KALA PHONOLOGY IN A TYPOLOGICAL AND REGIONAL CONTEXT

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Chapter 1: Introduction

1.1 The Kala Language: Background and Projects

Kala\(^1\) is a Western Oceanic language of the North Huon Gulf subfamily (Ross 1988), spoken along the Huon Gulf by around 3000 speakers in four dialects. Speakers are divided between six villages, from north to south along a stretch of coast about 50km long. From northernmost to southernmost, these villages are Manindala (also called Kela), Lambu (Logui), Apoze (Laukano), Kamiali (Lababia), Alēso (Buso), and Kui. While Kamiali, Alēso, and Kui all share a dialect, with minor differences between them, the northern three villages (Manindala, Lambu, Apoze) all have individual dialects. Kala’s closest relative languages in the North Huon Gulf subfamily are Jabêm (Bradshaw and Czobor 2005; Dempwolff 1939) and Bukawa (Eckermann 2007).

Kala is considered an endangered language, and its speakers are shifting to the use of Tok Pisin (a national lingua franca of Papua New Guinea) (Schreyer 2017). Kala’s endangerment status is rated at “6a” (“vigorous”) on the EGIDS by Ethnologue (Lewis, Simons and Fennig 2022) but this rating does not accurately reflect the situation for Kala speakers. Based on a variety of endangerment factors, it may be more accurately rated as a “3” (“definitively endangered”) on the scale created by the UNESCO Ad Hoc Group for Endangered Languages (Unesco 2003), in part due to the small community size (Schreyer 2017:127-129). In 2006, the Kala Language Committee

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\(^1\) Kala is the name its speakers use for this language. It is sometimes seen as “Kela”, although this is an exonym.
was formed, which consists of members of each village. The Committee is dedicated to support and decision-making responsibilities concerning the Kala language, which also involved the development of an orthography in 2010.

Kala lacks much previously published formal description. There is a brief phonemic statement by Collier and Collier (1975), which only applies to the dialect of Apoze. Another phonological inventory is presented by Johnson (1994), specifically for the dialect of the village of Kui. Other than this, a few terms are listed in Ross (1988) for the purposes of determining Kala’s genetic place in the New Guinea Linkage. SIL missionary, Mitchell Michie has been involved in an ongoing Bible translation project, which has produced a translation of the Gospel of Mark (Michie 2021) as well as some audio recordings of this work.

The beginning of the Kala documentation project of which I have been a member since 2017 began in 2010 with the community-driven project to create a consistent orthography for all Kala dialects and villages using the Latin alphabet (Schreyer, et al. 2013, 2015, 2017). Since the inception of this project, an illustrated dictionary has been published in 2012 by DeVolder, Schreyer and Wagner, which includes words from all four dialects of Kala (DeVolder, Schreyer and Wagner 2012). The relationship of this team with the Kala people began with John Wagner’s environmental anthropological studies on local and traditional affordance of natural aquatic resources (Wagner 2007; 2018). Kenneth Longenecker has done fishery studies in the region, with studies on fish diversity and resource usage (e.g. Longenecker, et al. 2010). In 2012, with the help of Kala speakers as well as colleagues, he created a fish monitoring program curriculum
for grades 7-8 in Lababia Primary School (in Kamiali), which is trilingual in Kala, Tok Pisin, and English. It is a curriculum designed to allow schoolchildren to perform their own monitoring of local fish populations so the community has a repository of data on the health and diversity of one of the greatest local resources (Longenecker, et al. 2012). Difficulties in language planning due to national policy shift are discussed in Schreyer and Wagner (2022), with a focus on the efforts of the Kala Language Committee.

Current material projects underway now include a larger dictionary (Kala to English and Tok Pisin; all four Kala dialects), a pedagogical grammar for use in the Kala communities, and a bilingual digital and physical encyclopedia of local aquatic environmental knowledge. The data that appear in this dissertation are all publicly available and archived in the Kaipuleohone archive through the University of Hawai'i at Mānoa. These data come from fieldwork that I did in 2017 and 2019 with Kala speakers in Papua New Guinea (Ransdell-Green 2017; 2021), as well as that done by Christine Schreyer (Schreyer 2017; 2019) in both southern and northern villages. Additionally, as of yet unarchived data from fieldwork in 2010 appear, with the express permission from Kala speakers. In 2019, I worked with two speakers from southern villages, Alēso and Kamiali, to make audio recordings towards an acoustic analysis of nasal vowels in Southern Kala. I use grammatical and phonological data from this 2019 fieldwork, as well as from my initial fieldwork trip in 2017, which took place in Kamiali, Aleso, and Kui, during which the Kala team began work towards our current three goals (the tripartite project of dictionary, grammar, and encyclopedia). The research team is
interdisciplinary in nature, consisting, other than me, of Christine Schreyer (linguistic anthropologist), John Wagner (environmental anthropologist), Kenneth Longenecker (marine biologist), and David Lacho (linguistic anthropologist and software developer). Schreyer and Wagner have written about the process of developing the orthography, from the perspective of the community research model (Schreyer 2013; 2015; 2017; Schreyer and Wagner 2013), from its inception in 2010 up to its status in 2017. It was designed together with community members from all six villages and four dialects so as to be compatible with all dialects.

The work done in this group has been community-based research. All projects undertaken have been approved by the Kala Language Committee, which consists of speakers of Kala from multiple villages. The projects have also been assisted by paid community researchers who have helped with transcription, translation, and other crucial endeavors. In the spirit of these practices, I have continued to my best ability to make my research benefit the speaker community when working with speakers as consultants. Everything contained in the present dissertation was possible thanks to my Kala consultants and it is to them that I dedicate the work that I do. I want to emphasize my devotion to the best interests of the community I have collaborated with and to all of those language experts who graciously agreed to work with me on the projects that made this dissertation possible. My Kala consultants have been my teachers and friends, and without them, none of this work would have existed. It is my hope to use parts of this dissertation toward a greater body of documentation and description of the
Kala language that I hope can serve in some small way to support the language, its speakers, and their descendants in perpetuity.

1.2 Dissertation Focus

The purview of this dissertation is the phonetics and phonology of Kala—in particular, the Southern Kala dialect.² The reason for this focus on the Southern dialect here is that most of my time spent in the field was in the southern villages (Kamiali, Alēso, and Kui) and amongst Southern dialect speakers living in Port Moresby (from Kamiali and Alēso) and so my knowledge of and data on Kala are most robust with regard to the Southern dialect. The three main dynamic phonetic processes that are the subjects of the acoustic analyses in Chapters 3-5 are all specifically recorded in speakers from the Southern dialect. Although it is my desire to be able to describe all parallel processes from the Northern dialect, I have focused on the data obtained from recordings made in Port Moresby due to appropriateness of these recordings for fine-grained acoustic phonetic work. Much of the recorded audio data from other contexts was not made in a physical environment that was conducive to high quality phonetic analysis. It is my hope that I may have the opportunity in the future to understand better the details of the phonetics of Northern dialects and be able to obtain recordings that would be possible to submit to such analysis as I have done for the Southern dialect.

² Where mentioned in Chapters 2-5, “Kala” refers to the dialect in question in those chapters, which is the Southern dialect.
The primary research question addressed in this dissertation is given as follows: “What is the typological profile of Kala’s phonology? How does it fit into the Huon Gulf context amongst nearby Oceanic and Papuan languages?”

On one hand, this dissertation serves as a deeper look at the phonetics and phonology of Kala, which otherwise has very little published description. In addition to creating this description, I then put Kala’s phonological profile in a wider context of its neighbors, both Oceanic and Papuan. By providing a broader view of this region’s dynamic processes, I highlight Kala’s unique features and how they relate to nearby languages.

In order to answer my research questions, I choose three prominent phonological processes in Southern Kala to investigate in detail using generally acoustic methodologies. Chapters 3, 4, 5 each addresses a different process—each of which happens to concern vowels: vowel deletion, vowel laxing, and vowel nasality. Each chapter begins with research questions and at least one hypothesis concerning the behavior of that specific process, based on predictions from relevant literature. The predictions are followed by descriptive details of the process from fieldwork, based on audio recordings and fieldnotes. Following this, I provide an overview of a quantitative study performed on data from this process and discuss the results and possible ramifications.

In each case, I have found that attempts to categorize these processes under typologically common terms is not simple; in each case, my predictions were not borne out by some particular property of the process. There is a common thread amongst all
these features, and that is that not all of their characteristics fall easily under a single category. This leads to the conclusion that it is not always appropriate to classify an entire phonological process, but rather to consider the different facets of each as independent factors. For example, vowel deletion functions as reduction in that it occurs more frequently in quick speech samples, but it is defies many typical explanations of reduction in that it occurs equally in stressed syllables and in unstressed. Vowel laxing does not appear to show any qualities of reduction, but it is also conditioned by a highly unusual environment for non-reductive laxing (or any kind of vowel centralization or lowering)—it is conditioned not by syllable shape, as is cross-linguistically common, but by vowel juxtaposition to continuant and nasal consonants. Nasality is contrastive in vowels and creates many minimal pairs, but also appears as a phonetically conditioned state in the environment of nasal consonants, albeit manifesting in an acoustically distinct manner.

Each of these processes demonstrates something that was not predictable, although each also adheres in other respects to predictions based on cross-linguistic data as well as by theory. In short, my studies of each process revealed unexpected complexities and a multifaceted nature that warranted acoustic investigation for its own sake. Additionally, elucidating the fine-grained details of each process was a desirable goal before attempting to understand Kala phonology in a wider typological context, which is the purview of Chapter 6.
1.2.1 Phonology Sketch and Dialectal Differences

Chapter 2 is a phonology sketch of all dialects of Kala, covering the breadth of details of each dialect as much as they are known to me. This sketch, although greater in detail and breadth than its predecessors (Collier and Collier 1975; Johnson 1994), is necessarily incomplete, as there are certain elements that I do not yet fully understand—for example, details of the allophony of /a/ (as realized as [a] and [ə]), which are not totally clear yet. However, I have included every detail of the phonology in each dialect that I am aware of, and have also included sound correspondences in phonemes of the differing dialects so that a comparison between the dialects is possible. I believe it is as crucial to understand the sound correspondences between the dialects of Kala as it is to understand those it shares with related languages (e.g. Jabêm and Bukawa) in order to form a clearer image of Kala’s phonological and historical development through space and time. Given Kala’s endangered status, I believe the further description and documentation of its features is vital.

1.2.2 The Processes

In addition to providing a detailed phonology sketch of Kala, which was previously unavailable elsewhere, the main goal of this dissertation was the investigation of the phonological and phonetic details of three dynamic processes in Southern Kala: vowel deletion, vowel laxing, and vowel nasalization. These three processes were chosen for their salience and uniqueness, and a deep of investigation each has shown that the
application of typologically and cross-linguistically defined phonological categories is not always straightforward.

Chapter 3 begins the investigation into the first of the three processes, vowel deletion. Southern Kala’s vowel deletion is unusual in that it can occur in stressed syllabes as well as unstressed, which not a common condition of vowel deletion or reduction. However, my impression of the deletion process was that it was more common in quick speech—a facet that would fall in line with usage-based approaches to reduction. The study in Chapter 3 investigations frequency rates of deletion in quick vs. slow speech, and evaluates whether or not vowel deletion shows signs of being a fully phonologized process or not. I find that different facets of this phenomenon show canonically different signs of phonologization vs. phonetic flux. Vowel deletion in Kala is not a process that fits neatly into a typology of sound change processes, but exists in a liminal space between phonology and phonetics.

Chapter 4 continues the foray into another vowel process in Kala, vowel laxing. Kala vowels appear to become lax in an environment that is fairly atypical for laxing processes cross-linguistically. I evaluate two types of vowel laxing (centralizing combined with lowering) that are prominent in the literature, which are supposedly driven by fundamentally different motivators, both perceptual and articulatory. In my assessment of Kala vowel laxing, I find that, although it does not fit well into the category of quality reduction, it also stands out amongst non-reductive laxing processes, given its unique conditioning environment (before [+nasal] and [+continuant] consonants). Once again, this Kala vowel process seems to defy distinct categorization.
Chapter 5 finishes the triad of vowel processes under investigation. This chapter is an acoustic phonetic look at the different manifestations of nasality in vowels in Kala, and how they differ based on phonemic status. Kala has a set of contrastive nasal vowels that parallel oral counterparts. All oral vowel qualities /a e i o u/ contrast with /ä ě ĭ ŏ ũ/. However, there is also contextual nasalization preceding nasal consonants, as in /dene/ ‘this’ → [dẽe]. Chapter 5 presents two hypotheses concerning the behavior of nasalization, given that it seems to exist in two functional spaces in the phonetics-phonology of Kala. The first hypothesis assumes that some acoustically measurable differences can be found between contrastive nasal vowels and contextually nasalized vowels. The second hypothesis, somewhat contingent on the first, is that contextually nasalized vowels will show some form of greater variability than contrastive nasal vowels. To test these hypotheses, I use two acoustic metrics of vowel nasality to understand how nasality is manifested in different ways within this same language. The results of the quantitative study in Chapter 5 show that, although nasality can be a contrastive feature of vowels in Kala, it can also behave non-constrastively in other contexts. Acoustic analysis shows that speakers’ articulation must distinguish these two kinds of vowel nasality, splitting the phenomenon, once again, between the phonetic and the phonological.

1.2.3 Typological Regional Survey

The second main goal of this dissertation is the placement of Kala within a broader regional typological image in terms of its phonology. In order to do this, I compare the
three processes described above and evaluate 50 nearby languages (both Oceanic and Papuan) for the presence of similar processes. I begin with two possible predictions: the first is that these processes may be represented in these sample languages as one or more areal traits. Papua New Guinea is a hotspot of language contact, especially between Papuan and non-Papuan (Austronesian) languages, and this phenomenon can be seen in other respects around the Huon region, such as the noted reciprocal diffusive influence of Binanderean (a Papuan family) languages and nearby Oceanic languages (Bradshaw 2017). The second prediction was that the processes found in Kala may be familial features, in which case I expected that they would appear solely amongst Oceanic languages of the Huon Gulf but would be lacking in the Papuan sample. These two predictions necessitated that a broad sample of languages across both Oceanic and Papuan languages.

The evaluation of these languages for the presence or absence of the processes found in Kala was initially broad. The narrowing of this view provided me with a more precise understanding of how exactly these processes were realized in their respective languages, leading to an illuminating example of how seemingly similar processes can manifest in diverse ways across languages and language families.
Chapter 2: Kala Phonology Sketch

2.1 Introduction

This chapter provides a sketch of the phonology of Kala. Kala has four dialects: one spoken amongst the three southern villages and one dialect per village in the three northern villages. Kala dialects differ in their number of phonemes and phonotactic structures, as well as in the distribution of nasal vowels. Most of my previous work has been on Southern Kala, as are the phenomena described in more detail in each of the next three chapters, since those are the villages I was able to visit the most in 2017 during fieldwork. In 2019, I worked with speakers of Southern Kala (from Kamiali and Alēso) who were living in the capital city of Port Moresby. For these reasons, most of my present phonological inquiry has focused on the Southern dialect. This phonological sketch details phonemes and rules of the Southern dialect, which are very similar between all three of the southern villages, Kamiali, Alēso, and Kui. In 2.2, I present details of the phonemes of Southern Kala. 2.3 discusses syllable structure, including arguments toward interpretation of a basic (C)V syllable structure and analyses of prenasalized and labialized consonant series. 2.4 provides information on a variety of allophonic processes, including a brief introduction to the three vowel processes that are the subjects of Chapters 3-5. 2.5 includes information on suprasegmental features, such as possible correlates of stress. The final section (2.6) of this chapter details the differences between Southern Kala and each of the three Northern dialects.

All of the data in this chapter are taken from materials gathered from fieldwork by myself or Christine Schreyer, between 2010 and 2019. All materials are archived in
2.2 Southern Kala Phonemes

Southern Kala has a phonemic inventory of 23 consonants in four places of articulation (labial, alveolar, palatal, and velar, plus labialization on certain labial and velar stops and consonants). The labialization of these consonants involves an offglide of /w/, articulated after the primary consonant. The only fricative is /s/ and there is only one liquid, /l/. Kala has vowels of five qualities: /a/, /e/, /i/, /o/, /u/, each of which can be contrastively oral or nasal. Kala has 7 phonemic diphthongs, /ae ai ei ou oi ao au/, which also have nasal counterparts. When diphthongs are nasal, nasality generally appears on the offglide of the diphthong. Note that my interpretation of phonemic status of prenasalized stops and labialized consonants is explained in Section 2.3.2.

Table 2.1. Southern Kala consonant phonemes. ³

<table>
<thead>
<tr>
<th></th>
<th>Labial</th>
<th>Alveolar</th>
<th>Palatal</th>
<th>Velar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stop</strong></td>
<td><strong>Plain</strong></td>
<td><strong>p b mb</strong></td>
<td><strong>t d td</strong></td>
<td><strong>k g ng</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Labialized</strong></td>
<td><strong>pʷ bʷ mbʷ</strong></td>
<td><strong>-</strong></td>
<td><strong>kʷ gʷ ngʷ</strong></td>
</tr>
<tr>
<td><strong>Nasals</strong></td>
<td><strong>Plain</strong></td>
<td><strong>m</strong></td>
<td><strong>n</strong></td>
<td><strong>ŋ</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Labialized</strong></td>
<td><strong>mʷ</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
</tr>
<tr>
<td><strong>Fricatives</strong></td>
<td></td>
<td><strong>s</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Approximants</strong></td>
<td></td>
<td><strong>w</strong></td>
<td><strong>r</strong></td>
<td><strong>j</strong></td>
</tr>
</tbody>
</table>

³ Kala orthography is very similar to IPA but differs with the following graphemes: <y> = /j/; <l> = /l/. All prenasalized stops are written as sequences, e.g. <mb>, <ŋgw> and labialized consonants written similarly (e.g. <kw>).
Table 2.2. Kala oral vowels.

<table>
<thead>
<tr>
<th>Oral Vowels</th>
<th>Nasal Vowels</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>ĩ</td>
</tr>
<tr>
<td>u</td>
<td>ū</td>
</tr>
<tr>
<td>e</td>
<td>ē</td>
</tr>
<tr>
<td>o</td>
<td>ō</td>
</tr>
<tr>
<td>a</td>
<td>ā</td>
</tr>
</tbody>
</table>

Table 2.3. Kala nasal vowels

All consonants and vowels appear to be able to occur word- or syllable-initially, except for nasal vowels, which almost always appear word-finally (see Chapter 5 on vowel nasality). Some exceptions include certain reduplicated forms (/jājā/ ‘yellow’) and place names (/arēso/ ‘village name’).

Below is a plot of the F1 and F2 of vowel quality (both nasal and oral) from a single female speaker of Southern Kala from Kamiali. Ellipses represent the range of values for all vowels. Data for these tokens are taken from audio clips of vowels found in Schreyer (2019) and Ransdell-Green (2021).
Kala has several diphthongs: /ae ai ei ou oi ao au/. The more common of these are /ae ai ao au/. The least common are /ou/ and /oi/. Examples of minimal pairs of diphthongs are below.
(2.1) /au/ ‘wind
   /ao/ ‘breatfruit’

   /kiᵐbai/ ‘ripe’
   /ᵐbae/ ‘perfective particle’

   /sei/ ‘who’
   /sai/ ‘touch’

   /poboi/ ‘wet’
   /boů/ ‘shallow water’

Diphthongs contrast with monophthongs of similar qualities.

(2.2) /de/ ‘bilum’
   /dei/ ‘sixth-born son’

   /ᵐbae/ ‘perfective particle’
   /ᵐba/ ‘no’

   /jou/ ‘need’
   /jo/ ‘question marker’
Diphthongs can also appear nasalized. When nasalized, it is typically offglides of the diphthong that bare nasalization, although nasalization may also spread to the rest of the vocalic nucleus of the syllable.

(2.3)  /ŋaĩ/ → [ŋãĩ] ‘leg’

/aũ/ → [äũ] ‘banana; garden’

/aõ/ → [äõ] ‘tooth’ (Alëso and Kui dialects)

/seĩ/ → [sẽĩ] ‘their’

2.2.1 Phonemic vs. Phonetic Intervocalic Glides

Vowel sequences of high or mid to low vowels may contain a phonetic glide between the vowels:

(2.4)  /nuã/ [nuwã] ‘one’

/ruã/ [ruwa] ‘two’

/tuã/ [tuwã] ‘bone’

/mia/ [mija] ‘go’

/urĩa/ [urija] ‘sister’

/maleã/ [maleja] ‘elder sister’

/sua/ [suwa] ‘they two’

My current assumption is that, because there is a phonetic glide present that there is not a phonemic glide. There are other environments (e.g. between two identical vowels) where a phonemic glide is clearly present, however, such as can be seen below. These are shown here with minimal (or near-minimal) pairs in which glides do not occur.
(2.5) /tawa/ [tawa] ‘bottom’ (vs. [ta] ‘sea’)
/tawε/ [pawe] ‘beach’ (vs. [mbaε] ‘perfect aspect particle’)
/jājā/ [jājā] ‘yellow’ (vs. [ja] ‘sun’)
/kajĩ/ [kajĩ] ‘you wash’ (vs. [kai] ‘you’ vs. [kaiwi] ‘hauling pole for a canoe’)

Other evidence that the glides /w/ and /j/ are phonemically distinct from their syllabic counterparts /u/ and /i/ can be found in the minimal pair created by the words such as [kui] (disyllabic) and [kwi] (monosyllabic), meaning ‘the village of Kui’ (also ‘tangled’) and ‘shirt’, respectively.

2.2.2 Labialized Consonants

Labialization in consonants only occurs in labial and velar series of stops. It is not clear that /ŋʷ/ is a phoneme in the Southern dialect (though it does appear in at least one of the Northern dialects). Typically, in Southern Kala, the reflex of Northern dialects’ /ŋʷ/ is /ŋgʷ/ (e.g. Manindala tauŋwe ‘mangrove’ and Southern Kala tauŋgwe).

(2.6)

a. kʷa.do.si.ja ‘barracuda’
b. gʷa.ᵐbe ‘large basket’
c. gʷa.re.sē ‘cockroach’
d. jo.mʷ‘I am afraid’
e. a.ru.gʷa.ᵐbe ‘triggerfish’
2.3 Southern Kala Syllable Structure

2.3.1 Basic Syllable Structure

Syllable structure in Southern Kala is CV or V. I choose here to analyze [mb], [d], and [ng] as prenasalized unit phonemes, and [p^], [b^], [m^] [mb^], [k^], [g^], and [ng^] as labialized unit phonemes, given that there are no other complex onsets that have been phonologized in the language.

These labialized consonants are one of the points of contrast between the Southern and Northern dialects; while all dialects include them, they are found more commonly in the Northern dialect: words that use a plain, non-labialized consonant in the Southern dialect often have a labialized consonant in the Northern dialect. There is even some occurrence of the labialized version amongst certain speakers of Kamiali, which is the northernmost of the so-called southern villages.

(2.7)

dome (southern)

dome (northern)

‘back’
Below are examples of (C)V syllable structure in Southern Kala.

(2.8)

**CV Structure**

a. ta ‘sea’

b. pi ‘up’

c. do ‘turtle’

d. tu.tu.mi ‘black’

e. ro.ro ‘black ant’

**V Structure**

a. a.rē ‘fresh water’

b. e ‘tree’

c. a.o ‘breadfruit’

d. a.ū ‘garden’

e. a.de ‘pillow’

f. u ‘dead’

g. i ‘fish’

h. go.do.u.si ‘lips’

i. kʷi ‘shirt’

My analysis of syllable structure and why I chose to use a (C)V interpretation for this study is detailed in the subsection below. Inherent to my argument that Southern Kala
has (C)V structure is my interpretation of prenasalized stops and labialized consonants.

2.3.2 Phonemic Status of [ⁿC] and [Cʷ] Patterns and Implications for Syllable Structure

Kala has phonological patterns that can be either be analyzed as nasal + voiced stop sequences (e.g. /ŋg/, /mb/), or as prenasalized voiced stops (e.g. /ⁿg/, /ⁿmb/). Similarly, there are patterns that can be analyzed as stop or nasal + glide sequences (e.g. /pw/, /mw/), or as labialized consonants (e.g. /pʷ/, /mʷ/). In the analyses with prenasalized stops and labialized consonants, the Southern Kala phonemic inventory is larger, but its syllable structure is simpler. In the analyses with consonant clusters, the phonemic inventory is smaller, but the syllable structure is more complex.

There are several reasons I analyze both of these patterns as unit phonemes (i.e. as prenasalized and labialized consonants). First, it allows me to make the generalization that Southern Kala has a (C)V structure. There are no other examples of consonant clusters, including complex onsets, anywhere else in the phonological patterns of the language. It is less likely that Kala has syllable codas, given data from the Southern villages. During clap tests, speakers generally show syllabification in CV patterns, such as in [i.ŋgu] ‘squid’, [i.nda.ne] ‘outside’, [i.mbi.ɾi] ‘species of fish’, [de.ɾnge] ‘bedbug’, and [po.mbo.ja] ‘butterfly’. However, some speakers also occasionally syllabified words differently during these tests (or less consistently with CV structure—individual speakers also appear to vary as to how they did so), such as [an.da.ra.wa]
‘path’, [bam.ba.ɾî] ‘tall (pl)’. Despite these examples, the overall preference seems to be for CV syllabification.

If codas do exist in Kala, they cannot occur word-finally, since no Southern Kala word ends in a consonant. Second, in order for a consonant to be analyzed as a coda, reference would have to be made to the following syllable: nasal codas could only occur if the following syllable had an onset of a voiced homorganic stop, and stop codas could only occur if the following syllable had an onset of a labial-velar glide (in the case of sequences like word-medial /pw/). This is because there are no other possible consonants that can follow another consonant word-medially (e.g. *[kapma], *[kapta]).

My analysis is also somewhat influenced by analyses of Kala’s closest relatives, Jabêm and Bukawa, along with related Numbami, which are all analyzed as having prenasalized stops as well as labialized consonants. Eckermann (2007:8-9), for example, states in his phonological description of Bukawa that it is possible to consider [ŋg], [bʷ], etc. to be sequences. However, he says that because the prenasalization component is close to the consonant in the unit in terms of point of articulation, he views it appropriate to treat them as unit phonemes. In the Bukawa orthography, as in Kala, these are written with separate individual letters (e.g. <ŋg>).

In Jabêm and Bukawa, prenasalized stops pattern the same way they do in Southern Kala—although they show a voicing distinction (Bukawa includes /t/, /p/, /k/, etc.), their distribution is identical—they can occur word-initially and word-medially, but not word-finally. This distribution is similar to that of most stop consonants. In Numbami, Bradshaw also privileges a prenasalized stop analysis over a consonant cluster
interpretation (Bradshaw 1978:43). He presents three pieces of evidence for this analysis. First, analyzing unit phonemes allows us to generalize that no Numbami syllable can end in a coda (which is otherwise true for Numbami). Second, the tok hait ‘disguised speech’ that is used in Numbami reverses words syllable by syllable. In this speech, prenasalized stops move and behave as a unit. Finally, in Numbami, prenasalization is neutralized at the beginning of a word. This can be seen in reduplicative forms by comparing their singleton and reduplication versions: bulē → bulembrebulē ‘small cowries’.

Ladefoged and Maddieson (1996:119) state that it is common for patterns of [mb], [nd], etc. to be analyzed as prenasalized stops rather than N+C sequences when they may occur at the beginning of word (which is true for Kala). Tak (2011:129) also mentions that N+C analyses are typically appropriate when the nasal is a part of the preceding syllable. In the case of word-initial patterns, this is not possible, as Kala words such as [ᵐba] are monosyllabic. In every respect, these sounds behave like unit phonemes in Kala in the manner of other stops.

Cross-linguistically, labialization is the most common secondary articulation for consonants (Ladefoged and Maddieson 1996:356), typically involving the rounding of lips and raising of the dorsum of the tongue toward the velum. It is not unlikely that Kala would have labialization, especially given the presence of the same patterns of its closest relatives. One factor in determining whether these patterns are a secondary articulation or a cluster is historical origin. Kawasaki (1982) claims that the origins of labialization often lie in “assimilatory allophonic labialization of a round vowel onglide”.
Nonetheless, many languages disallow labialized consonants to precede the vowel /u/ (Kawasaki 1982:19-21). Sometimes this is due to unrounding of a following vowel (Kawasaki 1982:23). This was the case Kim (2010) found in both Korean and Nuuchahnuhlth: labialized consonants do not occur before the high back rounded vowel /u/. Sometimes, as in the case of Korean, this process is synchronic and optional. In the case of Nuuchahnuhlth, it is obligatory: morpheme-final labialized consonants delabialize when a suffix beginning with /-u/ is attached (e.g. /hawikʷ-/ + /-uk/ → [hawikuk] (*hawikʷuk) (Kim 2009:46). This restriction is also true of Southern Kala, where we do not see examples of *[kʷu], *[mᵇʷu], etc. The most common vowels that this pattern precedes are /a/ and /i/, which follows a cross-linguistic pattern discussed in Kawasaki (1982:22), who notes that it is common for labialized consonants to precede front and low vowels.

Suh (2009:9) comments that one criterion used to determine whether a pattern is a sequence of Cw or a single labialized unit is distribution and productivity. If labialization occurs over a fairly wide range of consonants, it is more plausible to view this pattern as a series of clusters. If it occurs only on a restricted set (e.g. restricted by place, manner, etc.), it is more likely that they are phoneme units. Southern Kala cannot take labialization after all consonants: it occurs on velar stops [kʷ gʷ ŋʷ] (*ŋw is unattested in the Southern dialect, though it exists in at least in the Lambu and Manindala dialects) and labials [pʷ bʷ mʷbʷ mʷ]. Labialization does not occur on alveolars, palatals, or on fricatives. Given its relative restriction (compared to other languages in
which the Cw combination can occur with almost any consonant in the C position), it would make sense to analyze a unit phoneme.

Cross-linguistically, labialization is much more common on dorsal consonants than any other place of articulation (Maddieson 1984:37; Ladefoged and Maddieson 1996:356). In Ruhlen’s survey of 706 languages (Ruhlen 1987), he found that the least commonly labialized consonants were alveolars and dentals. Kawasaki’s survey (Kawasaki 1982) finds a similar result, with dorsals (velars and uvulars) found to be more likely to have labialization than labials or alveolars. While Kala does show the common pattern of velar labialization, it also allows labial consonants to be labialized, which is less common.

My interpretation of nasalized stop patterns is similar to that of labialized consonants—the simplest analysis is that these are unit phonemes. It is very common for Austronesian languages of Papua New Guinea in general to have prenasalized stops (Foley 2000:368), and to tend toward a simple (C)V structure (Foley 2000:369). For these reasons, I have chosen to analyze Southern Kala syllable structure as (C)V, as it is a much simpler and more elegant solution that requires no exceptions or further explanation. In further sections of this chapter, as well as in the earlier phonemic inventory discussion in Section 2.2, I base my understanding of the phonemes and phonotactics on arguments and evidence in this section.

Nonetheless, it is still possible to have an interpretation that includes codas and explains the data sufficiently. Even though Kala has no other complex onsets, it is still possible that these are simply limited to homorganic nasal + voiced stop sequences,
plus labial and velar consonants followed by the labial-velar glide. It is equally possible to analyze codas in the word-medial patterns, such as that within words like [deⁿge] ‘bedbug’, as long as there is an accompanying rule that states there may not be any word-final codas, and that codas must be followed in the next syllable by a homorganic voiced stop (in the case of nasal codas) or by a labial-velar approximant (in the case of labial and velar stop codas).

Even without accepting codas, patterns such as [ⁿd], etc. could be interpreted as a complex onset of a nasal plus a voiced stop. However, I choose to interpret patterns found in [ᵐba] ‘no’ and those in [taᵐbo] ‘eye’ as members of the same phonemic unit, since they show the same phonotactic distribution and behavior as each other as well as other oral stops.

