vowel systems of the languages' earlier stages or the current ones of related or neighboring languages, which suggests that they are more stable than the m-phonemic systems. Although the additional l-phonemic vowels are predictable, they are usually at least as perceptually salient as the site of the contrastive features that trigger them, if not more so, and can be as "psychologically real" to the speakers. In such cases, the segmentalist extraction of redundancies arguably obscures the way the language works.

Dispersion Theory holds that phonological systems maximize the perceptual distinctiveness of contrasts. At the s-phonemic level, so-called vertical vowel systems don't have this property. Lindblom (1986, 1990) and Flemming (1995) propose to reconcile vertical vowel systems with Dispersion Theory by appealing to a conflicting pressure for minimally complex articulations, which is best satisfied by central vowels such as ɨ and ə (see also Padgett and Ní Chiosáin 2001, Kaplan 2011 *et al.*, among others). Factorial typology then predicts that there should be vocalic systems in which this markedness constraint dominates dispersion (MINDIST) constraints, consisting of only "minimally complex" central vowels. Such vowel inventories are however not attested

either phonetically or in the output of the lexical phonology of any language.[13] All languages exploit the major dimensions of the vowel space, including the F2 dimension by distinguishing front and back vocalic l-phonemes (including Kabardian and Marshallese, see section 4 below). What is special about so-called vertical vowel systems is that their peripheral vowels are derived in the word phonology rather than underlying; they are l-phonemes rather than m-phonemes.[14]

A more interesting class of apparent exceptions are certain Papua New Guinea languages, whose high vowels have been phonemically analyzed as underlying consonantal nonsyllabic /y/ and /w/. I argue in section 3.1 that they are underlyingly indifferent with respect to syllabicity and appear in both nuclear and marginal positions as required by the language's stringent syllable structure. When syllabification applies, all these languages have /i/ and /u/.

For lexical representations, we may therefore remove the *if*-clause from Hyman's (2008) Vocalic Universal #5, quoted in (3).

(3) A vowel system may be contrastive only for aperture only if its vowels acquire vowel color from neighboring consonants.

We replace (3) with the categorical (4).

(4) All vowel systems have distinctive color and aperture.

This means that at the level of lexical representations there are no one-dimensional vowel systems, whether vertical or horizontal. Minimal vowel systems are triangular, making use of both the front/back dimension and the high/low dimension. To this we can now add the more specific substantive generalization (5).

(5) All vowel systems have at least a low vowel and two nonlow vowels. One of the nonlow vowels is a front unrounded high vowel, the other is back.

An apparent counterexample to (4) and (5) is Qawasqar (a Fuegian language), which UPSID cites as having the phonemes /ə, o, a/. But Clairis 1977, UPSID's source, represents them as /e, o, a/, and says that /e/ has the allophones [i], [x] (devoicing?), [ɯ], [ə], [e], [æ], [a], of which [ə] is the most frequent (hence UPSID's /ə/). Clairis moreover says that [i] tends to be stable in certain words, and proposes that /i/ is a distinct phoneme in those words. If this is correct, Qawasqar has a non-minimal four-vowel system /i, e, o, a/ of a common type (as in Campa, Klamath, Malagasy, Mazatec, Nahuatl, Tacana).

[13] There are of course vertical subsystems consisting of minimally complex reduced central vowels, such as English /ɨ/ and /ə/ (*Rosa's roses*). Irish has a subsystem of three short vowels /ɯ/, /ɵ/, /a/, plus six long vowels /i:/, /ɵ:/, /u:/, /e:/, /a:/, /o:/ (Ó Siadhail 1989: 35-37). /ɯ/, /ɵ/ have back allophones [u] and [o] respectively before broad (velarized) consonants and front allophones [i] and [e] before slender (palatalized) consonants, e.g. /lʹɯm/ → [lʹum] 'with me', /lʹɯNʹ/ → [lʹiNʹ] 'with us'.

[14] Even in vertical systems, when the nonlow vowels are not colored by a consonant or prosody, they are often front rather than central. In the two-vowel system of Arrernte, the non-high vowel appears as [i] in initial position where there is no consonant to influence it, and Hale therefore set it up as /i/ (quoted in Green 2001: 35). Wichita has a three-vowel system /i/, /e/, /a/, with three degrees of length; phonetically also [o] and [u]. /i/ ranges between [i] and [e], /e/ between [ɛ] and [æ], and /a/ between low back unrounded [ɑ] and (when short) [ʌ] as in *but*, with rounding next to /w/, rarely [u] (Rood 1975, n.d.). In the variety of Kabardian described by Colarusso (1992, 2006), the vowels transcribed as [ə] and [ɨ] are actually front vowels.

1.4 The argument from symmetry and from the loss of generalization

When phonemics is integrated into a derivational morphophonemics, the divergence between contrastiveness and distinctiveness gives rise to a well-known formal problem. One of the first mentions of it in the literature occurs in Bloomfield's description of Menomini height assimilation:

> "If postconsonantal y, w, or any one of the high vowels, i, ī, u, ū, follows anywhere in the word, the vowels ē and ō are raised to ī and ū... Since ū occurs only in this alternation, it is not a full phoneme." (Bloomfield 1939: ¶35).

So, $\bar{e} \rightarrow \bar{\imath}$ in (6a) and $\bar{o} \rightarrow \bar{u}$ in (6b) are parallel, but the former is morphophonemic and the latter allophonic, since $\bar{u}$ is in complementary distribution with $\bar{o}$.

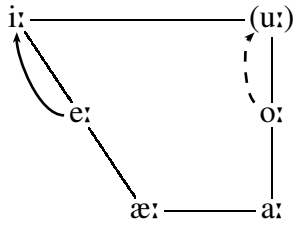
(6) a. /mayēček-waʔ/ → *mayīčekwaʔ* 'that which they eat'

b. /ātɛʔhnōhk-uwɛw/ → *ātɛʔnūhkuwɛw* 'he tells him a sacred story'.

Bloomfield called Menomini $\bar{u}$ a SEMI-PHONEME; other writers have used the term QUASI-PHONEME. We can now define these as l-phonemes which are not m-phonemes.

The phonemic level must mark the contrastive distinction between $\bar{\imath}$ and $\bar{e}$ and exclude the redundant, predictable one between $\bar{u}$ and $\bar{o}$. But if we want the derivation from morphophonemics to phonetics to pass through a phonemic level, we must split raising into a morphophonemic rule $\bar{e} \rightarrow \bar{\imath}$ (solid arrow in (7)) and an allophonic rule $\bar{o} \rightarrow \bar{u}$ (dashed arrow), although they are obviously the same process.

(7)



A formally identical English case was noted by Bloch (1941).

Although this duplication problem did not attract attention at the time, it led to a crisis in phonemic theory when it was raised by Halle (1959: 22) and Chomsky (1964) as an objection to any intermediate phonemic level (Anderson 2000). Crucially, *this problem does not arise in Stratal OT*. At any given level, the available contrasts are defined by the ranking of the relevant faithfulness and markedness constraints. Schematically, the asymmetric underlying vowel system of Menomini comes from a constraint — call it $*\bar{u}$ — that dominates IDENT(High) in the stem phonology, thereby suppressing the height contrast between $\bar{u}$ and $\bar{o}$. In the word phonology, both $*\bar{u}$ and IDENT(High) are dominated by height assimilation, whose activation brings in the new l-phoneme. In this way the grammar formally characterizes both the neutralization of the contrast between $\bar{u}$ and $\bar{o}$ in the stem phonology (which makes the height specification irrelevant in input representations), and the derived distinction between them in the word phonology.

The activation of context-sensitive markedness constraints not only enhances feature distinctions and maximizes dispersion, but creates more symmetric inventories, and maximizes feature economy in the sense of Clements (2003, 2009). Like dispersion, symmetry and feature economy are tendencies of phonological systems, not absolute requirements, but they are quantifiable and statistically verifiable, as shown for feature economy by Clements 2009, and legitimate criteria for adjudicating between different phonemic solutions. I venture the following conjectures:

(8) a. L-phoneme inventories are never less symmetrical than m-phoneme inventories.

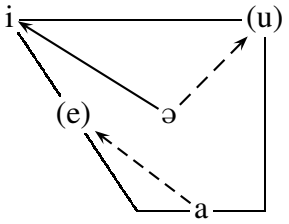
b. L-phoneme inventories are never less dispersed than m-phoneme inventories.

Jimi (another Central Chadic language) makes an instructive comparison with Moloko. It has three basic underlying vowels, {i}, {ə}, {a}, plus long {iː} and {aː} (Gravina 2010: 134-139). Unlike Moloko, it has no general vowel harmony, and its vowels are not normally affected by adjacent consonants, e.g. (9a,b,c), *except* that {ə} becomes [i], [u] after {j}, {w} or next to {ʔ^{w}}, {ʔ^{j}}, as in (9d-g), and {a} becomes [e] after {r^{j}}, {l^{j}}, as in (9h,i).

(9)	a.	{p^{w}ab^{w}-ən}	[p^{w}ab^{w}-ən]	'baobab flower'
	b.	{m^{j}əliŋ}	[m^{j}əliŋ]	'nine'
	c.	{pət^{j}ak-ən}	[pət^{j}ak-ən]	'type of antelope'
	d.	{jən-ən}	[jinən]	'head'
	e.	{wən^{j}-ən}	[wun^{j}ən]	'to sleep'
	f.	{bavəʔ^{w}-ən}	[bavuʔun]	'scar'
	g.	{ts^{j}igəʔ^{j}-ən}	[tʃi^{ŋ}giʔin]	'head (millet)'
	h.	{l^{j}am-ən}	[lemən]	'to get into a state'
	i.	{kər^{j}a-n}	[kəren]	'to bring'

Since {i} is an independent phoneme, whereas [u] and [e] are allophones occurring only in the contexts just mentioned, a split derivation would again be required to reconstruct a phonemic level. As in (7), the processes marked by dashed lines introduce new l-phonemes, increasing both symmetry and dispersion.

(10)



Unlike Menomini, Jimi does not achieve perfect symmetry. {a} is never raised to {o} due to a gap in the consonant inventory. Jimi has no labialized alveolars, so that the process that produces [e] after {r^{j}}, {l^{j}} has no corresponding labial triggers *{r^{w}}, *{l^{w}}.

1.5 The argument from diachrony: sound change, analogy, borrowing

The concept of a quasi-phoneme originated in the literature on sound change and phonologization, as part of the effort to solve the problem why allophonic distinctions sometimes remain unaffected when their conditioning environments disappear, and become phonemic instead (Ebeling 1960, Korhonen 1969, Liberman 1991, Janda 2003). The idea was that this happens when they for some reason have acquired "quasi-phonemic" status before the environment changes — in Stratal OT terms, when they have become l-phonemes by the criteria (A)-(G) in section 1.1. The allophones are already distinctive, but not yet contrastive. If sound changes are initiated postlexically (as must be assumed for many independent reasons) they do not affect lexical representations (Bermúdez-Otero 2015, Kiparsky 2015). This follows from the feed-forward relation between the strata.

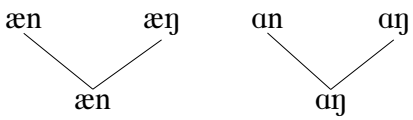
When a phonological opposition first becomes distinctive at the word level, there is no contrastive input from the stem level to realize it. If it is instantiated at all, it is not by inputs from the stem level, but by types of lexemes that don't go through the stem phonology. This is where marginal phonemes can enter the word phonology. These are of three types: *(1)* non-lexical categories, including function words and interjections, *(2)* loan vocabulary, in so far as it is unassimilated, as is independently diagnosable by the unavailability of stem-level morphology for it, and *(3)* word-level derivatives, where opacity can arise through cyclic application of phonology ("analogy"). And these are indeed exactly the contexts where new distinctions in a language first appear. The Menomini quasi-phoneme [u:] appears out of its triggering context in interjections, loanwords, and for some innovating speakers by analogical generalization from raising contexts (Bloomfield 1962: ¶1.16). In English, phonological properties of simple words are almost always retained in their word-level derivatives; e.g. the lengthened vocalic nucleus of monosyllabic words is inherited by their polysyllabic word-level derivatives (*cart, carter* vs. *Carter*). Contrasts such as *cider* [ɐɪ] vs. *spider* [ʌɪ] have emerged in some varieties of English (Scobbie 2002)[15].

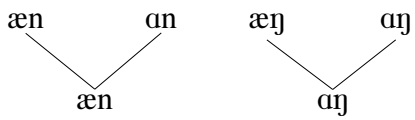
I conjecture that all phonemes arise as l-phonemes. They remain when a sound change makes their conditioning environment opaque (whereas postlexical allophones disappear), and become contrastive ("phonologized", in Praguian terms) when their distribution can no longer be predicted. This is essentially equivalent to Hyman's (1976, 2008) proposal of an automatic → extrinsic → phonemic trajectory of phonological alternations. Correspondingly, we may suppose that all mergers pass through a near-contrast stage. The phenomenon of DISPLACED CONTRAST is a combination of merger and phonologization.

Adapting loanwords involves not only approximating their pronunciation with native phonetic resources, but rendering the donor language's contrasts as best you can. In this task l-phonemes can be seen in action. Hsieh, Kenstowicz, and Mou (2009) show that Mandarin Chinese borrowers, using "reverse engineering", privilege the salient allophonic (in my terms l-phonemic) vowel distinction over the less salient phonemic distinction between the nasal codas. With only one s-phonemic low vowel /a/, pronounced [æ] before /n/, and [ɑ] before /ŋ/, Mandarin cannot express the four-way English distinction *ran* : *rang* : *Ron* : *wrong*. It chooses to map it into the available two-way distinction as in (11a), giving up the phonemic /n/ : /ŋ/ contrast in order to maintain the

[15]These are nominal exceptions to Stieber's Law, which says that allophonic features cannot spread by analogy (see Manaster-Ramer 1994). But if Stieber's Law is taken as a generalization about l-phonemes, it may well be exceptionless.

allophonic [æ] : [ɑ] contrast.

(11) (a) 

(b) 

Thus *Dan:Don* would be rendered as [dæn]:[dɑŋ], while *ban:bang* would both be [bæn]. By the criteria laid out in section 1.1, /æ/ and /ɑ/ are distinct l-phonemes in Mandarin, present in lexical representations just as /n/ and /ŋ/ are. The loan phonology privileges the front/back feature on vowels over the corresponding consonantal feature on nasal codas. Presumably the vocalic distinction is perceptually more salient than the consonantal distinction, as in the case of the Russian. Postlexical allophones are not used for such "reverse engineering" because they are not represented in the lexical phonology and unavailable for manipulation by speakers. For example, English borrowings from Chinese don't render tones by consonant voicing, although this might well produce approximations of at least some Chinese tonal contrasts.

