Set the Controls for the Heart of the Alternation: Dahl's Law in Kitharaka

Christian Uffmann
University of Sussex

Abstract

This paper looks at Dahl's Law, a voicing dissimilation process found in a number of Bantu languages, in Kitharaka, and argues that it is best analysed within a framework of minimal (contrastive) feature specifications. We show that the standard account of [±voice] dissimilation runs into a number of problems in Kitharaka and propose a new analysis, couched within the framework of the Parallel Structures Model of Feature Geometry (Morén 2003; 2006) and Optimality Theory, thereby also addressing the question of the division of labour between constraints and representations. The analysis shows that it is crucial to look at the whole system of phonological oppositions and natural classes in Kitharaka to understand how the process works, ultimately also using loanwords to glean crucial insight into how the phoneme system of Kitharaka is organised.

1. Introduction

There is a long-standing debate in phonology about where in the theoretical model linguistically significant generalisations reside. Much work in the past 20 years was devoted to identifying constraint interaction as the prime locus of such generalisations, most prominently in the framework of Optimality Theory (henceforth OT; Prince and Smolensky 1993). Research on the contribution of phonological representations, so prominent in the 1980s, has taken a back seat by comparison. This paper will address the question of the division of labour between constraints and representations, arguing that some generalisations are better made in the theory of representations (while others are best accounted for as constraint interaction), by looking at Dahl's Law, a dissimilatory process, in the Bantu language Kitharaka.

Besides addressing this overarching theoretical question, this paper has several other goals. Firstly, it demonstrates that even a seemingly straightforward alternation has its complications when analysed carefully with the whole phonological system of the language in mind. Secondly, it makes a case for privative features and feature specifications that only encode contrast, but little phonetic detail (also discussing how much non-contrastive information is encoded). Thirdly, it adds new data to discussions of Dahl's Law in Bantu, proposing a different analysis from the standard approach.

The standard approach goes as follows. Dahl's Law is a voicing dissimilation process found in a number of Eastern Bantu languages (see, for example, Meinhof 1906, Davy and Nurse 1982). A prefix stop which is underlyingly voiceless, will be voiced if the stem – or a subsequent prefix – starts with a voiceless segment. The prefix thus dissimilates in voicing from the stem or a following prefix. Usually, this alternation can be seen with velar /k/, though the alternation may also involve /t ∼ d/ and /p ∼ b/ in some languages. (1) gives some example forms from Kikuria (Odden 1994).

(1) Dahl's Law in Kikuria (Odden 1994)

oko-gaamba	'to say'	oko-reenda	'to guard'
oko-raara	'to sleep'	oko-bara	'to count'
ogo-tema	'to hit'	ogo-sooka	'to respect'
ogo-koŋoonta	'to split'	ugu-kuura	'to cry'

The examples show prefixal /k/, here, the infinitive (class 15) prefix *oko∼uku* (the alternation is due to vowel height harmony operating in this language), showing up as /g/ when followed by a voiceless segment, such as [t, s, k] (but except [h]). We will look at how the process manifests itself in Kitharaka in §2, pointing out some complications in the data and drawing up a list of issues that a formal analysis must address. We

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will argue that it is crucial to establish what the system of distinctive feature specifications in Kitharaka is, looking at the consonant system in general. We will therefore establish how the consonant system of Kitharaka is best analysed in terms of contrasts and oppositions (§3), develop a system of features specifications, couched within the Parallel Structures Model of Feature Geometry (Morén 2003) in §4, before presenting an analysis of Dahl's Law in the framework of Optimality Theory in §5. §6 discusses and concludes.

2. Dahl's Law in Kitharaka

Kitharaka is an Eastern Bantu language (E 54 in Guthrie's classification, as part of the Kikuyu-Kikamba or Central Kenya Bantu cluster, Guthrie 1967-1971), spoken by about 100,000 speakers in Kenya (Ethnologue), a very close relative to Kikuyu. Typical of Bantu languages, syllable structure is largely CV, but glides are permissible in onsets, yielding CGV structures. In addition, there are nasal + consonant (NC) sequences, the status of which will be discussed in detail below. This section will first review the pertinent data, then establish some pretheoretical generalisations regarding the workings of Dahl's Law in Kitharaka and sketch the main theoretical and analytical challenges that an analysis has to tackle.

2.1. The data

(2) gives some examples of Dahl's Law operating in Kitharaka, affecting the dorsal stop /k/. One observation is immediately striking: the alternation is not between [k] and [g], involving a simple change in voicing, but between [k] and [ɣ], involving a change in continuancy as well. We may be tempted to disregard this as minor phonetic detail, as Lombardi does in her analysis of Dahl's Law in Kikuyu, where we find the same alternation between [k] and [ɣ], and where she posits a postlexical adjustment rule that realises all underlying /g/ as [ɣ] (Lombardi 1995). This paper will argue that treating spirantisation as a phonetic surface phenomenon is problematic, and that the alternation is therefore more than a simple change in [voice].

(2) Dahl's Law in Kitharaka: examples[1]

a. [ɣ] before [p, t, c, k]

ɣapaandi	'small grasshopper'
ɣoto	'ear'
ɣeciko	'spoon'
ɣakaβo	'basket'

b. [k] elsewhere

keβaaŋga	'big knife'
koɣoro	'leg'
kerema	'mountain'
kajɔɣu	'small elephant'
kamote	'small tree'
kaanini	'small (class 12)'
kaɲua	'mouth'

Generally, though, this looks like a well-behaved version of Dahl's Law. A voiceless stop [p, t, c, k] triggers dissimilation. Prefix /k/ will be realised as [ɣ]. There are some complications to this picture, however. At this point, it is helpful to look at the consonants of Kitharaka. The table in (3) is based on auditory phonetic impression; segments will be reclassified later.