2.4 Allophonic Rules

This section details some allophonic rules that apply to segments in Southern Kala. There are many more processes that occur in vowels than consonants. Currently, I am only aware of consonantal allophony with regard to the /ɾ/ phoneme.

2.4.1 Consonants

2.4.1.1 Allophones of /ɾ/

The /ɾ/ phoneme is typically realized as an alveolar tap, but can also appear as a lateral [l]. This realization is most frequently seen word-initially, but can occur intervocalically.
(2.9)

/ɾiɾi/ → [ɾiɾi] ~ [ɾiɾi] ~ [ɾiɾi] ‘sword grass’

/iisa/ → [ısa] ~ [ısa] ‘mud’

/ɾiɾi/ → [ɾiɾi] ~ [ɾiɾi] ‘long’

In the context of the vowel deletion rule (Chapter 3), /ɾ/ forms onset consonant clusters with stops [tɾ], [kɾ], etc. Occasionally, when in this environment, /ɾ/ can be realized as [ɾ], which otherwise is not observed as an allophone of /ɾ/

(2.10) /turura/ → [tıura] ~ [tıura] ‘afternoon’

/keɾeme/ → [kreme] ~ [k.eme]

/guruwa/ → [guruwa] ~ [ɡuwa] ‘child’

/ɾ/ on rare occasions also appears as a trill [ɾ]. The context in which this occurs is not yet clear, but is not very common. I have observed it only rarely, such as in words such as /jaˈwaɾa/ [jaˈwaɾa] ‘spider’ and /kare/ [kare] ‘eldest daughter’, though these include the [ɾ] allophone most of the time. The conditions under which the trill appears are not yet clear. It may be that this is stylistic speech choice and is not conditioned by phonetic environment.
2.4.2 Vowels

Kala has many more complex phonological processes that apply to vowels than to consonants. Chapter 3-5 of this dissertation describe three of these in much greater detail and form the basis for the central phonological profile of Kala that I present in the context of Kala’s neighbors in Chapter 6. I give a brief account of the basics of each one here as well.

2.4.2.1 Vowel Deletion

Kala has a rule that deletes vowels between a stop and /ɾ/ when there is a vowel of identical quality in the following syllable. In total, the rule is as follows.

A vowel may be deleted in a word of >two syllables when immediately preceded by a stop consonant and immediately followed by an alveolar tap if the vowel in the following syllable is identical in quality. If a disyllabic word with the same segmental context is in a phrasal context, it too may have its first vowel undergo deletion (e.g. yowā bala > [jowā bra] ‘my brother’). Additionally, this rule sometimes causes /ɾ/ to manifest as [ɹ], which is not an allophone otherwise seen for this phoneme.

The rule for words of >2 syllables can expressed as follows.

(1) $V_a \rightarrow \emptyset / \text{-cont son} - r V_a$
The vowel deletion rule ignores stress environments. Both stressed and unstressed vowels can be deleted in this context, which is typologically unusual. See Chapter 3 for discussion of this, and see Section 2.5 for discussion of stress in Kala. As mentioned above, the deletion rule only applies to words of at least three syllables when in isolation, but in a phrasal context, this requirement is lifted. As shown in Chapter 3, the deleted forms are still technically in free variation with non-deleted forms. However, non-deleted forms are far more commonly observed in slower, careful speech style (referred to as *lento* speech style as per Greenberg (1966)) than they are in quicker, naturally casual (*allegro*) speech style. Nasality of the vowel in the following syllable does not appear to factor in to whether this rule applies or not, but only the quality of the vowel contributes toward the vowel being “identical”. As result, we see deletions in words such as /ˈtatarã/ → [tatrã] ‘blue, green’ and /pepelẽ/ → [peprẽ] ‘soft’.

Deletion can also apply across word boundaries, such as in the phrase /ˈkateɾe/ [ˈkatre] ‘just cut it!’ as well as across morpheme boundaries, as in /a-ˈkuru/ → [ˈakru] ‘holds (3s)’, in which a- is the third person singular morpheme.

The rule produces forms such as the examples in (6). Note how in words e. and f., it is a stressed vowel that is deleted.

(2.11)

a. /keˈreme/ → [ˈkreme] ‘tomorrow’

b. /biˈrigi/ → [ˈbrigĩ] ‘lightning’
c. /gere'aga/ → [gre'aga] ‘greens’

d. /a'nda'awa/ → [a'ndrawa] ‘road’

e. /guruwa/ → [guruwa] ‘child’

f. /du'mburu/ → [du'mbru] ‘teenage’

2.4.2.2 Vowel Laxing

Kala shows vowel laxing for front vowels /i/ and /e/ when they appear before consonants that are [+continuant]. This also appears to include nasals and prenasalized stops, even though these segments often do not pattern with continuants due to full oral closure. For a detailed discussion of vowel laxing in this environment, see Chapter 4.

Laxing is correlated with an increase in the frequency of F1 and a decrease in frequency of F2. Both of these features are evident in Kala (see Chapter 4 for a full analysis). My impressionistic observation had originally been that laxing was an optional process, which may still be the case, but in any case, it has shown to be statistically significant in all five of the speakers whose vowels were analyzed in Chapter 4.

Laxing produces forms such as those below.

(2.12)

/wese/ → [wɛse] ‘far’

/berɛ/ → [bɛre] ‘plate’

/a'ge'mbe/ → [a'ge'mbe] ‘falls’
/kiᵐbe/ → [ktⁿbe] ‘ripe’
/dini/ → [dⁿi] ‘that’
/sira/ → [sʳa] ‘they’

Words containing laxed vowels also have an optional process of laxing harmony. In laxing harmony, a front vowel in a syllable following another syllable containing a laxed vowel may also become lax.

(2.13)
/wese/ → [wɛse] ~ [wɛsɛ] ‘far’
/berë/ → [bɛɾe] ~ [bɛɾɛ] ‘plate’
/kiᵐbe/ → [ktⁿbe] ~ [ktⁿbɛ] ‘ripe’
/dini/ → [dⁿi] ~ [dⁿi] ‘that’

This rule may also apply iteratively, in words of three or more syllables, such as /sesete/ ‘they cut’, which can appear as [sɛsɛtɛ]. The first /e/ is laxed due to preceding a continuant, and the second and third vowels are laxed through harmony.

2.4.2.3 Non-phonemic Nasalization vs Nasal Vowels

Kala has contrastive nasal vowel phonemes. They exist in the same qualities as their oral counterparts: /ä ē ĩ ŏ ü/. The distribution of nasal vowel phonemes is such that they only appear word-finally, probably due to historical reasons, except in certain reduplicated terms (e.g. /jajä/ ‘yellow’) and place names (e.g. Alëso /arëso/ ‘name of a village’, which is composed of the word /arë/ ‘fresh water’ and /so/ ‘shoots’).
Kala also has some degree of assimilatory nasalization in phonemically oral vowels that precede nasal consonants (/m n ŋ m b m w n d ŋ g ŋ w/). Acoustic measurements, however, show distinct differences between the degree of nasality of a phonemic nasal vowel and that of a phonetically nasalized vowel. This may indicate positional neutralization of the oral/nasal distinction in vowels before nasal consonants, or that Kala speakers are implementing different degrees of nasalization in articulating nasalized vowels of different phonological status. See Chapter 5 for a deeper discussion of nasality in vowels.

(2.14)

/wā/ [wā] ‘canoe’

/wa̯mba/ [wāmba] ‘cargo’

/jē/ ‘beard’

/jē̯mbel/ [jē̯mbe] ‘pandanus sleeping mat’

### 2.4.2.4 Centralization of /a/

The phoneme /a/ is often centralized to [ə]. The conditions for this centralization are not yet clear. It is possible that is a type of vowel reduction related to allegro speech or word frequency, but further data analysis is needed to determine this. It is also possible that the centralized [ə] is in free variation with [a], although it never appears in certain lexical items and usually or always appears in others. It is particularly common (to the extent
that it could be said to be obligatory⁴) in diphthongs that include /a/ plus a high vowel /i/ or /u/: /au/ and /ai/. It is notably less common word-initially and word-finally, unless it is a part of a diphthong.

(2.15)

/ərẽ/ [ərẽ] ‘fresh water’
/ˈbærĩ/ [bærĩ] ‘long’
/tə/ [tə] ‘sea’
/ˈkana/ [ˈkəna] ‘our (INCL)’
/kare/ [kare] ‘eldest daughter’
/arisa/ [ˈarısa] ‘eldest son’
/ŋaĩ/ [ŋəĩ] ‘leg, foot’
/ˈawe/ [ˈawe] ‘then’
/sa/ [sa] ‘up, out’
/ˈtawa/ [ˈtawa] ‘bottom’
/ta’mbu/ [ta’mbu] ‘man’
/ˈaaũ/ [ˈaaũ] ‘garden’
/ai/ [ai] ‘Malay apple’
/ˈao/ [ao] ‘paddle’
/na’mbi/ [nə’mbi] ‘sago’
/ˈaiga/ [ˈeiga] ‘second-born daughter’
/gabo/ [ˈgabo] ‘big’
/ˈabu/ [ˈabu] ‘grandfather’
/adi/ [adı] ‘father’
/ˈako/ [ˈako] ‘swims (3s)’
/ˈtaɾu/ [ˈtaɾu] ‘place’
/ˈa’də/ [ˈa’də] ‘good’

In some words, especially in quicker or casual speech, /a/ becomes fronted as well as centralized, to the extent that it is realized as [e].

(2.16)

/ˈkai/ [kei] ~ [ke] ‘you’
/ŋaĩ/ [ŋəĩ] ‘leg’

⁴ My basis for this statement is multiple corrections from speakers when pronouncing words such as /ŋaĩ/ ‘leg’ as [ŋaĩ] rather than as [ŋəĩ].
This fronting in addition to centralization, at least in diphthongs, appears to be a stronger feature of the Southern dialect. Some instances of /e/ or /ei/ in the Southern dialect are seen as /ae/ or /ai/ in the Northern dialects (e.g. S. Kala /we/ [we] ‘crocodile’ vs. Lambu and Manindala /wae/ [wae] ‘crocodile’). These examples, however, show no evidence of being underlying /ae/ or /ai/ in the South, as they never appear as [ae] or [ai] there, unlike words such as a /kai/ ‘you’.

2.5 Suprasegmentals

Kala shows no evidence of having lexical tone. It does show stress, however, which often appears on the penultimate syllable of a word (and always does in the case of disyllabic words). In some cases, words of three or more syllables show stress on the antepenultimate syllable, as seen in (2.18).

(2.17) /ˈbaɾe/ ‘sweet potato’

/ˈweɡe/ ‘aunt’

/ˈmia/ ‘go’

/ˈkore/ ‘son’

/ˈbomi/ ‘your (DUAL)’

/ˈwaro/ ‘mouth’

(2.18) /ˈaimia/ ‘goes (3s)’

/ˈpepeɾe̞/ ‘soft’

/ˈtatarã/ ‘blue, green’
The acoustic correlates of stress are not yet well understood, but my preliminary understanding is that it is more consistently linked with intensity and duration than with pitch. On average, stressed vowels tend to be longer than unstressed vowels. The average stressed vowel is around 25% longer in duration than an unstressed equivalent (see Chapter 4, Section 4.5.2 for more discussion of this measurement), with stressed vowels averaging 102 ms in duration and unstressed vowels being around 78 ms.

Prosody or phrasal intonation appears to have some influences on stress placement in words in Kala. Some trisyllabic words have variable stress when spoken in isolation ([ˈsorome] vs. [soˈrome] ‘very; correct(ly)’) but appear consistently with stress in antipenultimate position when following or preceding a disyllabic word (which inevitably has penultimate stress and never ultimate stress placement). An example of this is the phrase /anda soɾome/ ‘very good’, in which stress on /soɾome/ always appears on the antipenultimate syllable: /ˈanda ˈsoɾome/.

2.6 Dialectal Differences

The northernmost three Kala villages include, from south to north, Apoze, Lambu, and Manindala. All dialects have some phonological differences from Southern Kala. This
section compares the differences in phonemic inventory, distribution, and phonotactics between Southern Kala and its three northern relatives.

2.6.1 Apoze

Apoze is the southernmost of the so-called northern villages, being adjacent to Kamiali (a southern village) and Lambu. Its dialect is considered to be one of the Northern dialects, but it is, in many ways, the closest of those three dialects to Southern Kala. Apoze dialect is different, however, in that it includes the phoneme /z/, which is absent in Southern Kala. Words that contain /z/ in Apoze appear with /d/ in Southern Kala. For example, the word for ‘food’ /mozi/ in Apoze, is /bodi/ in Southern Kala. There is also a correspondence between Apoze /m/ and Southern Kala /b/, as this same word exemplifies. Similarly, the Southern Kala prenasalized labialized bilabial stop /ᵐᵇʷ/ appears lacking a stop component altogether and is simply a labialized bilabial nasal /mʷ/. This pattern of lenition (stops > nasals) is seen in others of the same series too: Southern Kala /tʰəŋʷe/ ‘mangrove’ is /tʰauŋʷe/ in Apoze. Apoze typically reduces prenasalized labialized stops to labialized nasals; e.g. stops remain in words such as /maⁿge/ ‘hand’, which appears identical in the Southern dialects, but this generalization is imperfect, as there are pairs such as /jaⁿgaxe/ (Southern Kala) ‘white sand’ and /jaⁿgawe/ in Apoze. It may be that more frequent/common words, such as mange ‘hand, arm’, preserve the prenasalized stop, and less common words do not. However, there is no present frequency study to confirm or quantify this hypothesis.
Table 2.4. Apoze and Southern Kala cognate consonants. The expected pattern is broken by *maŋge* ‘hand’.

Apoze also shows consonant voicing in personal pronouns. The */b/~m/* alternation is also evident in these words, as is an inconsistent vowel difference that may only appear in personal pronouns.

<table>
<thead>
<tr>
<th>Apoze</th>
<th>Southern Kala</th>
</tr>
</thead>
<tbody>
<tr>
<td>mozi ‘food’</td>
<td>bodi</td>
</tr>
<tr>
<td>za ‘house’</td>
<td>da</td>
</tr>
<tr>
<td>mʷa ‘snake’</td>
<td>mᵇʷa</td>
</tr>
<tr>
<td>tauʰwe ‘mangrove’</td>
<td>tauʰgwe</td>
</tr>
<tr>
<td>jaŋawe ‘white sand’</td>
<td>jaŋgawe</td>
</tr>
<tr>
<td><strong>maŋge</strong> ‘hand’</td>
<td>maŋge</td>
</tr>
</tbody>
</table>

Table 2.4. Apoze and Southern Kala cognate consonants. The expected pattern is broken by *maŋge* ‘hand’.

Table 2.5. Consonantal differences in personal pronouns, comparing Apoze and Southern Kala.

<table>
<thead>
<tr>
<th>Apoze</th>
<th>Southern Kala</th>
</tr>
</thead>
<tbody>
<tr>
<td>gia ‘1ˢᵗ sg.’</td>
<td>kia</td>
</tr>
<tr>
<td>gai ‘2ⁿᵈ sg.’</td>
<td>kai</td>
</tr>
<tr>
<td>gara ‘1ˢᵗ pl. incl.’</td>
<td>kara</td>
</tr>
<tr>
<td>mara ‘2ⁿᵈ pl.’</td>
<td>bara</td>
</tr>
<tr>
<td>goa ‘1ˢᵗ du. incl.’</td>
<td>kawa</td>
</tr>
<tr>
<td>moa ‘2ⁿᵈ du.’</td>
<td>bua</td>
</tr>
</tbody>
</table>

Table 2.5. Consonantal differences in personal pronouns, comparing Apoze and Southern Kala.
Apoze has nasalized vowels in approximately the same distribution as Southern Kala, seen in words such as *tō* ‘walking stick’ and *sasā* ‘sawfish’. Many Southern Kala and Apoze words, such as these, appear identical. Nasalization appears to function the same way in Apoze as in Southern Kala, including possible phonetic nasalization of phonemically oral vowels preceding nasal stops or prenasalized voiced stops (e.g. *[jāŋgawe]*)

Like Southern Kala, Apoze lacks codas, and except for potentially emergent **Cr** onsets due to optional vowel deletion, I would generalize its syllable structure as identical to that of Southern Kala (generally (C)V).

### 2.6.2 Lambu

Lambu is one village north of Apoze. It is located to the south of the northernmost village, Manindala. The Lambu dialect is unique in that it makes productive use of irrealis/realis morphemes on verbs that are also used in nearby sister/cousin languages, Jabêm, Bukawa, and Numbami (Sibôma). No other Kala dialect still uses these morphemes productively, but they have rather fossilized them. They have lost their meaning distinction, but instead have produced irregular verb stems that still endure.

Cognate forms between Lambu and Southern Kala are somewhat comparable to those of Apoze, but some differences remain. The table below shows a comparison between cognates in Lambu, Apoze, and Southern Kala. Note the unusual example of lenition of Southern Kala */ŋw/* and Apoze */ŋʷ/* to */w/* in Lambu.
<table>
<thead>
<tr>
<th>Lambu</th>
<th>Apoze</th>
<th>Southern Kala</th>
</tr>
</thead>
<tbody>
<tr>
<td>mozi ‘food’</td>
<td>mozi</td>
<td>bodi</td>
</tr>
<tr>
<td>za ‘house’</td>
<td>za</td>
<td>da</td>
</tr>
<tr>
<td>mbwa ‘snake’</td>
<td>mw’a</td>
<td>mbwa</td>
</tr>
<tr>
<td>towe ‘mangrove’</td>
<td>tauŋ’we</td>
<td>tauŋ’g’we</td>
</tr>
<tr>
<td>jana’we ‘white sand’</td>
<td>jana’we</td>
<td>ja’g’awe</td>
</tr>
<tr>
<td>tutum’mi ‘black’</td>
<td>tutumi</td>
<td>tutumi</td>
</tr>
<tr>
<td>ma’ge ‘hand’</td>
<td>ma’ge</td>
<td>ma’ge</td>
</tr>
</tbody>
</table>

Table 2.6. Cognates of Lambu, Apoze, and Southern Kala.

Once again, ma’ge ‘hand’ is seen to break expectations. I have also added the example of tutumwi/tutumi/tutumi ‘black’ here to show this mw:m:m constrast between the three dialects. Another example of this is lasumwi/lasumi/lasumi ‘house fly’.

Lambu shows nasalization in similar distribution to Southern Kala and Apoze. It also lacks syllable codas. Like Apoze, it includes the phoneme /z/, which Southern Kala lacks. Lambu /z/ is cognate with Southern Kala /d/, as in bodi/mozi/mozi ‘food’ and duwi/zuwi/zuwi ‘bubbles, foam’, diŋgole/zıŋgole/zʊŋgole ‘frog’, and do/zı/za ‘turtle’.

As mentioned above, Lambu is the only dialect that still has productive use of irrealis/realis marking. Even though this is a morphosyntactic feature, it has a few interesting effects on phonology and morphophonemetics. One result is that there is a form of consonant voicing harmony between pronominal prefixes and realis prefixes (irrealis is unmarked in Lambu)

<table>
<thead>
<tr>
<th></th>
<th>Voiced consonant-initial stem⁵</th>
<th>Voiceless consonant-initial stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st sg</td>
<td>-go/-g’a</td>
<td>-ko/-k’a</td>
</tr>
<tr>
<td>2nd sg</td>
<td>-gu/-go</td>
<td>-ku/-ko</td>
</tr>
<tr>
<td>3rd sg</td>
<td>-gi</td>
<td>-ki</td>
</tr>
</tbody>
</table>

Table 2.7. Lambu realis markers and their consonant harmony.

⁵ Kala ostensibly lacks vowel-initial verb stems.
There are some apparent exceptions to this pattern. Some stems with initial /n/ or approximants use the voiceless versions of prefixes, e.g. -lia (gi) ‘not know’, -laĩ ‘sail’ and -nu ‘do, make’ (giving forms likes yokolia gi, yokolaĩ, yokonu). However, voiced stops always take the voiced versions of realis morphemes.

The variation in vowel quality in these productive irrealis markers is the same as can be seen in the fossilized versions of these same morphemes in Southern Kala. The o~wa/u~oli pattern in Southern Kala can be seen in verbs such as yokomale, kakumale, aikimale ‘laugh; smile’ (1st, 2nd, 3rd person singular, respectively), yokolia, kakulia, aikilia ‘not know’, and yoguli, kaguli, aigili ‘hit, strike’. However, this vowel series is not as consistent in Southern Kala as it is in Lambu.
2.6.3 Manindala

The dialect of Manindala, the northernmost village, is especially unique amongst its relatives in that it has syllable codas, which the other dialects lack. In this respect, it is similar to Kala’s closest relative languages, Jabêm and Bukawa.

Unlike the other two northern dialects, Manindala lacks /z/. Instead, some instances of /s/ are the resulting cognate. It’s also notable that some prenasalized stops appear as nasals, and what is plain /m/ in other dialects may appear as a labialized /mʷ/ in Manindala.

<table>
<thead>
<tr>
<th>Manindala</th>
<th>Lambu</th>
<th>Apoze</th>
<th>Southern Kala</th>
</tr>
</thead>
<tbody>
<tr>
<td>mosí ‘food’</td>
<td>mozi</td>
<td>mozi</td>
<td>bodi</td>
</tr>
<tr>
<td>sa ‘house’</td>
<td>za</td>
<td>za</td>
<td>da</td>
</tr>
<tr>
<td>mʷa ‘snake’</td>
<td>mʷba</td>
<td>mʷa</td>
<td>mʷba</td>
</tr>
<tr>
<td>tønek ‘mangrove’</td>
<td>towe</td>
<td>taŋwe</td>
<td>tauŋ‘e</td>
</tr>
<tr>
<td>jaŋawë ‘white sand’</td>
<td>jaŋawe</td>
<td>jaŋawe</td>
<td>jaŋgawe</td>
</tr>
<tr>
<td>tutumʷi ‘black’</td>
<td>tutumʷi</td>
<td>tutumi</td>
<td>tutumi</td>
</tr>
<tr>
<td>maŋge ‘hand’</td>
<td>maŋge</td>
<td>maŋge</td>
<td>maŋge</td>
</tr>
</tbody>
</table>

Table 2.8. Consonant cognates between all four Kala dialects.

Possible codas include -p, -k⁶, and nasal consonants -m, -n, and -ŋ. In this way, it is most similar in syllable structure to Kala’s closest relative languages. Jabêm and Bukawa both have codas -p, -b, -m and -ŋ, as well as -ʔ, which is only contrastive word-finally.

Nasal vowels have a different distribution in Manindala than in Southern Kala. Manindala has more final nasalized vowels, whereas in the same word, Southern Kala

⁶ Final -k in Manindala is sometimes realized as [ʔ].
and the other northern dialects would have an oral vowel instead. However, it does have other words showing similar nasalization as its neighbors, such as *alē* ‘water’, etc.

Some orthographic transcriptions of Manindala words appear with a final -ŋ, which is sometimes pronounced outright as a nasal consonant, and sometimes only nasalizes the previous vowel. A word such as *yaken* ‘armlet’ may be pronounced [jakẽ] or [jaken]. Some other words that have final nasal vowels in Southern Kala are also sometimes closed by different nasal consonants, such as *tatalan* [tatalã–tatalan] ‘blue, green’. All of this points to the possibility that Manindala may still be phonologizing nasal vowels, as there is still evidently free variation with final nasals in some words. By contrast, this phonologization is complete in Southern Kala and in the other Northern dialects.

Unlike nasal codas, oral stop codas have completely deleted in the other dialects, corresponding to ∅ (zero) in Southern Kala, Lambu, and Apoze, as in the below examples.

<table>
<thead>
<tr>
<th>Manindala</th>
<th>Lambu</th>
<th>Apoze</th>
<th>Southern Kala</th>
</tr>
</thead>
<tbody>
<tr>
<td>tak ‘sea’</td>
<td>ta</td>
<td>ta</td>
<td>ta</td>
</tr>
<tr>
<td>kiam ‘dog’</td>
<td>kiã</td>
<td>kiã</td>
<td>kiã</td>
</tr>
<tr>
<td>sorop ‘completely’</td>
<td>sorome⁷</td>
<td>sorome</td>
<td>sorome</td>
</tr>
<tr>
<td>berep ‘plate’</td>
<td>bere</td>
<td>bere</td>
<td>bere</td>
</tr>
<tr>
<td>dep ‘bilum’</td>
<td>de</td>
<td>de</td>
<td>de</td>
</tr>
<tr>
<td>-girip</td>
<td>-giri</td>
<td>-giri</td>
<td>-giri ‘hit, strike’ (3s)</td>
</tr>
<tr>
<td>jagaum ‘high tide’</td>
<td>jagaũ</td>
<td>jagaũ</td>
<td>jegaũ ~ jagaũ</td>
</tr>
<tr>
<td>tataran ‘blue, green’</td>
<td>tatarã</td>
<td>tatarã</td>
<td>tatarã</td>
</tr>
</tbody>
</table>

Table 2.9. Examples of cognates between Kala dialects, in which Manindala shows a word-final coda that is lacking in other dialects.

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⁷ The /me/ end of this word in the other dialects is likely due to a compound of *solo* ‘complete, right’ + *me* ‘just, only’, a common adverbial word.
Chapter 3: Vowel Deletion

3.1 Introduction

Vowel deletion is a common phonetic and phonological process, observed cross-linguistically in many phonetic environments, whether diachronically or synchronically (Ladefoged 2013:28-30). Word-medially, it is often referred to as syncope, which is the type of vowel deletion that I focus on in this chapter concerning deletion in Kala. In Kala, vowels may delete when occurring after a stop consonant and before an alveolar tap, but only if the vowel following this tap is of identical quality to the deleting vowel. Deletion is also generally restricted to words of more than two syllables, although disyllabic words may show deletion when in a phrasal context (see Section 3.4). Vowel deletion is possible in this same phonetic context in both stressed and unstressed syllables, which makes Kala’s pattern of vowel deletion fairly cross-linguistically unusual.

Vowel deletion may be considered the most extreme form of vowel reduction (Kapatsinski, et al. 2020:29), the process by which vowels in certain contexts become more centralized, devoiced, and/or shortened. In many languages, this process is linked to lexical stress systems, and occurs frequently in unstressed syllables; a vowel may reduce in quality (become more centralized), followed by or alternating with total deletion (as in e.g. Guayamí, Jivaro (Kapatsinski, et al. 2020:40)). Yet in other languages, vowels may delete entirely with no clear “intermediary stage” of reduction, shortening, centralization, etc. (as in e.g. Rukai, Margi, Carib), or they may have vowel phonemes that delete in some contexts, but reduce in other ways in other contexts,
such as in Alyawarra, in which /a/ deletes in a #__(C)C environment, but may be backed or raised to [e] or [ʌ] word-initially or word-finally (Kapatsinski, et al. 2020:40).

In this chapter, I look to a usage-based approach to vowel reduction to account for vowel deletion in Kala. In Section 3.4.1, I show that Kala has propagated the vowel deletion sound change through the language, not in total at once, but in different levels according to speech style (Greenberg 1966; Browman and Goldstein 1990). At the same time, there is an inherent contradiction to a usage-based approach in the very nature of Kala vowel deletion, which is apparently totally categorical (there are no intermediary forms of vowel reduction still observable in the language). Usage-based theories would predict that, if a sound change is not fully phonologized in the language, there will remain some detectable trace of deletion or some present excrecent or intrusive vowel (as shown e.g. in Chitoran and Babaliyeva (2007) for Lezgian vowel deletion). Kala shows no such traces, even though the deletion rule is still very productive and has not (yet) fully phonologized in the language.

This contradiction is fundamentally an issue of gradience vs. categoriality (Chitoran and Cohn 2009). Vowel deletion has pervaded Kala in stages, from allegro speech styles (Greenberg 1966) to lento, and, as can be seen in Section 3.4.1, is still in notable free variation in lento. For this reason, there is evidence that it is driven by automatization (Kapatsinski, et al. 2020) and potentially gestural overlap (Browman and Goldstein 1990). However, it is a categorical sound change, which is not easily explained by the above approaches. Whatever gestures are or were overlapping are unclear at this stage of the language.
Chitoran and Cohn (1990) describe the classic division of phonetics and phonology, in part, in terms of gradience and categoriality, showing that this distinction accounts for data from a range of languages from families. It is assumed that categorical changes result either from phonological or lexical pressures and exist in a separate module from phonetics. Phonetics, by contrast, supposedly governs gradient or continuous effects of speech, and is also assumed to be more universally applicable than phonology, which is language-specific. Despite the degree to which this modular view has been useful, there are cases of seeming contradictions that do exist: as Chitoran and Cohn put it, these are cases of gradience in phonology and categoriality in phonetics. It is the latter seeming contradiction that is relevant to the case of Kala vowel deletion.

In this chapter, I pose a central research question: Can a seemingly categorical sound change be accounted for using a usage-based framework, and moreover, can this sound change be shown to propagate through a language by speech style?

3.2 A Usage-Based Approach to Vowel Reduction

In many of the languages showing reduction or deletion that are covered in the survey portion of Kapatsinski, et al. (2020), deletion is confined to various unstressed positions, whether pre- or post-tonic. This survey includes 81 languages from a variety of families, all of which display some form of vowel reduction, centralization, deletion, devoicing, unrounding, or shortening. Kapatsinksi and colleagues argue that vowel reduction is not a phenomenon that results from imperfect intergenerational transmission (a change
catalyzed by children miscomprehending the input of their parents and other adults), but is a change brought about by experienced adult speakers. They argue that this kind of vowel reduction is due to optimization of gestural, goal-oriented movement patterns, which is an incremental efficiency typically found in speakers who have reached a level of experience necessary to find the smoothest transitional trajectory between a series of gestural articulatory goals (Kapatsinski, et al. 2020:19-20, 32). Essentially, this view of reduction takes a usage-based approach, which seeks to explain the mechanistic operations by which a given system (reduction of vowels) can emerge through automatization. Additionally, they argue, social consequences then further constrain to the extent of automatization that is ultimately carried out—feedback from interlocutors may prevent reduction from proceeding as far as it might otherwise.

The approach adopted in Kapatsinski, et al. (2020) is not inherently incompatible with the nature of vowel deletion in Kala. Kala vowels delete in specific phonetic environments, but do so regardless of whether the vowel is in a stressed syllabic position or not. I do not believe that this factor makes a functional, usage-based approach inappropriate, although it is difficult to use the languages listed in Kapatsinski, et al. (2020) as perfect parallels, since they (as most languages do) restrict vowel reduction/deletion to positions of prosodic weakness.

The predictions made by the automatization account, however, could certainly still apply to deletion in Kala, and evidence that I present below for my hypothesis that deletion happens more frequently in quicker, natural speech than in slower, careful speech (see Section 3.4.1 below) may offer some support toward this approach with
regard to Kala vowel deletion. If automatization is driving Kala vowel deletion, it would seem to follow that it would occur more readily in quicker, casual speech than in slower, careful speech.

The idea of certain phonetic and phonological processes taking place only or more frequently in quicker, casual speech is not novel—Greenberg (1966) discusses Japanese vowel devoicing in colloquial speech as an example of how certain kinds of reduction and deletion (in this case, devoicing of vowels between voiceless consonants) are more likely to happen in allegro speech (casual, faster, fluent speech) than in lento speech (slower, careful, more formal speech, or forms listed in isolation). He mentions that sound changes that occur at first only in allegro speech will eventually pervade the language in both allegro and lento speech styles (Greenberg 1966:516), which is exactly what has happened in the case of Japanese vowel devoicing. This is now a phenomenon that is not restricted by allegro or lento style. As Greenberg states (1996:516):

“If we assume that change first occurs in the allegro style and will show free variation in its first stage, then the most recent changes will be reflected in this manner. In the next stage the innovation invades the lento style, where it occurs as a free variant; but in the allegro style the new form is now exclusive. The last stage, with the change fully accomplished, shows the new form as the exclusive variant in both styles.”