1.6 The argument from poetic convention and language games

The artistic use of language, not just versification but also text-setting and language games, involves superimposing a second layer of constraints on already structured linguistic representations. In so far as it relates to phonology, the relevant level is obviously neither underlying representations and phonetics but somewhere in between.[16] The identity is not between s-phonemes, but l-phonemes provide the right representations, at least in many interesting cases. Here briefly are two telling examples.

The classical rules of French versification, which remained normative into the 20th century, stipulate that consonants that are deleted in word-final position count for purposes of rhyme, except that homorganic final voiced and voiceless obstruents are treated as equivalent. For example, *long* and *tronc* rhyme, but neither of them rhymes with *rond* or *pont*, which however rhyme with each other; none of them rhyme with *son*. Phonetically all five words end the same way, and traditional phonemics would reflect that: /tʁõ/ [tʁõ], /lõ/ [lõ], /mõ/ [mõ], /ʁõ/ [ʁõ], /sõ/ [sõ]. Morphophonologically they all end differently: {tronk}, {long}, {pont}, {rond}, {son} — the consonant shows up before suffixes, as in *tronquer, longue, ponter, ronde, sonner*. It is only in lexical representations that the two rhyming pairs match correctly: because of final devoicing at the word level, *long* and *tronc* both end in /-k/, and *dont* and *rond* both end in /-t/. The evidence that final devoicing of stops takes effect at the word level whereas final deletion is postlexical is that, in the classical *liaison* system (now as old-fashioned as the rhyming convention that reflects it) final voiced stops appear in devoiced form before a following vocalic word in close contact, e.g. *long hiver* [lɔ̃.ki.vɛʁ] 'long winter', *grand homme* [grɑ̃.tɔm] 'great man'. Therefore they must enter the postlexical phonology with the final consonant present but in devoiced form. In sum, traditional French versification conventions crucially refer to the lexical representation that is computed by the word phonology and forms the input to the sentence phonology:

(12) • Underlying (morphophonemic representation): {tʁonk}, {long}, {pont}, {ʁond}, {son},

[16] For example, *artificial* and *beneficial* rhyme, even though they differ underlyingly ({-s-} vs. {-t-}), and *keep* and *coop* alliterate, even though their initial consonants differ phonetically in backness.

- Lexical representation: /tʁõk/, /lõk/, /põt/, /ʁõt/, /son/
- Phonetic (and structuralist phonemic) representation: [tʁõ], [lõ], [põ], [ʁõ], [sõ]

That the rhyming conventions could outlive the 16th century pronunciation they reflect for centuries is presumably due to the fact that the living morphophonology of the language kept them intelligible.

Guimarães & Nevins 2013 used invented language games to probe whether Brazilian Portuguese nasal vowels are synchronically derived from vowel+nasal sequences, or underlying. Their experiments showed that the four nonlow nasal vowels [ĩ, ẽ, õ, ũ] are derived, whereas the low nasal vowel [ɐ̃] is an underlying segment. What accounts for this phonological difference? The phonetic difference between the plain and nasalized low vowel that G&N appeal to can hardly justify it. But there are some phonological processes, not mentioned by G&N, which show the low nasal vowel behaving differently from the nonlow nasal vowels in a way which suggests that /ã/, unlike the other nasal vowels, is an l-phoneme. Stems in {-an-} regularly contract with a following ending {-a}, e.g. *sã* [sɐ̃] 'sane' (fem.), from /san-a/ (cf. masc. *são* [sɐ̃w̃], from /san-u/). {-Vn-}stems where V is some other vowel than /a/ keep the stem form under these circumstances, e.g. *dona* [ˈdonɐ] 'lady', from /don-a/ (masc. *don* [dõ], from /don-u/), or in exceptional cases delete the nasal, e.g. *boa* [boɐ] 'good' /bon-a/ (masc. *bom* [bõ] /bon-u/). This distribution falls out if the low nasal vowel is formed at the stem level, whereas the other nasal vowels are formed postlexically.

(13) a. {san-} → /sɐ̃/ → /sɐ̃-a/ → [sɐ̃]

b. {don-} → /don-a/ → [ˈdonɐ]

2 Syllabification

2.1 Arrernte

Arrernte (an Arandic languages of Australia) has been claimed to have only VC(C) syllables (Breen & Pensalfini 1999 [B&P], Pensalfini 1998, Tabain et al. 2004). Evans & Levinson (2009: 434) cite B&P's work as "a clear demonstration that Arrernte organizes its syllables around a VC(C) structure and does not permit consonantal onsets… An initially plausible pattern turns out not to be universal after all, once the range of induction is sufficiently extended." VC(C) is indeed the most marked syllable type since it violates ONSET, NOCODA, and *COMPLEX, and contradicts the following generalizations (and a fortiori Jakobson's CV universal):

(14) a. All languages have syllables with onsets.

b. All languages have open syllables.

c. All languages that have syllables with complex codas have syllables with simple codas.

d. All languages have syllables with simple onsets.

B&P's claim that all Arrernte syllables lack onsets is about *underlying* representations. About 25% of words as actually pronounced begin with a consonant. Their analysis posits that they have an underlying initial /e-/, which is then deleted. Their claim that all Arrernte syllables are

closed is likewise about *underlying* representations. According to Henderson & Dobson (1994: 23) "nearly all Arrernte phonological words end in a central vowel, though this vowel need not be pronounced, and is often absent in sandhi when another vowel follows". H&D's transcription implies a phonemicization that is consistent with all four universals in (14). It has no underlying unpronounced initial /e-/, and posits final /-e/ where it is pronounced. (15) shows H&D's analysis in the first column, and B&P's in the second, with the actual pronunciation in the third.

(15)	B&P	H&D		
	/emp/	*mpe*	[mpɐ]	'let's go!'
	/em.eɳ/	*meɳe*	[mə́ɳə]	'food'
	/ekʷ.atʸ/	*kʷaɾtʸe*	[kʷá˞ɻ(e)]	'water'
	/inəkə/	*ineke*	[e.nə́.kə]	'let's go!'

So Arrernte's syllable structure violates (14) at most in underlying representations, and then only under B&P's analysis which posits underlying forms with initial vowels and final consonants that undergo aphaeresis and paragoge, not under H&D's analysis.[17] Let us consider the evidence for B&P analysis.

B&P's first argument for their morphophonological analysis is based on the generalization that the first syllable of a word is stressed, except if it is onsetless, in which case the second syllable is stressed. For if all words are assumed to begin with underlying V-, as in the first column of (15), stress can just be assigned to the second underlying syllable.[18] But an equally simple stress rule exploits the well-documented weakness of onsetless syllables, which causes them to be unstressable in some languages (Burzio 1994: 158, Downing 1998, Ryan 2014). Unambiguous evidence for this treatment of the Arrernte-type pattern comes from Iowa-Ota stress. In this language words are stressed on the first syllable, except if it has no onset, in which case they are stressed on the second syllable (Topintzi 2010: 58 ff., with other examples of this pattern).

(16)	a.	ˈpe.ce	'fire'
	b.	ˈhe.ro.ta	'morning'
	c.	a.ˈha.ta	'outtide'
	b.	i.ˈtʰa	'there'

Iowa-Ota has the same stress pattern as Arrernte, but it cannot be reduced to second-syllable stress by positing deleted initial vowels. Finnish secondary stress exhibits the same pattern. Four-syllable words normally get a stress on the third syllable, except if it is onsetless, e.g. *á.te.ri.a* 'meal', *kómp.pa.ni.a* '(military) company' (Karvonen 2005). KiKerewe demonstrates the prosodic defectiveness of onsetless syllables in several different ways: they are light, tonally defective, and do not induce compensatory lengthening when desyllabified (Odden 1995). Regardless of how the

[17] The same is true of the similar earlier claim about the syllable structure of the Kunjen dialects (Sommer 1970, 1981). As Sommer makes clear in the latter article, their output syllabification actually conforms to Jakobson's CV generalization.

[18] Two other ways to simplify stress have been proposed, also with strange syllable structure. Topintzi & Nevins (2014) make initial consonants in Arrernte moraic, with stress falling on the second mora, so that [mə́ɳə] is /mμə́μ.ɳəμ/ and [e.nə́.kə] is /eμ.nə́μ.kəμ/. Schwarz (2013) assigned vowels a "vocalic onset node" (≈ null onset), with other onset consonants being excluded by *COMPLEXONSET.

unstressability of onsetless syllables is modeled,[19] it undermines the argument for abstract /V-/ in Arrernte.

The second argument adduced by B&P for VC(C) syllabification in Arrernte is based on the plural/reciprocal suffix. After a stem with an odd number of syllables, the suffix is *-err* or *-errirr*. After a stem with an even number of syllables, the suffix is *-irr*. Stems of more than one syllable can also have the optional allomorph *-ewarr*. The syllable count comes out right if an initial vowel is posited in words that begin with consonants, so that (17a) begins in /e̱ṯ-/ and (17c) begins in /ek^{w}ern/.[20]

(17)	a.	ṯ-**érr**(irr)	'poke'
	b.	aṯ-**érr**(irr)	'grind'
	c.	k^{w}érn-**irr**, k^{w}érn-**ewàrr**	'swallow'
	d.	ak^{w}érn-**irr**, ak^{w}érn-**ewàrr**	'insert'
	e.	al^{w}árerrn-**èrr**(irr)	'leave for later'

The obvious alternative is that the allomorphy is stress-conditioned: the allomorph *-err-* must head a foot, the allomorphs *-irr* and *-ewarr* cannot.[21]

B&P's third argument is that the reduplication pattern of the frequentative indicates VC(C) syllabification.

(18)	emp^{w}arr-em	'is making'	emp^{w}arr**eparr**-em	'keeps making'
	akemir-em	'is getting up'	akemir**epir**-em	'keeps getting up'
	unt-em	'is running'	unt**epunt**-em	'keeps running'

For B&P, the frequentative suffix consists of a disyllabic foot, the first syllable pre-specified as *-ep-*, the second a copy of the final VC(C) syllable of the root. But this is a weak argument because prosodic morphology normally does not involve copying prosodic constituents of the base. Rather, affixes are prosodic templates (defined by constraints) that get their unspecified segmental content from the base (McCarthy & Prince 1986). If the syllable structure of the reduplicant is fixed by the reduplication morpheme itself, then it can't tell us anything about the syllabification of the base. The argument is further undermined by Pensalfini's (1998) observation that the same type of reduplication exists in Jingulu, which uncontroversially has CV syllabification, and therefore in any case requires some such alternative analysis. A straightforward formulation consistent with the theory of Prosodic Morphology is that the suffix is /-epVC/, with VC filled by the closest part of the stem melody, e.g. /emp^{w}arr/ → emp^{w}arr-epVC → *emp^{w}arr-eparr*.

The fourth argument, from the play language Rabbit Talk, is especially intriguing:[22]

[19] On one analysis onsetless syllables can be adjoined to an adjacent syllable to form a "sesquisyllabic" complex (Kiparsky 2003).

[20] Orthographic *rr* denotes an alveolar tap or trill, *r* a retroflex approximant [ɻ] (transcribed as *ṛ* in Pensalfini's and Breen's work). *rn*, *rt* are retroflex [ɳ], [ʈ]. The orthography uses *h* to mark detanl place of articulation in *th, nh* etc. I have replaced them by the IPA symbols to prevent confusion with aspiration.

[21] Compare stress-sensitive root allomorphy in Italian, e.g. *vádo, andáte, andáre* (Kiparsky 1996).

[22] The last two examples are from Breen; thanks to Toni Borowsky for passing them on.

(19)	Ordinary speech	Rabbit Talk	
	amp**áŋkem**	**aŋkem**amp	'moan-PRES'
	iŋw**ént**	**en̪t̪**iŋw	'tomorrow'
	(e)n^{y}t^{y}**én^{y}em**	**(e)n^{y}em**en^{y}t^{y}	'smell-PRES'

It looks like the initial syllable of the word, VC(C) in B&P's analysis, is moved to the end. But an unproblematic alternative is that the word rhyme (the portion of the word that includes the stressed vowel and everything that follows it, boldfaced in (19)) is flipped with the residue (prosodic circumscription), viz. (amp)(áŋkem) → *aŋkem-amp*.[23]

There is substantial positive evidence that Arrernte words do exhibit the universal preference for CV. One indication comes from the rendering of English loanwords. They insert a vowel after a final consonant, not before an initial consonant as the VC(C) syllable canon would predict.

(20)	parrike	'paddock'	(*eparrik)
	t̪ay(e)te	'side'	(*et̪ayt)
	p^{w}elerte	'bullet'	(*ep^{w}elert)

Arrernte songs categorically prefer CV. "In the Arandic [song] tradition, quite generally, the consonant of a line-final suffix [...] is transferred to the beginning of the line following, so that each line begins with a consonant, even if the actual Arandic word heading the line is vowel-initial..." (Hale 1984). Turpin (2012) moreover observes: "All sung syllables have an onset. ...creating a poetic line involves either deleting the line-initial vowel ([ɐˈɳʈəpə] → [ˈɳʈəpə] 'pigeon') or inserting a consonant ([ɐˈləmə] → [ˈwɐləmə] 'stomach')."

Postlexical syllabification shows CV preference as well. At the sentence level, ONSET and NOCODA are maximized:

(21) amp eŋk^{w}in̪ et̪ aṛek aMeṛek → [am.peŋ.k^{w}i.n̪e.t̪a.ṛe.ka.Me.ṛe.kə]
child your I see-PAST camp-at

'I saw your child at the camp' (Pensalfini 1998, from Green 1994)

Moreover, epenthesis is obligatory in phrase-final position and *e-* never occurs phrase-initially. This led Pensalfini (1998) to partially retract the B&P analysis at least for the phrasal level. However the arguments presented here seem to me to invalidate it for the word level too, and for any level of representation. Not only do Arrernte's lexical and postlexical phonological processes actively *favor* CV syllables, but the claim that its output inventory of syllable types is derived from underlying representations that have exclusively VC(C) syllables is difficult to sustain.[24]

[23] The sources don't reveal the stress of the Rabbit Talk forms; my guess is that they stay on the same syllable as in the original word, e.g. *áŋkemamp*.