[1] In Kitharaka, as in all Bantu languages, nouns belong to noun classes, expressed by prefixes. These are not given here, since they are not relevant to this topic. Note, however, the repeated occurrence of the diminutive (class 12) prefix *ka-* and the augmentative (class 7) *ke-* here, also demonstrating that the process is productive.

(3) The consonants of Kitharaka (phonetically)

	labial	dental	alveolar	palatal	velar
stop	p		t	c	k
fricative	β	θ∼ð			ɣ
nasal	m		n	ɲ	ŋ
nas+stop	mp mb		nt nd	ɲc ɲɟ	ŋg ŋk
approximant				j	
trill			r		

Note that there are no voiced stops in Kitharaka, except in nasal+stop combinations, the phonological status of which will be discussed presently. The phonological status of [β, ɣ] will also be scrutinised in greater detail. They are classified as voiced fricatives for the moment, but they might as well be sonorants. Among fricatives, note that the dental fricative varies in voicing; it can be realised as [θ] or [ð], but never triggers Dahl's Law, regardless of actual phonetic voicing (the native speaker consultant produced many instances of voiceless [θ]). This raises the question of how the dental fricative is specified phonologically. Note that the situation is the reverse in Kikuyu. There, the dental fricative is also variably voiced but always triggers dissimilation (e.g [ɣoðeka] 'to laugh', Lombardi 1995).

(4) [k] before [θ∼ð]

kaθaani ∼ kaðaani	'small plate'
koθingata ∼ koðingata	'to follow'
kiθaraaka ∼ kiðaraaka	'Kitaharaka'

A second interesting complication arises when we look at the locality conditions that hold for this process. What can stand between trigger and target? In other words, how far away from the initial [k] can a voiceless stop have to be to trigger the process? (5) shows that the process can bridge hiatus, i.e go across a vowel sequence, which would standardly be analysed as heterosyllabic.[2]

(5) Dissimilation and hiatus

kaiθe	'surprise sale item for fundraisers'
ɣeato	'big beehive'

In addition, a nasal consonant in an NC cluster is also transparent to dissimilation.

(6) Dissimilation across nasals and glides in clusters

ɣoonto	'somewhere'
ɣaaŋki	'small fire'
ɣɛɛmpɛ	'small wooden honeypot'
ɣwiɲcja	'to close the eyes'
ɣjɛmpɛ	'big wooden honeypot'

As the examples in (6) show, prefix /k/ dissimilates to a voiceless stop that follows a nasal directly. Nasals are not generally transparent, like vowels: a singleton onset nasal will block the process from applying, as in [kamote] 'small tree' (*[ɣamote]). Note that glides in onset clusters are also transparent; morphologically, they are underlying vowels, e.g. [ɣwiɲcja] from /ko+iɲcja/. Hiatus and NC cluster can also combine, as in [ɣaiɲci] 'thorny shrub fence', where initial /k/ dissimilates to a /c/, separated by two vowels, hence an additional syllable boundary, and a nasal consonant. waMberia (2002) tries to save the generalisation that

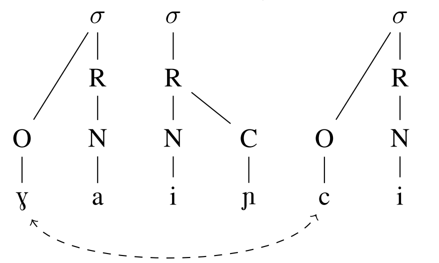
[2]We are aware that this is a somewhat contentious issue. Davy and Nurse (1982) argue that some vowel sequences in Kikuyu are in fact tautosyllabic, because Dahl's Law applies across them, while others are heterosyllabic, blocking dissimilation. If we accept their analysis, we could also argue for Kitharaka that dissimilation across vowel sequences means that they are not heterosyllabic. On the other hand, their claim that the difference in dissimilation is due to different syllabification is stipulative; the morphological structure of the blocking sequences is also different, involving specific prefixes. We cannot resolve the issue here but think that our analysis should account for the conservative assumption that vowel sequences are parsed into different syllables.

/k/ dissimilates to the nearest consonant by positing that these nasals underwent a phonological devoicing process. This analytic move looks stipulative, though, is not backed up independently, and seems to be motivated only by saving the generalisation that /k/ dissimilates to the nearest consonant. Therefore, we will assume that nasals in clusters are indeed transparent to the process.

2.2. *Locality*

To summarise, Dahl's Law in Kitharaka is subject to an interesting locality requirement. Initial /k/ does not just dissimilate in voicing to the nearest consonant, because glides, as second members of an onset, and coda nasals can be skipped (if NC in Kitharaka is indeed a coda-onset cluster, a point we will return to in the next section). It is also questionable that it dissimilates to the next syllable, as examples of dissimilation across vowel sequences show. Instead, the condition for dissimilation seems to be that two voiceless stops be in adjacent syllable onsets. This locality condition is, to our knowledge, hitherto unreported. In his typological survey, Odden (1994) distinguishes between root-adjacent, syllable-adjacent and unbounded interactions. The different transparent or blocking behaviour of nasals and glides, however, forces such a conclusion. Nasals block dissimilation when they stand in onsets but are transparent in codas. Dissimilation across hiatus suggests that trigger and target need not be in adjacent syllables. (7) illustrates this relation, using the example [ɣaiɲci] 'thorny shrub fence', which combines a coda nasal and hiatus.