Indeed, this is how we have seen Japanese vowel devoicing evolve and pervade speech styles as a sound change. In fact, in at least the Tōkyō dialect, it is almost
obligatory to devoice high vowels when they occur between certain voiceless consonants (Nielson 2012:162). This is in line with Greenberg’s prediction for how sound changes move through a language by speech style: first, it is limited to free variation in allegro styles, then pervades lento style in free variation, and is obligatory in allegro. Finally, the sound change becomes obligatory in both styles.

Other literature has addressed the mechanisms behind how and why some sound changes pervade languages in multiple steps according to speech style. Browman and Goldstein (1990) present a computational representation that makes use of tiers (similarly to autosegmental phonology) to model how articulatory gestures overlap and reduce in the spatiotemporal context of speech as produced by the human vocal tract. This model shows how the increased speed adopted in allegro styles can lead to overlap that results in what are traditionally described as processes of deletion, reduction, or assimilation. These effects may not be seen, or may be seen with less frequency, in lento styles. Additionally, Browman and Goldstein show the effect that a phrasal context may have on the likelihood of gestural overlap: using data from lead pellet X-ray studies, they show that these deletions, etc. are much more likely to occur in phrasal contexts than when words are spoken in isolation (Browman and Goldstein 1990:355-367). They use their model of gestures embedded in tiered tract variables to describe multiple phenomena (deletion, assimilation, reduction, devoicing, as well as some types of consonant insertion), which can all be described under a single gestural framework, instead of through individual and potentially unrelated segmental rules. Vowel reduction, under this analysis, is seen as a decrease in duration or magnitude in
the gesture that is associated with the vowel. This approach, following from the observations of Greenberg, would seem to be an appropriate tool to help understand the nature of vowel deletion in Kala, given its stylistic context.

Following a gestural overlap approach, Kala’s total deletion of vowels would seem to be the final or most extreme stage of this process. Although there is not currently any direct evidence of vowels reducing in a manner that is less total than deletion, it may have been observable in previous stages of this sound change. It is not possible today to know what forms intermediate stages in this deletion process may have taken. There is a variety of potential ways in which a language may “reduce” a vowel prior to total deletion: devoicing (as in languages such as Lezgian (Chitoran and Babaliyeva 2007) and Japanese (Nielson 2012)), shortening (Kim Mun (Clark 2008)), or change in quality (typically centralization, raising, or laxing) (as in Catalan (Marcet, et al. 2021)). Assuming, then, that Kala did have, at one point, an intermediary stage prior to full vowel deletion, it would follow that this sound change is not totally new but is rather the final stage of a cline of reduction over time.

Vowel reduction in unstressed syllables is also thoroughly investigated under an approach informed by Optimality Theory in Crosswhite (2004), which uses two different models along with Quantal Theory (Stevens 1989) to account for different types of unstressed vowel reduction. Barnes (2006), by contrast, uses a phonologization-based model to arrive at a single formal explanation for seemingly contradictory types of reduction across different languages—both those that involve “reduction” to a more peripheral vowel (e.g. /a i u/) and those that involve centralization. It is not clear how
useful this approach may be to understanding Kala deletion, since its explanation necessarily assumes an unstressed syllable position for the deleting vowel. In approaching vowel deletion in Kala, I want to move toward a usage-based framework that is not totally dependent on stress or tonic conditioning.

In the following section, I present some parallel cases of vowel deletion in languages that occur regardless of lexical stress. All of these languages are from the Oceanic subfamily of Austronesian, of which Kala is a member.

3.3 Stressed Vowel Deletion: Case studies from Oceania

Much of the literature on vowel reduction and deletion addresses unstressed vowel reduction or deletion, given its cross-linguistic prominence. However, although unstressed syllable vowel reduction is a strong cross-linguistic pattern, the elision of vowels is not limited to strictly unstressed syllables. In this section, I give an overview of some case studies of languages in which vowel reduction or deletion occurs regardless of the tonic status of the syllable. All but the last example (Tomini-Tolitoli) are diachronic sound changes, so they cannot be said to be completely parallel with Kala’s apparently synchronic vowel deletion, but the details of vowel deletion in these languages are similar enough in form and in outcome that I consider these processes from closely related Oceanic languages to be relevant to include in the context in which we view Kala vowel deletion.

Some examples from Kala’s subfamily of Oceanic, include Mussau, spoken on Mussau Island in the New Ireland Province of Papua New Guinea. Mussau, as noted by
Blust (2007), has developed geminate onset clusters due to a historical process of vowel deletion, as a part of an overall pressure to move longer words (greater than 2 syllables) toward a disyllabic structure. Even though vowel deletion in Mussau is diachronic and Kala’s is synchronic, the processes have similarities in both languages (e.g. syncope involving two syllables containing identical vowels producing disyllabic forms). Blust (2007) reviews the principle of “anti-antigemination” (AAG), a diachronic process proposed by Odden (1988), to account for vowel deletion in many Austronesian languages, in which vowels delete only between identical consonants, creating disyllables from longer words. “Anti-antigemination” was proposed in opposition to the hypothesis of “antigemination” of McCarthy (1986), who argues that general syncope is suspended between identical consonants. McCarthy’s view is that instead of this being a general rule for languages, the Obligatory Contour Principle (OCP) governs this instance of gemination avoidance, since it is observed in languages that otherwise contain geminates. Odden (1988), however, opposes this explanation, in part because data from several languages (including Mussau and others in Blust (2007)) disprove its universality. Blust’s (2007) purpose is to show how the effects of AAG demonstrate a link between the diachronic and the synchronic: the lexicon of a proto-language can supposedly influence sound changes in a modern language.

The creation of geminates through syncope is seen by Blust as one of several processes in a phonological conspiracy, all driven by a “preference” for disyllables. Disyllabicitity in Austronesian languages is very prominent, and approximately 94% of all Proto-Austronesian reconstructed word bases are disyllabic (Chrétien 1965). Blust
argues that many (though not all of) modern Austronesian languages’ syncope processes are motivated by inherited structural pressure toward a disyllabic word base form (not considering multimorphemic words). Though he does not offer a formal treatment of this “preference” for disyllabism, he suggests that it may be modelled as an “attractor” in a dynamic system approach, in the sense proposed in Kelso (1995), or as a “system-internal attractor” as in Wedel (2007). These are models of pattern formation in complex systems, of which language can be considered a type. Generally, however, the theories put forth in Kelso (1995) go beyond the scope of linguistics and of this present discussion. Despite the similarities Kala shows to vowel deletion Mussau and some of the other languages investigated in Blust (2007), I do not analyze Kala under the assumption of disyllabic attractors here.

Mussau’s syncope has included deletion of stressed vowels, as Mussau has penultimate stress, and many of these stressed vowels are those in which we see deletion. We see geminates⁸ resulting from deletion in words in the following sets, again forming when vowels delete only between identical consonants, and (although it is not mentioned in Blust (2007)) when the vowel found in the following syllable is also identical to the one to be deleted. Stressed vowels in the examples below are marked with an acute accent.

(3.1)

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⁸ Ostensibly, these are true geminate consonants (a consonant with sustained articulatory duration twice the length of its singleton counterpart), rather than a cluster of two released consonants that can sometimes result from vowel deletion (e.g. as in Yakima Sahaptin (Hargus and Beavert 2002, 2005, 2006)). Blust (2007) does not address this difference explicitly, but there is nothing in his description of these processes that would lead to an interpretation of the latter rather than the former conclusion.
*ai gagáli > ai ggali ‘razor’
*kikíau > kkiau ‘megapode’
*mumúko > mmuko ‘sea cucumber’
*mamáma > mamma ‘yawn’
*katóto > katto ‘star’
*mumúmu > mummu ‘suck’
*gagága > gagga ‘tidal wave’
*gorúru > gorru ‘seaweed species’ (Blust 2007:22-23; 31).  

Note that all deletion in Mussau occurs between identical consonants to create geminates, and vowels between non-identical consonants do not delete in this fashion. It also appears that vowels that delete must be followed in the next syllable by an identical vowel. In the first three examples shown in the list above, it is an unstressed vowel that is being deleted. Indeed, this is a pattern observed in many languages across the Austronesian family by Blust (2007). However, for the five latter examples from Mussau, the deleted vowel is stressed.

The case of Mussau vowel deletion is also very similar to two other Oceanic languages covered in Blust (2007:16-18; 25-26), Takuu and Tomini-Tolitoli. Takuu is spoken on a small atoll in the Bougainville Province of Papua New Guinea, east of the central Solomons chain. Like Mussau, Takuu has geminate consonants that have emerged solely due to vowel deletion between identical consonants. However, unlike Mussau, and most of the other languages surveyed in Blust (2007), its vowel

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9 To my knowledge, none of these forms involve reduplication.
deletion is not limited to trisyllabic or longer words but can occur in some disyllabic words as well. In the first set below, Takuu shows internal vowel deletion in words of three or more syllables, all of which (in these cases) are unstressed. In the below examples, the proto-forms represent Proto-Oceanic words.

(3.2)

*faka-kaha > fakka ‘light up’

*faka-kila > fakkila ‘polish’

*faka-kapi > fakkapi ‘draw in the sheet of a sail’

*fafine > ffine ‘female’

*fafie > ffie ‘firewood’

*fofonu > ffonu ‘deep (of water)’

*lalaki > llaku ‘scratch’

*mamafa > mmafa ‘heavy’

*tu-tunji > ttuni ‘set fire to’ (Blust 2007:17)

Blust notes that if two identical consonants are separated by a long vowel, syncope is not allowed.
In the examples below, Takuu words that are already disyllabic also undergo vowel syncope, but only if the two vowels in the words are of the same quality (although, interestingly, they may differ in vowel length, which is a phonemic feature for Takuu vowels). The remaining single vowel is lengthened (perhaps in compensation), or, as Blust mentions, this could be an example of metathesis (Blust 2007:18).

\[(3.3)\]

*fafa > ffaa ‘ride on the back of’

*kaka > kkaa ‘fiber around a coconut frond’

*lle > llee ‘to fly’

*lili > llii ‘angry’

*lolo > lloo ‘coconut cream’

*lulu > lluu ‘sheltered from the wind’

*papa > ppaa ‘flat board’

*pepe > ppee ‘butterfly, moth’

*pipi > ppii ‘kind of bivalve mollusk’

*rara > llaa ‘to heat over a fire’

*sisii > ssii ‘to hiss’

*toto > ttoo ‘blood’

If the vowels of a disyllabic word are not of the same quality, then no deletion occurs, as seen below.
Another case presented in Blust (2007) is that of Tomini-Tolitoli. This language has 12 dialects described in Himmelmann (2001), all spoken around the Tomini Gulf in north-central Sulawesi (Blust 2007:25). Himmelmann states (2001:71) that geminate consonants may arise through vowel deletion, when two identical CV syllables are reduced to a geminate consonant plus a single vowel (CVCV > CCV). A few examples below are from the Totoli dialect. These deletions are presented as synchronic and optional in Himmelmann (2001:71).

(3.5)

\[
\begin{align*}
\text{sasaakan} & \rightarrow \text{ssaakan} \quad \text{‘all’} \\
\text{molili} & \rightarrow \text{molli} \quad \text{‘yellow’} \\
\text{dedek} & \rightarrow \text{ddek} \quad \text{‘small’} \\
\text{pipi} & \rightarrow \text{ppi} \quad \text{‘cheek’} \\
\text{kuku} & \rightarrow \text{kku} \quad \text{‘foot’}
\end{align*}
\]

\[\text{I add emphasis here to indicate that deletion is apparently in free variation in Tomini and is not an obligatory rule. This is also the case in Kala.}\]
Totoli also has regular penultimate stress (Himmelmann 2001:73), meaning that the vowels being deleted in the latter examples (molili and kuku) must have been stressed. Blust states that Himmelmann (personal communication, 2004) said that in the case of disyllabic forms like kuku, the deletion only occurs in phrasal context with other words, e.g. baa kku ‘foot print’, amaŋ ddek ‘small uncle’, tau ddek mata ‘pupil of the eye [person small eye]’, buku ppi ‘cheekbone’. This is in contrast to trisyllabic examples, in which deletion can occur in isolation/citation forms (Blust 2007:26).

The conditions under which vowels delete in Kala are described below. There are several parallels that are evident with some of the above descriptions of vowel deletion in stressed and unstressed vowels in other Oceanic languages, although none of the cases match exactly the patterns found in Kala. In Kala, stress does not seem to play a role in vowel deletion, as both stressed and unstressed vowels can be deleted. Deletion is also optional, but quite frequent, especially in quick or natural speech. It is less likely to occur in slow, careful, or repeated speech, and is also somewhat less likely to occur in citation form or in isolation.

3.4 Vowel Deletion in Kala

The Southern dialect of Kala shows optional deletion of vowels in a way that may indicate a more complex syllable structure than the present CV pattern is developing. Vowels may delete in a very specific environment in Kala, as described below.
A vowel may be deleted in a word of >2 syllables when immediately preceded by a stop consonant and immediately followed by an alveolar tap, and the vowel in the following syllable is identical in quality. If a disyllabic word with the same context is in a phrasal context, it too may have its first vowel undergo deletion (e.g. yowā bala > [jowā bra] ‘my brother’). Additionally, this rule sometimes causes /ɾ/ to manifest as [ʃ], which is not an allophone otherwise seen for this phoneme.

Formalized, the rule for words of more than disyllabic structure is as follows.

\[ V_a \rightarrow \emptyset / [\text{-cont}] -r V_a \]

The rule does not apply if the word is only disyllabic unless it is in a phrasal context (similarly to the case of Totoli described above). For instance, words such as /kara/ ‘1pl (incl)’, /bara/ ‘brother’, /bere/ ‘plate’, /kuru/ ‘grab, hold’ will not show this deletion when spoken in isolation, but the word /a’kuru/ [a’ku] ‘grabs (3sg)’ may include deletion, being trisyllabic. It is also possible for deletion to occur across morpheme boundaries, such as in the phrase /kate re/ [katre] ‘just cut it!’.\(^{11}\) If a disyllabic word is a part of a phrase, it too may show deletion (e.g. /gere goŋgo’riki/ > [gre goŋgo’riki] ‘lots of things’, /gere ‘m’bolā/ [gre ‘m’bor] ‘something useless’). This is also observed almost exclusively in allegro casual speech.

\(^{11}\) This is one piece of evidence, as well, that the phenomenon at hand is in fact vowel deletion, and cannot be vowel insertion.
As mentioned above, vowels only delete when they are in a syllable preceding another vowel of identical quality. Interestingly, this is also a requirement for vowel deletion in Takuu, as discussed above). Nasality of the vowel does not seem to affect this process. That is, a vowel is treated as an identical vowel even if the phonemic nasality differs. This allows words like /peˈperé/ [peprē] ‘soft’ and /tatarã/ [tatrã] ‘blue, green’ to exhibit vowel deletion, even though there is a difference in nasality between vowels. The identical quality is what determines that deletion is possible, which could not happen otherwise.

This deletion process produces a categorical vowel state—that is, there is no partial reduction of the vowel quality. The vowel, if it is deleted, is completely gone. If it is not deleted, it does not undergo any kind of quality change, shortening, devoicing, or other type of reduction. In this way, it is in line some of the languages described in the survey of Kapatsinski, et al. (2019), such as Rukai, Margi, and Carib. There is no present “intermediary stage” of reduction, such a centralization, shortening, devoicing, etc. evident in the language. Nonetheless, speakers appear to be generally aware of both deleted and non-deleted forms of words and may switch between the different versions, sometimes seemingly consciously.

Below I give a few words in which deletion is possible, along with the deleted and non-deleted forms.

(3.6)

/giˈriwe/

[griwe] ~ [giˈriwe]
‘dance’

/kiriipi/

[kiri] ~ [kiriipi]  
‘pencil’

/turura/

[trura] ~ [turura]  
‘afternoon’

/taiame/

[trame] ~ [taiame]  
‘person’

/kiriiri/

[kiri] ~ [kiriiri]  
‘very, really’

/keireme/

[keireme] ~ [kireme]  
‘tomorrow’
/duˈmbru/

[duˈmbru] ~ [ˈdubru]

‘teenage’

/gaˈrawe/

[gaˈrawe] ~ [ˈgrawe]

‘moon’

Word-level stress in Southern Kala tends to fall on the penultimate syllable, as it does it in the above words, but this is not universally the case. There are some words that are trisyllabic (or longer) in which lexical stress may be on the antepenultimate syllable (e.g. /ˈjo mía/ ‘I go’, /ˈa m bolã/ ‘village’). There also appears to be some variation in stress placement between speakers, and phrasal prosody may exert a force over this as well, as the stress appears to fall on different syllables when these words are in phrases rather than spoken in isolation or citation form. Below is an example of this with the word /soˈrome/ [soˈrome] ‘entirely, very’. This word does not show any vowel deletion because it does not contain a stop consonant in the appropriate position, but I use it here to show how stress can appear variable. In citation forms or in isolation, it seems to show lexical stress either on the penultimate or on the antepenultimate, but in a phrase, it tends to be on the antepenultimate.
Because of this variable stress placement on words of more than two syllables, sometimes the vowels to be deleted are stressed, and therefore their deletion cannot be said to be driven entirely by tonic status. There are examples of stressed vowels deleting in the words below. In these words, the stress is clearly heard on the antepenultimate syllable (when in slower speech in which the vowel may not delete). The words below, /gururwa/ ‘child’ and /guruwara/ ‘children’, show that the deleted vowel may or may not be stressed (when spoken in isolation).
Southern Kala is a CV language, but its closest relatives (Jabêm and Bukawa), as well as one of its nearby Northern neighbor dialects (Manindala) include codas, although the selection of possible coda consonants is fairly limited in all examples (including certain velar and labial consonants and, in Jabêm and Bukawa, glottal stops). This vowel deletion in Southern Kala, although still synchronic (it is not fully phonologized, as in slower speech, the vowel may remain in place), could be leading Kala to develop a more complex syllable structure, although in the direction of more complex syllable onsets rather than codas. Cross-linguistically, vowel deletion is not an uncommon path toward greater complexity in syllable structure. Easterday (2019) discusses several patterns of vowel deletion that lead to complex syllable structure in languages that previously (or otherwise) had simpler tructure. In this survey, Easterday found that deletion was the second most common form of reduction. This study also found that, as syllable complexity in a given language increased, the number of vowel reduction
processes was also likely to increase (Easterday 2019:226), and the outcomes of syllable complexity due to reduction were more extreme for languages that already had high levels of syllable complexity. It is not unexpected then, that Southern Kala, a CV language, would have only one vowel reduction process in one particular phonetic environment, and that its potential effect on syllable structure is only to create the relatively simple C\textsuperscript{ɾ}V as the most complex possible syllable (e.g. \(/t\text{u.}\text{ru.}\text{ra}/ \text{‘afternoon’} > [\text{tru.rul}])

### 3.4.1 Quantifying Optional Vowel Deletion in Different Speech Styles

Early on in my work with Southern Kala, I observed that deletion seemed to occur more often in naturally quicker or more casual speech. This appeared to contrast to the situations in which speakers spoke words more carefully and slowly, or when repeating phrases and sentences to me as a learner of Kala. I realized that vowels, when they were deleting, were doing so in their entirety—there was no intermediate stage of reduction in which vowel quality, duration, etc. changed in any way. There was no stage at which vowels could be, for example, centralized instead of deleted in this phonetic context. Vowels were either there or they were not.

Vowel deletion is something that many Kala speakers are aware of to some degree. During orthography development talks in 2010, speakers floated the idea of using \(<\text{r}>\) as a grapheme to represent /\text{ɻ}/ (they ended up deciding on \(<\text{l}>\)), in part due to the very “r”-like quality that /\text{ɻ}/ can take on as an allophone in a deletion context—it often appears as [ɻ] in this context, some [ɾ], but never as [l] (which may be seen elsewhere).
Speakers also may or may not spell words with potential vowel deletion with the vowel included: /keˈreme/ ‘tomorrow’ may be spelled <keleme> or <kleme>, depending on the writer/speaker. Prior to orthography development decisions solidifying use of <l> as representation for the alveolar tap, speakers also sometimes used <r> in place of <l>, e.g. <kreme>. From my experiences in fieldwork on Kala, I noticed some speakers seem to be more aware of the vowel that is being deleted in these forms than others may be. Apparently, metalinguistic awareness of this particular sound change is variable, although I do not presently seek to quantify this awareness in this study. This is presented, rather, as a potential avenue for further research. Regardless, I do present evidence below pertaining to the frequency and stylistic context of vowel deletion among several speakers.

3.4.1.1 Methodology

In order to quantify the frequency and conditions under which this optional vowel deletion process occurs, I analyzed a small corpus of audio recordings of five different speakers of Southern Kala, from the three southern villages of Kamiali, Alēso, and Kui. These audio recordings were all made in 2017 or 2019 with Kala speakers living in either the southern villages or in Port Moresby, the capital city of Papua New Guinea. They were recorded either by myself or by Christine Schreyer, a fellow researcher on the Kala project. The recordings are all openly accessible and archived in Kaipuleohone (Ransdell-Green 2017, 2019; Schreyer 2017, 2019). This small corpus included three women and two men who were all native speakers of the Southern dialect of Kala, and
ranged in age between 40 and 60 years. The content of the recordings includes interviews about the Kala language, grammatical and lexical elicitations, narratives, and natural discourse and conversations. None of these recordings were taken with the intent to investigate vowel deletion specifically, but the audio quality in all of them is sufficient to determine whether deletion occurs or not. In total, the recordings used comprised of around 6.5 hours of audio across all speakers. Because these recordings were not originally intended for a systematic study of vowel deletion, the data presented necessarily includes more tokens from some speakers than from others.

Across the 5 speakers, some spoke more than others in the recordings, which will be reflected in the numbers of tokens per speaker of words that can have deletion. For each speaker, I counted instances of the uses of these “potential vowel deletion” words, and then determined whether the speech rate was natural, quick, and casual (aka allegro), or slow, careful, and/or the occurrence of the word was in a repeated/clarified utterance. Syllables per second is typically the metric used as a measurement of speech rate (Towell, Hawkins, and Bazergui, 1996; Covington, et al. 2005). The assessments for utterances in this study were performed in an impressionistic manner, however, a random sample of 20 utterances labeled “quick” and 20 labeled “slow” show that the average rate of a “slow” spoken utterance is 3.4 syllables per second, and the average “quick” utterance is 5.5 syllables per second.
See below an example of a word in a “slow” utterance, at 3.3 syllables per second.

Figure 3.1. Spectrogram of the word yagolē ‘I sail’, spoken at a rate of 3.3 syllables per second.

The audio recordings used here include both natural discourse and narrative (which typically included “quicker” utterances), as well as more slowly spoken interviews and grammar elicitations. In many cases, speakers would repeat or clarify something they had just said in Kala, most likely for ease of comprehension by me or another non-speaker of Kala.

My hypothesis, for this chapter, can be summed up as the following:

“Vowel deletion in Kala is more frequent in naturally quicker, more casual speech styles than in slower, more careful styles (or in repeated utterances).”
Following from the approaches of authors like Greenberg (1966) and Browman and Goldstein (1990), this would be a reasonable assumption to make about the context of Kala vowel deletion, regardless of the nature of this deletion as apparently categorical.

3.4.1.2 Results

The results for deletion rates by speaker are listed in the tables below, which offer some support for the above hypothesis. Speakers are identified here with initials H, D, G, B, and A. Overall, deletion rates range from 87.5% to 100% in quick speech, and from 14.3% to 60% in slow speech. Among the five speakers, the highest rates of deletions are found in G and B, who delete 100% of possible vowels in quick speech. B and A have the highest rates of deletion in slow speech, both at 60%. D shows an unusually low rate of deletion in slow speech, at only 14.3%.

<table>
<thead>
<tr>
<th>Speaker 1 (H)</th>
<th>Quicker/natural speech</th>
<th>Slower/careful speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deletion</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td>No deletion</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Total tokens</td>
<td>21</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speaker 2 (D)</th>
<th>Quicker/natural speech</th>
<th>Slower/careful speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deletion</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>No deletion</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Total tokens</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Speaker 3 (G)</td>
<td>Quicker/natural speech</td>
<td>Slower/careful speech</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Deletion</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>No deletion</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total tokens</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speaker 4 (B)</th>
<th>Quicker/natural speech</th>
<th>Slower/careful speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deletion</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>No deletion</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total tokens</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speaker 5 (A)</th>
<th>Quicker/natural speech</th>
<th>Slower/careful speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deletion</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>No deletion</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total tokens</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 3.1. Rates of vowel deletion by speaker in quick vs. careful speech.

These data were entered into a generalized linear mixed model in R (R Core Team 2021) using the formula for `glmer()` (a function of lme4 package (Bates, Maechler, Bolker and Walker 2014), with deletion rate and speech style as dependent and independent binary variables (Deletion vs. No Deletion; Lento Style vs. Allegro Style), respectively, and random effects of speaker and individual word. The result produced
70a $p$-value of $3.3e^{-7}$, showing a significant positive correlation between *allegro* speech style and vowel deletion.

Overall, the pattern appears to be that it is less likely for deletion to occur in a slower, careful, or repeated utterance. However, it is still more likely that deletion *will* occur in a slower utterances than that it will *not* occur in a quicker one. This would indicate that deletion is already pervasive in *allegro* styles and is still in free variation with non-deletion in *lento* styles. Therefore, it is not fully phonologized and is still productive. Despite the fact that this is a known manner in which sound change can propagate through a language, it is not necessarily what we would expect to see in an apparently phonetically categorical sound change like vowel deletion in Kala.

It is not typical for categorical changes like Kala vowel deletion to be found in propagation through speech styles. An example of a more predicted pattern is that of vowel devoicing in Japanese: as mentioned above, vowel devoicing between certain voiceless consonants is now totally categorical in the Tōkyō dialect, but is no longer in free variation in any but some very specific speech styles (Nielson 2012). That is, it has fully phonologized and is no longer productive. Were this change still optional in some contexts, it would be unusual to see no degree of gradience in the articulatory implementation. However, this is exactly what we see in the case of Kala vowel deletion. Typically, sound changes that are categorical in this way are understood to be those that are fully phonologized (including those, as shown in Mussau and Takuu, that are diachronic), which is at odds with many usage-based approaches to sound change. Automatization and gestural overlap theories would predict a gradient or continuous
effect—something that is not observable in Kala vowel deletion. In its categoriality, then, Kala deletion would appear to be a phonological change. But, as is clear from the data, it is not fully phonologized.

3.4.1.3 Discussion

Kala vowel deletion is unusual in several ways: first, it does not appear to be conditioned by lexical stress. While this is not unheard of, it is less common than reduction and deletion processes that are conditioned by stress (Easterday (2019:232) finds that between 60-80% of deletion processes (depending on the complexity level of canonical syllables in the languages) in languages that do have stress are conditioned at least in part by stress. This is not the case for Kala, in which vowels may delete in either stressed or unstressed syllables. We see very similar patterns in related Oceanic languages, both in diachronic (Mussau, Takuu) and synchronic (Tomini-Tolitoli) realms. Blust (2007) takes evidence from these and other languages that modern Austronesian languages are driven by inherited structural “pressures” to revert to a predominantly disyllabic lexical bases, as is the case for reconstructed lexemes of Proto-Austronesian. While I cannot speak to the theory underlying the concept of “systemic attractors”, it remains possible that these patterns seen in Kala’s relatives may be genealogically pertinent to Kala’s own deletion process.

The second unusual fact of Kala vowel deletion is that, in one respect, it is phonetically categorical: there is no known trace of an intermediary stage of vowel reduction in this process that remains in the present-day language (presumably it
Categorical deletion is not an unusual condition per se, but it is not predicted by a usage-based model for a sound change that is still in free variation in casual, quick speech. A categorical change would typically indicate that the deletion rule is fully phonologized throughout the language and is no longer productive. However, data show that this is not the case for Kala. There is a highly significant correlation between allegro (quick, casual) speech styles and vowel deletion, while in lento (slower, careful) styles, it is much less common. This kind of pattern for the propagation of a sound change throughout different speech styles is observed by Greenberg (1966) and forms the basis for usage-based approaches such as those described in Kapatsinski, et al. (2020), Browman and Goldstein (1990), Mowrey and Pagliuca (1995), etc.

Given the apparent contradiction of a categorical process that is not fully “finished” being implemented throughout all speech styles, it may be more appropriate to view different properties of individual sound change in terms of gradience and categoriality, rather than the entirety of the phenomenon itself: Kala vowel deletion is categorical in its articulatory implementation, but gradient in its variation by speech style. The dichotomy of gradience and categoriality parallels that of synchronism and diachronicity. For some Oceanic relatives of Kala (Mussau, Takuu), the vowel deletion process is diachronic and total. For others, it is apparently synchronic and in free variation (Tomini-Tolitoli). In Kala, deletion behaves as a fully phonologized rule in terms of its articulatory realization, and indeed might be compared to the diachronic processes described in Mussau and Takuu, if not for the clear incompleteness of its propagation through speech styles of the language. In this way, Kala deletion has two attributes: one
gradient and one categorial. The data show that it is not always appropriate to categorize a sound change as belonging to either gradient phonetics or categorical phonology. In this case, individual attributes of the sound change must be addressed in order to understand the phenomenon.
Chapter 4: Vowel Laxing

4.1 Introduction

In this chapter, I investigate the nature of Kala vowel laxing. I begin with two hypotheses. The first hypothesis (Hypothesis 1) assumes that vowel laxing in Kala fits a pattern of reductive quality change—or centralization and lowering—as a manifestation of the general phenomenon of phonetic vowel reduction. The second hypothesis (Hypothesis 2) assumes that Kala vowel laxing is non-reductive and would therefore show properties of laxing that is not associated with vowel reduction. In Section 4.2, I present background literature and previous work on what is often termed “reduction” and “laxing”, followed by definitions and reviews of two distinct patterns. 4.3 offers a description of laxing in Kala, including an optional laxing harmony process, while 4.4 presents illustrative case studies of both reductive and non-reductive laxing in a cross-linguistic context within both Austronesian and Papuan languages. Section 4.5 provides an overview of a quantitative acoustic study performed on Kala vowel laxing that seeks to determine whether Kala laxing is acoustically evident and also whether Hypothesis 1 can be supported or not. The results of this quantitative analysis lead to a conclusion that Kala vowel laxing does not entirely fit into the categories of reductive or non-reductive laxing. Section 4.6 contains my concluding remarks on this sound change and presents ideas for further research that might offer additional illumination into the issue of vowel laxing in Kala.
4.2 Background

This section offers some background and previous work on the phenomenon of vowel quality reduction, centralization and lowering, or laxing. From the literature available, the present terminology is sometimes inconsistent. The precise meanings behind terms like “laxing”, “centralization”, “quality reduction”, etc. are variable throughout different language descriptions. In this section, I discuss two general patterns that appear: centralization and lowering or laxing that is a part of the general feature “vowel reduction”, and that which does not follow reductive patterns, which I call “non-reductive laxing”. It is with these two patterns in mind (reductive and non-reductive) that I analyze Kala vowel laxing in order to place it in a broader typological picture.