[24] Another case where theorizing has been led astray by a misconstrual of abstract phonemic and morphophonemic reprerentations as phonetic transcriptions are Tundra Nenets word-final stops (Kiparsky 2006).

2.2 The universality of syllables

Hyman (1985, 2011, to appear) argues that Gokana has no phonological rules or constraints that must refer to syllable structure: its phonotactics and phonological alternations can all be stated in terms of segments and moras. Not all of them *have* to be stated that way, and the assumption that Gokana has syllables would entail no complications, lost generalizations, or violations of typological expectations, such as anti-syllabic phonotactics. There might be cases where the syllabification is indeterminate, as Hyman notes, in which case the theory would dictate the least marked syllable structure.

Hyman's point, then, is not that Gokana cannot have syllables but that nothing is gained by positing syllable structure in it; all the action is in the moras. Gokana is not the only language where the syllable plays second fiddle to the mora: Japanese is another one, and the existence of syllables in Japanese has likewise been doubted (Labrune 2012, but see Kubozono 2003, Kawahara 2012).

As Hyman is careful to note, a language can have syllables even if they play no role in its phonology. Not every phonological property of a language need be involved in its phonotactics and phonological alternations. It would be no more surprising for a language to lack phonological processes involving syllable structure than for it to lack phonological processes involving vowel height.

Like feet, syllables meet more scepticism and outright rejection than larger prosodic groupings such as phrases, both from linguists (Steriade 1999) and from phoneticians (Kohler 1966, Ohala 1990, Ohala & Kawasaki-Fukumori 1997). The main reason is probably that in many languages they are not phonetically demarcated, at least in casual speech, nor directly identifiable by some cross-linguistically invariant property. (The same is true of segments, as Hyman reminds me.) The syllable is not the sole domain of coarticulation, nor a "puff of air", nor a "chest pulse".[25] As Anderson (1982:546) states, "the facts of acoustics and of articulatory co-articulation make it quite impossible to segment and identify the speech stream directly in terms of such units." Rather, syllables, their constituents, and the boundaries between them are manifested in multiple ways by their phonological effects, and it is the explanatory connections that can be based on this construct that justifies it.

It is true that many generalizations involving syllables can be restated without reference to syllables, and doubters have sought to show that such restatements are in some cases as insightful or even more so. Certainly the early arguments for syllable structure in generative phonology, first as a feature (Chomsky & Halle 1968), then as a boundary marker (Vennemann 1972), and finally a constituent (Kahn 1976), were not conclusive. For example, the argument that syllable structure eliminates disjunctive environments such as "before a consonant or word boundary" is not sufficient because the generalization could be be equally well and possibly better addressed by sophisticated competitors to syllabic formulations. Some syllable effects can be expressed in terms of moras (Hyman 1985) or feet.

Even in languages such as Chinese, where syllables are well demarcated in speech, restrictions on codas and onsets could be reformulated in terms of postvocalic and prevocalic position.[26]

[25]This is not to say that syllabicity has no phonetic correlates. For example, Fougeron & Ridouane 2008 find that Tashlhiyt syllabic consonants are not longer than nonsyllabic consonants, but they are less coarticulated.

[26]Tellingly, even Pāṇini, whose rich descriptive apparatus includes phonological and morphological features, or-

The most persuasive argument for the syllable as a constituent is that it ties together a number of phenomena that competing syllable-less theories can only deal with separately in a disconnected way (Vaux & Wolfe 2009).

1. Distinctive syllabification, e.g. Finnish *hau.is.sa* 'in pikes' vs. *ha.uis.sa* 'in searches', English *ˌant.ˈac.id* vs. *ˌfan.ˈtas.tic*, respectively with unaspirated coda *t* and aspirated onset *t*. These are predictable from the morphology, but syllabification can also be contrastive, as marginally in Sanskrit, where some words have inherent hiatus, e.g. trisyllabic *ti.ta.u-* 'sieve' (vs. disyllabic *da.dau* 'gave'). These pairs do not differ as to mora count.

2. Differences between onset and rhyme position, e.g. British aspiration or light vs. dark *l*, and ambisyllabicity in the corresponding American cases (Gussenhoven 1986).

3. Stressability. Polish *ˈkrvi* is monosyllabic. Polish has penult word stress, so if the word were disyllabic, we'd expect **ˈkr̩vi*. Serbo-Croatian *kr̩ˈvi* is disyllabic; in Serbo-Croatian, syllabic *r* can bear stress and pitch accent like vowels do.

4. Syllable counting, e.g. alternating stress, allomorphy dependent on even/odd parity.

5. Sonority sequencing: syllable boundaries as sonority troughs, nuclei as sonority peaks.

6. Restrictions on syllable size.

7. Differences between open and closed syllables (not reducible to syllable weight because heavy syllables can be open and light syllables can be closed).

8. Prosodic morphology: reduplication, infixation, truncation.

9. Language use: text-setting in song and chanting, language games, speech errors.

Obviously not all of these manifestations of syllable structure will exist in a given language. But when they do, they converge.[27]

Obviously not all of these manifestations of syllable structure are likely to be found in a given language. But they converge to the extent that they are.

Suppose that Gokana has none of these things — no distinctive or contrastive syllabification, no audible syllable boundaries, no processes or constraints that distinguish onsets from codas, or count syllables, or are sensitive to syllable boundaries, or constrain the size of syllables, no evidence for syllables in versification or slogan-chanting, at least nothing that could not also be stated in terms of moras. Then is Gokana a language without syllables, or does it just not wear its

dered rules, constraints, blocking, Theta-roles, linking, and inheritance hierarchies, among others, did not use syllables, even though Sanskrit very clearly has them (Kessler 1994); they simply would not have made his grammar shorter. This is a case of the ICEBERG PROBLEM, fatal for the project of "describing each language on its own terms": a single language, however rich and precise the description, cannot reveal all aspects of UG.

[27] A caveat: syllable structure can change in the course of a derivation. The more careful formulation has to be that it must be consistent at any given level of representation. For example, in English *rhythm, spasm, plasm* are monosyllabic at the stem level. If the nasal were syllabic at this level, it would get stressed in words like *rhýthm-ic* (cf. *átom, atóm-ic*), and words like *éctoplàsm, ángiospàsm, cýtoplàsm, cátaclàsm, hólophràsm*, would be stressed on the second part, on the pattern of *èctopárasite, àngiothlípsis, èndotóxin, cỳtocóccus, càtatónia, hòmophóbia, hòmomórphism*, rather than on the pattern of *éctomòrph, ángiospèrm, éndolỳmph, cýtocỳst, péricàrp, hómophòbe, hómomòrph*. Spanish [je] is a diphthong in the lexical phonology and behaves as a heavy syllable for purposes of stress, but postlexically [j-] os resyllabified from the nucleus into the onset, as shown by its allophonic realization (Harris and Kaisse 1999).

syllable structure on its sleeve? In the absence of instrumental evidence, which might one day help decide the question (fn. 25), we have to rely on phonological arguments. Let's consider the pros and cons.

Hyman's idea that Gokana does not *have* syllables, only moras, is based on an *ex silentio* argument advanced in a more general context by Clements (2001: 72). The idea is that languages have syllable structure only when it is "activated", which is to say when it is "needed in order to express generalizations about the phonological system", such as phonotactic restrictions or phonological alternations (Hyman (2011). But this actually leads to an argument *for* syllables in Gokana: they explain many of its phonological properties that would otherwise remain arbitrary. Gokana obeys *all* cross-linguistic generalizations about syllable structure, including the ones in (14) and Jakobson's universal. Also, Gokana syllables are maximally bimoraic, and *COMPLEX is unviolated. Vowel-initial words get a predictable glottal stop, indicating that ONSET is active. It tolerates codas, but so do most languages. Gokana syllable structure is about as vanilla as can be. What makes it look odd is the frequency of hiatus, reflected in its long sequences of vowels, including identical vowels, apparently without rearticulation or other clues to syllable boundaries. Such examples don't per se argue against syllables, because they also occur in languages that unquestionable have syllables. For example, Finnish has hiatus, e.g. *vaa'an* [va:.an] 'scale' (gen.) vs. *vaan* 'but, however', disyllabic *häät* [hæ.æt] 'carbon monoxides' vs. monosyllabic *häät* [hæ:t] 'wedding(s)' (certainly contrastive, but probably not distinctive in normal speech), and long sequences of vowels such as *hääyöaie* [hæ:.yø.ai.e] 'wedding night intention', but that doesn't warrant the conclusion that Finnish has no syllable structure — on the contrary, syllables are hugely important in Finnish phonology and allomorphy.

There are also a number of Gokana-specific facts that syllables help make sense of:

(22) a. Roots have the shapes CV, CVV, CVC, CVCV, but not *CVVV. Analysis: they are minimally a syllable and maximally a bimoraic foot, satisfying ONSET.

b. Derivational suffixes can have the shape -V or -CV. Analysis: they are minimal (light) syllables.

c. Prosodic stems may be of the form CV, CVC, CVV, CVCV, CVVCV, CVVCVV, CVVVV, but not *CVVVCV, *CVCVVV. They are maximally disyllabic (disyllabic trochees), as Hyman himself notes. Since Gokana syllables are maximally bimoraic, the restrictions follow.[28]

d. Gokana has CV-reduplication. Analysis: the Gokana reduplicant is a minimal (light) syllable, a very common type of reduplication as predicted by Prosodic Morphology (McCarthy & Prince 1986, 1996).

Such constraints are obviously helpful to hearers and learners in parsing the morphological structure of word. These data undermine even the weaker claim that Gokana *can* be analyzed adequately without syllables.

[28]Hyman suggests that this distribution could be due to the lack of inputs that would yield *CVVVCV, *CVCVVV (an accident or a conspiracy?). For example, *CVCVVV must be of the form Root + Derivational suffix + Inflectional suffix, and this can be neither /CVC-V-VV/, because this sequence would undergo vowel shortening, nor /CVC-VV-V/, because derivational suffixes must be minimal syllables of the form -(C)V.

According to Hyman (2008), "imposing an arbitrary syllabification [on the word *kɛ̃ɛ̃ɛ̀ɛ̀ɛ̃ɛ̃ɛ́*] adds nothing to our understanding of Gokana". I find this unconvincing for two reasons. First, the syllabification would *not* be arbitrary, for it would have to be compatible with the language's constraints, including the ones in (22). Secondly, it seems too much to ask that the syllabification of *every* Gokana word should add something to our understanding of the whole *language*. We don't ask that of any other aspect of the phonological analysis of words. Rather, the analysis of the entire language has to be compatible with all its words and yield as many explanatory dividends as possible, within the language and across languages. A theory lives by the totality of its consequences.

A theoretical argument for the same conclusion follows from basic assumptions of OT. A constraint can be defeated only by a more highly ranked constraint. Prohibiting syllabification would require constraints that defeat syllable structure assignment. But syllabification per se violates neither faithfulness constraints or markedness constraints (although specific marked syllable structures violate such constraints as ONSET and *CODA, which can be ranked to yield the familiar factorial typology, and *resyllabification* does constitute a faithfulness violation). Such constraints are unmotivated and their adoption would expand the factorial typology in undesirable ways. For example, a language without syllables would not violate any constraints such as ONSET, *CODA, and *COMPLEX, and consequently not be subject to phonotactic constraints captured by those constraints.

This seems to me enough reason to reject the claim that Gokana has no syllables. Even if the symptoms of syllabicity in (22) are discounted, the very fact that the language is syllabifiable in conformity with typologically well-established constraints and preferences would be incomprehensible if it did not in fact have syllables. All in all Gokana speaks for rather than against the universality of syllables and CV syllables in particular, just as Arrernte does.

Japanese is a broadly similar case. It has the same kind of funny vowel sequences as Gokana, e.g. Bloch's example *ooóóo* 'let's cover the tail', and perhaps no syllable-conditioned phonological processes. Yet there is evidence for one-mora and two-mora syllables (McCawley 1968, Kubozono 1999, 2003, Itô & Mester 2003), possibly three-mora syllables, though Kubozono argues that these are divided into two syllables as /CV.VN/.

Labrune disputes the existence of syllables in Japanese, citing the three-way contrast in (23):

(23) a. *an.i* (three moras) /aNi/ [ˈãNi] 'ease'

b. *ani* (Two moras) /ani/ [ˈani] 'older brother'

c. *anni* (three moras) /aNni/ [ˈãnni] 'implicitly'

The contrast cited by Labrune has a natural syllabic interpretation, however: *an.i* : *a.ni* : *an.ni*, with coda nasals counting as moras and causing nasalization of the tautosyllabic vowel.[29] Yet Labrune cites it as evidence *against* syllables in Japanese, on the grounds that (23a) violates the generalization that a closed syllable cannot be followed by a syllable that starts with a vowel. One might as well cite it as evidence agains moras in Japanese, since it also violates the generalization that a consonant followed by a vowel is not moraic. Of course both generalizations are correct for the initial

[29] I am grateful to Junko Itô and Stefan Kaufmann for information on Japanese.

syllabification of unsyllabified segments, where onsets are universally favored over codas, but in morphologically derived words the syllabification of the base may prevail if faithfulness outranks these markedness constraints.[30] The moraic nasal in *an.i* 'ease', *an.itsu* 'idleness' is inherited from the root *an-* from which they are formed (Itô & Mester 2015a: 296). This root can also be seen in words like *anraku* 'ease', *anshin* 'peace of mind', *anga* 'quiet rest', *heian* 'peace'. Therefore the data in (23) don't confute the syllabic analysis. In fact, they support it. For Labrune's alternative that moraic nasals are 'special moras' which are "prosodic units in their own right which possess greater autonomy than syllabic codas" has nothing to say about this morphological connection. Labrune defines the class of 'special moras' by enumeration as moraic nasals, second parts of long vowels, *i* after a vowel, first parts of obstruent geminates, which are exactly the weak (non-head) moras of heavy syllables. The fact that these fall readily under a unifying syllabic characterization constitutes further evidence for the syllable (Itô & Mester 2015b: 371).

Phonological descriptions of Japanese have found syllables useful to represent surface contrasts such as *kóo.o* 'likes and dislikes' vs. *ko.oo* 'response', and variation in the pronuciation of vowel sequences, e.g. *o.ó.i* (three syllables) and *óo.i* (two syllables) 'is much', 'are many', or *o.ó.u* (three syllables) and *oo.u* 'covers' (Martin 1975: 17). Syllable structure also plays a role in rules of accentuation and word formation, clearly productive since many of them involve the nativization of borrowed words (Kubozono 1999: 53). On balance, then, the universality of the syllable seems well supported.