(7) Dahl's Law: between adjacent onsets.



2.3. *Theoretical implications*

Empirically, the analysis of Dahl's Law in Kitharaka poses several challenges and suggests theoretical implications, which we shall discuss briefly now. The main two challenges are (a) to define the set of triggers and to establish how the change /k/ → [ɣ] should be formalised (if it is not a straightforward case of voicing dissimilation), and (b) to capture the locality conditions. Both challenges crucially involve feature specifications. This paper will explore the idea of underspecified representations and privative features, roughly along the lines of the Parallel Structures Model of Feature Geometry (PSM; Morén 2003; 2006; see also e.g. Youssef 2010, Iosad to appear for applications).

We will argue that Dahl's Law in Kitharaka provides evidence for the assumption that features are privative, and that segments are only specified contrastively. The argument, which will be developed in the course of this paper, roughly goes as follows: As a basic assumption we take the autosegmental notion of assimilation and dissimilation where interacting segments must be adjacent at some level.[3] The OCP can then be invoked as a prohibition against two tier-adjacent occurrences of a feature. If all segments were fully specified for [voice], we could not capture the alternation, since the segments that intervene between trigger and target, redundantly specified for [±voice], would block the interaction. Whatever the interacting feature is, intervening material should not be specified for it. In the case of [±voice] dissimilation, we should therefore assume that vowels (at a minimum) are not specified as [+voice], since voicing on vowels

[3] We will briefly explore alternative notions towards the end.

is redundant. In addition, there is evidence for feature privativity as well. If the process was just a case of dissimilation of [±voice], specified on consonants, why are nasals sometimes transparent (in clusters)? If features are privative, this problem disappears. Only feature bearers (voiceless stops) interact, and all other segments simply are not specified for the dissimilating feature, hence cannot block. The only blocking condition is the locality condition that requires interacting segments to be in adjacent onsets.

In addition, the alternation between [k] and [ɣ], which phonetically involves more than just a change in voicing, can probably also be captured more simply and elegantly in a system of underspecified segments. The question then is how the segments of Kitharaka are specified. This is the topic of the next section, which looks at phonological processes to establish natural classes of segments and develops a system of contrastive specifications from this phonological behaviour, in line with the basic assumptions of the PSM.

3. The Consonants of Kitharaka

This section discusses the organisation of the Kitharaka consonant inventory, its system of oppositions, establishing natural classes of segments. This will feed into a discussion of distinctive feature specifications in the subsequent section. Crucial evidence for the organisation of the phoneme system comes from NC sequences, the status of which we have not yet discussed systematically, simply assuming that they are clusters. There is an alternative possibility, that they are prenasalised (complex) segments, and it has been argued for many Bantu languages that they have prenasalised segments.[4] The question is how Kitharaka NC sequences should be analysed, as singleton segments or as clusters. Evidence comes from phonological behaviour, (a) their distribution in a word and (b) combinatorics of N and C.

To start with the latter point, if these sequences are clusters, we can expect pretty much any consonant to combine with a nasal, and there should be relatively few restrictions on combinatorics, and few neutralisations. In contrast, the set of prenasalised consonants in any language that has them is typically much smaller than the set of simplex segments. In Shona, for example, prenasalised segments only occur with voiced stops, affricates and fricatives (e.g. Doke 1931, Fortune 1981). Other languages may only allow prenasalised voiced stops.

If the sequences are clusters, we do not expect to find them anywhere in the word, though. If they are coda-onset clusters, we would expect to find them word-medially rather than word- or morpheme-initially, since an NC sequence in an onset would violate the Sonority Sequencing Principle. Prenasalised segments should not show any such restrictions, being able to show up anywhere where a consonant can occur. We will look at these two arguments to see what kind of analysis is preferable in Kitharaka. As a welcome side effect, this will provide evidence for the organisation of the consonant system more generally.

3.1. NC distribution

Beginning with the distribution of NC sequences in a word, the evidence is mixed. (8) shows that they occur word-medially (a) as well as word-initially (b). However, all instances of word-initial clusters found involve a morpheme boundary, here, the class 9 prefix *N-*, or, for example, the 1st person singular verbal prefix, which is also *N-* in Kitharaka.

(8) Distribution of NC-sequences

a. word-medially

koriŋga	'to hit'
konɛɛŋkɛra	'to give'

[4] For a critical discussion, see, for example, Herbert (1986).

b. word-initially (with class 9 prefix)

mpaandi	'grasshopper'	-paandi
ntuundu	'owl'	-tuundu
ŋkaare	'car'	-kaare
mbori	'goat'	-βori
ɲɟɔɣu	'elephant'	-jɔɣu

In a cluster analysis, the initial nasal would have to be analysed as either extrasyllabic, or as a syllabic nasal (unless one accepts that the only onset clusters in the language would be falling sonority clusters). The informant's intuition and my own auditory impression were inconclusive. This does not necessarily support the analysis of these sequences as prenasalised complex segments, however. What speaks against such an analysis is that these sequences in initial position all seem to be morphologically complex. We will therefore turn to NC combinatorics for more conclusive evidence.

3.2. NC combinatorics

The examples in (9) demonstrate that there are no restrictions in the combinability of a nasal and a consonant, as long as the sequence is homorganic. A nasal can combine with any consonant, including nasals, which provides very strong evidence in favour of a cluster analysis. The examples in (9) all are hortative constructions in the 1st person singular. The first person singular prefix is *N-*, thus creating a cluster. The hortative prefix *ka-* additionally shows the productivity of Dahl's Law across NC clusters: Initial /k/ dissimilates to [ɣ] if the cluster contains a voiceless stop as a second segment.