4.2.1 Previous Work

Throughout the phonological and phonetic literature, there are many references to what may be called “[quality] reduction” of vowels, “laxing”, or “centralization”. The term “vowel reduction” is common throughout literature on English and other European languages, often in reference to the phonological leveling of contrast between vowel qualities in certain positions of prosodic weakness (e.g. unstressed syllables), typically in descriptions of schwa /ə/ or the most central vowel. In various languages, this process of reduction may be synchronic or diachronic, phonetic or fully phonologized. In usage-based approaches to reduction, in general (not only in vowels), the process is viewed as a result of gestural overlap or automatization (Browman and Goldstein
This perspective is in alignment with some of the phonetic experimental work on vowel reduction, such as that of Lindblom (1963; 1990). Lindblom (1963) provides quantitative experimental results indicating that vowels reach their articulatory targets as a function of that vowel segment’s duration, which implies that centralization and lowering (a vowel falling short of its formant target and thus being realized as less peripheral to the vowel space) is positively associated with shorter duration of that vowel (Lindblom 1963:1773, 1780-1781). In this study, Lindblom investigates the F1 and F2 frequencies of eight different vowels of Stockholm Swedish, and concludes that whether or not the speaker reaches their articulatory “goals” is determined by the timing of the syllable. He concludes, “In spite of efforts on the part of the talker to hit the bull’s-eye articulation, he cannot do so at fast rates, owing to the limitations inherent in the articulatory mechanism,” (Lindblom 1963:1780). This approach to vowel reduction, then, exists within the realm of articulation as a general motor function that is limited by time. Later, in Lindblom (1990), the author lays out a full theory that serves to account for intraspeaker variation in these same kinds of terms, which is called Hypo- and Hyperspeech Theory (H&H Theory). Here, Lindblom places the phenomena of hypospeech and hyperspeech (cf. “articulatory undershoot”, “clear speech” (Moon and Lindblom 1994)) in the context of universal tendencies of motor mechanistic systems (Lindblom 1990:413-416), in which there are two central influencing determinants to articulatory variation: the first being movement economy (leading generally to hypospeech), which is a pressure to conserve energy and effort,
and the other being the need to produce a coherent output according to social and communicative needs. These two determinants lead to intraspeaker variation, the balance between production constraints and reception constraints creating phonetically variable speech output. Essentially, Lindblom sums up his theory by stating that speakers have a choice of how perform speech, weighing the pressures of economy of movement versus the social and communicative demands of the output (Lindblom 1990:420). The approach behind H&H theory places articulatory variation within a wider realm of observations of the mechanisms of biological behavior, neither constrained solely to linguistic or speech functions nor to humans alone.

H&H theory predicts that vowel quality reduction or laxing would be a function of timing, as Lindblom concluded in his 1963 study as well, as a means of conserving effort in smaller time frames, during which it requires the speaker great effort to approach or meet the articulatory target. This observation is consistent with the various usage-based accounts of reduction, such as that in Kapatsinski, et al. (2020), which provides a typologically and genetically varied survey of general vowel reduction. Their account for reduction is automatization, which involves the optimization of articulatory sequences by experienced adult speakers, rather than as an example of the imperfections of intergenerational transmission (Kapatsinski, et al. 2020:20, 32). This optimized route between segments must then be selected for by social and other forces (cf. Lindblom’s “reception constraints” (Lindblom 1990:418)), in order to become permanent features of language amongst all adult speakers (Kapatsinski, et al. 2020:33-34). This usage-based view of reduction shows the phenomenon as a
phonetically gradual process, which is indeed a feature that is seen in vowel reduction in many of the example languages from Austronesian and Papuan families in Section 4.4, as many descriptions use terminology such that these processes are said to be “possible” or that they “may occur”, indicating that they are probably not fully phonologized and may be phonetically gradient.

Crosswhite (2004) approaches reductive vowel in languages where the reduction is fully phonologized (and not necessarily phonetically gradient) and involves some degree of phonological contrast reduction (e.g. certain vowel qualities may only appear in stressed vowels). This explanation of vowel reduction employs Optimality Theory. Crosswhite argues that phonological vowel reduction can be explained by two different constraints (one based on “prominence” and one on “contrast) to account for two types of vowel reduction, one in which non-corner vowel qualities (e.g. /e o/) are limited to stressed positions (e.g. leveling of mid vowel qualities to [a] in Belarusian (Crosswhite 2004:192), and /a/ is preferred. The other, seemingly contradictory pattern she discusses is one in which /a/ is dispreferred in unstressed syllables and reduces to [ə]. To account for these vowel reductions that appear to be at odds, Crosswhite utilizes differing constraints that can allow for the two processes to be employed in tandem within the same system, e.g. in Bulgarian, in which both patterns are observed (Crosswhite 2004:204).

Another approach to reductive vowel change is presented in Barnes (2006), who argues that many cases of vowel reduction that are claimed to be phonological are actually phonetic (Barnes 2006:19), but whether these changes are phonological (and
thus categorical) or phonetic (and gradient), they are inherently linked. Barnes employs a model of phonologization that transforms the gradient into the categorical, demonstrating that these processes do not need separate formal treatments, as Crosswhite concludes.

Further literature referring to “centralization” or “laxing” of vowels describes and explains systems of quality change that do not correlate with the associated timing and stress factors as discussed above in Kapatsinski, et al. (2020), Lindblom (1963, 1990), etc. There are many examples of languages with “tense-lax” pairs of vowels, in which pairs of phonetically similar vowels exist that differ by laxness, or centralization and lowering—mainly factors of F1 and F2 frequency. A more lax vowel is further from the periphery of the vowel space than its tense counterpart. Some languages with these pairs have phonologized the contrast (e.g. English, French /e/ vs /ɛ/) but in many languages, including many of the Austronesian and Papuan languages that I provide as illustrative examples in section 4.4 of this chapter, the relationship between tense and lax is an allophonic one.

Storme (2019) presents a perceptual motivation for laxing. He posits that the cross-linguistically common pattern of vowel laxing in closed syllables (referred to as Closed Syllable Laxing, or CSL) is driven by the need to increase perceptual salience through contrast enhancement of the place of articulation in consonants in syllable codas (Storme 2019:314). By contrast, the opposite type of pattern, Open Syllable Tensing, is partially explainable through the fact that peripheral vowels provide greater contrast enhancement for vowel quality, so when there is no following consonant place
contrast to enhance, it is perceptually preferred to enhance vowel quality instead. However, Storme points out that this explanation can only account for languages which show both CSL and OST. In languages that only include OST, however, tense vowels cannot be said to be a default. There would appear to be a preference for tense vowels in open syllables. Nonetheless, Storme argues that this is not precisely the case, but that OST follows from durational neutralization in open syllables (Storme 2019:310). Following neutralization of duration, the only distinction between the tense-lax pair is quality, and Storme assumes that this distinction is not enough to phonemically distinguish the pair, after which point, the quality distinction is also neutralized. The fact that the tense quality is chosen in these open syllables is presumed to be then driven by general preference for more peripheral vowels for reasons of perceptual salience.

To explain why lax vowels provide greater contrast of place distinctions of a following consonant, Storme looks to articulatory data concerning the formants of consonants, which naturally differ by place because they involve different articulators (lips, tongue, etc.) that all move at different frequencies, and thus, show different F1 and F2 frequency values. Storme shows that F1 and F2 realization of stop consonants at three places of articulation (labial, alveolar, velar) are much more distinct from each other when following a lower vowel than a high vowel (Storme 2019:315-317). Specifically, lowering of a high vowel improves F1 distinctiveness of place contrast of a following consonant, while centralization and lowering of the vowel improves distinctiveness of F2 for a following consonant (Storme 2019:318). This contrast
enhancement of consonant place therefore explains the laxing of non-low vowels when preceding a consonant coda.

Throughout surveys such as Storme’s, it becomes clear that this variety of laxing is not the kind referred to by authors who also discuss vowel quality change, such as Lindblom. The laxing explained by Storme and literature referring to language with tense-lax pairs does not place this sort of laxing in the general phenomenon of reduction. This kind of laxing is not conditioned by the same sorts of environments: quality change as a type of reduction is discussed as driven by either timing or vowel segment duration, prosodic weakness (e.g. lack of stress, word-position), or even by speech style (cf. allegro vs lento (Greenberg (1966)). Additionally, this kind of centralization and lowering is often accompanied by other markers of vowel reduction, such as (sometimes optional) deletion, shortening, or devoicing. In many languages descriptions, authors use terms like “lenis” or “weakening” to describe the varying effects of vowel reduction, some of which may involve quality reduction in the form of centralization and lowering.

Storme’s usage of the term “laxing” does not fall in line with what is being described in Lindblom, etc. It refers rather to patterns of tense and lax pairs of phonetically similar vowels that tend to be conditioned by one of two types of environments: syllable shape (closed vs. open syllables) or adjacent consonants (e.g. nasals). Storme shows several different subpatterns that fall under this type of laxing (Storme 2019:309), though all of them demonstrate laxing that is a distinct phenomenon from reductive quality change. In language descriptions, these pairs are not described
as being conditioned by unstressed syllables or other positions of prosodic weakness, but typically either described as different phonemes or as allophonically conditioned pairs within the environment of certain adjacent consonants or within different syllable shapes (open vs. closed).

Despite these sometimes overlapping usages of the terms “laxing”, “centralization”, or “[vowel] reduction”, there are two general laxing patterns and two distinct phenomena being described in the literature. It seems appropriate to distinguish the two due to their drastically differing conditioning environments as well as the different articulatory or perceptive accounts that attempt to explain them. It is for this reason that I designate two terms that I use in this chapter for the purposes of understanding laxing typology: reductive versus non-reductive laxing. In the following subsection, I provide working definitions for each of these kinds of laxing as I use them throughout this chapter.

4.2.1.1 Definitions

In this subsection, I define some of the basic properties of the two patterns of “laxing” as I use them in this chapter. The first I refer to as “reductive laxing” and the second as “non-reductive laxing”. These are the two patterns of laxing that I use to situate Kala laxing in a broader typological picture. The components of my archetypical definition of each type of laxing are taken from survey data (e.g. Kapatsinski, et al. 2020; Storme 2019), quantitative experimental data (e.g. Lindblom (1963, 1990), Moon and Lindblom
(1994)) and from patterns observed in individual language descriptions (such as those descriptions referenced in section 4.4).

4.2.2.1.1 Reductive Laxing

One usage of the term “laxing”, which I refer to in this chapter as “reductive laxing”, indicates a process of change in vowel quality that is often conditioned by stress environment (e.g. in unstressed syllables) or word position (e.g. positions of prosodic weakness, such as word-initial, word-final position). According to usage-based approaches (e.g. Lindblom 1963, 1990; Mowrey and Pagliuca 1995; Kapatsinski, et al. 2020), this type of laxing is a result of the pressure of articulatory optimization, which involves gestural overlap. This process has also been known to vary by speech style or rate (Lindblom 1990; Moon and Lindblom 1994; Browman and Goldstein 1990); vowel reduction has been observed to be more prominent in quicker or more casual speech styles, as are other types of sound changes (Greenberg 1966). As discussed in Chapter 3, in the case of vowel deletion in Kala, vowel reduction itself can be realized through multiple means, and sometimes more than one within the same process: devoicing, shortening, deletion, and change in quality can all be involved. For the purposes of this chapter, reductive laxing refers to change of quality of the vowel, specifically centralization and lowering, although the process of quality change may also coincide with durational decrease (Lindblom 1963; Lindblom 1990). For Lindblom, reduction is a result of durational decrease. For the purposes of this chapter, I assume that vowel reduction is generally a result of gestural overlap, in line with accounts given in
Kapatsinski, et al. (2020), Lindblom (1963; 1990), etc. and view reduction through a usage-based lens when evaluating common properties of quality reduction, as well as whether Kala shows any of these properties with regard to laxing.

Reduction, generally, can also be associated with word or phrase frequency (Bybee and Hopper 2001; Gregory, et al. 1999). Reductive laxing can be correlated with greater word or phrase frequency since, even though reduction reduces perceptual salience, this effect is lessened by the frequency, and thus predictability, of the word or phrase. Bybee and Hopper’s (2001) view is that frequency drives automatization, leading to further reduction. It is not currently possible to investigate the relationship between vowel laxing and word or phrase frequency in Kala, since not all of the materials archived for Kala have been fully transcribed yet.

In the table below, I present the basic common properties associated with reductive vowel laxing. These are, necessarily, generalizations, and in the case studies discussed in subsection 4.4, not every language shows every associated property of this category. These features are listed as an archetypical guide to broad patterns of processes that often produce similar outcomes in vowel quality change.
<table>
<thead>
<tr>
<th>Reductive Laxing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned by stress or word-position (prosodic weakness)</td>
</tr>
<tr>
<td>Associated with other forms of vowel reduction, such as durational shortening or devoicing</td>
</tr>
<tr>
<td>Can be influenced by word frequency</td>
</tr>
<tr>
<td>Often phonetically gradient</td>
</tr>
</tbody>
</table>

Table 4.1. Common properties of reductive vowel laxing.

4.2.1.1.2 Non-reductive Laxing

The type of laxing described in this subsection I term “non-reductive” laxing, as it is not associated with the general phenomenon of vowel reduction. This type of laxing refers to quality shift from one distinct value of height and backness to another quality, typically one that is more centralized (and less peripheral in the vowel space). Sometimes this difference in quality occurs as an alternation between two phonemically contrastive vowels typically close to each other in the vowel space, as in French (/e/ vs /ɛ/, etc.). In other cases, laxing may be allophonic, including a shift from one quality of a single phoneme to another. For example, this type of laxing is common in Austronesian languages, and is found in Ternate Malay (Litamahuputty 2012:16) for mid-vowels. /e/ and /o/ are realized as [ɛ] and [ɔ], respectively, when in closed syllables. In open syllables, they are realized as tense vowels [e] and [o]. Still in other languages, the contrast between lax and tense vowels is only semi-phonemic. In Ampenan Sasak (Pappas 2018), mid-vowels are laxed in word-final closed syllables but not lax elsewhere; nonetheless, Ampenan Sasak contrasts tense vs. lax vowels in certain
minimal pairs, its laxing rules do not apply to all loan words. In Bukawa, a close relative of Kala, /o/ is laxed to [ɔ] when before a consonant but not otherwise.

All of these different processes have in common a conditioning environment that is influenced by neighboring consonants or syllable structure. In the past, lax vowels were presumed to be produced employing greater muscular tension in the articulators (e.g. Jesperson 1889) but modern approaches have discounted this idea (from as early as e.g. Jones 1956) and the distinction is now considered to be one of height and backness quality. These pairs of vowels, especially those that are phonemically distinct (e.g. in English or German) often differ in duration as well: tense vowels have been proposed to be associated cross-linguistically with longer vowels (Lindau 1978) and indeed are often longer in duration (Stevens 1998). Storme (2019:307) also shows strong patterns for tense-lax pairs to involve high vowels as well as front vowels.

The table below presents a summary of the basic properties associated with non-reductive vowel laxing.
Non-reductive Vowel Laxing

<table>
<thead>
<tr>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>May be conditioned by syllable structure (e.g. lax vowels in closed syllables)</td>
</tr>
<tr>
<td>Tense vowels of a tense-lax pair associated with longer duration</td>
</tr>
<tr>
<td>May be conditioned by adjacent consonants</td>
</tr>
<tr>
<td>Tendency to affect high (or non-low) and/or front vowels</td>
</tr>
</tbody>
</table>

Table 4.2. Common properties of non-reductive laxing.

4.3 Laxing in Kala

Southern Kala shows evidence of laxing in its two front vowel phonemes /i/ and /e/, when these vowels precede consonants with the features [+continuant] and [+nasal]. This includes approximants /ɾ/, /s/, /ʃ, and /w/, as well as all [+nasal] consonants, including /m n ɳ/ and prenasalized stops /m b m bʷ ɗ g ɳ gʷ/. This is not totally unexpected, as nasals are shown to pattern with [+continuant] segments about as often as they do with non-continuants, as demonstrated by Mielke (2005) in his survey of 561 languages. The laxing pattern includes prenasalized stops, presumably due to the prenasalization patterning with other nasals (/m/, /n/, /ŋ/). Laxing is not seen before [-continuant] [-nasal] consonants: /p pʷ b bʷ t d k g kʷ gʷ/. Given the preponderance of consonants after which vowels become lax, laxing could be said to be the default, since it occurs before a wider selection of segments than its tense counterparts do. However, tense/lax variations appear to be in free variation in most conditions word-finally, so for
this reason, I do not state here that Kala has lax realizations for its base vowel phonemes.

The laxing process results in forms such as those below.

<table>
<thead>
<tr>
<th>/e/ preceding non-continuants</th>
<th>/e/ preceding continuants</th>
<th>/i/ preceding non-continuants</th>
<th>/i/ preceding continuants</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ete/ ‘cuts’ [ete]</td>
<td>/were/ ‘soon’ [were]</td>
<td>/iga/ ‘gets’ [iga]</td>
<td>/bira/ ‘you two’ [bra]</td>
</tr>
</tbody>
</table>

Table 4.3. Front vowels /i/ and /e/ preceding both continuants and non-continuants. Front vowels preceding a [+continuant] or [+nasal] consonant show laxing.

Originally, my initial view of laxing in Kala was that it was an optional process. This may be the case, although it is difficult to say definitively. Unlike Chapter 3’s investigation of vowel deletion, I did not code laxing instances as occurring in allegro or lento speech for the study in this chapter. Given that there is quite a bit of variation in individual speakers’ vowel qualities, it might be reasonable to assume that this process is still
productive and is not categorical or phonologized (yet?), despite the overall tendency toward laxing before continuants that the qualitative analysis shows.

I cannot speak to the status of diphthongs in vowel laxing, as their inherent non-steady formants produce an additional factor to control for in a study. I have not perceived laxing in diphthongs, but a deeper analysis of their realization is necessary before it can be ruled out.

4.3.1 Optional Laxing Harmony

There is also evidence of some degree of vowel laxing harmony in Kala, although I do not present acoustic details of this process in this chapter. If a word includes a laxed front vowel (due to preceding a continuant consonant), it is possible that a front vowel in the next syllable will also become lax due to assimilation to the previous vowel, which can be considered a gradient, non-phonologized form of vowel harmony. I say that it is gradient and non-phonologized since it has been my observation that this harmony process is optional and does not always occur when it could. It is also clear that this process is harmony because it can occur word-finally and can move through any consonant, even those that are not [+continuant] or [+nasal]. It would be useful to do to further acoustic investigation to find out exactly how prominent this harmony is.

Kala laxing harmony involves words that contain at least one front vowel that has been laxed due to a following continuant. The harmony effect is shown on the following syllable, when that syllable also contains a front vowel. In many cases, this is the same vowel as the laxed vowel front vowel in the previous syllable. From my impressionistic
observations, this process seems to be optional, so I do not know if it would show a statistically significant effect were vowels in such words put collectively into the same model. In order to perform an acoustic analysis, it would be necessary to have a substantial body of material of solely the (optionally) harmonized forms.

Examples of optional harmony laxing are given below. Note that is also apparently possible for this rule to apply iteratively across a word, from left to right, as seen in the trisyllabic word sesete ‘they cut’. The first /e/ is laxed due to the following [s], and the second is harmonized, but the third vowel is also often lowered as well to [ɛ], presumably from proximity to the previous laxed vowel.

/wese/ → [wɛse] ~ [wɛsɛ] ‘far’
/gindi/ → [gɪndi] ~ [gɪnd̞i] ‘enough’
/dene/ → [dɛne] ~ [dɛnɛ] ‘this’
/wiri → ['wiri] ~ ['wɪiri] ‘pot’
/sesete/ → [sɛsɛte] ~ [sɛsɛtɛ] ‘they cut’

I have not observed this feature spread occurring in phonemically nasal vowels, such as in the words /sesesẽ/ ‘they read’ or /lirĩ/ ‘sword grass’, which do not seem to be realized as *[sɛsɛsẽ] or *[lirĩ]. Nasal vowels with phonemic status seem to resist lowering in these conditions, however, vowel nasality was not a factor in the statistical analysis that follows in this chapter because phonemic nasal vowels almost never occur in a position other than word-finally in Southern Kala, and there are no word-final consonants either.

Laxing harmony is a feature also found in some other Austronesian languages, particularly in Western Indonesian languages (Teoh 1988). For example, Ternate Malay
has laxing of mid vowels /o/ and /e/ when in closed syllables, as exemplified below. All data are from Litamahuputty (2012:15-18).

[ˈɡaŋtɔŋ] ‘hang’

[ˈkæbɛl] ‘cable’

In addition to laxing in closed syllables, Ternate Malay shows laxing harmony: if a mid vowel appears in a syllable preceding a laxed mid vowel, the first mid vowel will also become laxed.

/ˈobeŋ/ → [ɔbɛŋ] ‘screwdriver’

/ˈnener/ → [ˈnɛnɛr] ‘small fish used as fish bait’

/ˈberes/ → [ˈbɛrɛs] ‘in order’

/ˈpɛɔt/ → [pɛɔt] ‘dented’

/ˈmesel/ → [ˈmɛsɛl] ‘(concrete) floor’

/ˈbokɔr/ → [ˈbɔkɔɾ] ‘bowl’

/ˈtɔfoɾ/ → [ˈtɔfoɾ] ‘shallow’

Vowel harmony also emerges due to another allophone of /e/, [ɪ], which appears in word-final position. /e/ in a preceding syllable assimilates to this quality, even if otherwise it would be laxed to [ɛ] due to being in a closed syllable.

/ˈbale/ → [bali] ‘turn around; reverse’

/ˈbebe/ → [ˈbɛbɛ] ‘duck’

/ˈpece/ → [ˈpɛʃɛ] ‘mud; sludge’

/ˈpɛnde/ → [ˈpɛnde] ‘short’
Another Austronesian language that shows vowel harmony is Besemah, a language spoken in the highlands of southwest Sumatra. Besemah also shows vowel laxing or lowering, in particular of high vowels, when they appear in closed syllables. /i/ and /u/ lax to [ɪ] and [ʊ], respectively, when followed by an oral or nasal conditioning consonant (a class including [p t k m n ŋ l r s ŋ]) and lower to mid vowels [e] and [o] when preceding a coda of either [ʔ] or [h]. All data presented are from McDonnell (2008:413).

/bini/ → [bini] ‘wife’
/rami/ → [rami] ‘busy’
/rinŋkih/ → [rɪŋkeh] ‘great’
/kisit/ → [kisɪṭ] ‘go’
/γusik/ → [γuseʔ] ‘visit’
kutu/ → [kutu] ‘louse’
/kamu/ → [kamu] ‘you (pl)’
/puntuŋ/ → [pʊntʊŋ] ‘firewood’
/abut/ → [abʊt] ‘heavy’
/basuh/ → [basoh] ‘wash’

Additionally, vowel harmony occurs when a high vowel is in an open penultimate syllable before a syllable with another high vowel that has been lowered due to being in a closed syllable (McDonnell 2008:413). This is very similar to the effect seen in Ternate Malay, only the affected vowels in Besemah are high vowels rather than mid vowels, as in Ternate Malay. Essentially, these languages both share regressive assimilation of vowel quality across syllables.
/kutu/ → [kutu] ‘louse’
/gigi/ → [gigi] ‘teeth’
/gigit/ → [ɡɪɡɪt] ‘bite’
/pitun/ → [pɪtʊn] ‘hold’

This kind of laxing harmony is different from Kala’s in two primary ways. First, Kala laxing is not triggered by closed syllables, since Southern Kala arguably does not have codas. Rather, it is triggered by the presence of a continuant consonant (including nasals) following a front vowel. Kala laxing harmony is also not regressive—it does not pervade a word from the right edge toward the left, as Ternate Malay and Besemah do. Kala’s harmony moves progressively, in the opposite direction, from left to right across a word.

Harmony is also found in languages much closer to Kala, such as Jabêm, spoken near Kala by around 2,000 people on the Huon Gulf and Peninsula. Jabêm has a larger phonemic vowel inventory than Kala does, which can be seen below. Orthographic representations are given in brackets.
Dempwollf (1939) reports that Jabêm actually has two types of vowel laxing or lowering. One is a phonological process that involves the laxing or tensing of a mid (/ɛ/ and /ɔ/) or mid-high (/ɛ~e/ and /ɔ~o/) vowel phoneme to the same height as another mid or mid-high vowel that is in the same word. Essentially, this phonological laxing involves harmony. Thus, no word can have mid or mid-high vowels that do not match in lax/tense quality. We see forms showing this in the examples below (all data here is taken from Dempwollf 1939:7—IPA transcription is my addition).

<table>
<thead>
<tr>
<th>Vowels of Jabêm</th>
</tr>
</thead>
<tbody>
<tr>
<td>i &lt;i&gt;</td>
</tr>
<tr>
<td>ɪ~e &lt;ɛ̃&gt;</td>
</tr>
<tr>
<td>ɛ &lt;ɛ&gt;</td>
</tr>
<tr>
<td>a &lt;a&gt;</td>
</tr>
</tbody>
</table>

Table 4.4. Vowel phonemes of Jabêm, a close relative of Kala.

ɛɾɛŋ ‘tomorrow’
gɛɾom ‘drum’
ɔjɔm ‘lazy’
gɔɾɛŋ ‘coconut cream’
berem ‘nail’
benoŋ ‘lull [no wind]’
ojo ‘earthquake’
moke ‘their head (3s POSS)’
Exceptions to this involve multimorphemic words, across which harmony apparently does not apply. This is also true for words that Dempwolff believes come from compounds, such as the last two examples below.

\[
\begin{align*}
\text{mø-we ‘taro shoots’} \\
\text{tonŋ-gɛŋ ‘[firm-only]= together’} \\
\text{ɛreme ‘frequently’} \\
\text{enŋso ‘fish hook’}
\end{align*}
\]

The second type of laxing in Jabêm is apparently phonetic\(^{12}\) and does not involve harmony. Dempwolff states rather briefly that a vowel followed by a consonant (note: not a coda) is usually laxer than a vowel not followed by a consonant. He provides examples of the \(/a/\) in \(/ka/ ‘tree’\) being tenser than \(/a/ followed by a consonant, and the \(/ɔ/\) in \(/gejɔb/ ‘he guards’\) being laxer than \(/ɔ/ that is not followed by a consonant.

Whether Dempwolff meant to indicate that this is a condition of codas rather than just following consonants is not clear, but he does not make the distinction for these purposes.

4.4 Laxing Cross-Linguistically in Austronesian and Papuan Languages

In this section, I examine cases of both non-reductive and reductive vowel laxing from cross-linguistic cases in languages related to Kala (Oceanic or Austronesian) or from the same general region (including Austronesian as well as Papuan languages). 4.4.1

\(^{12}\) In Bradshaw and Czobor’s 2005 translation of the original German, it is stated that these differences are “unintentional” and “do not serve to distinguish words” (Dempwolff 1939:3), which I interpret as indicating they are phonetic processes.
explores cases of non-reductive laxing, while 4.4.2 discusses examples of reductive laxing.

4.4.1 Non-Reductive Laxing

In this subsection, I cover examples of what I term non-reductive laxing. This is the type of laxing that is often conditioned by postvocalic consonantal environments in many languages, as demonstrated in Storme (2019). It is often, but not always, conditioned by a syllable coda. Tense-lax vowels tend to come in pairs, such as e/ɛ, o/ɔ, etc. Typically, this type of laxing does not occur on a cline, with many variations between a more peripheral and a more centralized realization, but is usually categorical with a bimodal distribution. It is also not known for being conditioned by stress, unlike reductive laxing. Storme (2019) surveys 15 languages that include what he terms CSL (closed syllable laxing) and OST (open syllable tensing). CSL is a well-known pattern, although it is not the only context in which non-reductive laxing occurs. Some of the languages in Storme’s survey that show either CSL and/or OST include Dutch, French, Klamath (Penutian), Kuteb (Niger-Congo), and Javanese (Storme 2019:307).

Amongst the various subpatterns that these languages with CSL and OST show, Storme (2019:308-309) demonstrates that many Austronesian languages have tense and lax vowels in complementary distribution, in which tense vowels occur in open syllables and their lax counterparts in closed syllables, showing both CSL and OST. This is especially notable in many Western Indonesian languages (e.g. Besemah
(McDonnell 2008), Ternate Malay (Litamahuputty 2012), Ampenan Sasak (Pappas (2018)).

Pappas (2018) presents the case of Ampenan Sasak, a Malay-Polynesian language spoken on Lombok Island in Indonesia, in which tense-lax mid vowels are contrastive in certain words and morphemes, but in complementary distribution otherwise. Typically, high mid vowels occur in final syllables closed by [:ʔ:] and in open syllables, while low mid vowels occur in final syllables closed by any other consonant. However, there are some minimal pairs that contrast high and low mid vowels ([:bɛrəmbɔk:] ‘discuss’, [:bɛrəmbɔk:] ‘breathe’ (Pappas 2018:5), as well as loan words that deviate from this alternation pattern ([:ros:] ‘personal name: Rose’, [:rɔs:] ‘personal name: Ross’), making the relationship between tense and lax vowels something other than purely allophonic.

Similarly, Smith (2021) reports that high vowels are laxed in final closed syllables in Hliboi, a language of West Kalimantan in Borneo. However, Smith hypothesizes that this is a diachronic trait inherited from a proto-language (possibly even reconstructable to Proto-Malayo-Polynesian). Potentially due to a stress shift to final syllables in Hliboi, lax vowels in this context have developed vowel breaking that includes a schwa offglide (Smith 2021:140-142).

One interesting pattern in an Austronesian language that Storme points out is that found in Paluai (Storme 2019:312-313; Schokkin 2014:30-35). In Paluai, which has several sets of contrastive tense-lax vowel pairs, /i/ and /ɪ/ are usually contrastive, except when before nasal segments, before which only [:t:] can occur. This is similar to
what is seen in Kala laxing before nasals and prenasalized stops, and is not an unexpected pattern, given that F1 frequently rises under the effects of nasalization in high vowels (Beddor 1993:180).

Another Austronesian case of vowel laxing is seen in Ngaju Dayak, an Austronesian (West Barito) language of Borneo. In Ngaju Dayak, vowel laxing is sensitive to morphological context. Brunelle and Riehl (2002) present a phonetic study that shows that vowels in final syllables closed by a tautomorphemic consonant undergo demonstrably less laxing than those in syllables closed by a consonant across a morpheme boundary.


In the Western Oceanic family, of which Kala is a member, we also see cases of vowel laxing conditioned by following consonants. However, in these languages, laxing is conditioned by any following consonant and not by a syllable coda or a particular class of consonant. In Jabêm, one of Kala’s closest relatives, vowels appear more lax when followed by a consonant than they do when followed by none (Dempwolff 1939:3). In Bukawa, the other most closely related language in Kala, Eckermann (2007:10)
states that /o/ has allophones [o] and [ɔ], which occur with no following consonant and before a consonant, respectively. Examples given of this alternation include [go] ‘bushrope’, po ‘laplap’, [om] ‘Sunday’, and [golom] ‘(it) burnt’. Once again, this patterns with Jabêm, in that laxness seems to be conditioned by a following consonant of any type and not only by a coda. Eckermann also mentions that /i/ and /ɪ/ are less distinct from one another when preceding the velar nasal /ŋ/, which is similar to the lack of contrast of /i/ and /ɪ/ in Paluai, as shown above. This would also follow, presumably, from the increase in frequency of F1 in a high vowel before a nasal consonant.

There are also examples of non-reductive laxing found amongst Papuan languages. Nabak, a Nuclear Trans New Guinea language of the Finisterre-Huon subfamily, shows laxing of different vowels in different phonetic environments. /i/ is realized as [ɪ] when before nasal consonants (Fabian and Fabian 1971:45-48). Laxing before nasal consonants is not unexpected, due to reasons mentioned above (Beddor 1993:180).

In Biangai, a Goilalan language of Morobe Province, /i/ may be laxed to [ɪ] or [ɛ] in final closed syllables, while /e/ may also be realized as [ɛ] before syllable-final /k/ (Healey 1973:25). This pattern is comparable to some of the laxing patterns seen in Austronesian languages discussed above, such as Sasak.

Another possible case of non-reductive laxing in a Papuan language is Hamtai (also called Kapau), an Angan language also spoken in Morobe Province. In Hamtai, non-low vowels (/i e o u/) are centralized with following /j/, /jʰ/ and /t/ (Healey 1981:100).
In these cases from Austronesian and Papuan languages, we see several of the common features associated with non-reductive laxing: centralization and lowering that occurs conditioned by adjacent consonants or consonant codas in a variety of ways. Tense and lax vowels tend to appear in pairs, whether or not they are in complementary distribution or not (although they often are). We also see that this type of laxing effect is not typically conditioned by stress, rhythm, or word-position, and is not described as being influenced by speech style or speech rate. However, there are no cases here that directly parallel Kala in its laxing conditioning: while laxing before nasals might be expected in high vowels (as seen in Paluai), there is no comparative case of laxing before continuants such as /ɾ s j w/, as seen in Kala. Southern Kala ostensibly has no codas, so already one of the common conditioning syllable environments for Austronesian vowel laxing cannot apply. Nor do Kala vowels lax before just any consonant, as is the case in its closest relatives, Jabêm and Bukawa. In the next subsection, I review a few case studies of Austronesian languages that show evidence of reductive vowel laxing and highlight the different properties these cases demonstrate.