The question whether all languages have syllables has a telling parallel in the syntactic question whether all languages are configurational. The claim that Gokana and Japanese lack syllables because they lack diagnostics for syllables is analogous to the claim that a language lacks a VP constituent because it has no diagnostics for it. In the absence of positive evidence for or against a VP, should we posit a minimal flat clause structure (Mohanan 1982, Simpson 1991, Austin & Bresnan 1996), or a VP?[31] The latter seems a better bet in view of previously overlooked evidence for a VP constituent, in some cases, interestingly, involving phonological phrasing (for Tamil, see Nagarajan 1995). Contemporary syntax leans towards the universality of VP.

3 Vowel systems

3.1 Kalam

The generalization that all languages have an /i/-type vowel is contradicted by analyses of some Papua New Guinean and Chadic languages. In these languages syllabic and nonsyllabic semivowels (high vowels and glides) are in complementary distribution, but phonemicized as underlying /y/ and /w/ (Fast 1953, Laycock 1965, Barreteau 1988, Comrie 1991, Pawley & Bulmer 2011, Smith 1999). This analysis reduces the phonemic vowel inventory to /e/, /a/, /o/, or just to /a/ (in some of the languages with an additional epenthetic /ə/ or /ɨ/).[32] Since *i, y* and *u, w* have the same segmen-

[30] Similarly the attempt to replicate the phonology of the source language in loanwords, as in Labrune's example *baiorin*° /baioriN/ 'violin'.

[31] Of course positive arguments against a VP constituent were sometimes adduced, one being that subjects and objects c-command each other for purposes of Condition C of Binding Theory. However, these arguments turned out to be fragile, and the formulation of Condition C on which it relies has itself been questioned.

[32] Or even to no vowels, as Barreteau 1988 does for Mofu-Gudur, also a Chadic language. His analysis predicts the surface vowels just from the consonants, prosodies and tone. The l-phonemic system appears to be this:

tal feature content, differing only in syllabicity,[33] this analysis amounts to specifying syllabicity in the phonemic inventory, despite its predictability, and despite the complementary distribution between the high vowels and glides. I believe that the need to specify semivowels as underlyingly nonsyllabic in these languages is an artifact of segmentalist phonemics, and present a Stratal OT analysis in which all underlying segments are indifferent as to syllabicity, and the semivowels are derived from underspecified {I}, {U}. This yields exactly the same output as positing underlying /y/, /w/ or /i/, /u/, because the actual realizations are determined by the languages' strict syllable structure. I demonstrate this with a reconsideration of the exemplary analysis of Kalam by Blevins & Pawley 2010 and Pawley & Bulmer 2011.

In addition to the semivowels at issue, Kalam has the vowels /e/, /a/, /o/, plus an epenthetic vowel which is inserted predictably after unsyllabifiable consonants, realized as high central short [ɨ], with a word-final [ə] allophone. Underlying forms can have long sequences of consonants, and some words have no vowels at all. Only /y/, /w/, and /s/ (the language's only fricative consonant) occur as word-internal codas. Word-finally any type of consonant is allowed, including obstruents, nasals, liquids and glides. Underlying forms are accommodated to a CV syllabic template where possible by inserting the nucleus /ɨ/, driven by the basic constraints ONSET and NOCODA.[34]

(24)	a.	/kn/	[ˈkɨn]	'sleep'
	b.	/kyn/	[ˈkiˑn]	'tree fern'
	c.	/an/	[ˈaˑn]	'who?'
	d.	/amy/	[ˈaˑˈmiˑ]	'mother'
	e.	/alw/	[ˈaˑˈluˑ]	'tree sp.'
	f.	/m/	[ˈmə]	'taro'
	g.	/b/	[ˈᵐbə]	'man'
	h.	/kay/	[ˈkaˑj]	'group, gang'
	i.	/key/	[ˈkeˑj]	'separately'
	j.	/koy/	[ˈkoˑj]	'blind'
	k.	/tdk-sp-m/	[tɨ́ⁿdiɣisiβɨ́m]	'you are trimming (branches)' (trim-PROG-2PL)
	l.	/md-n-k-nŋ/	[mɨ́ⁿdinɨ́ɣiniŋ]	'while I was staying' (stay-1SG-SUFF-while)
	m.	/ypd/	[yɨ́βɨ́nt]	'be straight'
	n.	/pttt/	[ɸɨ́ɾɨɾɨ́ɾ]	'quivering'
	o.	/ym/	[ˈjiˑm]	'plant crops'
	p.	/wN/	[ˈwuˑN]	'hair, fur, feathers'

With respect to syllabification, Kalam phonemes can be divided into three classes:

(25) a. Consonants /p b m t s d n c j ñ k g ŋ l/ – always nonsyllabic.

[–back, –round]	[+back, –round]	[+back, +round]	
i	ɨ	ɯ	u
ɪ	ə	ʊ	ʊ
e	ʌ	o	o
ɛ	ɑ	ɔ	ɔ

[33]This has been generally accepted at least since Jakobson, Fant, & Halle 1952, irrespective of whether syllabicity is represented featurally as in Chomsky & Halle 1968, or by position in a syllabic constituent as in Kahn 1976, Gussenhoven 1986, and later work.

[34](24a-j) are from B&P, (24k, l) are from P&B.

b. Vowels /e a o/ – always syllabic.

c. Semivowels /i u/ ∼ /j w/ – syllabic and nonsyllabic.

The epenthetic vowel [ɨ] ([ə] word-finally) is not in the underlying inventory, and is pronounced shorter than underlying vowels and vocalized semivowels:

(26) a. Epenthetic [ɨ], [ə] are short: /kn/ [ˈkɨn], /m/ [ˈmə]

b. Phonemic vowels are half-long: /kay/ [ˈkaˑj]

c. Including the syllabic allophones of the semivowels: /kyn/ [ˈkiˑn]

B&P give four arguments that the semivowels are always underlying consonants. Their first argument is that while /a e o/ are found word-initially in native words, no native words begin with /i/, /u/ or any central vowel. Instead, words may begin with [ji] or [wu]. B&P analyze them as beginning phonemically with /j/, /w/.

(27) a. /ym/ [ˈjiˑm] 'plant crops'
b. /wN/ [ˈwuˑN] 'hair, fur, feathers'

P&B (2011: 31) describe the vowels in such words as predictably inserted "release vowels" colored by the adjacent semivowel. However, as reproduced in (27), B&P consistently transcribe them as as half-long, like regular vowels and like the vocalized glides in words like (24b) /kyn/ [ˈkiˑn], but unlike the short vowel predictably inserted between two consonants in (24a) /kn/ [ˈkɨn].[35] That means that they are not release vowels, but vocalized glides, which for P&B's analysis means that the semivowels are vocalized as as [ji-], [wu-] before consonants, since no words begin with [i-], [u-]. P&B do not account for these data. A simpler alternative is that Kalam words are syllabified to have onsets where possible, so initial glides are [ji-], [wu-] before consonants and [j-], [w-] before vowels. Since semivowels can be both syllabic nuclei and margins, an initial semivowel followed by a consonant can satisfy the the CV preference by being syllabified as /ji-/, with the same melodic element serving as onset and nucleus. For example, underlying {Im} (or for that matter underlying {im} or {ym}) is then syllabified as /jim/, rather than as */im/, */jm/, or as */jm̩/. Since vowels cannot be affiliated with onsets, it also follows that underlying {Am} (or {am}) must be syllabified as /am/ rather than as */a͡am/. This derives the generalization that words can begin only with a consonant or with a true vowel but not with a semivowel or with an epenthetic /ɨ/.[36] There is then no need to specify the the semivowels as underlyingly nonsyllabic. This analysis is straightforwardly implementable in OT, as we'll see shortly in tableau (31) below. Before proceeding to that formalization, let us review B&P's remaining three arguments for underlying /y/, /w/.

B&P's second argument for underlying /y/, /w/ is that a word can end in a consonant or in a vocalized semivowel [-i] and [-u], but not in a vowel [-a], [-e] or [-o], e.g. (24d) /amy/ [ˈaˑˈmiˑ], but */ama/ *[ˈaˑˈmaˑ]. On their assumption that [-i] and [-u] are underlying consonants, this follows

[35] Inadvertently (I think) omitted in (24h,i,j), where I have inserted it.

[36] Words beginning with a central vowel are excluded because the central vowel is only added after otherwise unsyllabifiable consonants.

from the constraint that words cannot end in vowels. I assume the weaker constraint that words cannot end in nonhigh vowels.[37]

B&P's third argument is based on the distribution of the two allomorphs of the negative prefix or pro-clitic /ma-/ ∼ /m-/ 'not, not yet'. The choice of allomorph is phonologically determined: /m-/ occurs before vowels: /m-ag-p/ 'he did not speak', /m-ow-p/ 'he has not come', /m-o-ng-gab/ 'he will not come'. /ma-/ occurs before consonants and before semivowels: /ma-pkp/ 'it has not struck', /ma-dan/ 'don't touch', /ma-ynb/ 'it is not cooked', /ma-wkp/ 'it is not cracked'.[38]

(28)	a.	/ma-ag-p/	[ˈmaˑˈŋgɨp]	'he did not speak'
	b.	/ma-ow-p/	[ˈmoˑˈw(u)p]	'he has not come'
	c.	/ma-d-an/	[ˈmaˑˈⁿdaˑn]	'don't touch'
	d.	/ma-wk-p/	[ˈmaˑˈwuˑˈɣɨp]	'it is not cooked'

B&P's assumption that semivowels are underlying consonants explains this distribution. But so does my assumption that initial semivowels before consonants are syllabified as CV- to maximize onsets, as discussed in connection with the first argument.

B&P's fourth argument is that the only word-internal surface vowel sequences in Kalam are [i:a:], [i:o:], [i:e:], [u:a:], [u:o:], [u:e:]. These words have an alternative monosyllabic pronunciation in free variation (P&B 2011: 32), and P&B sometimes transcribe them with a bridging glide (see (29c)).

(29)	a.	/gyak/	[ˈŋgiˑˈaˑk], [ˈŋgiˑˈaˑk]	'they did'
	b.	/kyep/	[ˈkiˑˈeˑp]	'excrement'
	c.	/kyon/	[ˈkiˑˈoˑn]	'insect sp.'
	d.	/kwam/	[ˈkuˑˈaˑm]	'tree sp., *Garcinia archboldiana*'
	e.	/kwel/	[ˈkuˑˈeˑl]	'tree sp., mango'
	f.	/kuok/	[ˈkuˑˈoˑk]	'bowl'.

B&P reason that these are the only permitted word-internal vowel sequences because they are underlying consonant+vowel sequences, hence exempt from the prohibition against adjacent vowels. They would have to add some constraint to ensure that such hiatus sequences only arise after a consonant, in order to rule out such words as */yon/ *[ˈiˑˈoˑn] in Kalam. On my account this follows automatically without any additional constraints. Since Kalam permits no tautosyllabic consonant clusters, and specifically no initial clusters, we know that *COMPLEX is undominated. ONSET forces to be syllabified with onsets where possible, so initial glides are [ji-], [wu-] before consonants and [j-], [w-] before vowels, e.g. /im/ = /ym/ = /Im/ is syllabified as [jiˑm]. Vowels must be syllabic, so /am/ = /a̯am/ = /Am/ is syllabified as /am/. This derives the generalization that words can begin only with a consonant or with a true vowel but not with a semivowel or with an epenthetic /ɨ/. We also know from such data as (24c,d,e) that ONSET is dominated. The ranking *COMPLEX ≫ ONSET forces the syllabification [ki.on] rather than [kyon].

[37] On the other hand, it is conceivable that final high vowels are actually pronounced with an offglide, as in English, where a word like *bee* [biy], is transcribed as [bi:].

[38] The transcriptions in (28) are inferred from the information in P&B 2011: 30.

All the pieces of our OT analysis are now in place. The constraints are listed in (30) and the derivations are illustrated in (31). In the representations, "V" stands for an empty nucleus (a syllable head with no affiliated phoneme). I give alternative inputs in the tableau in order to show the noncontrastive status of syllabicity in underlying representations.

(30) Constraints

a. *V]$_\omega$: A word can't end in a vowel.

b. SON: Consonants are nonsyllabic, vowels are syllabic (see (25)).

c. NUC: A syllable has a nucleus.

d. IDENT(F): Input [αF] does not correspond to output [$-\alpha$F].

e. DEP: Don't insert a segment.

f. MAX: Don't delete a segment.

g. *COMPLEX: A syllable does not have a consonant cluster.

h. ONSET: A syllable has an onset.

i. *CODA: A syllable does not have a coda.

(31)

	*V]$_{\omega}$	SON	NUC	IDENT(F)	DEP	MAX	*COMPLEX	ONSET	*CODA
Input: /kn/, /kn̩/									
1a. kn			*						
1b. kn̩		*							
1c. ☞ kVn									*
1d. kin					*				*
1e. kV.nV	*								
Input: /kin/, /kjn/, /kIn/									
2a. kVn						*			*
2b. ☞ kin									*
2c. kn			*		*				
2d. kij				*	*				*
2d. ki	*				*				
Input: /im/, /jm/, /Im/									
3a. Vm						*		*	*
3b. im								*	*
3c. ☞ jim									*
3d. kim					*				*
3e. ji.mV	*				*				
Input: /an/, /a͡n/									
4a. ☞ an								*	*
4b. a͡an		*						*	*
4c. kan				*	*				*
Input: /amy/, /ami/, /amI/									
5a. a.mi	*							*	
5b. ☞ a.mij								*	*
5c. a.mVj					*			*	*
5d. a͡a.mVj		*							*
5e. a͡m						*		*	*
Input: /ama/									
6a. a.ma	*							*	
6b. a.ma͡a		*						*	*
6c. amak					*			*	*
6d. ☞ am						*		*	*
Input: /kjep/, /kiep/, /kIep/									
7a. kjep							*		*
7b.☞ ki.ep									*
7c. kep						*			*
7d. ki.tep					*				*

It will be seen that FINALC ('prosodic words must end in consonants') crucially outranks NOCODA and DEP-V. That monoconsonantal words such as (24h) /m/ [ˈmə] undergo epenthesis follows not from reranking the constraints for those derivations, as B&P suggest, but from standard constraints

that are plainly unviolated in Kalam: lexical words are accented, accents fall on a syllable, and syllables contain a vocalic nucleus.[39]

Underlying forms are accommodated to a CV syllabic template by inserting the nucleus [ɨ] where necessary, driven by the basic constraints ONSET and NOCODA. The insertion of the predictable [ɨ]-vowels can be regarded as part of the syllabification process. The evidence that they are epenthesized phonologically, rather than intruded phonetically, is that they are obligatory regardless of speech rate, provide a nucleus for syllables that would otherwise lack one, and carry word stress. Several strands of evidence show that they originate specifically in the word phonology rather than in the postlexical phonology. They are grouped into binary feet within the domain of a word: in a word consisting of such syllables, odd-numbered ones can get stressed (Pawley & Bulmer 2011: 30). Corroborating the lexical status of epenthetic vowels is the partial unpredictability, or perhaps morphological conditioning, of these stresses. For example, the second stress is on the fifth syllable in (24k) and on the third syllable in (24l), perhaps because of the different morphological structure. Finally, each member of a compound counts as a separate word for purposes of the syllable count and word-finality. The inserted nucleus [ɨ] is for these reasons an l-phoneme, not part of the s-phonemic representation because it is predictable. Hence the regular CV syllable structure of the language cannot be represented at the s-phonemic level. P&B posit initial syllabifications with consonantal syllables like /t.d.k.s.pm/, /m.d.n.k.nŋ/, contrary to Jakobson's CV universal. The simple CV syllabification is, however, visible in lexical representations, where the l-phoneme /ɨ/ is present.