(9) 1st sg. hortative constructions

ɣaamperiɛ	'let me deny'	-peria
ɣaantaikɛ	'let me vomit'	-taika
ɣaaɲciatɛ	'let me wipe'	-ciata
ɣaaŋkoorɛ	'let me uproot'	-koora
kaambatɛ	'let me pluck maize'	-βata
kaandiŋgɛ	'let me hit'	-riŋga
kaanɟjatɛ	'let me sweep'	-jiata
kaaŋgitɛ	'let me cut'	-ɣita
kammeɲɛ	'let me know'	-meɲa
kannɛŋkɛrɛ	'let me give'	-nɛŋkɛra
kaɲɲoroontɛ	'let me despise'	-ɲoroonta
kaanθiŋgatɛ	'let me follow'	-θiŋgata

Any of the consonant phonemes of Kitharaka can combine with a nasal, and no contrasts are neutralised. A nasal can combine with any of the four voiceless stops, assimilating in place (and the voiceless stops will trigger Dahl's Law). Nasals combine with nasals as well, yielding surface geminates. These facts speak strongly in favour of a cluster analysis. The alternative would have to be to state that every oral consonant of Kitharaka also exists as a prenasalised version, and to have a separate explanation for nasal gemination. The only piece of evidence in favour of a single segment approach may be the fact that NC clusters cause lengthening of a preceding vowel, which since Clements (1986) has traditionally been analysed as a case of compensatory lengthening; see, however, Downing (2005) for an analysis of this lengthening as a more general, phonetically grounded case of pre-nasal lengthening.

For general arguments in favour of a cluster analysis, also see Downing (2005). In Kitharaka, there are independent reasons not to view this lengthening as compensatory. First, there are some lexical exceptions where the process does not apply morpheme-internally, as, for example, [koriŋga] 'to hit' and [koθiŋgata] 'to follow'. Secondly, lengthening is blocked in reduplication, as in (10). NC sequences are thus possible without concomitant lengthening; hence lengthening is no good argument in favour of analysing NC sequences as prenasalised segments.

(10) Reduplication and lack of pre-NC lengthening

-taaŋga	'disturb'	ɣo-taaŋga-taŋga	'to disturb every now and then'
-muunta	'pierce'	ko-muunta-munta	'to pierce quickly or many times'
-nɛɛŋkɛra	'give'	ko-nɛɛŋkɛra-nɛŋkɛra	'to give quickly'

In sum, then, NC sequences are best analysed as clusters in Kitharaka: nasals and consonants combine freely, and initial clusters are heteromorphemic. The locality conditions for Dahl's Law thus have to state that some nasals (those in clusters) are transparent to the process while others block it. In addition, we find some evidence for the organisation of the consonant system. While there are no neutralisations of contrasts, the generation of an NC clusters does trigger one process: [β, r, j, ɣ] become voiced stops [b, d, ɟ, g] in the clusters [mb, nd, ɲɟ, ŋg]. Thus, four sounds, which an impressionistic auditory classification put in different categories, actually form a natural class of continuants or perhaps sonorants in Kitharaka. We can thus propose the reclassification in (11). Based on phonological behaviour, observable in NC clusters, Kitharaka has three parallel series of labial, alveolar, palatal and velar stops, nasals and sonorants, plus one fricative.

(11) The consonants of Kitharaka (phonologically)

a. plain consonants

	labial	coronal	palatal	velar
stop	p	t	c	k
fricative		θ∼ð		
nasal	m	n	ɲ	ŋ
sonorant	β	r	j	ɣ

b. in nasal clusters

	labial	coronal	palatal	velar
stop	mp	nt	ɲc	ŋk
fricative		nθ∼nð		
nasal	mm	nn	ɲɲ	ŋŋ
sonorant	mb	nd	ɲɟ	ŋg

The next section will use this classification as a starting point, motivating it in detail and discussing what distinctive feature specifications should be assumed, using the minimal and purely contrastive specifications of the Parallel Structures Model as a starting point.

4. Feature Specifications

Motivating the consonant system in (11), we can identify a number of natural classes, justified by their phonological behaviour:

1. Voiceless stops [p, t, c, k]: triggers of Dahl's Law
2. Sonorants/continuants [β, r, j, ɣ]: harden to voiced stops in NC clusters
3. Nasals [m, n, ɲ, ŋ]: first element of clusters, undergo place assimilation
4. Plus evidence for four places of articulation, based on place assimilation facts: labials [p, β, m], alveolars/dentals [t, r, n, θ∼ð], palatals [c, ɟ, ɲ], velars [k, ɣ, ŋ].

We will now consider how this translates into feature specifications. As shown in Dresher (2009), contrast is not a given but only follows from the careful analysis of oppositions in a language and the phonological activity of classes of sounds. We will therefore explore several options and weigh the evidence.

4.1. Dahl's Law as manner dissimilation

In terms of a theory of strictly minimal feature specifications, we face a problem: Dahl's Law is generally known as a voicing dissimilation process, but impressionistically, laryngeal specifications do not seem to be contrastive in Kitharaka; we don't need reference to voicing to contrastively specify all phonemes. It would suffice to assume a class of stops, voiceless by default, two classes of sonorants and nasals, voiced by default, and a single fricative, which varies in voicing and is therefore unspecified for [voice] as well. The table in (12) illustrates how we can classify the consonants of Kitharaka without any recourse to laryngeal features, just in terms of manner features. In the PSM, manner features are contained under a C-Manner and a dependent V-manner node; traditional features are replaced with [open] and [closed]; stops are classified as C-manner [closed], while fricatives are C-manner [open].