### 4.4.2 Reductive Laxing

In contrast to non-reductive laxing, reductive laxing can be viewed through a usage-based approach as a product of articulatory optimization (Kapatsinski, et al. 2020), gestural overlap (Browman and Goldstein 1990; Mowrey and Pagliuca 1995), and when still in the process of phonologization, it is often observed more often in quicker speech styles (Lindblom 1963, 1990; Moon and Lindblom 1994). Vowel reduction as a broad
phenomenon can include many outcomes, such as devoicing, shortening, unrounding, as well as changes in quality. Kapatsinski, et al. (2020) cover a range of different reductive changes in quality, including unrounding and changes in height, but one of the most common descriptions in their survey is vowel centralization and lowering. For five of the 15 languages in this survey that include quality change as a type of reduction, all vowels qualities are affected, although some retain distinct qualities (Maidu, Island Carib, and Pech) while centralizing, and some (Guaymí, Gugada) reduce vowels of all qualities in unstressed syllables to [ə] (Kapatsinski, et al. 2020:26). Two languages (Ningil and Zuni) also showed only high vowels reducing. Below, I give some examples of reductive laxing in Austronesian languages.

Lelepa, spoken in Vanuatu, optionally reduces /e/ to schwa in unstressed syllables, while /a/ is reduced to [ə] in the same context (Lacrampe 2014:34-35). Lacrampe notes that the optional reduction of /e/ to [ə] is the first step in a process that may produce full deletion. In this way, we can see that this is a gradient process rather than a categorical one.

In Seediq, a Formosan language spoken in Taiwan, vowels of all qualities are reduced to schwa when in an antepenultimate syllable (Tsukida 2005:293). Tsukida states that stress in Seediq is penultimate (Tsukida 2005:293), so this rule would appear to be conditioned by stress environment. This reduction process produces forms in which peripheral vowels become centralized with the addition of another morpheme, which removes stress from the affected vowel: /qita/ + /an/ → [qetaan] ‘to see’ and /qada/ + /an/ → [qədaan] ‘to throw’. It also affects diphthongs: /baitaq/ + /an/ →
[betaqan] ‘to spear’. Seediq also reduces vowels in reduplicated forms, as seen in this plural reduplication /laqi/ ‘child’ → [ləqə-laqi] ‘children’.

Another example of reductive laxing is found in Venen Taut (Fox 1979), a language of Vanuatu. The high vowel /i/ is laxed to [ɪ] in unstressed closed syllables, whether stressed or unstressed, when word-initial or medial: /itˈtalu/ [tˈtalu] ‘he has gone to the garden’, /mɪˈmilɪ/ [mɪmɪl] ‘short’. Likewise, /u/ is laxed to [ʊ] in the same condition: /χup/ [xʊp] ‘Pacific pigeon’, /uˈdɾɪləni/ [ʊˈdɾɪləni] ‘all’ (Fox 1979:4-5). A third peripheral vowel, /a/, is also centralized, in slightly different conditions. /a/ is realized as [ʌ] in only unstressed syllables word-medially or initially: /abˈlaui/ [ʌbˈlaui] ‘they planted it’, /γapət/ [ˈxapət] ‘chief (Fox 1979:4).

Ilocano, a Philippine language, centralizes certain vowels in unstressed syllables: /i/ is realized as [ɪ] in an unstressed syllable, while /a/ is centralized to [e] (Rubino 1997:16). The pattern of vowels affected by centralization and lowering is interesting, since they do not include all possibly phonemic qualities, yet the affected vowels do not form a natural class. Another Philippine language, Pangasinan, laxes /i/ to [ɪ] in unstressed syllables: /ɪba/ [ˈiba], but /ɪˈner/ [ɪˈner] (Benton 1971:7).

In Patep, an Oceanic language of Morobe Province in Papua New Guinea, vowels reduce to schwa in initial-position unstressed syllables (Lauck 1992:4). In post-tonic unstressed syllables, the vowel in that syllable is also almost always [a], which Lauck (1979:134) suggests could be a form of vowel reduction.

In Nakanai, spoken in New Britain of Papua New Guinea, /i/ may lax to [ɪ] word-finally after /s/ or /t/, as in /pasi/ [ˈpasi] ~ [ˈpasi]. ‘very’. Johnston (1980:253) also states
that the [ɪ] allophone may be so ‘lenis’ as to be inaudible, which I presume indicates devoicing or shortening. This shows that the process is evidently a phonetically gradient one.

Throughout Papuan languages too, there are many examples of reductive quality change. In Urim, a Nuclear Torricelli language spoken in East Sepik Province, what is thought to be underlying /i/ is realized as [ə] in certain unstressed syllables (Luoma 1985:109-111). This reduction may also result from a kind of vowel harmony. As Luoma, states, it appears that in Urim, successive syllables in words normally proceed from having more open vowels to more closed, and any cases in which vowels go from more closed to more open, or in which there are identical vowels, the first vowel is realized as [ə] (Luoma 1985:111-112).

In Yimas, a Lower Sepik language also spoken in East Sepik Province, /a/ is realized as [ʌ] in unstressed syllables (Foley 1991:45).

In Ningil, a Nuclear Torricelli language from Sandaun Province, /ɨ/ is likewise realized as [ə] in unstressed syllables (Manning & Saggers 1977:59).

In contrast to non-reductive laxing, reductive laxing is driven by pressures of optimization and gestural overlap, often conditioned by stress or word position. It does not tend to be conditioned by syllable structure or by adjacent consonants.

4.5 Quantitative study of vowel laxing

This section details an acoustic investigation into vowel laxing in Southern Kala to understand the typological profile of laxing (whether it best fits into the category of
reductive or non-reductive laxing). The goal of the study was to determine whether Kala has acoustically evident traits of reductive vowel laxing or not, in order to test Hypothesis 1, which is that Kala laxing is reductive in nature, and Hypothesis 2, which is that Kala laxing is non-reductive. The first of the reductive traits investigated is correlation between F1 and F2 (specifically, centralization and lowering) and lack of stress. As discussed above, usage-based accounts of vowel reduction would predict that reductive centralization and lowering should be correlated with word positions of prosodic weakness (in this case, a lack of stress). A lack of correlation of this type would suggest that vowel laxing is Kala may not be reductive in nature, but may be driven by other influencing factors than reduction. A second reductive trait that is often indicative of reductive laxing is duration; shorter vowel segment duration is associated with reduction (e.g. Lindblom 1963; 1990), and may coincide with reductive quality change as well.

In this study, I also test Hypothesis 2 (that Kala laxing is non-reductive) by investigating the mean value of F1 and F2 in vowels preceding consonants that are [+continuant] or [+nasal] and those that precede all other consonants in order to determine that there is statistically significant acoustic evidence for the laxing phenomenon in front vowels that I had observed. I compare front vowels (/e i/) and non-front vowels (/o a u/) before [+continuant] (/ɾ s w j/) and [+nasal] consonants (/m n ñ m b ñ m b w ñ g/), versus the same vowels before non-nasal and non-continuant consonants. Audio recordings of the vowels of five native Kala speakers were used in this study. Results show that F1 and F2 are significantly different in front vowels
preceding [+continuant] and [+nasal] consonants, while non-front vowels are not similarly affected.

The results of these experiments show that there is acoustically detectable laxing in front vowels before continuants and nasals. The results also fail to show that this laxing is conditioned or influenced by either unstressed syllables or shorter duration in vowels.

4.5.1 Methodology

For this investigation of vowel laxing in Kala, I began with approximately 6.5 hours of audio recordings of Kala speakers from the Southern villages (Kamiali, Alēso, and Kui). Many of these recordings are the same recordings used in the vowel deletion study. They are all openly accessible and archived in Kaipuleohone (Ransdell-Green 2017, 2019; Schreyer 2017, 2019) and were made by either myself or my co-researcher, Christine Schreyer, during fieldwork in Papua New Guinea. They contain speech from five different native speakers of Southern Kala, 2 male and 3 female, between the ages of 40 and 60 years. The content of the recordings varies from grammatical elicitations and interviews to natural discourse, narratives, and other kinds of conversations. As in the vowel deletion study, there were inevitably more speech tokens for some speakers than others, given that these recordings were not originally made with experimental purposes in mind. The quality of the audio is sufficient that formants can be accurately recognized and extracted by Praat.
I manually segmented 3207 vowels of all five phonemic qualities (/a e i o u/) in the speech of all 5 speakers using Praat. Since these audio recordings were not originally intended for experimental purposes, it was inevitable that speakers produced varying numbers of tokens each, ranging from 211 to 1518 total vowel tokens per speaker. I used a Praat script (Kawahara 2010), which I modified and ran to extract mean formant values for F1 and F2 from each vowel. Another Praat script (DiCanio 2011) was used to extract the duration of each vowel segment.

For each speaker, I modified the formant settings in Praat as appropriate (lifting the formant ceiling for speakers with higher voices, etc.) to ensure an accurate formant read on the part of Praat. I excluded diphthongs from this study (/ai ei oi ae ou/) since they presented an additional complication in terms of their naturally non-steady formant values. Given that the mean value of the formant was the measure used for this study, and not formant trajectory over time, I did not have a simple way of integrating diphthongs into this analysis.

I also coded each vowel for place of articulation of the following consonant, since it has been shown that place of articulation can influence the formants of an adjacent vowel due to the differing formant height for consonants by place (Stevens, et al. 1999). For example, Stevens, et al. find that F1 in [b] is higher than F1 in [d], which is in turn higher than F1 in [g]. The higher frequencies for bilabials, for example, were found to be due to the greater speed at which the lips move as compared to other articulators. Due to this difference in F1 realization for consonants of different places of articulation, I
included this factor in my study in anticipation that there would be some effect on the F1 of vowels.

For this study, it was crucial to understand if and how laxing is realized in stressed versus unstressed vowels. On disyllabic words, stress almost always falls on the penultimate syllable but there is more variation of stress placement in words of three or more syllables. It also appears that stress placement can vary by speaker. This problem merits further investigation, but that is beyond the scope of this particular chapter. From my preliminary observations, stress appears to be more associated with intensity (and possibly duration) than pitch, although further research is needed to confirm this acoustically and statistically, as well as to put Kala lexical stress in a context of phrasal intonation and prosodic structure. Generally, I interpreted in stress in a necessarily impressionistic manner for this study, given the lack of detailed acoustic analysis of Kala stress that is available.

The relationships between stress status (stressed vs. unstressed), duration, and mean F1 and F2 were modeled using lmer(), a function of the “lme4” package (Bates, Maechler, Bolker and Walker 2014) for R (R Core Team 2021) to analyze the data in a series of linear mixed-effect models. Stress was modeled as a determinant of F1 and F2 frequency. I also looked at the relationship between F1 and F2 frequencies and duration, since a correlation between laxing and shorter duration might suggest a reductive nature of laxing. I analyzed both F1 and F2 values by phoneme and by whether the vowel preceded a [+continuant] or [+nasal] consonant or not. Initially, I created separate models for /e/ and /i/ within each of the 5 speakers and then for both
individual vowels across speakers, with speaker as random effect. I also created models that grouped /i/ and /e/ together as a natural class as compared to other vowels, both inter- and intra-speaker.

Because of the high degree of variation in vocal tract properties between speakers, I think the data are most illuminating to look at intra-speaker. Because /i/ and /e/ have different individual phoneme profiles with regard to F1 and F2, it is also most useful to consider them as individual phonemes, but it is also important to note that this is a natural class of phonemes that is affected rather than the entirety of all vowels.

4.5.2 Results

There was no significant correlation found between either F1 or F2 in /e/ or /i/ (as individual phonemes nor as a natural class) and either vowel duration or stress. This was true for all speakers. However, stress and duration did show a positive significant correlation ($p = < 0.05$) to each other, but only once utterance-final unstressed vowels were removed from the model. This is because utterance-final (and to a lesser degree, word-final) unstressed vowels tended to be very long in duration compared especially to non-final unstressed vowels but also to stressed vowels. The exclusion of these vowels showed that otherwise, stressed vowels tend to be longer by an average of 23.5 ms than equivalent unstressed vowels, whether in initial or medial word position. The average stressed vowel was 102 ms, while the average unstressed vowel (excluding utterance-final vowels) was 78.5 ms.
The mean F1 value of front vowels (/i/ and /e/) was significantly correlated with the [+/- continuant] feature of the consonant following a given front vowel. That is, F1 appears generally lower when the vowel is followed by a [+continuant] consonant, including nasals. In the first models, I analyzed vowels by speaker, both collectively with both /i/ and /e/ as a natural class ([+high -back]) and as individual phonemes (/i/ and /e/). In all models, word identity and place of articulation of the following consonant were included as random effects.

I also analyzed all front vowels collectively with word identity and place of articulation of the following consonant as random effects, as well as speaker. This also produced a p-value of 0.002).

The mean F2 value also appears to be correlated to whether a vowel precedes a continuant or nasal or a non-continuant non-nasal consonant. F2 appears higher for vowels preceding non-continuant non-nasals than those preceding continuants or nasals. The effect for a following consonant’s continuance was stronger in the case of /i/ (p = 0.0009) than it was for /e/ (p = 0.002).

Both /e/ and /i/ show significant lowering and centralization and lowering before continuant consonants for all speakers (p = 0.001), with some individual speakers showing stronger effects than others. The highest calculated p-value for any speaker’s front vowels was equal to 0.003. By contrast, similar analyses performed for vowels of other qualities (/a/, /u/, /o/) did not produce significant results, showing that, at least
within this conditioning environment, /e/ and /i/ are the only phonemes affected and subsequently centralized or laxed.\textsuperscript{13}

The spread of values of one speaker, H (female, 48 years of age), for the vowel /i/ is shown in the graph below. The labels mark the mean value for F1 and F2. /i/ followed by a non-continuant is shown in orange, while /i/ followed by a continuant is shown in teal.

\textsuperscript{13} There are several allophones of the /a/ vowel that show centralization under certain other conditions that not entirely clear, but this lies outside the purview of this chapter.
Figure 4.1. A plot of F1 and F2 of the /i/ vowel of a single speaker. The orange solid ellipse containing round points shows the values for /i/ preceding non-continuants/non-nasals, while the teal dashed line containing triangular points shows the values for /i/ preceding continuants/nasals. The labels represent the mean of these values.

By contrast, we see the spread for the vowel /e/ from the same speaker, again with orange for /e/ before non-continuant non-nasals and teal for /e/ before continuants and nasals. In this graph you can see the difference for F2 is much more slight for /e/ than for /i/.
Figure 4.2. A plot of F1 and F2 of the /e/ vowel of a single speaker. The solid orange ellipse containing round points shows the values for /e/ preceding non-continuants/non-nasals, while the teal dashed ellipse containing triangular points shows the values for /e/ preceding continuants/nasals. The labels represent the mean of these values.
It is evident that there is significant laxing of front vowels before continuants and nasals, and that this does not occur before stops (non-continuant, non-nasal). It also appears that, for both /i/ and /e/, the spread of lax vowels shows greater variability within the vowel space than tense vowels do.

There was no evidence that laxing is associated with stress or duration, as neither F1 nor F2 of front vowels was correlated with unstressed syllables or with shorter vowel duration. This means that we do not have evidence that Kala vowel laxing is reductive.

4.5.3 Discussion

Kala front vowels /i/ and /e/ show significant laxing (or centralization and lowering) before consonants that are [+continuant] or [+nasal]. While it is not unheard of for a certain subsection of vowel qualities to undergo laxing (rather than all vowels), it is less common in Austronesian languages for this subsection to consist of front vowels specifically. More often, languages with tense-lax pairs in complementary distribution are restricted to high vowels (e.g. Paluai, Thao), non-low vowels (e.g. Javanese, Chamorro), or mid-vowels (e.g. Ampenan Sasak, Ngaju Dayak, Besemah, Ternate Malay). It is less common for the affected vowel group to be defined in terms of the front/back axis.

The most unusual feature of Kala laxing, however, is not the affected class of vowels, but the conditioning environment. It is not unexpected that nasals might condition laxing, since Beddor (1993:180) states that an increase in F1 is associated
with nasalization of a vowel. F1 increase equates to the lowering of a vowel, which is one element of laxing. This effect would be articulatorily understandable, although it would not necessarily explain the decrease in F2 that is evident in Kala front vowels. What is not clear from any typological or phonetic data is the conditioning of laxing prior to continuant segments. In fact, Storme (2019:330) points out that, in several languages in his survey (Javanese, French, Kairiru), liquids and glides actually prevent laxing that would otherwise occur before consonant clusters, which is in part explained by their vowel-like nature. Following this principle, we could even expect laxing to be blocked in Kala before continuants, rather than the opposite.

Kala laxing does not show a significant correlation with unstressed vowels. This is one of the central indicators that laxing is not reductive in nature, given that, from usage-based perspectives, reduction occurs as an articulatory result of vowels being in positions of prosodic weakness. Neither of the laxing front vowels (/i e/) showed any correlation with stressed syllables, nor did any other vowel quality. This was the case for all speakers in the experiment. Another type of vowel reduction, reduction of duration, was also not shown to be correlated with a greater degree of laxing for either of the two front vowels. These results suggest that laxing is not associated with vowel reduction in unstressed syllables, but that vowel shortening may be. Therefore, it could be said that Kala does not lack vowel reduction, but rather seems to lack reductive quality change.

Regardless of Kala’s unique conditioning environment for laxing, the process is conditioned nonetheless by a certain kind of adjacent consonant, and not by unstressed syllables, which is more akin to my definition of non-reductive laxing above. It evidently
does not occur to any greater degree in unstressed syllables, even though unstressed syllables have been shown to be on average, shorter in duration than stressed syllables. Laxing is also not apparently affected by word-position, since the vowels sampled include those from syllables in initial and medial\textsuperscript{14} word positions. Whether or not Kala laxing is phonetically gradient or not is not entirely clear. Prior to this quantitative analysis, my impression had been that laxing was an optional process, which may still be the case. If this is true, laxing would show phonetic gradience with regard to the property of free variation with tense vowels. The spread of tokens for front vowels before continuants or nasals appears to be greater than that of their tenser counterparts, potentially indicating that the values for F1 and F2 in the lax allophones have greater variability than the tense allophones. This greater variability could also be viewed as a form of gradience. However, because it is possible for both reductive and non-reductive laxing to show gradience in the outcome of laxing, this fact does not place Kala laxing clearly in either category.

4.6 Conclusions

Kala shows laxing of front vowels before consonants that are [+continuant] or [+nasal]. This effect can be quantified by both increase in frequency of F1 of /i/ and /e/ and decrease in F2, which has an overall centralizing effect. This process may also trigger at optional laxing harmony, in which another front vowel in a following syllable or syllables also laxes. This harmony effect may apply iteratively across a word from left to

\textsuperscript{14} Vowels in this sample could not logically include those in word-final syllables, since they consist of vowels before consonants, and there are no word-final consonants in Southern Kala.
right, although phonemic nasal vowels appear resistant to laxing. Non-front vowels do not appear to show the same laxing effects. While lexical stress is related to longer duration (except when utterance-final, which triggers a longer duration in unstressed vowels), neither appears to be correlated with laxing. For this reason, Kala laxing does not fit well into the “reductive” category. Nonetheless, the conditioning environment for its laxing is also not typical for cases of “non-reductive” laxing either. Overall, Kala shows a unique process that defies several predicted behaviors of laxing of both types.
Chapter 5: Vowel Nasality

5.1 Introduction

This chapter details an analysis of vowel nasality in Southern Kala. As presented in Chapter 2, Kala has five phonemically nasal vowels that contrast with five phonemically oral vowels of the same qualities (/a e i o u/), while also having phonetically nasalized vowels that precede nasal stop consonants. This chapter is an investigation of quantifiable acoustic markers of vowel nasality in both the phonemically contrastive nasal vowels and phonetically nasalized co-articulated vowels that are not contrastive.

My research questions concerning nasal vowels are as follows. If both types of nasalized vowels are acoustically indistinct from one another, are vowels undefined for nasality when preceding nasal consonants (and so positionally neutralized)? Furthermore, if they are acoustically distinct, what does this imply about the fine degrees of articulatory difference that speakers have control over? Moreover, are these potential differences perceptible, and if so, is the nature of this perceptual distinction phonological or purely phonetic? Although the present methodology for this chapter relies on acoustic phonetics, the implications behind the answer to this question are fundamentally phonological. The quantitative study described in this chapter is meant to test the following two hypotheses.

Hypothesis 1: There is some acoustically measurable distinction between contextual nasalization in pre-nasal consonant environments and nasality found in distinctive nasal vowel phonemes.
**Hypothesis 2**: If contextual nasalization of vowels is acoustically distinct from phonological (distinctive) nasality in nasal vowel phonemes, there will be some degree of phonetic gradience or variation in the prior that is not seen in the latter.

The metric used in the study of the chapter concerns acoustic measurements that may correlate with vowel nasality in Kala (Chen 1997; Styler 2017), such as the relative amplitude of two metrics in particular: A1-P0 and A1-P1. “A1” is defined as the amplitude of the highest amplitude harmonic in the first formant (F1), and “P0” and “P1” as the first and second “nasal poles”, respectively (see section 5.4 for more details about nasal poles). By subtracting the value of the amplitude of a nasal pole (P0 or P1) from that of the amplitude of the highest harmonic of an oral formant, we can find one metric associated with nasality (A1-P0 or A1-P1). Using these metrics, I seek to define an acoustic profile of nasality in Kala, evaluating whether these measurements are significantly correlated with one or more types of vowel nasality in Kala and how they manifest. Furthermore, I investigate whether phonemically nasal vowels and vowels nasalized due to coarticulation show different degrees of nasality with regard to these measurements, and whether there is greater variation in contextual nasalization than in distinctive nasal vowels.

Section 5.2 introduces the basic types of nasalization in vowels found in Kala: phonologically distinctive nasal vowels that contrast with oral vowels of the same qualities, and contextual nasalization of phonologically oral vowels in a pre-nasal consonant environmental. Section 5.3 offers a discussion of nasal vowels cross-linguistically, whether in contrastive or allophonic roles (or in a few cases, both, as is the
case in Kala). 5.4 investigates some of the ways nasality in vowels has been measured acoustically. 5.5 details a quantitative study performed on Kala to test the hypotheses mentioned above.

5.2 Nasality Types

Kala vowels show two types of nasality. The first type of nasal vowel is phonemically contrastive, and appears, probably for historical reasons, almost exclusively word-finally (e.g. /ˈarē/ ‘fresh water’), except in some reduplicative forms (e.g. /ˈjājā/ ‘yellow’) and place names (e.g. /ˈarēso/ ‘village name’). As in IPA transcription, the Kala orthography marks this type of nasal vowel with a tilde, or titi (the word for ‘wave’ in Kala): ā, ĕ, etc.

The second type of nasal vowel in Kala is that which is phonetically conditioned via coarticulatory assimilation when preceding a nasal consonant (including prenasalized stops): /m n ŋ m b w ŋ g ŋ/. These nasalized vowels are not marked orthographically.

5.2.1 Contrastive Nasality

There are many examples of minimal pairs that demonstrate the contrast between nasal and oral vowels.

(5.1) wa
   ‘uncle’
   wā
   ‘canoe’
Historically, these nasal vowel phonemes in Kala come from the loss of word-final nasal codas. In Kala’s most closely related languages, Bukawa and Jabêm, there are both nasal and oral word-final codas. In Jabêm, the possible codas are -p -b, -m, -η, and -ʔ (written as -c in orthography). Cognates that in Southern Kala end in a nasal vowel, in Jabêm may end in a nasal consonant, such as Jabêm baliŋ and S. Kala balĩ ʰbaĩl ‘faraway’. Similarly, some Bukawa cognates also include similar patterns in Kala, e.g. Bukawa aluŋ and S. Kala alũ ʰaṟũ ‘fourth son’. Interestingly, Bukawa is also reported to have final -VN sequences in free variation with nasalized vowels (Eckermann 2007:09). This may suggest that Bukawa could develop contrastive nasal vowels under the same conditions (and in the same position, word-finally) as Southern Kala did.
Of the four dialects of Kala, three are of the Northern villages (Apoze, Lambu, and Manindala). While Apoze and Lambu generally show the same patterns and distribution of phonemic nasal vowels as Southern Kala, Manindala’s dialect is different with regard to nasal vowel distribution. Manindala retains some word-final codas, just as Jabêm and Bukawa do. In Manindala, the possible codas include -p, -k, -n, -m, and -ŋ. For this reason, nasal vowels have a somewhat different distribution in Manindala. Some words in Manindala have a final nasal vowel (e.g. *marjē ‘hand’), whereas in the same word, Southern Kala and the other northern dialects have an oral vowel instead (*marjē). This appears to indicate that the Southern dialect has oralized many formerly nasal vowels (e.g. Mindala *bĩ/biŋ vs S. Kala *bi ‘words, story’). However, Manindala does have other words showing similar nasalization as its neighbors, such as *ale/iare/ ‘fresh water’, etc. Some orthographic transcriptions of Manindala words appear with a final -ŋ, which is sometimes pronounced outright as a nasal consonant, and sometimes only nasalizes the previous vowel (*ale~alen [iare~aren]). A word such as *yaken ‘armlet’ may be pronounced *[jakē] or *[jaken]. Some other words that have final nasal vowels in Southern Kala are also sometimes closed by different nasal consonants, such as *tatalan [tatarā–tataran] ‘blue, green’. All of this points to the possibility that Manindala may still be phonologizing nasal vowels, as there is still evidently free variation with final nasals in some words. It may also be that the proliferation of contrastive nasal vowels through the lexicon is incomplete, possibly more thoroughly phonologized in frequent words (although there is no robust data to support this). By contrast, this phonologization is complete in Southern Kala and in the other Northern dialects.
Distinctive nasal vowels in Southern Kala, therefore, appear almost exclusively at the ends of words. As mentioned above, exceptions include ostensibly reduplicated forms (/jãjã/ ‘yellow’) and compounds in which the first component is also a single word with a final nasal vowel, such as the name of the village Alēso /arēso/ (from /arē/ ‘water’ and /so/ ‘shoot’, referring to a waterfall) or the compound /arēwasā/ ‘tea’, from alē [arē] ‘water’ and wasā [wasā] ‘hot’. Due to evidence observed in the Manindala dialect as well as that from Bukawa and Jabêm, Southern Kala vowels appear to have developed from the loss of word-final nasal consonants, which lead to the distinction of oral and nasal vowels. This has produced many minimal pairs in modern Kala, which has many mono- and disyllabic words that might have otherwise become homophones if the oral/nasal distinction had eroded after the loss of final nasal consonants. Allophonically nasalized vowels, by contrast, appear in a mutually exclusive environment—before word-medial nasal consonants.

5.2.2 Allophonic Nasality
In addition to contrastive nasal vowels, Kala also has vowels that become phonetically nasalized before nasal consonants, including nasals and prenasalized stops (/m/, /n/, /ŋ/, /ᵐb/, /ᵐbʷ/, /ⁿd/, /ⁿg/, /ⁿgʷ/) due to coarticulation.

(5.6) /jeᵐbe/ → [jẽᵐbe] ‘pandanus sp.’
(5.7) /maⁿdᵃᵐbe/ → [mãⁿdᵃᵐbe] ‘low tide’
(5.8) /oʳoᵐbo/ → [oʳõᵐbo] ‘fishing net’
(5.9) /gomo/ → [gõmo] ‘comes’
The development of nasal vowel phonemes was possible in Kala because final nasal consonants deleted, along with all other codas. Oral stops, such as /p/ and /k/, which are still present in Manindala dialect, resulted in no change to the previous vowel (Manindala /tak/ vs. S. Kala /ta/ ‘sea’, /bəep/ vs. /bərε/ ‘plate’), which remained oral. It is not surprising that S. Kala lost its codas and hence developed word-final contrast between nasal and oral vowels, given that erosion of consonants is common at the end of a word, especially when it leads to a less complex syllable structure. However, it is not likely that the present contextual nasalization of vowels word-medially before nasal consonants will ever produce a similar outcome. Since this kind of nasalization occurs toward the middle of a word, the final erosion that led to the contrastive nasal vowels is unlikely in this situation. One conceivable but unlikely path to phonologization of this presently contextual nasalization would be if the environment in which it occurs were to be eliminated—such as if the conditioning nasal consonants were to become oral instead ($m > b$).

5.3 Nasal Vowels Cross-Linguistically

Nasal vowels are defined as vowels that are produced with air flow escaping through the nasal cavity and nose as well as through the mouth, which means that the velum must be lowered to allow for air to flow out of the nose during vowel production. Nasal
vowels may be phonemically contrastive with oral vowels, or vowels may be phonetically nasalized as an effect of co-articulation. This assimilation may be anticipatory (regressive), usually occurring in a vowel before a nasal consonant, or progressive (also known as “perseverative”), usually occurring in a vowel after a nasal consonant.

According to WALS (World Atlas of Language Structures) (Hajek 2013), approximately one quarter of the world’s languages show evidence of phonemically contrastive nasal vowels (of WALS’ sample of 244 languages, 64 have phonemically nasal vowels). In languages that do have phonemic nasal vowels, many have fewer nasal vowel phonemes than they do oral vowels. 60% of WALS’ samples showed this pattern (Hajek 2013). One possible factor in the imbalance between oral and nasal vowel phonemes in many languages may be that nasalization tends to distort perceptual distinctiveness between vowels, especially among high vowels (Krakow, et al. 1988), including a higher F1 in non-low vowels (Beddor 1983: 180). This phenomenon is listed by Storme (2019) as one possible reason for vowel laxing before nasal consonants, especially of non-low or high vowels (Storme 2019:313). However, despite this tendency, Hajek states that it is difficult to predict the shape of an imbalanced nasal-oral vowel map (Hajek 2013).

An example of an imbalance between oral and nasal vowels is Yoruba, which has 7 oral vowels /i e æ a o ɔ/, but only nasal equivalents in /ĩ ë å ũ ɔ/, which eliminates height distinctions among mid vowels (Oyelaran 1971:39-41). Another language with imbalance between oral and nasals vowels is Kashubian (West Slavic),
which has 9 phonemic oral vowels but only two phonemic nasal vowels, /ɛ/ and /ã/ (Brooks 1969; Topolińska 1974). Lakota (Siouan) has five phonemic oral vowels (/i/, /e/, /a/, /o/, /u/) but only three nasal vowels (/ɪ/, /ʊ/, /ɑ/) (Rood & Taylor 1996). Maba (Nilo-Saharan) has 12 phonemic oral vowels but only one nasal vowel, /ũ/ (Edgar and Lavers 1991). However, some languages defy the generalization made by Ferguson (1966) that “the number of nasal vowels is never greater than the number of non-nasal vowel phonemes”. Koyra Chiini (Songhai), spoken in Mali, has phonemic contrast of vowel length, as well as nasality (Heath 1999). There are more short nasal vowels than short oral vowels (/i e a o u/, compared with /ɪ ē ā æ ō ŭ/) but fewer long nasal vowels than short nasal vowels: /iː eː aː oː uː/ vs. /ɪː ōː/ (Hajek 2013).