B&P say that Kalam *i* does not neatly fit into Hall's (2006) typology of phonologically epenthetic vs. phonetically intrusive (excrescent) vowels, on the grounds that it has two properties of intrusive vowels in addition to the standard properties of epenthetic vowels: it does not repair illicit structures, and it is a central vowel ([ɨ], word-finally [ə]). Neither of these arguments hit the mark. The first argument overlooks the generalization that Kalam epenthetic vowels provide a nucleus for consonants that would otherwise have to be syllabified as codas but are prohibited in coda position.[40] But providing a nucleus for unsyllabifiable consonants *is* repairing syllable structure. The second argument is based on the incorrect premise that inserted central vowels are always intrusive rather than epenthetic. There are many well-documented instances of epenthetic central vowels, for example in German (Wiese 1986, 2000: 245), Catalan (Wheeler 2005, Ch. 8), Armenian (Vaux 1998a, 1998b, 2003, Delisi 2015), Slovenian (Jurgec 2007), some dialects of Berber (Dell & Tangi 1993), Salishan languages (Parker 2011), and Mongolian (Svantesson 1995, Svantesson et al. 2005) — all demonstrably phonological cases of ə-epenthesis, some of them cyclic or morpho-

[39] B&P's remark in this connection that "technical problems within OT grammars can always be solved by invoking additional constraints" is unduly dismissive. Actually the data are predicted by the theory, in the sense that if monoconsonantal words did *not* undergo epenthesis, the analysis would require otherwise unwanted constraints, as the reader can verify in tableau (31).

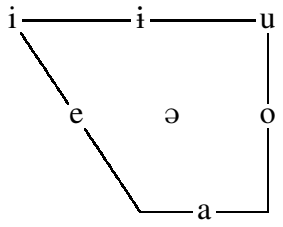
[40] This is not inconsistent with their formulation that vowels are inserted after consonants that require a release. It may be that syllable-final consonants must be released. Another question is whether it is justified to attribute the release property not only to plosives, but also to nasal stops and /l/, as B&P have to do; only the continuants /s/, /y/, and /w/ are licit medial codas. Phoneticians normally use the term release for the separation of articulators in plosives, and explain that plosives prefer syllable onsets because that is where their release burst is most easily preceptible. The prohibition of sonorant stops in word-internal codas in Kalam cannot be explained the same way, because they are not released with a noisy burst, and would be easily perceptible even in coda position, and are in fact common as codas across languages.

logically conditioned, hence definitely lexical. The correct generalization is the converse: intrusive vowels are always central (unless of course they acquire peripheral features from their context). In other words, independent peripheral quality is a diagnostic for epenthetic vowels, but central quality is *not* a diagnostic of intrusive vowels. That being the case, Kalam epenthetic vowels fit perfectly into Hall's typology; they do not have "mixed properties".

Thinking that Kalam epenthetic vowels have mixed properties, B&P classify them as a third category which they call REMNANT VOWELS. They propose that remnant vowels arise from the historical loss of reduced unstressed vowels, followed by reanalysis of deletion as insertion in the complementary contexts (rule inversion) and possibly generalization of the new insertion process, and that this origin explains their mixed properties. This is no doubt how the Kalam epenthetic vowels arose. However, even supposing contrary to fact that Kalam vowels had mixed properties, B&P's historical account would not explain that mixture, for there are numerous synchronic epenthesis processes that are extended inversions of original syncope and apocope processes and do *not* have mixed properties (see Andersen 1969 on the synchrony and diachrony of Ukrainian paragoge; on some analyses even the English schwa in the plural, genitive, and reduced copula is a case). In any case there are at present no known clear instances of epenthesis with mixed properties. The two-way distinction between phonologically epenthetic and phonetically intrusive vowels offers a sufficient typology of vowel insertion.

Comrie (1991) argues that of the seven Haruai vowels in (32), only /ə/ is phonemic.

(32)



[ɨ] is an anaptyctic vowel predictably inserted after the first consonant in a sequence of consonants or in a word that consists only of consonants. Comrie analyzes the high vowels *i* and *u* as /y/ and /w/, on the basis of arguments that are similar to those of B&P for Kalam. He analyzes *a* as /əə/, and tentatively derives the mid vowels *e* and *o* from /əyə/ and /əwə/, respectively, with the reservation that some lexical items are exceptions to these contractions, and others undergo them only optionally. By strict structuralist methods this amounts to a contrastive distribution, leaving Haruai with a horizontal vowel system of three phonemes /e/, /ə/, /o/. My suspicion is that they may be reanalyzed as morphophonemically unspecified for syllabicity along the lines of what I proposed above for Kalam, emerging at the lexical level as vocalic and consonantal l-phonemes depending on syllable structure.

3.2 Kabardian

In the course of their argument that universals are "myths", Evans & Levinson (2009: 438) claim that it is "contested" whether all spoken languages have vowel phonemes at all, citing the Northwestern Caucasian languages, where "the quality of the vowel segments was long maintained by many linguists to be entirely predictable from the consonantal context (see Colarusso 1982; Halle 1970; Kuipers 1960)." (E&L 2009: 438). It must be said that there is no such debate about

Northwestern Caucasian or any other languages; Colarusso (1982) and Halle (1970) demonstrated a minimum inventory of two contrastive vowels.[41] And it is not accurate that "although most scholars have now swung round to recognizing two contrasting vowels, the evidence for this hangs on the thread of a few minimal pairs, mostly loanwords from Turkish or Arabic." (*ibid.*) Actually the majority of scholars recognize a *three-vowel* system, and to the extent that some have "swung round" to the two-vowel analysis, it is not from the vowel-less analysis but from the three-vowel analysis. Nor does the evidence particularly depend on Turkish and Arabic loans, or on minimal pairs. On the contrary, the strongest evidence comes from native words and the core vocabulary (Colarusso 1992: 22).

The history of scholarship on Kabardian phonology is worth reviewing as an example of the theory-dependence of phonemic analyses. Older reference grammars of Kabardian set up seven vowel phonemes: two variable short vowels /ə/ and /ɐ/, whose realization depends mostly on the following consonant, and five stable long vowels /ɑ: i: u: e: o:/, phonetically more peripheral than the variable ones (Jakovlev 1948, Turchaninov & Tsagov 1940, Abitov et al. 1957, Šagirov, A. K. 1967, Bagov et al. 1970, followed by Maddieson 1984, 2013). Jakovlev (1923) discovered that the stable vowels can be derived by fusion of the short vowels with a glide. Most s-phonemic theories allow fusion (e.g. phonemicizing English [ɚ] as /ər/, or French and Portuguese nasal vowels as V+N sequences). In these it is straightforward to reduce Kabardian /i: u: e: o:/ to underlying /əy/, /əw/, /ɐy/, /ɐw/ respectively. Historically /ɑ:/ undoubtedly comes from an analogous fusion of /ɐh/, but synchronically it can't quite be reduced to that under the strictures of s-phonemics. So in addition to /ə/ and /a/, analyses typically posit it as a third s-phoneme. Its representation has been the subject of some debate. Currently favored is /a:/ (Choi 1991, Matasović 2006, Wood 1994, Gordon & Applebaum 2006, Applebaum & Gordon 2013). An older theory posits /a vertical three-vowel system /ə/ /ɐ/ /ɑ/ system (Trubetzkoy 1925, 1929, 1939, Catford 1942, 1984, Kumaxov 1973, 1984). Abstract generative analyses, on the other hand, can easily derive the fifth long vowel [ɑ:] from /ɐh/, in some cases ultimately from /hɐ/ and /ɐɣ/ by other processes. The result of that further analytic step is the two-vowel system of Kuipers 1960, Halle 1970, and Colarusso 1992, 2006.

It cannot be emphasized enough that the seven-vowel, three-vowel, and two-vowel solutions with its two variants do not reflect any disagreement about Kabardian, only the differences between phonological theories. The data and phonological generalizations of Kabardian are not at stake. Each analysis follows rigorously from exactly the same facts depending on the principles that it assumes. Even the choice between the two variants of the three-vowel phonemic system is a deep question of principle. What is at stake is whether phonemics should privilege phonetic criteria, or morphophonemic criteria and the overall simplicity of the grammar. The former in this case favor a qualitative opposition /ɐ/ : /ɑ/, the latter point to a quantitative opposition /a/ : /a:/. Far from being a dismaying free-for-all, this spectrum of analyses is heartening because it means that our understanding of Kabardian has reached a point where it can be advanced by sharpening

[41] The two-vowel analysis is originally due to Kuipers 1960. After presenting it, he goes further by eliminating first /ɐ/ by doubling the consonant inventory with a set of ɐ-colored consonants, and then, in an extreme tour de force, eliminates the remaining vowel /ə/ by enriching the phonemic representation with an abstract juncture marker ":". In this analysis, not only were all phonemes consonants, but every consonant was a morpheme, and every morpheme was a consonant. It was conclusively refuted by Halle 1970, Kumaxov 1973, and Colarusso 1982, and has found no followers since.

phonological theory and typology by empirical work on other languages.

The upshot, then, is that Kabardian has at least three vocalic phonemes (s-phonemes), reducible to two underlying m-phonemes. With that and the failure of the refutation of the CV universal, E&L's case against phonological universals falls apart.

Even though Kabardian is not vowel-less, it remains, at the level of s-phonemic representations, an exception to the proposed universals on vowel systems in (14). A look at its phonology makes it likely that its lexical representations do conform to them. Phonetically, Kabardian makes full use of the vowel space, with unrounded and rounded front vowels and rounded back vowels, in three heights, ten vowels in all according to Colarusso 1992. In (33) I give examples of his phonetic and underlying forms, to which have added the phonemic representation according to the three-vowel analysis.

(33) a. [suwogʷɛpsɪˈsɑˑś] 'I was thinking of you.' (p. 78)
/səwəgʷapsəˈsɑ:ś/
sə- w- a- gʷə+ psəsa- aɣ- ś
I- you- DAT- heart+ think- PAST- AFF

b. [q̇ɪzx̂ʷɪzɛteˑwuvæˈʔɑˑræræ] 'the reason why he stopped' (p. 86)
/q̇əzx̂ʷəzataywəvaʔa:rara/
∅- q̇ə- z- x̂ʷə- z- a- t- y- a- wəva+ ʔa- aɣ- ra- ra
3- INCEPT- what- for- self- DAT- SURF- DIR- DAT- stop+ there(upright)- PAST- PART- DEF

c. [wuzæpɪrɪsˈšɑˑś] 'I led you' (p. 104)
/wəzapərəsša:ś/
wə- ∅- za- pə- rə- s- šə- aɣ- ś
you- 3- all- sever- distr- I- lead (out)- past- aff

d. [dɛriˑdɛˈzoˑk̇ʷə] 'we are going for a long walk' (p. 83)
/darəydazawk̇ʷə/
də- ∅- yə- rə- yə- da+ zə- a- w- k̇ʷə+ a
we- 3- path- distr- dir- out+ around- pres- prog- move+ intr

e. [sɪq̇e:wɑˑś] 'I hit'
/səq̇aywahś/
sə- q̇a- y- a- w+ a- aɣ- ś
I- hor- 3- dat- strike+ at- past- aff

This ten-vowel repertoire arises by assimilation in height, backness, and rounding to a following consonant, if there is one.[42] Vowels are fronted before [–high] coronals (alveolars, alveopalatals, palatoalveolars), fronted and raised before [+high] coronals (palatals and palato-alveolars), backed before plain uvulars and pharyngeals, backed and rounded before rounded uvulars, and raised and rounded before labiovelars (there are no plain velars). Onset consonants also color the following vowel, but in a variable and gradient manner at the level of phonetic implementation, as Colarusso

[42]It is always tautosyllabic, if Colarusso (1992: 15) is right that all intervocalic consonants are ambisyllabic, e.g. /dəda/ [ˈdɾ̩.dæ].

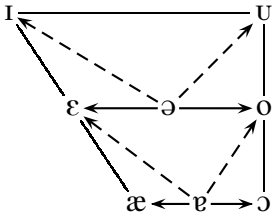
(1992: 31) makes clear. Word-finally and before labials and the laryngeal /ʔ/, which lack a distinctive tongue position, the vowels are unraised and front (Colarusso 1982: 96, 1992:30).[43] These assimilations, summarized in (34), generate ten surface vowels.

(34)

Before consonants which are:	[–high –back –round]	[–high –back +round]	[–high +back –round]	[–high +back +round]	[+high –back –round]	[+high +back +round]
/ə/ is realized as:	ɛ	ö	ɘ	o	ɪ	u
/ɐ/ is realized as:	æ	ɔ̈	ɑ	ɔ	ɛ	o

The chart in (35) summarizes the assimilation patterns of backness and roundness, and (dashed arrows) of height; note that the mid vowels each have two sources.

(35)



Before /ʔʷ/, which triggers rounding but not backing, /ə/ and /a/ are realized as *ö*, ɔ̈, not shown in the two-dimensional diagram. The long vowels /i:/ /u:/ /e:/ /o:/ originate by the same assimilation processes before /y/ and /w/, which are then deleted with compensatory lengthening. /h/ neutralizes /ə/ and /a/ without any other coloring effect, and deletes like the other glides, giving /a:/.