(12) Feature specifications without laryngeal features

	C-manner [closed]	C-manner [open]	[nasal]
/p, t, c, k/	✗		
/β, r, j, ɣ/			
/m, n, ɲ, ŋ/			✗
/θ∼ð/		✗	

In line with the assumptions of the PSM, manner specifications are minimal, and there has to be one set of mannerless segments (Morén 2003; 2006). The set of 'sonorants' was chosen as the mannerless set, because it shows relatively wide latitude in terms of phonetic realisations, as a glide, a trill, or a voiced spirant, and, following a nasal, as a voiced stop. This allophonic variation would, in the spirit of the PSM, not be treated as phonological, but could be explained as the phonetically natural choice, since nasals are also stops. The status of nasals is somewhat unclear in the PSM. Many actual analyses dispose of the feature [nasal] and express this contrast differently (see, for example, Morén 2006). For the moment, let us assume a traditional [nasal] feature.

Dahl's Law would suddenly look quite different, not as a voicing dissimilation process, but as a case of long-distance manner dissimilation, disallowing two C-manner [closed] features in subsequent onsets. The first segment would then simply shed its [closed] feature, yielding mannerless [ɣ]. While this conveniently formalises the change [k] → [ɣ] as a single change, it seems typologically rather odd: long-distance manner dissimilation of stops is robustly unattested. Is there a way of capturing the process as laryngeal dissimilation?

4.2. Dahl's Law as laryngeal dissimilation

When thinking of Dahl's Law as voicing dissimilation, the view that features are privative causes an immediate problem, because what dissimilates in Kitharaka is two voiceless segments, in other words, those segments that would not be laryngeally specified in standard feature theory.[5] Lombardi (1995) faces the same problem in Kikuyu, forcing her to assume that the dissimilating prefix velar is underlyingly [voice] /ɣ/, and that [k] is derived. This implies, though, that all sonorants are redundantly specified as [voice], including variably voiced /θ∼ð/.

An elegant way out of this problem is to assume that the dissimilating feature is not [voice], but rather [spread glottis] — in PSM terminology, C-laryngeal [open]. Dahl's Law would therefore be a prohibition against onset-adjacent instances of C-laryngeal [open]. Phonetically, this is unproblematic. Voiceless stops in Kitharaka are in fact aspirated. An additional benefit is that it makes Dahl's Law typologically normal, a Bantu version of Grassmann's Law. But how would this translate into distinctive feature specifications?

We could simply replace the stop feature C-manner [closed] in (12) with C-laryngeal [open]; then, there would be a set of aspirated segments which by default is realised as voiceless stops. The downside of this is that it yields an odd and random looking mix of manner and laryngeal features, setting up contrast between aspirated sounds, fricatives and nasals, as opposed to a straightforward three-way manner distinction. A more elegant solution would be to reconceptualise the representation of nasality. As stated earlier, the status of [nasal] is unclear in the PSM. Nasals, however, are also stops, traditionally specified as

[5] Though see Blaho (2008) for use of a feature [voiceless].

[−continuant], here C-manner [closed]. In that case, a laryngeal feature can come in to establish contrast between nasal and oral stops. The table in (13) illustrates this alternative classification, which uses manner and laryngeal features, disposing of [nasal], very much in the gist of, for example, Morén (2006).[6]

(13) Feature specifications with C-laryngeal [open]

	C-manner [closed]	C-manner [open]	C-laryngeal [open]
/p, t, c, k/	✗		✗
/β, r, j, ɣ/			
/m, n, ɲ, ŋ/	✗		
/θ∼ð/		✗	

There is a problem with this approach, however. Removing a C-laryngeal [open] specification in the application of Dahl's Law would yield a nasal stop. An ad-hoc adjustment rule would become necessary. In other words, there is no longer a natural explanation for why [ɣ] is the optimal repair for an illicit sequence of [k] and another voiceless (aspirated) stop: [ŋ] would be the expected repair instead.

The conundrum can be solved if one allows some non-contrastive information in, assuming that feature specifications do go beyond pure underlying contrast. Of course, this is one of the central questions in phonology: Which allophonic alternations are phonological, which are a matter of phonetic implementation, and how can we find out? Most analyses seem to draw a rather arbitrary line. The PSM takes a conservative stance, encoding only underlying contrasts, unless there is clear evidence that an allophonic process is phonologically motivated. For now, let us assume that the alternation between [β, r, j, ɣ] and [b, d, ɟ, g] is indeed phonological, that there is a phonological series of voiced stops in Kitharaka, even though they may only appear after a nasal and the contrast is only on the surface (and we will look for a motivation of this later). Retaining the feature [nasal], the following specifications could be assumed:

(14) Feature specifications including voiced stops

	C-manner [closed]	C-manner [open]	[nasal]	C-laryngeal [open]
/p, t, c, k/	✗			✗
/β, r, j, ɣ/				
/m, n, ɲ, ŋ/	✗		✗	
[b, d, ɟ, g]	✗			
/θ∼ð/		✗		

In this case, removal of a C-laryngeal [open] specification from /k/ would yield [g]. Since [g] is not a licit segment unless preceded by a nasal, a further repair (removal of C-manner [closed]) yields [ɣ]. Thus, this approach also needs two steps to go from [k] to [ɣ], but both steps are motivated. An additional advantage of these specifications is that the post-nasal hardening of the mannerless continuants to voiced stops is easily explained as spreading of the C-manner [closed] feature. See also Padgett (1994; 1991) for showing how manner assimilation is often parasitic on place assimilation, especially nasal place assimilation, crosslinguistically. But which of the three feature analyses sketched here is to be preferred? Loanword adaptation provides some clues.