The development of contrastive nasal vowels is very frequently due to the phonologization of nasalized vowels in proximity to a nasal consonant, followed by the erasure of the nasal consonant environment, typically though the deletion of the nasal consonant. In many cases, this is through the loss of a final nasal consonant, in which a -VN pattern eventually becomes -Ṽ. This is the pattern described by many works on vowel nasality in general, such as those of Ruhlen (1978:223-232), Ferguson (1966; 1974), etc. Greenberg (1966) discusses this process of phonologization as an example of the variation that is an inherent feature of the intermediary stages in the development of contrastive nasal vowels, from VN to VN to Ŋ. He states that in some stage prior to full phonologization, there is free alternation between VN and Ŋ, prior to the Ŋ-only stage. This shows that these processes are completed in stages, and have multiple states over time between the initial VN sequence and the final Ŋ result. An example of a
language that is likely in the process of the phonologization now is Bukawa, one of Kala’s closest relatives. As Eckermann (2007:9) states, vowels followed by final nasal consonants ([hoŋ~hō] ‘all’, [kɪŋ~kǐ] ‘give’) are in free variation with nasalized vowels (-VN ~ -Ṽ). The loss of the final nasal varies by speaker and possibly by dialect, according to Eckermann, but is distinct enough to speakers that some wish to write these words without their final nasal consonants (Eckermann 2007:9). It seems conceivable that this type of intermediary stage once existed in Kala as well before the development and full phonologization of its word-final contrastive nasal vowels, especially given the apparent free variation in the Manindala dialect of -ṼN and -Ṽ in some words.

Not all languages with nasalized vowels contrast them with oral counterparts. Contextual nasalization of vowels in the environment of nasal consonants is a very common assimilatory pattern. Cohn’s survey of the feature [+nasal] (Cohn 1993) looks across many secondary sources of typological and cross-linguistic investigations of nasality and nasalization in both vowels and consonants in order to answer certain questions about the cross-linguistic nature of the [+nasal] feature. She looks at languages that have contextual nasalization—phonetic nasalization of vowels of an assimilatory nature that does not contrast phonologically with orality in vowels—as well as distinctive nasality, in which nasal and oral vowels do contrast phonologically.

In Cohn’s survey of nasality, she assumes that languages with distinctive nasality in consonants will also have some kind of contextual nasalization as an assimilatory effect on vowels (Cohn 1993:151). The two possible directions for nasal assimilation are
anticipatory nasalization (regressive: nasality moves left across a word) and perseverative (nasality moves right across a word). Of 165 languages in Cohn’s survey, she finds that 48 have no mention in their descriptions of directionality in contextual vowel nasalization, 61 are reported to have anticipatory nasalization, 30 have progressive nasalization, and 26 are reported as having both types (Cohn 1993:159). Cohn’s survey also finds that it is more common for long-distance nasalization (that is, nasalization of a vowel triggered by a nasal consonant that is not directly adjacent) to occur in those languages that show progressive nasalization than those with only anticipatory (Cohn 1993:159-162).

Long-distance nasalization, or nasal spread, can be a result of contextual nasality. If it does occur, it will always affect adjacent vowels (Schourup 1972; Cohn 1993). There is ostensibly a hierarchy of segments which vary in their “permeability” when it comes to nasal spread. Schourup (1971) offers a survey of 13 languages that show nasal spread, and concludes with the following hierarchy of segments, from most permeable to least: vowels > laryngeals (h, ?) > w, j > r, l > obstruents. This means that if a given language spreads nasalization through a segment class that is less permeable, then it implicitly does so for segments that are more permeable as well. Cohn’s own survey of nasal spread included 37 languages, and found similar results as Schourup. However, her results lead her to propose that nasal spread through laryngeals is independent of spread through supra-glottal segments (Cohn 1993:167).

In Cohn’s survey, there are a number of languages reported to show both distinctive nasality in vowels and contextual nasalization. Of 60 languages in the survey
that are described as having distinctive nasality in both consonants and vowels, 31 had no information available on the behavior of contextual nasalization in vowels. Of the remaining 29 languages, 25 were described as showing neutralization of distinctively nasalized vowels in the context of nasal consonants. Of these languages reported to have such neutralization, no information was given on possible phonetic distinctions between distinctive vs. contextual vowel nasalization, with one exception of Bengali, which was said to have stronger contextual nasalization of vowels than distinctive nasalization (Cohn 1993:156). The four remaining languages that were not described as having such neutralization are Albanian (Paleo-Balkan, Indo-European), Nama (also known as Khoekhoe, spoken in Namibia and South Africa), Picurís (a Kiowa-Tanoan language spoken in New Mexico, United States), and Havyaka Kannada (also known as Havigannada; spoken in Karnataka, India). For Albanian, contextual nasalization is described as stronger than distinctive nasalization. In all three other cases, however, distinctive nasalization is described as stronger than contextual nasalization (Cohn 1993:156). There are also two languages reported as having no nasality distinction in consonants, but both distinctive and contextual nasality in vowels. These languages are Ewe (Niger-Congo) and Senadi (Senufo; Niger-Congo). Ewe is described as having no neutralization of nasal vowels, and having stronger distinctive nasalization than contextual, while Senadi does have neutralization (Welmers 1950).

Below, I discuss some of the languages mentioned in Cohn’s survey, in particular languages that appear to have no positional neutralization with regard to nasal vowels. These include Picurís, Nama, Havyaka Kannada, and Ewe. These brief descriptions are
meant as illustrations of language with both contextual and distinctive nasal vowels, in which there is no neutralization reported. This is evidently not the norm, according to the sample in Cohn’s survey, as most languages with these two types of nasal vowels are described as neutralizing vowel nasality in context of nasal consonants. I present these descriptions as examples of languages that apparently run counter to the norm.

5.3.1 Picurís

Picurís is a Kiowa-Tanoan language spoken by about 220 people in Picuris Pueblo, New Mexico, in the United States. Picurís has six oral vowel phonemes and six nasal vowel phonemes; for each vowel quality, there is an oral and nasal counterpart: /i į e ě a ā e ā o ō u ū/, resulting in 12 total vowel phonemes. In this respect, it is like Kala, which has five vowel qualities that all appear as both oral and nasal. Trager states in her 1971 description of Picurís that nasal vowel phonemes are most nasalized when they are not adjacent to a nasal consonant. Nasal vowels appearing after nasal consonants are described as less nasalized toward the beginning of the vowel, while nasal vowels appearing before nasal consonants are less nasalized toward the end of the vowel (Trager 1971:31). Following this, nasal vowels in between two nasal consonants are said to be even less nasalized overall. This would appear to suggest that the nasal consonant is in fact driving the nasality effacement and the closer sections of the vowel to the conditioning nasal consonants are more influenced by what Trager considered to be a dissimilatory effect.
Trager also describes both anticipatory and progressive nasalization of phonemically oral vowels when adjacent to nasal consonants. This then means that nasal vowels become less nasalized and oral vowels become more nasalized in the context of nasal consonants (Trager 1971:32). While this could be interpreted as neutralization, it is not described this way by Trager, and the degree of nasalization of phonemically nasal vs. oral vowels in this context are not described as equivalent or indistinguishable, although there is no acoustic analysis presented.

5.3.2 Nama
Nama, also called Khoekhoe, is a Khoe language spoken in Namibia and South Africa by 200,000 people. It has an oral vowel phoneme inventory consisting of 5 qualities: /i e a o u/ and a nasal vowel inventory of 3 qualities: /ũ ã ĕ/ (Crothers, et al.1979:87). Phonemically oral vowels are also described as undergoing contextual nasalization when adjacent to nasal consonants. This contextual nasalization is described as “weaker” than distinctive nasality in vowels, due to evidence from kymographic tracings (Beach 1938:46). Whether this conclusion can be replicated using more modern acoustic techniques remains unknown.

5.3.3 Havyaka Kannada
Havyaka Kannada is a dialect of the Kannada language, also known as Havigannada, spoken in Karnataka, India. It has an inventory of 5 oral vowel qualities: /i e a o u/. Of these qualities, only two have phonemic nasal counterparts: /ũ/ and /o/. There is also
contextual nasalization that applies to all oral vowels: when following a nasal consonant, a phonemically oral vowel is nasalized. However, sometimes nasalization is blocked in certain environments; if the vowel in question is followed by a voiced oral consonant, the nasalization does not take place (Pandey 1977:256-257), resulting in surface forms such as the following: nasalization occurs in [nākku] ‘to lick’, [nūsī] ‘mosquito’, and [nēmē] ‘to wander’, but is blocked in [neggu] ‘to lift’, [nīru] ‘water’, and [nʌli] ‘to dance’. Pandey states in his description of nasalization in this dialect that phonemic nasalization is “heavier” (Pandey 1977:258), and that there are minimal pairs, though uncommon, such as /tinna/ ‘will not eat’ vs. /tinnā/ ‘a Brahmin will not eat’ (Pandey 1977:258). Presumably these two forms, though both ending in some sort of nasal(ized) vowel, are pronounced differently. Given the existence of minimal pairs like this, it could not be said that Havyaka Kannada has neutralization of nasality.

5.3.4 Ewe

Ewe is a Niger-Congo language of the Kwa subfamily native to Togo, Ghana, and Benin. It is spoken by approximately 20 million speakers. It has 8 vowel qualities: /i e ɛ a o ɔ u/. Most dialects have all qualities as nasal vowel phonemes as well, though some lack certain nasalized qualities. Various claims and analyses have been made about nasality in both vowels and consonants in Kwa languages broadly, including Ewe (e.g. Westermann (1930), Ansre (1961), Stahlke (1971), Capo (1977)), ranging from claims that there is no nasal distinction in consonants, in which nasality is predictably conditioned solely by nasal vowels, to the idea that all nasal vowels are underlying
derivable from -VN sequences. Depending on which analysis one adheres to, Ewe may have two forms of nasality in vowels: phonemic (distinctive) nasality and phonetic (contextual or conditioned) nasality. If the analysis that nasality is distinctive in consonants is adopted (e.g. as in Stahlke 1971), then Ewe has vowel nasality that is conditioned by nasal consonants in a synchronic sense as well as phonemic nasality in vowels (which would have developed under similar circumstances—due to the loss of a word-final nasal consonant). Cohn’s survey lists Ewe as a language both without distinctive nasality in consonants, but also as a language that shows both distinctive and contextual nasalization in vowels without neutralization (Cohn 1993:155-156). No source known to me states that there is neutralization of nasality in any context, which may well indicate that there is a phonetic difference between distinctive nasality in vowels and contextual nasalization. However, I am not aware of any acoustic analysis stating as much.

5.3.5. Neutralization: Predictions

If this sample of languages with both contextual and distinctive nasalization in vowels is taken as representative of such languages in general, then it would be reasonable to predict that there may well be positional neutralization of vowels before nasal consonants in Kala, which may mean that there would be no phonetic difference detectable through acoustic analysis between vowels nasalized by context and those that are distinctively nasalized. However, if there is no neutralization, it would fall in line
with the four unique examples in languages discussed above if distinctive nasality were shown to be stronger than contextual nasality in Kala.

There is a further issue in neutralization that is more general—incomplete neutralization, which has been studied extensively for a variety of languages and phonological processes. Many studies on positional neutrality have led to acoustic phonetic findings that indicate that what have classically been considered unambiguous cases of neutralization in fact produce phonetically distinguishable outputs and are therefore said to be incomplete. One such well-studied example of incomplete neutralization is final obstruent devoicing in languages such as a German. Various authors have addressed this phenomenon (e.g. Dinnsen and Garcia-Zamor (1971), Dinnsen (1984), Port, Mitleb, and O'Dell (1985), Port and Crawford (1989)), finding evidence that German speakers produce measurably different outputs for words ending in devoiced vs. voiceless segments (e.g. *Bund* ‘association’ and *bunt* ‘colorful’) and that the neutralization is not total. These studies have shown that final devoiced obstruents and voiceless counterparts are not identical in their articulatory and acoustic realization. Therefore, it seems plausible that at least some of the languages for which it is stated that there is positional neutrality of nasality in vowels in some contexts may in fact be cases that appear more similar to those languages such as Picurís, Nama, etc. Cohn states that it is possible that some of these supposedly neutralizing languages actually do have phonetic distinctions between their nasal vowel types, but that presumably, any “physical difference” between distinctive and contextual nasality would be “phonologically irrelevant”. Such cases might be viewed as examples of incomplete
neutralization. If this were the case, it might be difficult to draw a conclusion about the differences between these supposed “no neutralization” languages and any incomplete neutralizing languages.

None of the four “no neutralization” languages described above in this section appear to have in-depth comparative acoustic analyses available that contrast distinctive vs. contextual vowel nasality. Regardless, for my present study of Kala nasality, I take an acoustic approach. Because of this, the way that “strength of nasality” is measured acoustically is crucial to determining whether there is quantitative evidence of vowel nasality differences in Kala. In the following section, I discuss some of the methods that have been used for the acoustic measurement of nasality.

5.4 Acoustics of Nasality in Vowels

Chen’s 1997 study of the acoustics of nasal vowels in English and French found that nasal vowels can be measured by investigating the values of certain acoustic prominences. These include the amplitude of certain harmonics, along with the amplitude of certain “nasal poles”, also known as “nasal peaks” or “nasal formants” (Chen 1997:2363-4; Styler 2017:2470). “A” stands for the amplitude of a harmonic, so “A1” represents the amplitude of the harmonic highest in amplitude in the first formant (F1) of a given vowel. Likewise, “A3” is the amplitude of the highest harmonic in the third formant (F3). “P” represents “nasal poles”\textsuperscript{15}. A1-P0, then, is the amplitude of the nasality.

\textsuperscript{15} Nasal poles are discussed in Styler (2017) as a particular resonance associated with nasality, consisting of three main components (place in the frequency spectrum, bandwidth within the spectrum, and amplitude of the resonance). Nasal poles have also been referred to as nasal
lowest nasal pole subtracted from the amplitude of the highest harmonic in the first formant. This is the first of two well-vetted correlates of nasality in vowels in the literature. The other that is used in this study is A1-P1, or the amplitude of the first highest harmonic in the first formant, from which the value of the amplitude of the second nasal pole (P1) is subtracted. According to Chen, the low F1 of high vowels can overlap with the frequency range of the nasal prominence, leading to interference (Styler, 2017:2470). Because of this possible interference, most acousticians have used the A1-P0 measurement rather than the raw amplitude of the harmonics.

In Chen (1997), A1-P0 dB value is found to be lower in nasal vowels than in oral vowels (Chen 1997:2363). This fact is due to the coupling of the nasal cavities (paranasal sinuses, especially the maxillary and sphenoid), which causes a decrease in dB for A1, while the expanded area in the nasal cavities allows for an increase of the first nasal pole (P0). So, when A1-P0 is measured for nasal vowels, there is a lower value for A1 with a higher value for P0, resulting in a lower final value of dB. For oral vowels, by contrast, the A1-P0 value is typically greater than for nasal vowels.

5.5 Quantitative Study of Kala Nasality

This section details a quantitative study into the acoustic nature of the different types of nasal(ized) vowels in Southern Kala. The purpose of this study is to test the two hypotheses presented in 5.1, the second of which is contingent on the first: Hypothesis 1: In Kala, nasality in contextually nasalized vowels (before nasal consonants) presents formants (Chen 1997). For instance, P0 (or N1, as in Chen (1997)), is defined there as between 250 and 450 Hz, usually on the first or second harmonic.
different values of acoustic markers than nasality in distinctively nasal vowels;

**Hypothesis 2:** If contextual nasalization of vowels is acoustically distinct from phonological (distinctive) nasality in nasal vowel phonemes, there will be some degree of phonetic gradience or variation in the prior that is not seen in the latter.

In order to test the first hypothesis, I model data of vowel segments and their A1-P0 and A1-P1 values. This is done for distinctive nasal vowels as well as contextually nasalized vowels, as well as oral (non-nasalized) vowels, in order to determine whether there is a statistically significant correlation between either of these values and nasality in general. I look at comparisons of these values between the two types of nasal vowels (allophonic and phonemic) when compared with oral vowels. I have grouped vowels by whether they are final or non-final, since the two types of nasality are mutually exclusive in these positions: distinctive nasal vowels occur (generally) only at the ends of words, whereas contextually nasalized vowels occur only non-finally (word-medially before a nasal consonant). Oral vowels occur in both positions. My results for this test show that while there is a strong significant correlation between A1-P0 and distinctive nasal vowels when measured were taken at the mid-point of the vowel, the same cannot be said for contextually nasalized vowels. Contextually nasalized vowels, while showing lower dB of A1-P0 than oral vowels, did not show a statistically significant correlation with this metric.

Hypothesis 2 is contingent on the test results of the first hypothesis. Given the positive evidence in support of Hypothesis 1, it was possible to test Hypothesis 2. In order to test Hypothesis 2, the same data were used. A comparison between vowel
qualities of both distinctive nasal vowels and contextually nasalized vowels was done in order to determine whether there is a greater degree of phonetic variation (that is, greater spread of A1-P0 values) between different qualities in the contextually nasalized vowels than between qualities of distinctively nasal vowels. This outcome could be predicted by usage-based approaches, such as those mentioned in Greenberg (1966), etc. The results of this second test also showed evidence that this may be the case in Kala: there was a greater range of variation in A1-P0 value in vowels (of all qualities) in phonetically nasalized contexts than in distinctive nasal vowels. This suggests that nasalization is less predictable in contextual environments than for distinctive nasal vowels. It may also suggest that nasalization in contextual environments is more “in flux” or even optional, being as it is, not phonologized in the way distinctive nasal vowels are. This would follow the principles put forth in Greenberg (1966) as well: that pre-phonologized processes show phonetic variance (or free variation between different phonetic realizations) that is not always seen in fully phonologized processes.

The following subsections below provide further details on these two studies and their results. 5.5.1 describes the methodology (including stimuli, procedure, and acoustic and statistical analysis), while the results for both tests are presented in 5.5.2. Section 6 provides discussion of these results.

5.5.1 Methodology

This study involved acoustic phonetic measurements of A1-P0 and A1-P1 in Kala vowels that were collected as a part of a reading task from a female Kala speaker. In
the following subsections, I discuss the stimuli, procedure, acoustic analysis, statistical analysis, and results for this study.

5.5.1.1 Stimuli

The stimuli consisted of a curated list of Southern Kala words to be read by the speaker. The list was designed to contain an approximately equal number of tokens containing oral, phonemic nasal, and phonetically nasalized vowels. The word list contained 559 words of varying length. This list produced a total of 2515 vowel tokens. The list of words was pseudo-randomized as to prevent juxtaposition of words containing the same type of nasal(ized) vowel. This word list was created with words from the Kala dictionary project (unpublished as of yet), which in total includes some 1600 words in all four dialects of Kala. This dictionary contains words gathered through fieldwork from 2010 through 2019 and was vetted by native speakers in the Kala Language Committee.

5.5.1.2 Procedure

The participant was a female native speaker of Southern Kala from Alēso village, residing in Port Moresby. The participant read each word within a frame sentence. The frame sentence was chosen both for its naturalness to the participant and its phonetic appropriateness in having no phonemically nasal vowels in it or even phonetically nasalized vowels near the target word: /kaŋgu bi ___ kəɾemə/, “say the word ___ tomorrow”.
The words were written in the recently developed (2010) Kala orthography (Schreyer 2015), which the participant was familiar with. The participant read the list of words within the frame and was recorded by a Zoom H4n Pro recorder using a Shure SM35 headset microphone, digitized at 44.1kHz and 16 bits. The recording was made in a quiet room in the capital city of Port Moresby.

5.5.1.3 Acoustic analysis

After recording the reading of the word list, I segmented, labeled, and annotated the .wav files in Praat (Boersma and Weenink 2022), labeling all vowels in target words for quality and condition, which here is defined as one of three categories: phonemic nasal vowels (e.g. /ä/), oral vowels (e.g. /a/ as [a]), and allophonically nasalized vowels that precede nasal consonants (e.g. /a/ as [ã]) preceding a nasal consonant). I also transcribed the specific words that the vowels occurred in. Finally, using a Praat script (Styler 2014), I extracted acoustic measurements for all labeled vowels. Information extracted for these vowels included (at five points throughout the vowel duration): vowel quality (/a e i o u/); formant values for F1, F2, and F3; A1-P0 value, A1-P1 value, word identity, duration, number of syllables in the word, and measurements of the amplitude for all nasal poles and harmonics.

The extracted measurements used in the first study were A1-P0 and A1-P1. The A1-P0 measurements were taken at five equally spaced points throughout the duration of each vowel. LPC (linear predictive coding) settings were adjusted by vowel quality before extraction of formant values: [a] at 6000 Hz max, [e] and [o] at 5800Hz, and [i]
and [u] at 5100 Hz. The present analysis only concerns the measurements from the midpoints of each vowel (i.e. at 50% of the way through each vowel). The average A1-P0 value for each vowel quality in phonemic, phonetic, and oral vowels was measured to determine any change in nasality strength over time for all three types of nasality vowel states. In order to approach the second Hypothesis, which concerns variation in A1-P0, I also measured the degree of variation in the value of A1-P0 for each quality of vowel, between both contextual and distinctive nasal vowels.

5.5.1.4 Statistical analysis

5.5.1.4.1 Hypothesis 1: Acoustic Differences Between Contextual and Distinctive Nasal Vowels

In order address Hypothesis 1, which concerns acoustic distinction between contextual and distinctive nasals, I created a series of mixed-effects linear regression models to model the acoustic features using the lme4 (Bates, Mächler, Bolker & Walker 2015) and lmerTest (Kuznetsova, Brockhoff & Christensen 2017) packages in R (R Core Team 2018). There is evidence that nasal vowels are articulated orally differently from their oral counterparts (i.e. in ways other than velar action) and these effects are distinct for each individual vowel in each individual language (Styler 2017:2478). This fact complicates the nasality~orality difference by adding another dimension of variability. For this reason, the linear regressions used to model data in the present paper include vowel quality as a fixed effect. For each vowel quality within each nasality type, I took
averages of the five equidistant points of measurement over the duration of the vowel segment of the A1-P0 value in order to determine whether nasality strength varies over time in phonetic or phonemic nasalized vowels.

Each model included fixed effects of nasality condition, vowel quality, their interaction, and a random intercept of word identity. The restriction of phonemically nasal vowels to word-final position necessitated the split of data into two sets: word-final vowels, which allows for comparison of underlyingly oral and underlyingly nasal vowels; and non-word-final vowels, which allows for comparison of underlying oral vowels surfacing as oral with underlying oral vowels allophonically surfacing as nasal.

5.5.1.4.2 Hypothesis 2: greater degree of variation in contextual nasals than in distinctive nasals

In order to test Hypothesis 2, which states that there will be greater phonetic variation in contextual nasal vowels than in distinctive nasal vowels, I measured the A1-P0 variation in contextual vs distinctive nasal by quality. Styler (2017:2478) points out that A1-P0 is not useful to compare across qualities of vowels, as the vowel quality itself may have an effect on A1-P0. It is for this reason that I included quality as a fixed effect in the models used for Hypothesis 1 in the above subsection. Therefore, to test for degree of variation of A1-P0 between contextual and distinctive nasal vowels, I looked only within qualities (e.g. comparing contextually nasalized [ĩ] to distinctively nasal /i/). I used another lmer model for this measurement.
5.5.2 Results

This section contains results for the tests of both Hypothesis 1 and Hypothesis 2. Hypothesis 1 test results are broken into two groups--results for non-final vowels (that is, contextually nasalized vowels vs. oral vowels) and final vowels (distinctive nasal vowels vs. oral vowels).

5.5.2.1 Hypothesis 1

Results of the lmer models testing Hypothesis 1 are below. Subsection 5.5.2.1.1 contains results of models that included non-final vowels, while 5.5.2.1.2 shows results from models containing final vowels. The models shown in the sections below use A1-P0 and A1-P1 as dependent variables.

5.5.2.1.1 Non-Final Vowels

The first model used A1-P0 as a dependent variable. Data from only non-final vowels is used in this model. This means the only nasal vowels involved included in this model are non-phonemic, since phonemic nasal vowels only appear word-finally in Southern Kala. In this model, there were 308 vowel tokens, of which 67 are nasalized vowels (non-phonemically, preceding nasal consonants), and 241 are oral (occur outside of a nasal context).

The first model, which used A1-P0 as a dependent variable, showed no significant correlation between A1-P0 measurement and vowel nasality. Nasalized vowels appearing before nasal consonants and oral vowels out of nasal context do not
show significant differences with regard to A1-P0 value. Non-final vowels do not tend to contrast phonemically in terms of nasality, so that they may be not be distinguished acoustically is not unexpected.

The next model on non-final vowels used A1-P1 as a dependent variable. This measurement, although often correlated to nasality in some cases (Styler 2015; 2017), seems to be less a reliable metric cross-linguistically. In Styler’s study, it was shown to be a stronger correlate in English nasal vowels than in those of French. However, for this study on Kala non-final nasalized vowels, A1-P1 seems to similarly show a lack of statistically significant acoustic difference between non-final oral vs. nasalized vowels.

There was a decrease in the average value of A1-P0 (though not for A1-P1) in phonetically nasalized vowels over the duration of the vowel. As mentioned previously, a decrease in the amplitude of A1-P0 is associated with vowel nasality. Typically, nasalized vowels decreased in A1-P0 value by about 1-2 dB over the duration of the vowel segment, indicating an increase in strength of nasality the closer the vowel approaches the nasal consonant. This is a predictable result, given that in these types of contextually nasalized vowels, the conditioning segment is the following nasal consonants. Presumably, as the speaker approaches the onset of the nasal consonant, the velum is increasingly lowered. As the next subsection addresses, phonemic nasal vowels do not show a gradual increase in nasality. In fact, they show an increase in A1-P0 at the point of the final measurement, showing a weakening of nasality.
5.5.2.1.2 Final Vowels

The final two models included only final vowels: final phonemic nasal vowels and final phonemic oral vowels are used in these models. The first of these two models indicated that, for final vowels, there is a significant correlation for A1-P0 (p < 0.05). This result is expected, based on previous literature (Chen 1997; Styler 2017), in which nasal vowels are found to have A1-P0 value that is 2-6dB lower on average (Chen 1997:2363). There also appeared to be some vowel quality effects for [i] in nasal vowels, which is also not unexpected, given that F1 in high vowels is often affected by nasalization (Beddor 1993:180).
Unlike the variation over time in A1-P0 value found in non-final phonetically nasalized vowels, phonemic nasal vowels did not show the same degree of decrease of A1-P0 amplitude from the beginning of the vowel toward the end. This is not an unexpected result, given that there is no conditioning nasal consonant segment following the vowel, as there is for the contextually nasalized vowels. The nasal strength of the distinctive nasal vowels did not change in a predictable way except that, at the very last time point measured, there was sometimes a slight decrease in A1-P0. This could indicate that nasality drops off toward the very end of the vowel’s articulation, possibly due to the speaker raising the velum again in anticipation of speaking the next word in the framing sentence (/kereme/ ‘tomorrow’), which begins with an oral segment. If the tokens for this study had been spoken in isolation or in a framing sentence that did not begin with an oral segment, it is possible that this effect might not have appeared.

The fourth and final model, which predicts A1-P1 for final vowels, shows similar results as the previous model using A1-P1: A1-P1 is shown to be lower in amplitude for nasal vowels than for oral vowels. This final model also showed some interaction with vowel quality, especially in nasal [o] and [u]. [u] might be expected to show quality interaction, due to its low F1 as a high vowel, but the reasons for the differences in quality for [o] are not as clear.
5.5.2.2 Hypothesis 2

The results in this subsection address the tests for Hypothesis 2, which states that a greater degree of phonetic variation will be found in contextually nasalized vowels than in distinctive nasal vowels. I measured this variation in the spread of A1-P0 values found in contextually vs. distinctive nasal vowels. Because there is a strong indication that vowel quality itself can affect A1-P0 amplitude, I measured variation and compared only within vowel qualities. I used an lmer model for this test, as well, which produced a significant result ($p = 0.05$). The result showed that wider variation in A1-P0 is positively correlated with contextual nasal vowels, and that distinctive nasal vowels showed much less variability. On average, contextual nasal vowels showed about ~8 dB of greater variation with respect to the A1-P0 measurement than distinctive nasal vowels did. So in this respect, at least, it is true that there was greater phonetic variation amongst contextual nasals than distinctive nasals. Of course, there are other ways in which phonetic variation could be measured.

5.6 Discussion

This was a study of nasality in Kala vowels that sought to determine whether there is evidence for two hypotheses concerning the measurement of nasality in vowels, both contextually nasalized and distinctively nasal. Hypothesis 1 states that there will be some acoustic distinction between phonemic nasal vowels (found only word-finally) and oral vowels, and non-phonemic nasalized vowels that appear before nasal consonants (only non-finally) and corresponding non-final oral vowels. Results from models using
the A1-P0 and A1-P1 metrics of vowels nasality have shown a distinction between phonemically nasal vowels and oral vowels, but not for allophonically nasalized vowels and oral vowels. Phonemic nasal vowels show an A1-P0 value that is around 2-6dB lower than that of oral vowels. This result suggests that nasality in vowels is acoustically less pronounced in allophonically nasalized vowels than it is in phonemically nasal vowels, which may follow differing articulatory gestures or different duration and overlap of gestural patterns that speakers use for different kinds of nasalized vowels, depending on the phonemic status of those vowels. It is also possible that A1-P0 and A1-P1 are not appropriate metrics to use for the measurement of nasalization as a coarticulation in Kala, but some other measurement may better show their distinction from purely oral vowels.

Hypothesis 2 states that there will be greater phonetic variation shown within contextual nasalized vowels than in distinctive nasal vowels. For this study, I tested this hypothesis by measuring the respective degrees of variance in A1-P0 for both contextual and distinctive nasal vowels. I compared this value within vowel qualities, since there is evidence that A1-P0 itself may be influenced by vowel quality (this is also why vowel quality was a fixed effect in the models for testing Hypothesis 1 above). The results show that there is a significant correlation between a wider degree of variation in A1-P0 value and contextual nasalized vowels. This indicates that contextual nasal vowels have more widely varying degrees of nasalization in their articulation than distinctive nasal vowels, which are both “more nasal” overall than contextual nasals and have less variability. Subsequently, it could be said that contextual nasal vowels are “in
flux” or less articulatorily defined. This itself is likely why there was no strong correlation shown between A1-P0 value and contextual nasals vs oral vowels in the result from the tests of Hypothesis 1. Contextual nasals are less predictable. Some tokens may be more strongly nasalized than others. This is not unexpected, given previous observations from those such as Greenberg (1966), in which processes that are not (yet?) phonologized show a greater degree of free variation than fully phonologized processes. Greenberg’s example is, in fact, nasal vowel development over time—in the beginnings of the development process, there is only the VN sequence, followed by variation between VN and ŶN, then by free variation between ŶN and the Ŷ sequence, and finally, by only Ŷ. This kind of variation is also seen in other processes that I investigate in previous chapters in Kala, such as in vowel deletion discussed in Chapter 3, which is arguably not fully phonologized, as it does not occur all of the time. This could be what is occurring with contextual nasalization—it occurs some of the time, and/or to varying degrees of nasality strength because it is not a fully phonologized process. Distinctive nasals, however, which contrast with oral vowels (and make many minimal pairs), lack this variability and fluctuation and are more consistent and predictable.

The results of the two acoustic studies indicate that nasality in Kala vowels is not entirely contrastive, nor is it entirely in complementary distribution with orality. Kala has both contrastive and allophonic nasality in vowels, which appear acoustically distinct from one another. Additionally, it is apparently unlike the majority of languages that do show both contextual vowel nasalization and distinctive nasal vowels (at least, those
covered in surveys such as Cohn's (1993)) in that it is not positionally neutralized (or, if it is, it must be an example of incomplete neutralization). There is evidence that the two types of nasality are distinct from one another and that one shows a greater level of variation in the “strength” of its nasality. Speakers implement nasality in a different way (or to a different degree) depending on the phonological status of the nasal vowel in question. The results from the test of Hypothesis 1 may also be directly related to the results of testing Hypothesis 2—the very fact that A1-P0 was not found to be significantly correlated to contextual nasality may indeed be due to the variation of this value that occurs in this type of nasality, as was shown by the second study.