By the criteria (A)-(G) of section 1.1, these assimilations are phonological processes, not coarticulation processes, and they take effect in the word-level phonology, everywhere within the word domain, but not across phonological word boundaries (Gordon & Applebaum 2010: 51). They are categorical and operate on discrete feature values. Note especially that [–high] consonants trigger a chain shift, so that [o] and [ɛ] represent either /ə/ and /ɐ/, depending on the following consonant.

The surface vowels of Kabardian are thus l-phonemes. The ten-vowel system that emerges at the word level is symmetric and dispersed. It is isomorphic to UPSID's ten-vowel system for Korean (Maddieson 1984: 283). Perhaps significantly, the four-way combination of the values of [round] and [back] that is its outstanding typological feature is also found in coterritorial Turkish and its relatives, and elsewhere in Eurasia (Uyghur, Selkup, Seto, Dagur, among others).

[43] E.g. /ʔa/ [ʔæ] 'hand', /psəʔa/ [ˈpsɛʔæ] 'wetness', [ˈpsɛ>ʔˈ˩ʔæ>] in Colarusso's narrower transcription. They are represented as central vowels [ə] and [ɐ] in Gordon & Applebaum 2006, which would be more consistent with the expectations of dispersion theory (Flemming 1995). But in the samples I have heard they are definitely front in agreement with Colarusso's description: https://www.youtube.com/watch?v=gtuU5_U-gL4, https://www.youtube.com/watch?v=4-BY1vYfM_Q, https://www.youtube.com/watch?v=r_qQCUDaz-I .

3.3 Marshallese

The other famous case of a vertical vowel system is Marshallese. Bender (1963) had posited the phonemic vowel system (36) (I have replaced the unrounded back vowels with their offical IPA symbols).

(36)

[–back, –round]	[+back, –round]	[+back, +round]
i	ɯ	u
ɪ	ɤ	ʊ
e	ʌ	o
ɛ	ɑ	ɔ

This is isomorphic to the Mofu-Gudur vowel system mentioned in fn. 32. Bender 1968 reduced it to four vowels, taking the center series *ɯ,ɤ,ʌ,ɑ* as basic (p. 20)[44], and deriving the other eight vowels by assimilation to adjacent consonants:

(37)
a. [–back,–round] next to "light" (palatal or palatalized) consonants p^y,t^y,m^y,n^y,l^y,j,y
b. [+back,–round] next to "heavy" (plain, or perhas velarized) consonants *p,t,k,m,n,ŋ,l,r,h*
c. [+back,+round] next to labialized consonants $k^w,n^w,ŋ^w,l^w,r^w,w$

When a vowel appears between consonants that differ in backness and rounding, it assimilates to both and is accordingly pronounced as a diphthong. This results in 24 diphthongs [iɯ], [iu], etc.

Bender further noted that the second row of vowels /ɪ ɤ ʊ/ can be eliminated from the inventory by deriving it from two sources: lowering of /ɯ/ before deleted /ʌ/, and raising of /ʌ/ before deleted /ɯ/:

(38)
a. /b^{w}ʌk^{w}ɯ/ [b^{w}ʊk^w] 'bladder', cf. /b^{w}ʌk^{w}ɯ-n^y/ [b^{w}ʊk^{w}ɯn^y] 'his bladder'.
b. /wɯbʌ/ [ʊb^w] 'chest', cf. /wɯbʌ-n^y/ [ʊb^{w}ʌn^y] 'his chest'

He rejects this further reduction for the phonemic level because it would violate biuniqueness. Words like [b^{w}ʊŋ^w] 'night' could be phonemicized either as /b^{w}ʌŋ^{w}ɯ/ or as /b^{w}ɯŋ^{w}ʌ/, unless one had access to the morphonological information about the underlying second syllable from suffixed forms, which is not available at the phonemic level. At the morphophonemic level, this objection falls away.

Nevertheless Bender's remarkable solution does not fully adhere to the principle of bi-uniqueness, and transcends structuralist procedures of segmentation and classification, for the context that triggers the vowel allophones is sometimes itself deleted, and the phoneme /h/, the "heavy" counterpart of /y/ and /w/, never surfaces at all. For example, the three-way contrasts in long vowel vowels seen in (39) are due to deleted intervocalic glides.

(39)
a. /mayar/ *mɛɛr* 'to tell a lie', /mahaj/ *mɑɑj* 'open field', /mawar/ *mɔɔr* 'bait'
b. /mʌyʌj/ *meej* 'dark colored', /rʌhʌj/ *rʌʌj* 'bright colored', /tʌwʌj/ *tooj* 'conspicuous'

[44]Though in practice he writes the phonemes as /i,ɪ,e,a/.

The implication of these data for a Stratal OT analysis is that vowel coloring must take effect in the lexical phonology, and then made opaque by postlexical processes. So in the derivation /mayar/ → mɛyɛr → *mɛɛr*, lexical assimilation is masked by the postlexical deletion of its trigger.[45]

Independent evidence that intervocalic glide deletion is postlexical is that Marshallese does not allow superheavy syllables (*CVVC, *CVCC), except for those that arise by just this deletion process. Thus postlexical glide deletion makes the syllable structure constraint opaque.

However, there is evidence that assimilation *also* applies postlexically, as a coarticulation process. In rapid speech, consonant assimilation across word boundaries can feed vowel allophony, especially in sequences of identical consonants. For example, in (40b) /bek/ is pronounced like /bek^{w}/ [bok^{w}] 'sand' through assimilation to the initial /k^{w}/ of the following word (Byron Bender, p.c.).

(40)	a.	/bek/	[bʌk]	'take'
	b.	/bek k^{w}ẹyẹt n^{y}e/	[bok^{w} k^{w}ẹ̣ẹ̣t ne]	'take that octopus'

Phonetic implementation adds further color nuances to the vowels, which Bender interprets as due to "competing consonantal influences on a less fully specified vowel": the vowel in /t^{y}ʌk^{w}/ moves from front to back with increasing rounding, all at mid height: [t^{y}ẽ̞õ̞k^{w}]. Similarly, /k^{w}ʌt^{y}/ is pronounced [k^{w}õ̞ə̞̃t^{y}].[46] It is not uncommon for constraints to be enforced at more than one level, with the respective applications obeying the ground rules at each level, as appears to be the case here.

I conclude that Marshallese vowel assimilation is a categorical word-level process operating on binary feature specifications, overlain by a gradient postlexical coarticulation effect.

Since the relation of levels in Stratal OT does not have to be biunique, the underlying three-height vertical system of three vocalic m-phonemes /ɯ ʌ ɑ/ (or /i e ɑ/) that Bender 1968 entertained can be maintained. The fourth vowel height arises in the lexical phonology, where all vowels also assimilate to palatal and labial consonants. This yields the system of twelve vocalic l-phonemes (36), which is identical to the s-phonemic inventory of Bender 1963.

4 Conclusion

All putative phonological universals are framed in terms of theory-dependent categories, and defined on some theory-dependent level of representation, most often the phonemic level. Therefore the linguistic descriptions on which they are based cannot be theory-neutral or atheoretical. The approach of "describing each language in its own terms" is at best aspirational. With one

[45]The data in (39) undermine Hale's (2000) claim that the vowels of Marshallese are not only phonologically but *phonetically* underspecified for backness and rounding (he pointedly represents them at both levels with arbitrary dingbat symbols), and that the twelve vowels in (36) and their diphthongal combinations are introduced only in the acoustic/articulatory output. It would be hard to account for the contrasts in (39) as resulting from coarticulation (at least under standard assumptions about the phonology/phonetics interface). Deletion of glides would also have to be an acoustic/articulatory process, in counterbleeding order with acoustic/articulatory assimilation.

[46]Choi (1992: 68) also concludes that the smooth transition between vowel qualities must also be due to phonetic coarticulation processes: the F2 trajectory for Marshallese /t^{y}e͡ap/ 'to return' shows no steady-state position for the tongue during the realization of the diphthong.

exception, all grammars I am aware of draw heavily on existing descriptive frameworks.[47] Since there are no theory-neutral grammars, there is no theory-neutral typology. In terms of Hyman's (2008) distinction, *there are no "descriptive" universals of language*. All universals are analytic, and their validity often turns on a set of critical cases where different solutions can be and have been entertained. The choice between these is not a matter of taste or whimsy but of different assumptions, each one with testable empirical consequences in a multitude of other languages. It follows that the search for better linguistic descriptions, more illuminating typologies, and stronger cross-linguistic generalizations and universals should go hand in hand.

Stratal OT's word level representations encode the typologically significant phonological properties omitted in s-phonemic representations, including syllabification regardless of whether it is contrastive or not, and "quasi-phonemes". They also encode typologically significant abstract structural information that is missing in the phonetic record, such as metrical and prosodic structure and feature sharing, while omitting postlexical features and structurally irrelevant coarticulation phenomena. This makes word phonology the sweet spot where typological generalizations appear at their tidiest: it seems likely that it obeys all phonological universals that phonemic representations do, and then some. The difference is most dramatic where phonemic theory imposes extremely abstract analyses, as in vertical and one-vowel systems. But the argument that the word level should replace phonemics in typological research can also be made in languages where lexical representations are fairly close to classical phonemic representations.

Since the lexical level of representation is empirically supported and formally anchored in Stratal OT and Lexical Phonology, it is a good candidate for replacing the classical s-phonemic level. That would remove an unmotivated residue of structuralism and replace it with a well-motovated level of representation that serves some of the same functions. Our analysis of unusual syllabification and vowel systems shows it to be a Goldilocks level that is just right for typology, in that it conforms to some important generalizations that are obscured for technical reasons in structuralist phonemic representations, therby leading to cleaner typologies and turning near-universals into solid exceptionless universals.

Since lexical representations and l-phonemes were not defined with an eye on typology, its positive typological implications a nice bonus that supports Stratal OT. In broader perspective, the outcome encourages the joint pursuit of linguistic theory and typology, where universals are not just inductive generalizations from putatively theory-neutral linguistic descriptions but hypotheses that at once guide analysis and are informed by it. It has the hallmark of a good theory, that it leads *both* to better linguistic descriptions *and* to stronger cross-linguistic generalizations and universals. Going beyond the typology of segmental inventories and syllable structure, the relevance of lexical representations is worth exploring further in dispersion theory, language acquisition, language use, and sound change.

[47] The exception is Pāṇini's Aṣṭādhyāyī, built from scratch strictly by using minimum description length as the sole criterion for establishing both the generalizations and the formalism in which these are expressed. This was done by defining the technical terms and conventions of the system in the grammar itself, so that minimum description length then requires that they are introduced if and only if they reduce the overall length of the grammar — that is, if the minimum possible cost of defining them is outweighed by the maximum possible grammatical simplification they allow. Autochtonous philologies such as that of the Japanese *kokugakusha* (Bedell 1968) and the Arabic tradition originating with Sibawayh (Versteegh 1997) also describe their respective object language in its own terms, but they were not comprehensive grammars in the modern sense. They were more concerned with settling points of usage and philosophical issues than with grammatical analysis per se.

References

ABITOV ET AL. 1957. *Grammatika kabardino-čerkesskogo literaturnogo jazyka.* AN SSSR, Moskva 1957.

ALBER, BIRGIT. 2005. Clash, Lapse and Directionality. *NLLT* 23: 485–542.

ANDERSON, STEPHEN R. 1978. Syllables, segments, and the Northwest Caucasian languages. In Syllables and segments, ed. Alan Bell and Joan B. Hooper, 47-58. New York: North-Holland Publishing Co.

ANDERSEN, HENNING. 1969. A study in diachronic morphophonemics: The Ukrainian prefixes. *Language*. 45: 807-830.

ANDERSON, STEPHEN R. 2000. Reflections on "On the phonetic rules of Russian". *Folia linguistica* 34: 11-27.

APPLEBAUM, AYLA & MATTHEW GORDON. 2013. A comparative phonetic study of the Circassian languages. In Chundra Cathcart, Shinae Kang, & Clare S. Sandy (eds.) *Proceedings of the 37th Annual Meeting of the Berkeley Linguistics Society: Special Session on Languages of the Caucasus,* pp. 3-17.

AUSTIN, PETER & JOAN BRESNAN. 1996. Non-configurationality in Australian aboriginal languages. *Natural Language and Linguistic Theory* 14: 215-268, 1996.

AVERY, PETER, B. ELAN DRESHER & KEREN RICE (EDS.). 2008. *Contrast in Phonology. Theory, Perception, Acquisition.* Berlin, Boston: De Gruyter Mouton.

BAGOV, P. M., B. X. BALKAROV, T. X. KUAŠEVA, M. A. KUMAXOV, G. B. ROGOVA (EDS.). 1970. *Grammatika kabardino-čerkesskogo literaturnogo jazyka, 1. Fonetika i morfologija.* Moskva: Nauka.

BARRETEAU, DANIEL. 1988. *Description du mofu-gudur : langue de la famille tchadique parlée au Cameroun.* Paris: Editions de l'ORSTOM.

BEDELL, GEORGE. 1968. *Kokugaku grammatical theory.* PhD dissertation, MIT, Cambridge, MA.

BENDER, BYRON W. 1963. Marshallese phonemics: labialization or palatalization? *Word* 19: 335-341.

BENDER, BYRON. 1968. Marshallese phonology. *Oceanic Linguistics* 7: 16-35. `http://www.jstor.org/stable/3622845`

BENDER, BYRON W. 1971. Micronesian languages. *Current Trends in Linguistics* 8.426-465.

BERMÚDEZ-OTERO, RICARDO. 2012. The architecture of grammar and the division of labour in exponence, in Jochen Trommer (ed.), *The morphology and phonology of exponence: the state of the art, pp. 8-83.* Oxford: OUP.

BERMÚDEZ-OTERO, RICARDO. 2015. Diachronic origins of opacity and incomplete neutralization. In Patrick Honeybone & Joseph Salmons (eds.) *Oxford Handbook of Historical Phonology.* Oxford: OUP.

BLEVINS, JULIETTE. 2009. Another universal bites the dust: Northwest Mekeo lacks coronal phonemes. *Oceanic Linguistics* 48.264-273.

BLOCH, BERNARD. 1941. Phonemic overlapping. *American Speech* 16: 278-84.

BLOCH, BERNARD. 1953. Contrast. *Language* 29: 59-61.

BLOOMFIELD, LEONARD. 1933. *Language*. Chicago: University of Chicago Press.