4.3. Evidence from loanwords

When languages borrow words, they are adapted to the phonological structure of the borrowing language. In the case of segments found in the donor language but not in the borrowing language, this usually means that these segments have to be replaced with licit ones. Sometimes, however, a foreign segment may be

[6] A reviewer suggests removing manner specifications altogether as an alternative way of establishing contrasts; the dental fricative would then have to be reigned in with one of the other classes and distinguished by a place feature. This seems to be at odds with the established dimensions of contrast, though, and we cannot think of a viable analysis in such terms, but still would like to mention it as an interesting alternative possibility, which cannot be pursued here.

retained. Through extensive borrowing it may ultimately become a segment of the borrowing language. Both such adaptations and non-adaptations provide clues about the feature specifications of Kitharaka.[7] First, consider some non-adaptations. Kitharaka only has one phonological fricative /θ/. So what happens when English words are borrowed containing /f, s, ʃ/? (15) shows that these are preserved. Infinitive forms of verbs are given here because the infinitive prefix is *ko-*, an undergoer of Dahl's Law. Now, if Dahl's Law had indeed been reanalysed as a manner dissimilation process, we would not expect initial /k/ to dissimilate to voiceless /f/ or /s/. If it still is a laryngeal dissimilation process, however, /k/ should dissimilate, and this is indeed what we find.

(15) Loanwords: voiceless fricatives

ɣasukuru	'school'	(attested; also [ɣacukuru])
ɣofirisi	'to freeze'	(attested)
ɣoʃiti	'to shit'	(ad-hoc borrowing)

As [f, s ʃ] trigger Dahl's Law, it cannot be a process of manner dissimilation. Instead, these 'new' fricatives seem to be classed as voiceless or aspirated, thus causing dissimilation. It may seem odd to classify [f, s ʃ] as [spread glottis] or C-laryngeal [open] but see Vaux (1998), who argues that the unmarked state of voiceless fricatives is to be [spread glottis], now also known as Vaux's Law (as labelled by Avery and Idsardi 2001). [θ ∼ ð] is not reclassified in this way because it is not a uniformly voiceless fricative but variably voiced, hence not subject to Vaux's Law. We can thus suggest the following amended table:

(16) Feature specifications including borrowed fricatives

	C-manner [closed]	C-manner [open]	[nasal]	C-laryngeal [open]
/p, t, c, k/	✗			✗
/β, r, j, ɣ/				
/m, n, ɲ, ŋ/	✗		✗	
[b, d, ɟ, g]	✗			
/θ∼ð/		✗		
/f, s, ʃ/		✗		✗

While the behaviour of borrowed fricatives demonstrates that dissimilation involves a laryngeal feature, there are still some open questions regarding the rest of the system. Are voiced stops as non-contrastive segments represented separately featurally, or should we assume that nasals are phonologically plain stops? Here, looking at the adaptation of voiced stops is helpful. (17) gives two examples of nonce borrowings with initial [d] and [g].

(17) Loanwords: voiced stops

kondansi	'to dance'	(ad-hoc borrowing)
koŋgeti	'to get'	(ad-hoc borrowing)

Perhaps surprisingly, these words are adapted as NC sequences. This behaviour suggests several things. Firstly, it means that Kitharaka [ŋg], not [ɣ], is seen as the nearest match for English [g]. This provides strong independent evidence against the view expressed by Lombardi that [ɣ] are underlying /g/ that undergo some surface adjustment, since then, we would expect English [g] to be identified as /g/ and adapted as [ɣ], if the adaptation process involves the identification of corresponding phonemes rather than surface phonetic similarity (see e.g. LaCharité and Paradis 2005). (Under the assumption of phonetically minimal adaptations, we should also expect a mapping of English [g] to Kitharaka [ɣ].) Secondly, this adaptation also supports the initially problematic assumption that the change /k/ → [ɣ] is not a single change but involves two separate changes. If [ɣ] were just a voiced version of /k/, we would expect it to be a good match for English [g] in adaptations, again assuming that adaptations are sensitive to the phonological status of

[7] Loanwords were elicited with a native speaker consultant, yielding both attested (established) Kitharaka loans as well as ad-hoc (nonce) borrowings of English words. There is no reason to assume that the consultant's intuitions are atypical.

segments in the donor language and that speakers would map the opposition /k–g/ onto a phonologically equivalent opposition in Kitharaka. Thirdly, it supports the view that the hardening of the continuants after nasals is a phonological process, as the resultant segment seems to be processed as a separate unit. Speakers identify [g] in a foreign word, and identify that it is a stop, aiming at preserving its stop quality, even at the cost of a prosthetic nasal. If [g] was just a phonetic variant of /ɣ/, its stop quality would be irrelevant phonologically, and we would expect English [g] to map onto Kitharaka [ɣ].

4.4. Interim summary

To conclude, we explored different options for classifying the Kitharaka inventory. Loanwords provide crucial evidence for the classification in (16) that supports the view that Dahl's Law still is a laryngeal dissimilation process, despite the fact that the underlying inventory of Kitharaka does not seem to display any contrast along the laryngeal dimension. This contrast is derived, however; voiced stops do exist on the surface, and loanword adaptation also provides crucial evidence here that this surface alternation is phonological in nature, that [b, d, ɟ, g] are seen as different segments than [β, r, j, ɣ] by speakers. This also shows that notions of contrast need to be defined carefully, and that in an analysis of a language the question about the number of phonologically – that is featurally – distinct segments is not trivial but requires careful analysis, supporting the notion expressed by Dresher (2009) that contrast is a language-specific concept, requiring careful analysis.