Kala nasality embodies two vowel nasality situations that are often seen separately in other languages. Comparisons of nasality in languages that do not have contrastive vowel nasality, like English, and those that do, like French, have shown that there are meaningful acoustic differences between how nasality is implemented in each type of language (Styler 2017:2480). In Kala, these two kinds of vowel nasality exist side by side. One form of vowel nasality is distinguishable from orality via statistically significant differences in A1-P0, and one is evidently not. In the languages I am aware of that demonstrate both contextual and distinctive vowel nasality, I have not found any acoustic studies that quantify statements about the strength of their different nasalities, although descriptions stating that one form of nasality is stronger or more pronounced than the other typically follow the pattern seen in Kala--distinctive nasals are described as stronger than contextual nasals.
Once again, Kala sound changes show a tendency to be caught between categories—nasal vowels here are both contrastive and not, depending on their word position. As would be predicted in usage-based approaches to sound change, the unphonologized process of contextual nasalization shows some degree of variation that is not seen in distinctive nasal vowels. Similarly to Kala vowel deletion and vowel laxing, vowel nasality is yet another element of Kala that show properties of multiple phonological categories, being realized in a state of quasi-contrast.
Chapter 6: Typological Regional Survey

6.1 Introduction

One of the goals of this dissertation is to put Kala’s phonological and phonetic profile in a wider areal and familial context of the Huon Gulf and nearby regions of Papua New Guinea. There are few phonetic or phonological approaches to either this region as a linguistic area or of Austronesian Huon Gulf languages as a subfamily. A central goal of this chapter is to examine the context in which Kala exists—beyond the boundaries of this single language, from its direct neighbors, both Austronesian and Papuan, and to the neighbors of those languages. This chapter focuses on comparing languages through phonetic and phonological processes that have been studied in depth in the previous chapters (3, 4 and 5) in Kala, to attempt to ascertain whether and how these features may be evident in both genetically related Austronesian languages (of the Huon Gulf subfamily) and nearby non-Austronesian (Papuan) languages. In determining whether some or all of the features in Kala may be wider areal or familial features that could contribute toward a wider phonological and phonetic picture of Papua New Guinean languages in the region, I use the three central features in this survey: vowel reduction/deletion, vowel laxing, and nasality, which are described and studied in detail in Kala in chapters 3, 4, and 5, respectively. Toward this end, this chapter describes a survey of 50 languages and their phonological processes that may show similarities to those in Kala. The surveyed area extends from the Huon Gulf to nearby regions. The Austronesian languages are all from Kala’s family of Huon Gulf languages, which is
itself a subfamily of the North New Guinea subfamily of Western Oceanic (Ross 1988). Papuan (non-Austronesian) languages were also included in this survey, though I restricted the geographical coverage of these languages based on how many intervening language areas interceded between survey languages and Kala’s linguistic area. A goal of this chapter is to provide an overview of the phonological processes in these other languages within the broader area in which Kala is spoken, and whether and how these languages may show similarities in those processes as those explored in Kala in earlier chapters. A broader goal is to provide a view of the phonologies of these other languages toward a clearer picture of potential areal or familial features in phonology in this region. I discuss how phonology and phonetics, domains which are not commonly covered in linguistic areal approaches to Papua New Guinean languages, could be better represented in this wider view of the region.

This chapter is structured as follows. Sections 6.2 and 6.3 address some of my initial predictions about how traits might appear across the languages of the survey selection if the phonological processes in question were areal and how they would appear if the processes were familial traits. Section 6.4 offers some background on the features that are covered in this survey as well as a brief overview of the ways these processes appear in Kala. Section 6.5 contains a description of the methodology for the survey and details how each of the three phonological features were defined for the survey languages and how these languages were determined either to have or not have such features, as well as showing some results of the survey for each feature. Section 6.6 presents conclusions and discussion of the results. Given the acoustic analyses I
did for these phenomena in Kala, it would be ideal to compare them to similarly detailed quantitative analyses in the surveyed languages. However, such analyses are not widely available for the languages of the region in general, making it ultimately difficult to take a more fine-grained approach to determining phonological and phonetic “similarities” in these processes. Many of the phonological descriptions in the literature for the languages surveyed are restricted to short sketches, focusing mainly on phonemic inventory. It is my hope that by offering this kind of more detailed acoustic analysis for Kala, I can contribute in a small way to the kind of phonetic description that is lacking for less well documented and endangered languages of Papua New Guinea. Our understanding of phonetic and phonological issues cannot be complete with severely lacking data and analysis of languages in a part of the world so rich in linguistic diversity.

If one or more of these processes found in Kala constitutes a familial trait amongst the Western Oceanic (Austronesian) language of the Huon Gulf, we might predict that they would appear in a number of nearby related languages. The Oceanic languages in this survey are limited to the Huon Gulf subfamily of North New Guinea Linkage, which includes 40 languages (Hammarström, et al. 2022; Ross 1988). Within the Huon Gulf subfamily, there are a further four subfamilies. It is possible that some phonological features found in Kala may represent familial traits only in some of these subfamilies. If one of more of these features is a familial trait (or a shared innovation), it would be reasonable to predict that they would appear in Austronesian languages of the region but not necessarily in adjacent Papuan languages. Conversely, if any of these
phonetic processes are instead areal traits, I would predict that these features would show up across both Austronesian and Papuan languages of the region. Below I discuss why either of these possibilities might be expected.

6.2 The Huon Gulf Region as a Linguistic Area

While there has been investigation into general traits of Papua New Guinean languages in some way that might constitute a linguistic areal investigation (e.g. Foley (2000:357), who states that “. . . large-scale processes of convergence have shaped languages over many millennia, giving rise to areal traits”), most of the features considered in this literature have been lexical and morphosyntactic. What phonological information that has been considered (such as Foley 2000:367-370) consists mostly of similarities between shared segments in phonemic inventories, and to a lesser extent syllable structure and suprasegmental features. Phonological and phonetic processes have not been analyzed en masse for the region, or for any subregion that I am aware of outside of individual genetic groups.

While the concept of a linguistic area is not new (Trubetzkoy 1923, 1928), its precise definition, including all necessary and sufficient properties, is a matter of debate. No exact definition is agreed upon in the literature. Campbell (2006) discusses variations in definitions that have been put forth. Parameters vary, such as the number of languages that must be involved to constitute a language area, the number of features that must be shared amongst these languages, the types of shared features (e.g. the features should be not solely lexical but also morphological, syntactic,
phonological, etc.), the typological “weight” of such features, as well as geographical concerns, such as whether or not isoglosses must be more or less overlapping or continuous. To illustrate the lack of definitional clarity even in cases of an accepted linguistic area, Campbell uses the example of the Balkan linguistic area, the status of which is well-known and rarely debated. He points out that even this widely accepted linguistic area does not perfectly adhere to any of the “rules” of the various definitions that exist (e.g. Sherzer 1973, Katz 1975, Schaller 1975) and that scholars of this region do not agree on which languages should be included in the area nor on which features should be counted (Stolz 2002).

Trubetskoy’s original 1923 presentation of what could be called a precursor to the concept of a linguistic area (jazykovoy soyuz “language union”) does not make a distinction between inherited features and those that are diffused via contact. Rather, the more primary features of his definition are geographical region and shared cultural history: his definition rests on the fact that the features are shared across several languages, whether they got there through genetic horizontal transfer or lateral transfer due to “prolonged proximity in time and parallel development” (Trubetzkoy 1923:116; translation from Toman (1995:204)). A later work from 1928 offers a more precise definition of two types of Sprachgruppe ‘language groups’, one of which includes genetically related languages with regular sound correspondences, and the other the Sprachbünde. The latter is defined by morphosyntactic, lexical, and phonological similarities that cannot be attributed to genetic inheritance. This is the beginning of the modern definition of a linguistic area.
Later scholars have differed in the details of what is sufficient to make a linguistic area. Katz (1975) uses a simple and straightforward definition that, though concise, is actually quite permissive: it would technically allow for just one shared trait to define a linguistic area. It allows for a linguistic area if at any given time, there is a continuous geographical area intersected by at least one language boundary that is encompassed by at least one isogloss (Katz 1975:16, elements of translation from Campbell (2006:5). This definition is very inclusive: taken to its extreme, a linguistic area could be made up of a region with only two languages and one isogloss. Schaller’s (1975) definition, on the other hand, requires a “series of common traits” (Schaller 1975:58) across at least three languages. Some authors wish to include this requirement of “more than two” traits to differentiate a linguistic area from a history of borrowing between just two languages, and some view it even as a trivialization of the concept itself to include such instances of two-language borrowing (Thomason 2001). However, Campbell (1985, 2006) argues that there is no clear line between simple borrowing and a full language area. In fact, it might be most useful to understand both as different places on the same spectrum of diffusive influence. As Campbell (1985:29) states, it is likely more useful not to view “linguistic areas” as binaries (asking “whether or not” something is a linguistic area) but rather to view certain contact situations a “stronger” or “weaker” case of a linguistic area.

Campbell’s overview of the linguistic area definitional concepts concludes with a relatively inclusive idea of a linguistic area. For Campbell, it seems that the key to a linguistic area is its history of diffusion, which is of greater significance than strict
numbers of languages and traits or what is or is not allowed with regard to geographical boundaries. Regardless of the variability in definitions, if we can accept that a linguistic area is one in which multiple languages share at least one linguistic trait that cannot be attributed to shared innovation, but to diffusion through language contact, then we might expect that these traits would include phonetic and phonological traits as well as lexical and morphosyntactic traits.

Despite its definitional imprecision, the concept of a linguistic area remains one that is inherently relevant to the region of New Guinea. Foley (2000) covers many commonalities that have arisen in New Guinean languages due to diffusion, from structural traits in morphology and syntax and lexical items (Foley 2000:367-386) to common devices in discourse, narrative, and genre (Foley 2000:386-392). Diffusion, then, is a common phenomenon in Papua New Guinea. In fact, differentiating which features of a language or family are diffused and which are inherited is not necessarily simple for Papuan languages, and determining higher level genetic groups has been notoriously fraught. According to Foley, comparative linguistics in Papuan languages must “proceed with care and utmost rigor” (Foley 2000:359). This is, in his judgment, in part necessitated by the fact that the vast majority of language descriptions from the region are less than 50 years old, making it difficult to tease apart what is inherited genetic material from what has been diffused or borrowed from other unrelated languages. This admission in itself hints at some kind of highly complex linguistic area in which vertical and horizontal transfer have become intertwined with each other many times over within a time depth that may be up to 50,000 years deep (Bellwood 1998).
Nichols (2002) includes New Guinea in the “residual zone” category in her work on linguistic diversity, in which waves of immigrating peoples have added many layers of linguistic diversity to the region, without one family supplanting another entirely, but rather influencing each other in many ways over time. These different populations may be one factor that has led to such a high level of genetic diversity in the region, while also allowing for continued and repeated waves of contact-induced diffusion to spread across language boundaries over a great deal of time.

Linguistic areas tend to include a variety of different kinds of shared traits, although as evident in the conflicting literature on the topic, some may consider a single isogloss to be sufficient criteria. There is evidence of such areas (both those with a single common trait to define the area as well as those with many from various subsystems in the languages, from morphosyntax to phonology) across Austronesian regions as well as Papuan language spaces. The concept of the “Papuasphere” is often restricted to non-Austronesian languages in Papua New Guinea (e.g. Palmer 2018:4), although it is interesting to consider that, in areas of high contact, Oceanic languages inevitably exert influence over Papuan languages (and vice versa). Even though they may not be central to the Papuasphere, they are undeniably a part of the linguistic ecology of the broader region. The very fact that there is so much diffusion shows this.

One example of a proposed linguistic area amongst Austronesian languages is that of South Borneo. Adelaar (2021) makes an argument for this linguistic area, which includes several languages that do not constitute a family, but nonetheless share particular traits that are not seen in other nearby languages. These languages are
Banjar Malay (a Malayic language), Ngaju (a West Barito language), and Ma’anyan (a Southeast Barito language), and to some degree, Malagasy (another Southeast Barito language) (Adelaar 2021:81). While these languages are all Austronesian, they do not make up a subfamily in themselves. Their shared traits include those of morphological, syntactic, and semantic domains, such as a non-volitional prefix and the grammaticalization of a noun buah ‘fruit’ that has come to represent affectedness. The phonological changes are those that do not correspond to a shared innovation from any proto-language. These sound changes consist of the shift of Proto-Malayo-Polynesian *s > h, and nasal spread of a prefix N- across word stems, which nasalizes not only the onset of the stem but also instances of *y\textsuperscript{16} in the following syllable. The outputs of these processes may be very similar across languages, such as nasal spreading in Ngaju and Ma’anyan, which appears to function identically in both. The outputs may also manifest somewhat differently, or even be absent in some languages: in Banjar Malay, nasal spread does not happen, and is realized differently in Malagasy (Adelaar 2021:88-90). Similarly, the *s > h process is consistent across all languages but occurs only inconsistently in Banjar Malay, and is taken one step further in Malagasy, in which *s is deleted entirely (*s > h > ∅). Nonetheless, these phonological changes represent general common traits across the proposed linguistic area and can be spoken of as similar with respect to most of their properties.

\textsuperscript{16} In the Austronesianist conventions, *y represents a reconstructed palatal glide /j/. 
This is the kind of spread of traits I would expect to see across other Austronesian languages and non-AN Papuan languages around the Huon Gulf, if any of the processes I have described in Kala constitute areal traits amongst Kala’s neighbors. I would not expect these traits to be limited to Austronesian languages of the region, but would expect them to appear in Papuan languages as well. Language contact and influence between Austronesian and Papuan languages is well documented (e.g. Klamer (2012), Grace (1981), Kluge (2012)). It is thought that this is due to widespread multilingualism between Austronesian and non-Austronesian speakers over many centuries (Lynch 1981, Ross 1988), as well as the cultural exchange that comes with such high linguistic diversity.

Certain regions of New Guinea are hotspots of reciprocal contact-induced change, such as East Nusantara, the “Bird’s Head” region of New Guinea, the state of East Timor, Bougainville, and the Solomon Islands. However, feature spread has been noted much closer to Kala’s home on the Huon Gulf. Bradshaw (2017) presents evidence of Oceanic languages’ influence on nearby (non-Austronesian) Binanderean languages, and vice versa. Some of these traces are found in Binanderean languages (even some reconstructible to Bindanderean protolanguages) where no Oceanic languages are now present, whose speakers ostensibly moved inland or north along the coast over time. Some of these traces in Binanderean languages include Oceanic etyma: for example, Proto-Binanderean *wa(N) ‘canoe’ (< Proto-Papuan Tip).

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1 Papuan Tip languages constitute a branch of the Western Oceanic family spoken along the southern tip of the island of New Guinea. They number 63 languages, according to Glottolog.
There are also grammatical borrowings from Oceanic in Binanderean languages, such as a clusivity distinction in the first person dual and plural (Bradshaw 2017:400-401), which is not a typical Papuan feature, but very common in Oceanic languages. One of the Binanderean languages that is considered aberrant for its family is Ghu-Samane (also called Waria, Paiawa, Bapi, and Garaina) (Bradshaw 2017:403). Ghu-Samane shows only around 17-18 percent of the vocabulary items seen in neighboring North Binanderean languages, such as Zia, Yekora, and Suena. It also presents possible phonological influences from Oceanic languages, as it includes several phonemes unusual for Binanderean languages, including a phonemic glottal stop /ʔ/ (written <q> in orthography), a velar fricative, and a three-way contrast between nasals rather than a two-way contrast (Oceanic languages, by contrast, tend to include three places: /m n ŋ/ (Bradshaw 2017:404), rather than the more typical two-way contrast of /m n/ found in various Papuan languages of the region). Bradshaw points out several possible contact influences on Ghu-Samane vocabulary as well, such as borrowings from nearby Oceanic language Numbami. Like Kala (and other Huon Gulf languages) Numbami shows an inconsistent retention of Proto-Oceanic *k in several terms: it retains *k in words like kuliawa ‘dolphin’ and kulita ‘octopus’ (cf Kala kuliẽ [kuriẽ] and kali [kuri]), but loses it in ai ‘tree, wood’ (cf Southern Kala e, Northern dialects ae) (< *kayu) and iya

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Hammarström, Olof; Forkel, Reinhard; Haspelmath, Martin; and Bank, Peter. 2022. Glottolog 4.0. Leipzig: Max Planck Institute for Evolutionary Anthropology. 161

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\(^{18}\) *q represents a reconstructed glottal stop phoneme.
‘fish’ (cf Southern Kala i, Manindala/Lambu yĩ) (< *ikan). Some of the words that appear to be borrowed from Numbami into Guhu-Samane show loss of *k where in modern Numbami, it is retained. For this reason, Bradshaw posits that early Guhu-Samane speakers may have borrowed these forms from a dialect of Numbami that retained instances of *k that is no longer spoken. Particular examples of Oceanic borrowings that seem likely include: Guhu-Samane baka ‘canoe’ (< PPT *waga/waka < POc *waga), uriapai\(^{19}\) ‘dolphin’ (< Numbami kuliawa) and uritta ‘octopus’ (< Numbami kulita < POc *kuRita).

Possible Binanderean influence on Oceanic Papuan Tip languages include structural ordering features such as SOV word order, postpositional phrases, and preposed genitives. All of these features are typical for Binanderean languages (and indeed other Papuan languages), but atypical for Oceanic languages, which typically show SVO order. Bradshaw notes that the Oceanic languages of these areas that do retain their SVO order, prepositions, etc. are those that are the farthest from the mainland coast out into the Solomons, such as the Kilivila subgroup of the Trobriands and the northerly Woodlark Islands (Bradshaw 2017:401). Presumably, the lack of intense contact of these Oceanic speakers with Binanderean languages has led them to retain their more typical Oceanic structures.

\(^{19}\) Proto-Oceanic *kuliap ‘dolphin’ appears with an epenthetic final vowel in Numbami kuliawa (< Pre-Numbami *kuliapa). kuliawa can be reanalyzed in as kulia + awa ‘mother’, which Bradshaw points out was likely semi-calqued by bilingual speakers into Guhu-Samane uria + pai ‘mother’ (Bradshaw 2017:404-405).
Given the strong evidence we have of reciprocal diffusion and influence of features (lexical, morphological, syntactic, semantic, phonological) from a variety of languages in Papua New Guinea of both Austronesian and non-Austronesian origin, it would not be surprising if some of the phonetic features found in Kala were also present in nearby languages of the Huon Gulf. If this is the case, I would predict that the properties of these processes would show more than superficial similarities, such as we have seen in other presumptive linguistic areas, such as that of South Borneo.

6.3 Familial Features of the Huon Gulf

Another possible scenario in which features can be shared across language boundaries is through genetic inheritance of shared innovations. Presumably, these are all results of diachronic processes (at some point), which can be traced using the comparative method. These kinds of sound changes are not the nature of the features I have investigated in Kala, however. In Kala, vowel deletion, vowel laxing, and preconsonantal vowel nasalization all show signs of being not (yet?) fully phonologized. If any of these processes are shared across genetically related languages that do not have a sibling-level relationship, presumably they cannot be said to be “shared innovations” in the typical historical sense, but rather some kind of convergent evolution toward a similar outcome. While it is possible that these innovations could be due to chance or because they are cross-linguistically common sound changes, it is also not unheard of for sound changes with similar outputs to persist across related individual families independently. Such a case in Austronesian is described by Blust (2007), concerning disyllabism across Austronesian languages, and the myriad of processes that have persisted...
language-internally, all of which conspire to produce an output of disyllabic word stems. Some of these processes in certain languages are diachronic, while others are ostensibly synchronic, suggesting that a move toward disyllabism across AN languages has been an ongoing phenomenon. Blust presents the possibility that this phenomenon constitutes an “attractor state” in Austronesian languages, or a particular state in a dynamical system toward which the system evolves.

Potentially, if a particular output were produced by multiple types of phonological changes (in a “conspiracy” (e.g. Crist 2001)) across a number of languages in a family, it could be analyzed under a similar concept. If this were the case for the processes under examination in chapters 3-5, I would expect to see similar outputs but not necessarily identical processes or conditioning environments. Rather, I might predict that superficially dissimilar processes would all appear to have same kinds of effects toward some particular outcome. In this scenario, I would predict that at least one of Kala’s phonetic/phonological processes would be present across multiple Oceanic languages of the region, but that it would be limited to Oceanic languages and not be diffused into Papuan neighbors.

6.4 The Features of the Survey

In this survey, I examine three central phonological features described in Chapters 3-5, as found in the Southern dialect of Kala. This section provides an overview of these features as they appear in Kala as well as some general background about these kinds of features and how they may manifest cross-linguistically. Further background is found in their respective chapters: Chapter 3 (vowel reduction and deletion), Chapter 4 (vowel
laxing), and Chapter 5 (nasal vowels and vowel nasalization). Due to these features being discussed at length in the previous chapters, the overview here is brief.

6.4.1 Vowel Reduction and Deletion

Vowel reduction is a broad phenomenon that is not restricted to one kind of environmental trigger nor to a single output. From a usage-based viewpoint, vowel reduction is understood as a function of articulatory optimization (e.g. Kapatsinski, et al. 2020), in which the trajectory of articulatory gestures is streamlined (see Chapter 3, Section 3.1). This is often known to occur in unstressed syllables or other positions of prosodic weakness. It is likely to propagate by speech style as well, appearing in allegro (quick or casual speech) before lento styles (Greenberg 1996). This appears to be the case in Kala, based on the quantitative analysis presented in Chapter 3 (see Section 3.4.1).

The possible outputs of vowel reduction are varied. Quality reduction is a common form of reduction, in which a more peripheral vowel becomes centralized and/or lowered, or more generally moves toward a schwa-like vowel quality. Another possible manifestation of reduction is shortening, in which the duration of the vowel segment is reduced. Devoicing is a form of reduction that often occurs in juxtaposition to voiceless consonant segments (e.g. high vowel devoicing between voiceless consonants in Japanese), but may also occur word-finally or in other positions.

In addition to quality reduction, shortening, and devoicing, vowel reduction may include total deletion. This can be viewed as the most complete form of reduction. In
some processes, vowel reduction may manifest in multiple ways. Especially when in the
process of phonologization or pre-phonologization, vowel quality reduction may exist in
free variation with deletion, for example. Often, deletion is seen as a latter stage of
reduction, although this is not the case in Kala, evidently. Kala vowel deletion is
optional, and more likely to occur in fast speech, but not does alternate with quality
reduction or partial deletion (see Chapter 3, Section 3.4). In this sense, it is unusual,
being clearly not yet fully phonologized (as it is optional), but also being complete when
it does occur.

In terms of its environment, Kala vowel deletion occurs under a very specific
condition. A vowel in a word of more than two syllables may be deleted if that vowel
occurs between a stop consonant and an alveolar tap, and if and only if the following
syllable includes a vowel of identical quality (regardless of nasality of that vowel). This
leads to an output that effectively creates a more complex syllable onset (CrV) than is
canonical in Southern Kala otherwise (CV).

6.4.2 Vowel Laxing

As discussed in Chapter 4 on Kala vowel laxing, I distinguish this process from vowel
reduction in several ways: I expect vowel laxing to be determined by either syllable
shape or adjacent consonants, and not typically conditioned by weak syllables or
speech rate in the way that quality reduction may be (see Chapter 4, Section 4.2.1.1 for
supporting literature on why and how I make this distinction, as well as how I determine
the nature of laxing in Kala).
In many languages with tense-lax pairs of vowels, there is a tendency for the lax version to occur under certain conditioning environments. A common environment is closed syllables, in which lax vowels are more cross-linguistically frequent, and open syllables, in which tense vowels are more frequent. This may even be the case in languages that do have a phonemic distinction between tense and lax vowels (e.g. French) due to diachronic processes. Storme (2019) presents data on this phenomenon from a range of diverse languages and families, and proposes a perceptually-driven model to explain these strong cross-linguistic patterns. However, the approach taken in Storme does not explain Kala laxing.

Laxing in Kala is entirely phonetic, as there is no contrast between tense and lax vowels in the language. It can affect only /i/ and /e/ phonemes (front vowels), producing [ɪ] and [ɛ], respectively. The most unusual property of Kala laxing, and that which has made it difficult to categorize and explain, is the conditioning environment. As shown in the acoustic analysis of Chapter 4, Kala laxing is triggered in a front vowel when it precedes either a nasal consonant (including prenasalized stops) or consonants that are [+continuant]. While the nasal consonant conditioning would not be totally unpredicted (due to the known acoustic effects of nasality on non-low vowels, as shown in e.g. Beddor (1993:180), there is no precedent in the literature that I am aware of in which [+continuant] is a conditioning factor of laxness in vowels.

Vowel laxing in Kala may also cause laxing harmony within the same word. If a front vowel is laxed, then another front vowel in a subsequent syllable of the same word may
also become lax, such as /ˈgindi/ ‘enough’ → [ˈɡɪndi] ~ [ˈɡɪndɪ]. This is another feature that surveyed for in the languages around the Huon Gulf.

6.4.3 Nasal Vowels and Vowel Nasalization

Nasality in vowels can be contrastive or contextual. In this chapter, I refer to contrastive nasality as “nasal vowels” and contextual nasalization as “vowel nasalization”. Often, when it a language has developed a phonemic contrast in nasal vs oral vowels, it has diachronic origins in contextual nasalization, which has lost some element of its conditioning environment leading to phonologization (Ruhlen 1978:223). In Kala, nasality in vowels can be contrastive, in that there are many minimal pairs differentiated by nasality in the vowel. However, nasalization also occurs in contextually determined environments; specifically, vowels of all qualities may be nasalized when preceding a nasal consonant (including prenasalized stops). However, as shown in Chapter 5, the acoustic markers of nasality tend to be stronger in phonemically nasal vowels than in contextually nasalized vowels. This is not an uncommon condition in languages that have both phonemic nasal vowels contrasts as well as contextually nasalized vowels (due to co-articulatory assimilation in the context of nasal consonants).

6.5 Survey Methodology

For the crosslinguistic survey of this study, both Austronesian and Papuan languages (which are defined here as non-Austronesian languages of Papua New Guinea) are included for evaluation. In order to attempt to place Kala in a broader areal and familial
image, the languages selected were taken from Austronesian and Papuan languages in the region surrounding the six villages in which Kala is spoken. This area extends from the central Huon Gulf and somewhat beyond. Austronesian languages included here are all from Kala’s family of Huon Gulf languages, which is itself a subfamily of Western Oceanic. From here, I examined Papuan languages that were within the Huon Gulf region and slightly beyond. The cutoff point used for “beyond” was that these languages were all within two degrees of separation of any of the Austronesian languages. Two degrees of separation here means that the survey was restricted to languages that are spoken no more than two languages (geographical areas inhabited by a language) away from where Kala is spoken. The geographical and linguistic parameters of the survey were restricted in this way in order constrain the region in question, as it was not possible to survey all 832 Papua New Guinean languages for the purposes of this chapter. Ultimately, the geographical cutoff point for the survey is arbitrary, although consistent across families and subfamilies.

As a result, I surveyed 40 Huon Gulf (Austronesian) languages and 18 nearby Papuan languages. I used the standards of Glottolog to determine what was an individual language (as opposed to a dialect or variety). In each of these groups, I examined phonological descriptions that were either independent or a part of a larger descriptive grammar of the language. Eight of these languages (four Papuan and four Austronesian) had very little or no available phonological description, and so I have not included them in this survey. After eliminating the languages for which there was insufficient description, a total of 50 languages (36 Huon Gulf and 14 Papuan) remained
in the survey. Overall, I consider three main dynamic phonological features: vowel reduction and/or deletion, vowel laxing (including any laxing harmony), and nasal vowels and/or vowel nasalization (contrastive or assimilatory).

Map 6.1. Positive case languages of the survey region, from the Huon Gulf and Huon Peninsula inland.

For the preliminary list, my working definitions for these phenomena were very broad. For example, I coded any language as a positive case for vowel reduction if its descriptions made reference to vowel deletion, elision, reduction, or neutralization, but also for descriptions that included terminology such as “shortening”, “devoicing”, “centralization”, “lenis” vowels, or distinctions related to length (e.g. “short” vs. “extra-
short”). My definitions for vowel laxing included any descriptions of vowels becoming more centralized or lowering in some phonological or phonetic context. Likewise, my coding for positivity in nasal vowels/nasalization included any mention of either phonemic nasal vowels in a language and/or vowel nasalization due to phonetic reasons (e.g. coarticulation, nasal spreading). Additionally, each language was evaluated for descriptions of any kind of stress system, lexical tone, or pitch accent system, as this could have an effect on vowel reduction/deletion (e.g. pretonic deletion).

After evaluating all languages for the presence or absence of these three features, I narrowed my focus to those that I deemed positive cases for each feature. I then investigated the details of the features in those languages.

6.5.1 Survey Methodology and Results by Phenomenon

This section details further methodology as it applies to the evaluation of each phenomenon and provides the quantitative and qualitative results of the survey, and offers some discussion of three phonological processes as they appeared in the surveyed languages. I also describe how I determined whether a feature was present or absent in a given language, the affected vowels in each process, the conditioning environments, and the resulting quality or qualities of the resulting vowels (in languages for which this information was documented), as well as other resulting factors (e.g. syllable structure outputs for vowel deletion, known developmental pathways for nasal vowels). I also compared properties of each process for every positive-case language to
the parallel process in Kala. Each process is in turn analyzed by language genetic
type—Austronesian languages vs. Papuan languages.

6.5.1.1 Vowel Reduction and Deletion
For vowel reduction/deletion, a more detailed evaluation necessitated determining
which vowels were affected (i.e. generalized to a natural class, if possible), what the
conditions were for reduction and/or deletion, and whether the process involved quality
reduction, full deletion, or potentially both or either. I also looked at whether
reduction/deletion was affected in any way by suprasegmental features such as stress,
tone, pitch accent, etc. I considered scope of reduction/deletion—some languages may
have this phenomenon restricted in some way by some factor that is not strictly
phonological, such as morpheme boundaries/morphological structure or lexical class of
a word. Another factor considered here was what kind of effect vowel reduction/deletion
has on syllable structure as well—in some cases, vowels delete seemingly to further
maintain a CV structure found elsewhere in the language, but in others, it produces an
output of more complex structure, where otherwise the language shows CV or some
other similarly simpler structure. In Kala deletion, the effect produced is one of
increasing syllable structure complexity, from a CV structure to complex onset of CrV.
6.5.1.1.1 Vowel Reduction and Deletion in Surveyed Austronesian Languages

Out of 36 Austronesian languages of the region that were surveyed, six (~17%) had phonological descriptions that included vowel reduction and/or deletion. It is possible that more languages actually include some form of reduction/deletion, but due to limited phonological and phonetic descriptions, I cannot take such unknowns in account.

<table>
<thead>
<tr>
<th>Austronesian: Vowel Deletion/Reduction</th>
<th>Vowels affected</th>
<th>Conditioning environment</th>
<th>Reduction or Deletion</th>
<th>Syllabic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musom</td>
<td>All qualities</td>
<td>Unstressed syllables</td>
<td>Quality reduction</td>
<td>None</td>
</tr>
<tr>
<td>Patep</td>
<td>All qualities</td>
<td>Unstressed syllables</td>
<td>Quality reduction</td>
<td>None</td>
</tr>
<tr>
<td>Hote</td>
<td>All qualities</td>
<td>Across morpheme boundaries: $V_1, V_2 \rightarrow V_1$</td>
<td>Deletion</td>
<td>Maintains CV</td>
</tr>
<tr>
<td>Numbami</td>
<td>High vowels</td>
<td>Across morpheme boundaries with high vowels: $V_1, V_2 \rightarrow V_1$</td>
<td>Deletion</td>
<td>Maintains CV</td>
</tr>
<tr>
<td>Wampar</td>
<td>Non-back vowels</td>
<td>Certain lexical classes of words</td>
<td>Deletion</td>
<td>Simplifies</td>
</tr>
<tr>
<td>Mapos-Buang</td>
<td>All qualities</td>
<td>Unstressed syllables</td>
<td>Quality reduction</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 6.1. Austronesian languages within the survey area that are described as having vowel deletion or reduction.