BLOOMFIELD, LEONARD. 1962. *The Menomini Language.* Edited by Charles F. Hockett. New Haven: Yale University Press.

BLUMENFELD, LEV. 2004. Tone-to-Stress and Stress-to-Tone: Ancient Greek Accent Revisited. *BLS* 30.
http://journals.linguisticsociety.org/proceedings/index.php/BLS/article/

BOAS, FRANZ AND DELORIA, ELLA. 1941. *Dakota Grammar.* (Memoirs of the National Academy of Sciences, 23.) Washington: U.S. Government Printing Office.

BOROWSKY, TONI. 1993. On the Word Level. In Sharon Hargus and Ellen Kaisse (eds.) *Studies in Lexical Phonology.* pp. 199-234. New York: Academic Press.

BREEN, GAVAN, & ROB PENSALFINI. 1999. Arrernte: A language with no syllable onsets. *Linguistic Inquiry* 30: 1–25.

CASALI, RODERIC F. 2014. Assimilation, markedness and inventory structure in tongue root harmony systems. ROA 1319.
http://roa.rutgers.edu/content/article/files/1319_casali_1.pdf.

CATFORD. J. C. 1942. The Kabardian language. *Maitre Phonétique*, 3rd Series 78: 15-18.

CATFORD, J. 1984. Instrumental data and linguistic phonetics. In Jo-Ann W. Higgs and Robin Thelwall (eds.), *Topics in Linguistic Phonetics, In Honour of E. T. Uldall*, 23-48. Coleraine, N. Ireland: New University of Ulster.

CHEN, HSIN-CHANG. 2012. Phonological variation and entailments in conditioned vowel shift: A case study of English *o*-fronting. MS., Stanford University.

CHOI, JOHN D. 1991. An acoustic study of Kabardian vowels. *Journal of the International Phonetic Association* 21(1): 4-12.

CHOMSKY, NOAM. 1964. *Current issues in linguistic theory.* The Hague: Mouton.

CHOMSKY, NOAM, AND MORRIS HALLE. 1968. *The sound pattern of English.* New York: Harper & Row.

CLAIRIS, C. 1977. Premiere approche du Qawasqar: Identification et phonologie. *La Linguistique,* 13: 145-152.

CLEMENTS, G. N. 2001. Representational economy in constraint-based phonology. In T. Alan Hall (ed.) *Distinctive feature theory.* Berlin & New York: Mouton de Gruyter. 71–146.

CLEMENTS, G. N. 2003. Feature economy in sound systems. *Phonology* 20:287–333.

COLARUSSO, J. 1982. Western Circassian vocalism. *Folia Slavica* 5: 89-114.

COLARUSSO, J. 1992. *A grammar of the Kabardian Language*. Calgary: University of Calgary Press.

COLARUSSO, J. 2006. *Kabardian (East Circassian).* Lincom Munich: Europa.

COMRIE, BERNARD. 1991. On Haruai vowels. In Andrew Pawley (ed.) *Man and a Half: Essays in Pacific Anthropology in Honour of Ralph Bulmer*, 393-397. Auckland: The Polynesian Society.

CURRIE-HALL, DANIEL. 2007. The role and representation of contrast in phonological theory. Ph.D. dissertation, University of Toronto. *Toronto Working Papers in Linguistics.*

CURRIE-HALL, K. 2013. "A typology of intermediate phonological relationships" *The Linguistic Review* 30: 215–275.

DECAMP, DAVID. 1958. The Pronunciation of English in San Francisco. Part 1. *Orbis* 7: 372-91.

DECAMP, DAVID. 1959. The Pronunciation of English in San Francisco. Part 2. *Orbis* 8: 54-77.

DELISI, JESSICA L. 2015. *Epenthesis and prosodic structure in Armenian: A diachronic account.* Ph.D. Dissertation, UCLA Indo-European Studies.

DELL, F. & TANGI, O. 1993. Syllabification and Empty nuclei in Ath-Sidhar Rifain Berber. *Journal of African Languages and Linguistics* 13: 125-162.

DINNSEN, DANIEL A. 1985. A re-examination of phonological neutralization. *Journal of Linguistics* 21: 265-279.

DIXON, R.M.W. 2009. *Basic Linguistic Theory. Volume 1: Methodology.* Oxford: OUP.

DOWNING, LAURA J. 1998. On the prosodic misalignment of onsetless syllables. *Natural Language and Linguistic Theory* 16: 1-52.

DRESHER, B. ELAN. 2009. *The contrastive hierarchy in phonology.* Cambridge: CUP.

EBELING, C.L. 1960. *Linguistic units.* The Hague: Mouton.

ELSON, MARK J. 1975. Symmetry in Phonology. *Language*. 51: 293-302.

EVANS, NICHOLAS & STEPHEN C. LEVINSON. 2009. The myth of language universals: Language diversity and its importance for cognitive science. *Behavioral and Brain Sciences* 32: 429–492.

EVANS, NICHOLAS & STEPHEN C. LEVINSON. 2010. Time for a sea-change in linguistics: Reponses to comments on "The myth of language universals". *Lingua* 120: 2733-2758.

FAST, P.W. 1953. Amuesha (Arawak) phonemes. *International Journal of American Linguistics* 19: 191-4.

FOUGERON, CÉCILE & RACHID RIDOUANE. 2008. On the phonetic implementation of syllabic consonants and vowel-less syllables in Tashlhiyt. *EFE* XVII: 139-175.

GORDON, M. & A. APPLEBAUM. 2006. Phonetic structures in Turkish Kabardian. *Journal of the International Phonetic Association* 36(2): 159-186.

GREENBERG, JOSEPH H., C. A. FERGUSON & E. A. MORAVCSIK (ED.). 1978 *Universals of human language*, volume 2. Stanford: Stanford University Press.

GUIMARÃES, MAXIMILIANO, & ANDREW NEVINS. 2013. Probing the representation of nasal vowels in Brazilian Portuguese with language games. *Organon* 28:155–178. `ling.auf.net/lingbuzz/001693/current.pdf`

GUSSENHOVEN, CARLOS. 1986. English plosive allophones and ambisyllabicity. *Gramma* 10: 119-142.

HALE, MARK. 2000. Marshallese phonology, the phonetics-phonology interface and historical linguistics. *The Linguistic Review* 17: 241-257.

HALL, TRACY. 1993. The phonology of German /R/. *Phonology* 10.43-82.

HALLE, MORRIS. 1959. *The Sound Pattern of Russian.* The Hague: Mouton.

HALLE, MORRIS. 1970. Is Kabardian a vowel-less language? *Foundations of Language* 6: 95-103.

HARRIS, JOHN. 1987. Non-structure-preserving rules in Lexical Phonology: Southeastern Bantu harmony. *Lingua* 72: 255-292.

HARRIS, JOHN. 1990. Derived phonological contrasts. In Susan Ramsaran (ed.) Studies in the pronunciation of English: A commemorative volume in honour of A.C. Gimson, 87-105. London: Routledge.

HARRIS, JAMES W., AND ELLEN M. KAISSE. 1999. Palatal vowels, glides and obstruents in Argentinean Spanish. *Phonology* 16: 117–190.

HENDERSON, JOHN & VERONICA DOBSON. 1994. *Eastern and Central Arrernte to English dictionary*. Alice Springs: Institute for Aboriginal Development.

HOFMANN, ERICA. 1990. A preliminary phonology of Bana. MA thesis, Univerity of Victoria.

HSIEH, FENG-FAN, MICHAEL KENSTOWICZ, & XIAOMIN MOU. 2006. Mandarin adaptations of coda nasals in English loanwords. In Andrea Calabrese and Leo Wetzels (eds.) *Loan Phonology: Issues and Controversies.* Amsterdam: John Benjamins.

HUALDE, JOSÉ IGNACIO. 2005. Quasi-phonemic contrasts in Spanish. In Benjamin Schmeiser, Vineeta Chand, Ann Kelleher & Angelo Rodriguez (eds.), *WCCFL* 23. Somerville, MA: Cascadilla Press.

HYDE, BRETT. 2002. A restrictive theory of metrical stress. *Phonology* 19: 313–359.

HYMAN, LARRY M. 1976. Phonologization. In A. Juilland (ed.), *Linguistic studies presented to Joseph H. Greenberg*, 407-418. Saratoga.

HYMAN, LARRY M. 1983. Are there syllables in Gokana? In Jonathan Kaye, Hilda Koopman, Dominique Sportiche, & André Dugas (eds.), *Current approaches to African linguistics*, vol. 2, 171–179. Dordrecht: Foris.

HYMAN, LARRY M. 1985. *A theory of phonological weight.* Dordecht: Foris.

HYMAN, LARRY M. 2008. Universals in phonology. *The Linguistic Review* 25: 83–137.

HYMAN, LARRY M. 2011. Does Gokana really have no syllables? Or: what's so great about being universal? *Phonology* 28: 55–85.

HYMAN, LARRY M. 2015. Does Gokana REALLY have syllables? A postscript. *Phonology* 32: 303-306.

ITÔ, JUNKO & ARMIN MESTER. 2003. Japanese morphophonemics: Markedness and word structure. Cambridge, Massachusetts: MIT Press Linguistic Inquiry Monograph Series 41.

ITÔ, JUNKO & ARMIN MESTER. 2015a. Sino-Japanese phonology. Chapter 7 of *Handbook of Japanese Phonetics and Phonology*, ed. by H. Kubozono. pp. 289-312. Berlin: Mouton de Gruyter.

ITÔ, JUNKO & ARMIN MESTER. 2015b. Word formation and phonological processes. Chapter 9 of *Handbook of Japanese Phonetics and Phonology*, ed. by H. Kubozono. pp. 363-395. Berlin: Mouton de Gruyter.

JAKOBSON, ROMAN. 1931. Die Betonung und ihre Rolle in der Wort- und Syntagmaphonologie. *Réunion Phonologique Internationale tenue à Prague: 18-21/XII 1930*, pp. 164-183. Praha, Jednota Československých Matematiků a Fysiků. Reprinted in *Selected writings 1: Phonological studies,* 1962, pp. 117–136. The Hague: Mouton.

JAKOBSON, ROMAN. 1958. Typological studies and their contribution to historical comparative linguistics. *Proceedings of the Eighth International Congress of Linguists*, Oslo. Reprinted in *Selected writings 1: Phonological studies,* 1962, pp. 523–532. The Hague: Mouton.

JAKOBSON, ROMAN, GUNNAR FANT, MORRIS HALLE. 1952. *Preliminaries to speech analysis.* Cambridge, Mass: MIT Press.

JAKOVLEV, N. F. 1923. *Tablitsy fonetiki kabardinskogo iazyka.* Trudy podrazriada issledovaniia severokavkazskikh iazykov pri Institute Vostokovedeniia v Moskve, I. Moscow.

JAKOVLEV, N. F. 1948. *Grammatika literaturnogo kabardinocherkesskogo jazyka.* Moscow.

JANDA, RICHARD D. 2003. "Phonologization" as the start of dephoneticization — or, on sound change and its aftermath: of extension, lexicalization, and morphologization. In Joseph, Brian D. and Richard D, Janda (eds.), *The handbook of historical linguistics,* p. 401-422. Oxford: Blackwell.

JURGEC, PETER. 2007. Schwa in Slovenian is epenthetic. 2nd Congress of the Slavic Linguistic Society. Berlin: ZAS. August 24.
`http://www.hum.uit.no/a/jurgec/schwa.pdf`.

KAGER, RENÉ. 2007. Feet and metrical stress. In de Lacy, Paul (ed.) *The Cambridge handbook of phonology.* Cambridge: Cambridge University Press.

KAHN, DANIEL. 1976. *Syllable-Based Generalizations in English Phonology.* Ph.D. thesis, MIT.

KAPLAN, ABBY. 2011. *Phonology Shaped by Phonetics: The Case of Intervocalic Lenition.* ROA 1077. `http://roa.rutgers.edu/article/view/1107`

KARVONEN, DAN. 2005. *Word Prosody in Finnish.* Ph.D. thesis, University of California at Santa Cruz.

KAWAHARA, SHIGETO. 2012. Review of Laurence Labrune 2012 *The phonology of Japanese. Phonology* 29. 540–548.

KENSTOWICZ, MICHAEL & NABILA LOURIZ. 2009. Reverse Engineering: Emphatic Consonants and the Adaptation of Vowels in French Loanwords into Moroccan Arabic. *Brill's Annual of Afroasiatic Languages and Linguistics* 1: 41–74.

KESSLER, BRETT. 1994. Sandhi and syllables in Classical Sanskrit. In E. Duncan, D. Farkas, & P. Spaelti (Eds.), *The proceedings of the Twelfth West Coast Conference on Formal Linguistics*, pp. 35–50. Stanford, CA: CSLI Publications.

KEYSER, S. J. & STEVENS, K. N. 2006. Enhancement and overlap in the speech chain. *Language* 82: 33-63.

KIM, SUSAN. 2001. Lexical Phonology and the Fricative Voicing Rule. Journal of Linguistics 29: 149-161.

KIPARSKY, PAUL. 1996. Allomorphy or morphophonology? In Rajendra Singh (ed.) *Trubetzkoy's Orphan: Proceedings of the Montréal Roundtable "Morphophonology: Contemporary Responses"*. Amsterdam: Benjamins, 1996.

KIPARSKY, PAUL. 2003. Syllables and moras in Arabic. In C. Fery and R. Vijver (ed.) *The Syllable in Optimality Theory.* Cambridge University Press.

KIPARSKY, PAUL. 2006. Amphichronic linguistics vs. Evolutionary Phonology. *Theoretical Linguistics*, 32: 217-236, 2006.

KIPARSKY, PAUL. 2015. Phonologization. In Patrick Honeybone & Joseph Salmons (eds.) *Oxford Handbook of Historical Phonology.* Oxford: OUP.

KIPARSKY, PAUL. TO APPEAR. *Paradigms and opacity.* Stanford: CSLI Press.

KLEBER, FELICITAS, TINA JOHN & JONATHAN HARRINGTON. 2010. The implications for speech perception of incomplete neutralization of final devoicing in German. *Journal of Phonetics* 38: 185-196.

KOEHN, EDWARD AND SALLY KOEHN. 1986. Apalai. In Derbyshire, Desmond & Pullum, Geoffrey, eds. *Handbook of Amazonian languages*, vol. 1, pp. 3-127.

KOHLER, K. J. 1966. Is the syllable a phonological universal? *Journal of Linguistics* 2: 207–208.