5. Analysis

With contrastive feature specifications established, an analysis of the actual process involved in Dahl's Law is straightforward. In theory-neutral terms, an initial /k/ will dissimilate to the next onset if it also contains an aspirated (C-Laryngeal [open]) segment. Dissimilation means that /k/ will lose its C-Laryngeal [open] feature. The resulting segment is [g], a dorsal consonant specified as C-manner [closed]. As [g] is not a licit segment if unsupported by a nasal, presumably because it has to share its manner specification with the preceding nasal, the problematic C-manner [closed] feature is also removed, yielding [ɣ]. In the following, I will briefly outline an Optimality-Theoretic analysis of this process. The reader may also formalise the process in their favourite theoretical framework and compare, if they so desire. The analysis will be based loosely on the autosegmental version of OT proposed in Uffmann (2005) and PSM-OT in Morén (2006).

To begin with, the locality condition (onset adjacency) has to be captured. Uffmann (2005) proposes a class of *SKIP constraints for non-local interactions.

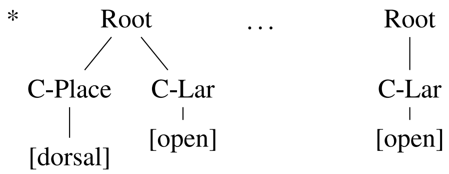
(18) *SKIP No material should intervene between interacting segments

This constraint expands into the following hierarchy.

(19) *SKIP(Ons) » *SKIP(σ) » *SKIP(Seg)

Dahl's Law can be captured by a constraint against two tier-adjacent instances of a C-Laryngeal [open] feature, if the first segment is also [dorsal] (only /k/ dissimilates). This constraint is thus violated by structures such as the one given in (20); the constraint, OCP(dorstop) for short, penalises such structures.

(20) OCP (dorstop) no sequence of a voiceless dorsal stop and another voiceless stop



Note that the constraint does not say anything about how much material may intervene between the two segments; this is determined by the ranking of the OCP constraint with respect to the hierarchy of *SKIP constraints. Since *SKIP constraints have to know what interacting segments are evaluated, I propose to conjoin them with the OCP constraint: if there is an OCP violation, and the interacting segments are separated by some category X, then *SKIP(X) is violated. Since the process can skip segments and syllables but not onsets, the following ranking can be established:

(21) *SKIP(Ons) » OCP (dorstop) » *SKIP(σ) » *SKIP(Seg)

Satisfaction of the OCP constraint is important but only if no onsets are crossed. (22) gives two tableaux. In (a), we find Dahl's Law operating across hiatus and a coda nasal. A syllable is skipped but satisfaction of the OCP ranks higher. In (b), the OCP is also violated. There are two instances of voiceless stops in [kamote] 'small tree'. However, satisfaction of the OCP would entail violating *SKIP(Onset).

(22) Capturing locality effects

a. Interaction across syllables

'shrub fence' /ka+inci/	*SKIP(Ons)	OCP(dorstop)	*SKIP(σ)	*SKIP(Seg)
[kaiɲci]		*!		
☞ [ɣaiɲci]			*	*

b. but not across onsets

'small tree' /ka+mote/	*SKIP(Ons)	OCP(dorstop)	*SKIP(σ)	*SKIP(Seg)
☞ [kamote]		*		
[ɣamote]	*!		*	*

Locality requirements covered, let us now consider why dissimilation yields [ɣ] as a resulting segment. We argued that the repair involves removing offending features rather than adding new ones. Therefore, feature deletion is less acceptable than feature insertion, which means that the anti-insertion constraint DEP(F) outranks the anti-deletion constraint MAX(F). Now, removal of C-lar [open] would yield a voiced stop [g]. As we have seen there is a restriction prohibiting [g] if not preceded by a nasal. In other words, [g] must in some sense be licensed by a preceding nasal. This can be formalised as a requirement to share its C-manner [closed] feature. Let us call this constraint LICENSE(g).

(23) LICENSE(g)
A segment which is C-manner [closed], and which has no further manner or laryngeal specifications, must share this feature with an adjacent segment.

Now, let the DEP constraints and LICENSE(g) outrank MAX(F) and the result will be that repairs involve the removal of features until a licit segment is created. (24) shows how the /k/ → [ɣ] mapping then emerges as optimal, using the example [ɣotaika] 'to vomit'.

(24) Choosing the optimal segment

/ko+taika/ 'to vomit'	OCP	DEP(Seg)	DEP(F)	LIC(g)	MAX(F)
[kotaika]	*!				
[gotaika]				*!	*
[ŋgotaika]		*!			*
[ŋotaika]			*!		*
☞ [ɣotaika]					**

The faithful mapping [kotaika] is not optimal because it violates the OCP constraint (see (23) again). Recall that [k] bears both a C-Manner [closed] and a C-Laryngeal [open] feature. Just removing C-manner [closed] results in the candidate [gotaika], which, however, violates high-ranked LICENSE(g). This licensing requirement could be satisfied by prosthesising a nasal, as in [ŋgotaika], which is a possible Kitharaka word. However, it violates DEP. Changing /k/ into [ŋ] would involve a DEP(F) violation (addition of [nasal]). Other changes, too, would involve the non-optimal addition of features. This leaves us with [ɣotaika], which involves the removal of two features, but which nevertheless is the optimal candidate.[8]

6. Discussion

This paper has provided an account of Dahl's Law in Kitharaka. The analysis concluded with an OT account, but the OT formalisation was not the main point. Instead, the analysis relied crucially on a careful analysis of the distinctive feature specifications of Kitharaka. With any other set of specifications, the OT formalisation would have had to look rather different. In most OT accounts, featural representations are taken as a given or as relatively trivial, with little discussion, the relevant generalisations and explanations deriving from the system of constraints and their interactions instead. This paper redresses the balance and shifts part of the burden of explanation to the representational component of phonology. The peculiar locality conditions require crucial reference to representations and also require careful thinking about what kind of feature specification to assume. We are taking the locality conditions here as evidence in favour of underspecified representations using privative features. In addition, the choice of features was crucial. Is Dahl's Law still a case of laryngeal dissimilation? If features only encode the contrastive minimum, this is an open question. However, we could show that it is indeed still a laryngeal feature which dissimilates, though it is not [voice], as is usually assumed in analyses of Dahl's Law, but [spread glottis], or C-laryngeal [open].

Another point regards the mapping of [k] to [ɣ]. Why [ɣ]? The paper showed [ɣ] is demonstrably not the voiced counterpart of [k]. Again, the explanation is not solely in constraint interaction – it is to some part, as it is argued that repairs preferably involve the removal, rather than the addition of features in Kitharaka. The constraints operated on feature specifications, however, that were the result of in-depth analysis and that are idiosyncratic to Kitharaka. It is specific to the feature specifications proposed here, for example, that the alternation does indeed involve the systematic removal of features until a licit (here: phonologically mannerless and laryngeally unspecified) segment is created. We hoped to show, however, that there are very good independent reasons for assuming precisely these feature specifications, in which [p, t, k] are specified for both manner and phonation, [b, d, g] are specified only for manner and [β, r, j, ɣ] are specified for neither.

But is an account using full standard feature specifications really not feasible? And: do we need to think about representations, or could constraint interaction explain everything? Such an approach would face three problems that may not be unsurmountable but that would require a number of ad-hoc patches, with the result that the analysis would suffer from significantly reduced explanatory power.

First of all, the change [k] → [ɣ] needs to be formalised and explained. Given full feature specifications, a number of changes would have to be necessary, at least involving the features [voice], [continuant], and possibly [sonorant], plus segment-specific processes that capture the distinctions between [r] and [j], for example. Then, the question is why precisely these changes are optimal. They can be modelled in OT, but an analysis would involve a seemingly random ranking of different IDENT(F) constraints. The idea that features are removed until an optimal segment is found cannot be transferred to this account because the insight that [β, r, j, ɣ] form a class of mannerless segments cannot be captured, either.

Secondly, the locality conditions must be captured. The autosegmental idea of relativised adjacency and dissimilation only between tier-adjacent elements could not be transferred. All segments between

[8] A reviewer notices a potential wrinkle, since this analysis is incompatible with loanword evidence where input [g] does not shed its manner feature to become [ɣ]. This tableau can thus not account for the loanword mapping of [g] to [ŋg]. There are two possible responses to this. Firstly, one could add a constraint as a proviso that underlying [g] are preserved (e.g. in the gist of Comparative Markedness (McCarthy 2003)). Secondly, there are many cases of such mismatches, where loan phonology and native phonology go different ways. For example, in Korean a final aspirated stop deaspirates (laryngeal neutrealisation), while a borrowed final aspirated stop will be repaired via vowel epenthesis. See, for example, Boersma and Hamann (2009) for such examples and their argument that loanwords are adapted in a speaker's perception grammar.

trigger and target would be specified for [±voice]. The explanation would have to shift to the constraints. As Dahl's Law holds between onsets, it may be tempting to invoke a constraint OCP(voice/Onset) which disallows identical [±voice] specifications on two subsequent onsets. Such a constraint would be blind to all intervening material but just set up a correspondence relation between two syllable positions. While this may work for the case at hand, it makes an awkward typological prediction: that there is dissimilation between onsets completely disregarding intervening codas. In a language that allows obstruents in codas, the constraint OCP(voice/Onset) would completely ignore them. Hence, for an input /kabka/, dissimilation would yield [kabga] (where [g] dissimilates to initial [k]) and only accidentally assimilates to the preceding stop) while /kapka/ would yield [kapga]. There are no examples of dissimilation working like this, as for example, shown in Odden (1994), and a theory of long-distance interactions that excludes such pathological dissimilation patterns should be preferred.

Thirdly, full feature specifications would face a problem with /θ∼ð/. Variation in voicing should be accompanied by variation in the value of [±voice]. Then, why does the fricative always behave as if it was voiced, phonologically (it does not trigger Dahl's Law)? So, either it is specified as [+voice], regardless of actual voicing, or it must be underspecified. Then, if underspecification is allowed in anyway, why not think about it more fundamentally? If, on the other hand, /θ∼ð/ is phonologically [+voice], what does this say about the phonetic realism of features, and how could that be squared with an account in which features are very surface-oriented in the sense that feature specifications can be trivially inferred from the phonetic properties of a segment? At any rate, in neither account there is a trivial way of assigning features.

In sum, a full specification account that leaves the burden of explanation to the constraint component of the phonological grammar is not very promising in terms of explanatory adequacy. The proposal here divides the burden of explanation up, giving both the constraint component and the representations their share. Future research may be able to shed more light on the viability of such a proposal in which both the computational and the representational component of grammar contribute to an analysis. A more principled theory of such a division of labour still remains a desideratum, however.

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