KORHONEN, MIKKO. 1969. Die Entwicklung der morphologischen Methode im Lappischen. *Finnisch-Ugrische Forschungen* 37: 203-62.

KUBOZONO, HARUO. 1999. The syllable as a unit of prosodic organization in Japanese. In Tsujumura, Natsuko (ed.), *The handbook of Japanese linguistics*, 31-61. Oxford: Blackwell.

KUBOZONO, HARUO. 2003. The syllable as a unit of prosodic organization in Japanese. In Caroline Féry & Ruben van de Vijver (eds.), *The syllable in optimality theory*, 99-122. Cambridge: CUP.

KUMAXOV, M. A. 1973. Teorija monovokalizma i zapadnokavkazskie jazyki. *Voprosy jazykoznanija* 4/1973: 54-67.

KUMAXOV, M. A. 1984. *Očerki obščego i kavkazskogo jazykoznanija.* Nal'cik : Izdatel'stvo El'brus.

KUIPERS, A. H. 1960. *Phoneme and Morpheme in Kabardian.* The Hague: Mouton.

LABOV, WILLIAM. 1994. *Principles of Linguistic Change.* Vol. 1.

LABRUNE, LAURENCE. 2012. Questioning the universality of the syllable: evidence from Japanese. *Phonology* 29: 113-152.

LADD, D. ROBERT. 2006. "Distinctive phones" in surface representation. In Louis M. Goldstein, D. H. Whalen, & Catherine T. Best (Eds.), *Laboratory Phonology* 8 (pp. 3–26). Berlin: Mouton de Gruyter.

LAYCOCK, D.C. 1965. *The Ndu language family.* Linguistic Circle of Canberra Publications, Series C, 1. Canberra: Australian National University.

LEVIN, J. 1985. *A metrical theory of syllabicity.* (doctoral dissertation, MIT).

LINDBLOM, BJÖRN. 1986. Phonetic universals in vowel systems. In John J. Ohala and Jeri J. Jaeger (eds.) *Experimental Phonology*. Orlando: Academic Press. 13–44.

LINDBLOM, BJÖRN. 1990. Explaining phonetic variation: a sketch of the H&H theory. In W. J. Hardcastle and A. Marchal (eds.) *Speech production and speech modelling*, pp. 403-439. Dordrecht: Kluwer.

LILJENCRANTS, J., & B. LINDBLOM. 1972. Numerical simulation of vowel quality systems: The role of perceptual contrast. *Language*, 48: 839-862.

MACMAHON, APRIL M.S. 1991. Lexical Phonology and sound change: the case of the Scottish vowel length rule. JL 27:29-53.

MADDIESON, IAN. 1984. *Patterns of sounds.* Cambridge: CUP.

MADDIESON, IAN. 2013. In: Dryer, Matthew S. & Haspelmath, Martin (eds.) *The World Atlas of Language Structures Online.* Leipzig: Max Planck Institute for Evolutionary Anthropology. http://wals.info/

MADDIESON, IAN & KRISTIN PRECODA. 1990. Updating UPSID. *UCLA Working Papers in Phonetics* 74: 104–111.

MANASTER-RAMER, ALEXIS. 1994. On Three East Slavic Non-Counterexamples to Stieber's Law. *Journal of Slavic Linguistics* 2: 164-170.

MARTIN, SAMUEL. 1975. *A reference grammar of Japanese.* New Haven: Yale University Press.

MARTINET, ANDRÉ. 1964. *Elements of general linguistics.* Chicago: University of Chicago Press.

MARTÍNEZ-GIL, FERNANDO. 1993. Galician nasal velarization as a case against Structure-Preservation. *Proceedings of the Nineteenth Annual Meeting of the Berkeley Linguistics Society*, pp. 254-267.

MATASOVIĆ, RANKO. 2006. *A short grammar of East Circassian (Kabardian).* Zagreb. http://mudrac.ffzg.unizg.hr/~rmatasov/KabardianGrammar.pdf

MCCARTHY, JOHN & ALAN PRINCE. 1986. *Prosodic Morphology 1986.* http://scholarworks.umass.edu/linguist_faculty_pubs/13

MCCARTHY, JOHN & ALAN PRINCE. 1993. *Prosodic Morphology I: Constraint Interaction and Satisfaction.* http://scholarworks.umass.edu/linguist_faculty_pubs/14

MCCAWLEY, JAMES D. 1968. *The phonological component of a grammar of Japanese.* The Hague & Paris: Mouton.

MOHANAN, K. P. 1982. Grammatical Relations and Clause Structure in Malayalam, in Joan Bresnan (ed.), *The Mental Representation of Grammatical Relations*, pp. 504-589. Cambridge, Mass.: The MIT Press.

NAGARAJAN, HEMALATHA. 1995. Gemination of stops in Tamil: implications for the phonology-syntax interface. https://www.ucl.ac.uk/pals/research/linguistics/publications/wpl/95paper

ODDEN, DAVID. 1995. The Status of Onsetless Syllables in Kikerewe. *OSU Working Papers in Linguistics* 47: 89-110.

Ó SIADHAIL, MÍCHEÁL. 1989. *Modern Irish: Grammatical Structure and Dialectal Variation.* Cambridge: CUP.

OHALA, JOHN. 1990. Alternatives to the sonority hierarchy for explaining segmental sequential constraints. In Michael Ziolkowski, Manuela Noske, and Karen Deaton (eds.) *Papers from the 26th Regional Meeting of the Chicago Linguistic Society. Vol. 2, The Parasession on the Syllable in Phonetics and Phonology*, 319–338. Chicago: University of Chicago, Chicago Linguistic Society.

OHALA, JOHN, & HARUKO KAWASAKI-FUKUMORI. 1997. Alternatives to the sonority hierarchy for explaining segmental sequential constraints: The shape of morphemes. In Stig Eliasson and Ernst Håkon Jahr (eds.) *Studies for Einar Haugen*, 343–365. Berlin: Mouton de Gruyter.

PADGETT, JAYE. 2010. Russian consonant-vowel interactions and derivational opacity. In Brown, W., A. Cooper, A. Fisher, E. Kesici, N. Predolac & D. Zec (eds.) *Proceedings of the eighteenth Formal Approaches to Slavic Linguistics meeting.* Ann Arbor: Michigan Slavic Publications, 353-382.

PARKER, ALIANA. 2011. It's that schwa again! Towards a typology of Salish schwa. *Working Papers of the Linguistics Circle of the University of Victoria* 21: 9–21.

PAWLEY, ANDREW, & RALPH BULMER. 2011. *A dictionary of Kalam with ethnographic notes.* Canberra, A.C.T.: Pacific Linguistics, School of Culture, History and Language, College of Asia and the Pacific, The Australian National University,

PENSALFINI, ROBERT. 1998. The development of (apparently) onsetless syllabification: a constraint-based approach. In Gruber, M. Catherine, Derrick Higgins, Kenneth Olson, Tamra Wysocki (eds.) *CLS* 32.

PENSALFINI, ROB. 1998. The development of (apparently) onsetless syllabification: a constraint-based approach.
`http://espace.library.uq.edu.au/view/UQ:11049/rpsyllab.pdf`

PIROTH, HANS GEORG & PETER M. JANKER 2004. Speaker-dependent differences in voicing and devoicing of German obstruents. *Journal of Phonetics* 32: 81-109.

PORT, ROBERT F. & MICHAEL O'DELL. 1985. Neutralization of syllable-final voicing in German. *Journal of Phonetics* 13: 455-471.

PORT, ROBERT F. & P. CRAWFORD 1989. Incomplete neutralization and pragmatics in German. *Journal of Phonetics*, 17: 257–282.

PRINCE, ALAN, & PAUL SMOLENSKY. 1993. Optimality Theory: Constraint interaction in generative grammar. RuCCS Technical Report 2, Rutgers University, Piscateway, NJ: Rutgers University Center for Cognitive Science. Revised version published 2004 by Blackwell.

RIDOUANE, RACHID. 2007. Gemination in Tashlhiyt Berber: an acoustic and articulatory study. *Journal of the International Phonetic Association* 37: 119-142.

ROCA, IGGY. 2005. Strata, yes, structure-preservation, no. In Geerts, Twan, Ivo van Ginneken, and Haike Jacobs (eds.) *Romance languages and linguistic theory 2003*. Amsterdam: Benjamins.

ROOD, DAVID S. 1975. Implications of Wichita phonology. *Language* 51: 315-337.

RUBACH, JERZY & GEERT BOOIJ. 1990. Syllable structure assignment in Polish. *Phonology* 7: 121-158.

RUBACH, JERZY. 2000. Backness switch in Russian. *Phonology* 17.1: 39-64.

RYAN, KEVIN. 2014. Onsets contribute to syllable weight: Statistical evidence from stress and meter. *Language* 90: 309–41.

ŠAGIROV, A. K. 1967. Kabardinskij jazyk, in: V. V. Vinogradov (ed.) *Jazyki narodov SSSR, T. IV, Iberijsko-kavkazskie jazyki,*, 165-183. Moskva: Nauka.

SCHWARTZ, JEAN-LUC, LOUIS-JEAN BOË, NATHALIE VALLÉE & CHRISTIAN ABRY. 1997. Major trends in vowel system inventories. *Journal of Phonetics* 25: 233-253.

SCOBBIE, JAMES M., & JANE STUART-SMITH. 2008. Quasi-phonemic contrast and the fuzzy inventory: examples from Scottish English. In: Avery, P., Dresher, B.E. & Rice, K. (eds.)

Contrast in Phonology: Theory, Perception, Acquisition. Berlin: Mouton de Gruyter, pp. 87-113.

SIMPSON, JANE. 1980. Cyclic syllabification and a first cycle rule of vowel-rounding in some dialects of Australian English. MS. http://ses.library.usyd.edu.au//bitstream/2123/1725/1/simpson-cyclic-syl

SMITH, TONY. 1999. *Muyang Phonology.* Yaoundé: SIL.

SOMMER, BRUCE. 1970. An Australian language without CV syllables. *IJAL* 36: 57-58.

SOMMER, BRUCE. 1970. The shape of Kunjen syllables. In D. L. Goyvaerts (ed.) *Phonology in the 1980s*, pp. 231-44.

STERIADE, DONCA. 1999. Alternatives in syllable-based accounts of consonantal phonotactics. In Osamu Fujimura, Brian Joseph, & Bohumil Palek (eds.), *Proceedings of LP* 1998, v.1, 205- 246. Prague: Charles University and Karolinum Press.

STEVENS, K.N. & KEYSER, S.J. 1989. Primary features and their enhancement in consonants. *Language* 65: 81-106.

SVANTESSON, JAN-OLOF, ANNA TSENDINA, ANASTASIA M. KARLSSON & VIVAN FRANZEN. 2005.

THE PHONOLOGY OF MONGOLIAN. Oxford: Oxford University Press.

SVANTESSON, JAN-OLOF, ANNA TSENDINA, ANASTASIA M. KARLSSON & VIVAN FRANZEN. 2005.

THE PHONOLOGY OF MONGOLIAN. Oxford: Oxford University Press.

TABAIN, MARIJA, GAVAN BREEN & ANDREW BUTCHER. 2004. VC vs. CV syllables: a comparison of Aboriginal languages with English. *Journal of the International Phonetic Association* 34: 175-200.

TOMLIN, RUSSELL S. 1986. *Basic word order: functional principles.* London: Croom Helm.

TOPINTZI, NINA. 2010. *Onsets: suprasegmental and prosodic behaviour.* Cambridge: Cambridge University Press.

TOPINTZI, NINA,AND ANDREW NEVINS. 2014. Arrernte moraic onsets: stress and beyond. http://www.enl

TRANEL, BERNARD. 1992-1994. Tone sandhi and vowel deletion in Margi. *Studies in African Linguistics* 23: 111-183.

TRUBETZKOY, N. S., 1925. Review of Jakovlev 1923. *Bulletin de la Société de Linguistique de Paris*, XXVI p. 277 ff.

TRUBETZKOY, N. S. 1929. Zur allgemeinen Theorie der phonologischen Vokalsysteme. *Travaux du Cercle Linguistique de Prague* 1, p. 39 ff.

TRUBETZKOY, N. S., 1939. *Grundzüge der Phonologie.* Prague: Travaux du Cercle Linguistique de Prague, No. 7.

TURCHANINOV, G. & M. TSAGOV. 1940. *Grammatika Kabardinskogo Jazyka.* Moscow: Izdatel'stvo Akademii Nauk.

TURPIN, MYFANY. 2012. The metrics of Kaytetye rain songs, a ceremonial repertory of Central Australia. http://linguistics.ucla.edu/event/icalrepeat.detail/2012/10/03/325/-/pho

VAUX, BERT. 1998a. The laryngeal specifications of fricatives. *Linguistic Inquiry* 29: 497-511.

VAUX, BERT. 1998b. The phonology of Armenian. Oxford: Oxford University Press.

VAUX, BERT. 2003. 'Syllabification in Armenian, Universal Grammar, and the Lexicon,' Linguistic Inquiry 34: 91-125.

VAUX, BERT & ANDREW WOLFE. 2009. The Appendix. In Eric Raimy & Charles E. Cairns (eds.) , *Contemporary Views on Architecture and Representations in Phonology*. Cambridge, MA.: MIT Press.

VAUX, BERT & BRIDGET SAMUELS. 2015. Explaining vowel systems: dispersion theory vs natural selection. *The Linguistic Review* 32: 573–599.

VENNEMANN, THEO. 1972. On the theory of syllabic phonology. *Linguistische Berichte* 18: 1-18.

VERSTEEGH, KEES. 1997. The Arabic linguistic tradition. In *Landmarks in Linguistic Thought* vol. 3. London: Routledge.

WAGNER, MICHAEL. 2002. The Role of Prosody in Laryngeal Neutralization. *MIT Working Papers in Linguistics* 42: 373-392.

WELLS, JOHN. 1982. *Accents of English.* Cambridge: Cambridge University Press.

WIESE, RICHARD. 1986. Schwa and the structure of words in German. *Linguistics* 24: 697-724.

WIESE, RICHARD. 2000. *The phonology of German.* Oxford: OUP.

WILLSON, HEATHER. N.D. *A brief introduction to Marshallese phonology.* `http://linguistics.byu.edu/faculty/hwills1/ABriefIntroductiontoMarshalle`

WOOD, SIDNEY. 1994. A spectrographic analysis of vowel allophones in Kabardian. *Working Papers* 42, pp. 241-250. Lund: Lund University Department of Linguistics.