The languages that are described as having reduction/deletion are Musom, Wampar, Hote, Patep, Mapos-Buang, and Numbami. Of these six languages, three are described as having full deletion (Wampar, Hote, Numbami), while the other three (Musom, Patep, Mapos-Buang) are described as having vowel quality reduction. For four out of six languages, all vowel qualities are described as being affected by the reduction or deletion process (Musom, Patep, Hote, Mapos-Buang). In Wampar, all non-
back vowels are affected. In Numbami, differing high vowels that come into contact across affix + stem boundaries causes deletion of the second vowel. The preponderance of systems in which all vowels are affected seems to fall in line with what is observed in Kala, in which all vowel qualities (as well as both nasality qualities, both oral and nasal) can be deleted in Kala’s vowel deletion process.

The conditions of deletion/reduction were more varied amongst these languages. Three languages (Musom, Patep, Mapos-Buang) included deletion or reduction in unstressed vowels, a very common condition of vowel reduction in general (see Chapters 3 and 4). Three languages (Hote, Wampar, and Numbami) often delete vowels that are in direct juxtaposition, effectively restoring CV structure. This is actually the opposite of what vowel deletion does in Kala, in which an otherwise CV syllable structure is complicated by vowel deletion, creating onset clusters of CrV. In other languages (Wampar and Hote), vowel deletion is restricted by morphophonemic or lexical parameters (e.g. only occurring in certain morpheme or word classes). The effect of vowel deletion on syllable structure is an interesting one, as the process is capable of having the opposite effect—that is, producing more complex syllable structure rather than maintaining a simpler CV structure. This phenomenon is explored in depth by Easterday (2019) for languages in which vowel reduction co-occurs with and may produce more complex syllable structures (Easterday 2019:215-250).

No languages surveyed here showed the exact unique conditioning environment that is seen in Kala, in which vowels only delete if they are preceded by a stop, and a vowel of identical quality is in the following syllable, which is preceded by an alveolar
tap (e.g. /ambarã/ > [ambrã] ‘village’). This property of the process would seem to be one of its more unusual elements. However, though no languages surveyed demonstrated similar conditioning environments to Kala’s, there are other languages in the broader Austronesian language family that exhibit deletion processes that more closely resemble this deletion process in Kala (cf. Chapter 3, Section 3.2 for more discussion on the cases of Mussau, etc.), in that they involve juxtaposed syllables containing identical vowel qualities and also produce otherwise uncommon consonant clusters for that languages, although they are not located in the general Huon Gulf region or nearby, and so would not be included in the present survey. Some of these deletion processes are analyzed by Blust (2007) as part of an Austronesian family-wide phonological conspiracy toward an attractor state of disyllabism ((Blust 2007:1-2), also see Chapter 3, Section 3.3 for further discussion). Whether or not Kala’s vowel deletion is due to movement toward such a state is unclear at this time. However, none of the deletion processes in the survey appeared to be producing an output that is consistent with such a family-wide conspiracy; Kala deletion sometimes produces disyllables, but it also can produce trisyllabic words. Additionally, Kala has many monosyllable content words, and does not seem to conform very strictly to the typical Austronesian pattern described by Blust.
6.5.1.1.2 Vowel Reduction and Deletion in Surveyed Papuan Languages

For this survey, there were 18 Papuan languages within the range of the survey specifications. 14 of these had sufficient descriptive literature to determine whether they had some form of vowel reduction or deletion. Of these 14, 5 languages (~36%) were described as having vowel reduction or deletion (Safeyoka, Suena, Urim, Menya, and Borong). Two languages (Borong, Suena) have full deletion, while three (Safeyoka, Menya, Urim) have quality reduction to some central vowel defined as [ə] (Menya and Urim) or [ɨ] (Safeyoka).

<table>
<thead>
<tr>
<th>Vowels affected</th>
<th>Conditioning environment</th>
<th>Deletion or Reduction</th>
<th>Syllabic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safeyoka</td>
<td>High vowels</td>
<td>Lack of pitch-accent</td>
<td>Quality reduction</td>
</tr>
<tr>
<td>Borong</td>
<td>Non-high vowels</td>
<td>Between certain morphemes: $V_1V_2 \rightarrow V_2$</td>
<td>Deletion</td>
</tr>
<tr>
<td>Menya</td>
<td>Single quality: /a/</td>
<td>In certain morphemes, appears dissimilatory</td>
<td>Quality reduction</td>
</tr>
<tr>
<td>Suena</td>
<td>Single quality: /u/</td>
<td>After /m/</td>
<td>Deletion</td>
</tr>
<tr>
<td>Urim</td>
<td>All qualities</td>
<td>Unstressed syllables; as a result of vowel harmony</td>
<td>Quality reduction</td>
</tr>
</tbody>
</table>

Table 6.2. Papuan languages within the survey area that are described as having vowel reduction and/or deletion.

For many of these languages, the vowel qualities in question that are affected by deletion and reduction processes are more restricted than those found in the Austronesian sample. Safeyoka reduction only affects high vowels, while Borong deletion affects all vowel qualities except high vowels. Suena and Menya show deletion only of certain vowel qualities (/u/ and /a/, respectively), while Urim reduction can affect all vowel qualities, but specifically as a function of vowel harmony.
As for conditioning environments, the results for surveyed Papuan languages were about as varied as those for the Austronesian languages. Safetyoka’s reduction appears to occur only in vowels that lack a pitch-accent. Reduction in Urim occurs solely in unstressed syllables and also the result of what Luoma (1985:110) calls vowel harmony: Luoma states that vowels in words typically proceed from the left edge of a word rightward from open to more closed, and any aberration from this pattern (a more closed vowel preceding a more open one, or two identical vowels in juxtaposed syllables) will cause the first vowel to be reduced to [ə]. For example, /kərek/ ‘hen, rooster’ is realized as [kərek] and /atók/ ‘white ant’ as [atók]. In disyllabic words in which the first syllable contains a vowel quality that is underlyingly more closed or just as closed as the vowel in the second syllable, the first vowel will sometimes\(^{20}\) reduce to [ə]: /kəlu/ ‘bottom’ → [kəlu], /təkor/ ‘not red’ → [təkor], /nam’pa/ ‘dog’ → [nəm’ba], /ten’tar/ ‘miserable’ → [tən’tar].

Menya reduction, which is restricted to a sole phoneme of the quality /a/, is ostensibly a dissimilatory process, in which syllabically juxtaposed instances of /a/ cause the first vowel to reduce to [ə], although seemingly this is restricted to morphologically complex sequences of prefix(es) and stem. This process is part of a more extensive series of fusion and loss processes that delete or alter segments at morpheme boundaries in Menya (Whitehead 2004:9-10).

\(^{20}\) Luoma (1985:111) describes this reduction as somewhat optional and variable. When words are articulated more slowly, they are described as being closer to the underlying full vowel quality. This would suggest a perhaps not yet fully phonologized process.
6.5.1.2 Vowel Laxing and Laxing Harmony

Similarly to vowel reduction and deletion, for vowel laxing and laxing harmony, I organize these processes across languages first by which vowels are affected. In many cases, not all vowel phonemes undergo laxing. In some cases, vowels are neutralized to lax phonemic counterparts (e.g. /i/ → /ɪ/) and sometimes the laxing was a case of predictable allophony (e.g. /i/ → [ɪ]). In each language, the phonemic inventory was examined to determine which of the two above possibilities was the case. I also determined what the conditions were for laxing and how these were described in the literature. Some descriptions contained terms like “centralization”, “neutralization”, etc. In some cases, descriptions of vowel reduction overlapped with those of vowel laxing (e.g. the case of Urim (Luoma 1985:109-111)). In these cases, it was necessary to determine which of the phenomena the properties of the process were most closely aligned with. For example, if the environment was described as an unstressed syllable, was conditioned by word-position, or was described as more common in quick speech, it was categorized as reduction, and discussed in the previous subsection, whereas if the conditioning was due to syllable shape or adjacent consonants, it was categorized as laxing. For more discussion of the differences between reduction and laxing, see Chapter 4.

The secondary sub-feature of the laxing element was laxing harmony—specifically, I looked for languages in which lax vowels that were determined by some conditioning further affected non-lax vowels (within the same word, typically), turning them lax. I included languages that were described as having some kind of vowel
harmony. In Kala, if a front vowel is laxed in a polysyllabic word and that same word contains another following front vowel, that front vowel may also become lax. Kala’s laxing harmony is somewhat unusual in that it is optional, unlike many systems described as a vowel harmony (e.g. those in Turkic languages). However, I found that some of the extant laxing harmony systems in languages of the area were similarly likely non-phonologized.

6.5.1.2.1 Vowel Laxing in Surveyed Austronesian Languages

Of the 36 Austronesian languages surveyed, four (~11%) were described as having a process that could be defined as vowel laxing. As mentioned above, languages in this category were considered positive cases if they showed laxing of vowels due to syllable shape or adjacent consonants. Cases that were described as lowering, reducing, or centralizing vowels in unstressed syllables, quick speech, etc. were categorized instead as cases of vowel reduction (see Chapter 4 for an in-depth discussion of why I make this distinction).

<table>
<thead>
<tr>
<th></th>
<th>Vowels affected</th>
<th>Conditioning environment</th>
<th>Harmony</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jabêm</td>
<td>Phonetic: all</td>
<td>Closed syllables</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Phonemic: mid vowels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hote</td>
<td>Non-low vowels</td>
<td>Closed syllables</td>
<td>Yes</td>
</tr>
<tr>
<td>Bukawa</td>
<td>Non-low back vowels</td>
<td>Closed syllables</td>
<td>No</td>
</tr>
<tr>
<td>Mangga-Buang</td>
<td>All but mid round vowels</td>
<td>Before backed velar consonants</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 6.3. Austronesian languages within the survey area that are described as having vowel laxing.
Affected vowels in this category were restricted to non-low or non-low back vowels in Hote and Bukawa, respectively. In Mangga-Buang, all vowels may be affected except for mid round vowels. Jabêm is an interesting case because it has two different vowel laxing processes. One process is described as phonetic (Dempwolff 1939, translation in Bradshaw and Czobor 2005:3) and can affect all vowel qualities. This process is conditioned by syllable shape, with (non-phonemic) lax versions of vowels appearing in closed syllables, and their tenser counterparts in open syllables. Another tense-lax feature of Jabêm is phonemic and related to its vowel harmony system. Jabêm has the following seven vowel phoneme inventory: /i e ɛ a u o ɔ/. In almost any polysyllabic word in which there is a tense (or a lax) mid vowel, the other mid vowel must also match in laxness/tenseness, hence words like /ɛɾɛŋ/ ‘tomorrow’, /ɡɛlɔm/ ‘drum’, /ɡoŋɛ/ ‘coconut cream’, but /belem/ ‘nail’ and /benoŋ/ ‘lull’ (Bradshaw and Czobor 2005:7).

Conditioning in this category is described as syllable-determined for three out of four languages. Jabêm, Hote, and Bukawa are all described as laxing vowels in closed syllables. Mangga-Buang is the one exception in that its vowel laxing is determined by an adjacent consonant of a particular class, its backed velar series.

Laxing harmony is found in two out of four of the languages, Jabêm and Hote. Jabêm’s system is described above. Hote’s laxing applies to vowel phonemes /e/, /o/, and /i/, which are laxed to [ɛ], [ɔ], and [ɪ], respectively, when in closed syllables. Vowel

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harmony applies to non-low vowels, which harmonize across morpheme boundaries (stem to affix) to match the stem's vowel in height (Muzzey 1979:28-29).

Overall, there was no laxing process amongst surveyed Austronesian languages that had identical properties to Kala laxing, especially where the conditioning environment for Kala is concerned. Kala’s laxing of vowels before [+nasal] and [+continuant] consonant segments is unusual. However, two languages did show somewhat comparable harmony systems.

6.5.1.2.2 Vowel Laxing in Surveyed Papuan Languages

Of 14 Papuan languages included in this survey, four (~29%) were described as having some process that could be called vowel laxing. The criteria for distinguishing quality reduction from laxing was the same for Papuan languages as it was for Austronesian languages.

<table>
<thead>
<tr>
<th>Language</th>
<th>Vowels affected</th>
<th>Conditioning environment</th>
<th>Harmony</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nabak</td>
<td>Non-back vowels</td>
<td>Before nasals; certain word positions</td>
<td>No</td>
</tr>
<tr>
<td>Biangai</td>
<td>Unrounded non-low vowels</td>
<td>Closed syllables; adjacent to various consonants</td>
<td>Yes</td>
</tr>
<tr>
<td>Hamtai (Kapau)</td>
<td>Non-low non-central vowels</td>
<td>Following /j/ and /t/</td>
<td>No</td>
</tr>
<tr>
<td>Kâte</td>
<td>Single quality: /e/</td>
<td>Before nasals, /ʔ/, /r/, /z/</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 6.4. Papuan languages within the survey area that are described as having vowel laxing.

Affected vowels varied by language and were often quite restrictive natural classes:

Nabak laxes non-back vowels, but Biangai and Hamtai limit their laxing to unrounded
non-low vowels and non-low non-central vowels, respectively. Kâte laxes a single vowel /e/.

Conditioning environments were also varied: Nabak and Kâte both include laxing before nasals (which, as mentioned previously, is not totally unexpected cross-linguistically), although Nabak also laxes vowels in initial word position, and Kâte also does so before other certain consonants (/? r z/) (Flierl and Strauss 1977:xvi). Biangai laxes different vowels before different consonants, which brings into question whether Biangai actually has a series of laxing rules or if they are all a part of some greater phonological conspiracy, or all simply separate but similar rules. /i/ laxes to [ɪ] in closed syllables, /e/ → [ɛ] before syllable-final /k/, as well as after /w/ and /j/. Healey (1973:27) describes these processes as in “fluctuation”, which suggests they are not fully phonologized and may be optional or variable. /ʌ/ and /a/ are also affected by several processes, which may or may not be laxing proper: /ʌ/ has a tendency to centralize to [ə], which is actually blocked when the vowel occurs after certain consonants, such as /l p t k/ or when it is in a word with falling pitch contour (Healey 1973:28). Hamtai laxing is said to occur in /i e o u/ when following palatal glides /j/ or /jʰ/ (the latter of which is realized as [ʃ] or [ɕ]). Healey also claims there is a similar but “lesser” effect when these vowels are following /t/ (Healey 1973:100).

The only Papuan language surveyed that did include a laxing harmony system was Biangai. [ɪ] may appear in final closed syllable or in a penultimate syllable that precedes a final syllable containing /i/ as [i]. This is particularly interesting, since it seems to be almost the opposite of laxing harmony. However, there is another
interesting effect that this laxed vowel may have on preceding vowels in the word. If a vowel laxes to [i], the other allophones of /i/ preceding it are also realized as [i], as in the word /sisimpili/ ‘type of grass’ > [sǐsǐmbtli]. The right-most [i] is conditioned by [i] in the final syllable, and the one prior to that is conditioned (presumably) by the closed syllable /sim/, but the first vowel of the word seems to have been laxed due to harmony from the other laxed vowels (Healey 1973:24).

Overall, no single process amongst Papuan languages shared all the properties of Kala vowel laxing. Some of the vowels affected did seem to include natural classes that were similar to Kala’s (front vowels vs. non-back, non-low, etc.), but none were an exact match. Conditioning environments were quite varied, and although some included laxing before nasals (as in Kala), no other language showed the exact class of [+continuant] consonants triggering laxing. Some languages did seem to have similarly inexplicable conditioning consonants that formed no obvious natural class, such as /j/ and /t/ or /ʔ r z/. Biangai in particular may have a series of laxing processes that are all conditioned by different consonants, which is equally unusual.

6.5.1.3 Nasal Vowels and Vowel Nasalization

I distinguish the above terms “nasal vowels” vs. “vowel nasalization” by phonological status: nasal vowels, I define here as nasal vowel phonemes that are contrastive with oral vowels. Vowel nasalization I define as any vowel that is nasalized through some phonetically motivated process—e.g. vowels that are proximal to nasal consonants or other nasal(ized) vowels, and gain the [+nasal] feature because of this. I coded for
whether nasality is phonemic in vowels in the languages of my survey, as well as the
good of the nasal vowels (as opposed to oral vowels). If there is vowel nasalization, I
coded for the conditions of the nasalization. In the interest of historical analysis, I have
also noted any known path to the development in the cases of phonemic nasal vowels.

6.5.1.3.1 Nasal Vowels and Vowel Nasalization in Surveyed Austronesian

Languages

Of 36 Austronesian languages surveyed, just two (~6%) were described as having nasal
vowels and/or vowel nasalization, Bukawa and Numbami. This could be due to under-
description of phonetic nasalization, although it is also the case that phonemic nasal
vowels appear quite rare in this region too.

<table>
<thead>
<tr>
<th>Vowels affected</th>
<th>Conditioning environment</th>
<th>Phonemic</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bukawa</td>
<td>Non-back vowels</td>
<td>In process?</td>
<td>In process loss of final nasals</td>
</tr>
<tr>
<td></td>
<td>Before nasals; certain word positions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numbami</td>
<td>Unrounded non-low vowels</td>
<td>No</td>
<td>Unclear</td>
</tr>
<tr>
<td></td>
<td>Closed syllables; adjacent to various consonants</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6.5. Austronesian languages within the survey area that are described as having nasal
vowels or vowel nasalization.

Bukawa is probably the most interesting case. Its process of nasalization would appear
to parallel what has already happened in Kala, especially Southern Kala. Eckermann
(2007:9) states that words with final velar nasal consonants may be pronounced without
the final consonant itself and instead with a nasalized vowel. Words such as dinan "my
mother" may be realized as [dinan] or [dinā]. The effect is in fact so salient that some
speakers prefer to spell such words without the final consonant.
The only other language within the bounds of the survey in which nasalization of vowels is mentioned at all is Numbami. Bradshaw (2006:56; 59-60) mentions nasal vowels being used in several onomatopoeic ideophones, such as pā-adala “bam, bang”, pī-adala “springing up”, sī-adala “spraying, spurting”, and kāiandala “shoutingly”. However, these nasal vowels are not regular phonemes of the language and never contrastive. At the same time, they are not apparently conditioned by any neighboring nasal consonant, and so cannot be said to be contextual. They are marginal sounds in Numbami relegated to a specific type of word—much like the glottal stop in English utterances like “uh-oh”.

Nasalization of vowels due to co-articulation appears either to be under-described in Austronesian languages of the survey region, or very unusual. Given how cross-linguistically prevalent this kind of process is, I lean toward an assumption that it is under-described, especially considering the general dearth of detailed phonetic description for the languages in question. Phonemic nasal vowels are certainly very rare in this area, with only perhaps Bukawa being yet in the process of developing such a phoneme set, and in a similar manner that Kala seems to have done.

6.5.1.3.2 Nasal Vowels and Vowel Nasalization in Surveyed Papuan Languages

Again, the findings for nasal vowels and vowel nasalization were sparse amongst the Papuan languages, as they were in the Austronesian sample. Only two Papuan languages out of the 14 that were surveyed (~14%) had descriptions mentioning either nasal vowel phonemes or contextual vowel nasalization.
Table 6.6. Papuan languages within the survey area that are described as having nasal vowels or vowel nasalization.

<table>
<thead>
<tr>
<th>Language</th>
<th>Vowels affected</th>
<th>Conditioning environment</th>
<th>Phonemic</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesê</td>
<td>All qualities</td>
<td>N/A: all nasal vowels are phonemic</td>
<td>Yes</td>
<td>Unclear</td>
</tr>
<tr>
<td>Zia</td>
<td>All qualities</td>
<td>Nasal vowels both phonemic and phonetic</td>
<td>Yes</td>
<td>Various</td>
</tr>
</tbody>
</table>

In the case of Mesê, a Western Huon language of the Rawlinson subfamily, nasal vowel phonemes exist for each of 6 vowel qualities, all of which have oral counterparts: /i e ø o u a/. There is otherwise little information about Mesê phonology, and the full story of its path to nasal vowel phonemes is not completely clear. However, comparing Mesê words with their Nabak\(^{22}\) cognates shows that at least some of them appear to have arisen from the loss of a final consonant, as evidenced by examples such as Mesê /gê/ ‘you’ and Nabak /geŋ/. Suter (2018:190) mentions that Mesê word-final -n is in the process of disappearing, introducing nasal vowels. He mentions that an intermediate stage of the loss of final -n is for it to become -ŋ, followed then by full loss of the consonant and phonemic nasality in the vowel. For example, the third person singular ending of the intermediate past tense marker is źâ < *zanŋ < *zan. At the time of the recording of much of phonological data available (Vanaria and Vanaria 1995), words were transcribed as either having a final -ŋ or a nasal vowel at the end. This pattern is distinctly reminiscent of those seen in both Manindala Kala and Bukawa, both of which

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\(^{22}\) According to Suter (2018:5), Mesê and Nabak have a sibling-level relationship.
have seemingly semi-phonologized nasal vowels word-finally. In the former, nasal vowels are distinct in some words and less so in others\textsuperscript{23}, which are generally transcribed with a final -ŋ. In the latter, the pronunciation of final consonant or final nasal vowel varies by speaker or situation (Eckermann 2007:9). However, it is not clear if this is the only developmental path of Mesē’s nasal vowels, since some sources also contain words with non-final nasal vowels, such as /īliŋ/ ‘grass species’, /õde/ ‘run’, /ākau/ ‘house for young men’ (Vanaria 2002:1-3).

Zia is a Binanderean language, spoken to the south and somewhat inland from Kala. It has nasal vowel phonemes for all vowel qualities that contrast with oral vowels: /i ē ə ɔ u/. In addition to nasal vowel phonemes, Zia is also described as having contextual nasalization in vowels immediately following nasal consonants: /nɔnɔ/ ‘things’ → [nɔnɔ̃]. Evidently, contextual nasalization is capable of spreading through certain segments, such as /w/, /j/, and /g/. As for the development of Zia nasal vowel phonemes, the origins appear to be quite varied. Some word-internal nasal vowels originate sequences such as *VŋV > *ṼwṼ, as well as from the loss of medial -*N- (*andiso > āīso ‘skin’), and the loss of final -*ŋ (Wilson 1981:12-16). While the latter is similar to other examples both from the region (Mesē, Kala, Bukawa, etc.) as well as a common mechanism of nasal vowel phonologization cross-linguistically, the other pathways are less common and of particular interest, considering that Kala phonetic nasalization occurs in similar conditions. Zia shows that assimilatory nasalization in

\textsuperscript{23} For more discussion of nasal vowels in Manindala dialect, see Chapter 2, Section 2.6.3.
these contexts (i.e. word-internally) can, in fact, lead to phonemic nasal vowels, regardless of how unusual these processes would seem.

In conclusion, nasality in vowels in the Papuan languages of the region is either drastically under-described or very rare. It is my suspicion that nasalization outside of phonemic contexts is under-described, and that when nasality is described in these languages, it is mainly when this distinction is contrastive with oral vowels. Due to general under-description in the phonetic domain, it is difficult to gauge the prevalence of contextual nasalization from the results of this survey.

6.6 Discussion

The results of the survey were varied and ultimately inconclusive in answering the primary research questions in entirety. The broad types of processes examined for each of the surveyed languages were not rare, per se, but varied with regard to their individual properties to such a degree that I hesitate to call them the “same” process in each language. Superficial similarities, in most cases, give way to individual variation to the extent that few processes mirror those of Kala in any appreciable way. In this discussion, I review the frequency of each process type and speculate on some possible reasons that the results show what they do.

Overall, the presence of vowel reduction and deletion was the strongest amongst the three phenomena surveyed. In total, 11 out of 50 languages surveyed were described as having this feature, including 6 out of 36 Austronesian languages and 5 out of 14 Papuan languages. In all, this phenomenon was probably the most broadly
defined, since I did not exclude positive cases to processes of total deletion alone, but
the kinds of vowel reduction that tend to either lead to deletion or may alternate with
deletion. Even though this feature was found throughout a variety of both Austronesian
and Papuan languages of the survey region, the specific properties displayed in these
processes did not align exactly with those found in Kala. Kala deletion occurs in a
specific environment, which was not found replicated in any of the survey languages.
Nor was Kala’s unique situation of total but optional deletion found in any descriptions
available for the languages in question. Overall, quality reduction and total deletion
occurred with about equal frequency in surveyed languages: 3 out of 5 Papuan
languages and 2 out 6 Austronesian. Not only were the common conditioning
environments (e.g. unstressed syllables, V.V contexts) quite different from Kala’s (see
Chapter 3; Kala does not delete vowels solely in unstressed syllables), but the vowels
affected varied as well. Some languages deleted or reduced all vowel qualities, while
others did so only for single qualities. Other restrictions to reduction or deletion included
lexical or morphological parameters, which is all lacking in Kala deletion. Especially
salient was the fact that only in one language surveyed (Suena) did vowel deletion lead
to greater syllabic complexity, as it does in Kala. Neither amongst Austronesian nor
Papuan languages in the sample was there a clear pattern of reduction or deletion
patterns that show similar properties to Kala, even though on a surface level, this type
of process would not appear to be uncommon in the region.

The results for vowel laxing have a similarly wide range of characteristics.
Slightly less common in surveyed languages, at 8 positive cases out of 50, vowel laxing
was more regularly conditioned amongst Austronesian languages than amongst Papuan. In all Austronesian languages but one, laxing is conditioned by closed syllables. This is expected, given this is a common conditioning environment for vowel laxing cross-linguistically, and also seen in Austronesian languages well outside the survey region. Amongst Papuan languages, laxing seems to be more often conditioned by adjacent consonants, often motivated by some unclear factor. Two languages (Nabak and Kâte) are reported as having laxing before nasals, which is not surprising, given the effect on F1 that nasalization has on non-low vowels (Beddor 1993:180). What is less clear is the motivation behind some of the other reported triggers of laxing: juxtaposition with groups of consonants that do not seem to form a clear natural class (e.g. /ʔ r z/ in Kâte). Even if there were a clear natural class (such as [+nasal] or [+continuant] in Kala), it is not clear what the articulatory or perceptual motivation behind such a sound change would be.

Nasal vowels and vowel nasalization were the phenomena with both the least representation phonologically, and the least amount of description phonetically. Although I strongly suspect that contextual vowel nasalization is far more common than the results of this survey show, there is a lack of phonetic description in general for many of the languages of this region, making it difficult to determine for sure why this feature shows up so rarely. As for phonemic nasal vowels, Kala does appear to be an outlier in this region. Although its sibling Bukawa appears to be undergoing a parallel nasal vowel phoneme development, the other members of Oceanic along the Huon Gulf show no similar process. Zia and Mesē, a Binanderean and a Finisterre-Huon language,
respectively, both show interesting developmental pathways to nasal vowel phonemes, although these two languages are not closely genetically related, nor are they spoken particularly near each other (Zia is far south along the Huon Gulf, while Mesé is up on the Huon Peninsula and somewhat inland). Therefore, it would seem unlikely that their systems have much to do with each other, and are likely cases of convergent evolution.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Austronesian languages surveyed</th>
<th>Papuan languages surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vowel reduction/deletion</td>
<td>~17% (6 of 36)</td>
<td>~36% (5 of 14)</td>
</tr>
<tr>
<td>Vowel laxing</td>
<td>~11% (4 of 36)</td>
<td>~29% (4 of 14)</td>
</tr>
<tr>
<td>Nasality in Vowels</td>
<td>~5% (2 of 36)</td>
<td>~14% (2 of 14)</td>
</tr>
</tbody>
</table>

Table 6.7. Positive cases for each feature, grouped by Austronesian and Papuan languages included in the survey.

In a more detailed evaluation of each process in each language in this survey, it becomes clear that the properties of each of these features vary widely by language. Regardless of how common that process is from a superficial view, on deeper inspection, the details have little in common with those found in Kala. It is not possible to state that any of these features are clearly areal or familial with any certainty, given that they all vary notably in their individual characteristics.

Several possibilities for this lack of evidence arise. First, this result could be due to a lack of sufficiently precise phonetic and phonological data from the sources available. Most of the documentation and description for the languages of this survey is morphosyntactic or lexical. Phonological descriptions are often relegated to appendices or at least comprise a much slimmer selection of pages of a sketch than even a single
subsection of the morphosyntactic description. Many of the languages have phonological descriptions limited to a few pages of organized data from SIL fieldworkers, most of which are concerned primarily with phoneme inventories and less so with the descriptions of dynamic processes. Phonetic descriptions are even more lacking, so it may be that the details necessary to make an adequate comparison with such phonetic detail as I have applied to Kala’s processes is absent from the present descriptions of the languages in this survey. Acoustic work is notoriously difficult in a fieldwork setting, and this is shown in the data that is (un)available today.

Another possibility is that Kala is a part of some linguistic area, but this is not shown via the processes I selected to survey for. Not all linguistic areas include phonological or phonetic traits. The fact that phonology and phonetics are not always inextricably bound to other domains in language area contexts is evidenced by Blevins’ work on the spread of certain phonemes within a linguistic area with little to no lexical borrowing. Such an example is the North Californian language area, which consists of several unrelated languages: Karok, which is an isolate; Chimariko (an isolate), Tolowa and Hupa (Athabaskan languages), and Yurok and Wiyot (Algic languages). Despite a lack of lexical borrowing into Yurok from its neighbors, it shows glottalized consonants like many of the other languages (Blevins 2017:210-12), which are attributed to language contact and diffusion of phonemic development independent of individual lexical items. This suggests that the borrowing of traits is granular and can be restricted in ways that are not always predicted. It is possible that there are areal traits Kala
shares with other nearby languages that are not captured by evaluation of dynamic phonetic processes only.

It is also possible that because these are dynamic phonetic features that have not been fully phonologized (in the cases of each vowel feature explored here, except for contrastive nasal vowels) that they have not been enacted by the speech community for a long enough time to show spread throughout Kala’s neighbors. One of the reasons that Blevins gives for the diffusive spread of glottalized consonants in the Northern Californian is a long history of cultural contact, intermarriage, and multilingualism in the region (Blevins 2017:212). This is also reflective of the social context of the Huon Gulf, but it may be that not enough time has passed since these phonetic processes began for these particular features to be picked up as areal traits. Rather, it might be reasonable to look for more solidified phonological processes of languages in the region that also cannot be attributed to shared inheritance in order to determine possible phonological traits of a linguistic area. It may be that none of these are shared by Kala itself, and a more fruitful search would require leaving that particular language as a baseline for comparison. I believe that further research might be useful in accounting for phonological elements more broadly from all of these regional languages. This would not mean exploring only shared phonemes, but also processes that are more entrenched in the languages and show signs of being more fully phonologized.

Regardless of these possibilities, one conclusion that I arrive at after this survey is that phonetics (and to a lesser extent, phonology) is a domain in which the languages of the Huon Gulf are drastically under-documented and under-described. It is my hope
that the kind of work I have done in the previous chapters can contribute toward a
clearer image of dynamic processes in this region. If this survey cannot provide certain
evidence of a phonologically-motivated linguistic area in and around the Huon Gulf, it
may at least be able to provide a typologically illuminating look at the phonological
ecology of an incredibly linguistically diverse part of the world.
Chapter 7: Conclusions

This dissertation details several elements of Kala phonology as well as a typological investigation of similar traits in neighboring languages. Chapter 2 begins with a phonological sketch of the Kala language, while Chapters 3 through 5 concern in-depth analyses of three dynamic processes found in the Southern dialect: vowel deletion, vowel laxing, and nasal vowels/vowel nasalization. In Chapter 6, I discuss the results of a typological survey performed with a sample of languages from the surrounding region in which Kala is spoken, which provides a broad view of the phonologies of both Oceanic and Papuan languages in the wider Huon area and shows Kala’s differences and similarities based on these processes’ presence in the survey languages.

Chapter 3 details the first of the vowel processes investigated in depth in Kala, which is vowel deletion. Vowel deletion in Kala shows certain qualities of being reductive in nature. According to a usage-based approach, vowel reduction is more likely in quicker or more casual speech. An analysis of speech rate and frequency of deletion in several Southern Kala speakers shows that deletion is more likely to occur in quick speech than slower speech, even though it does occur in slow speech as well. Vowel deletion in Kala is unusual in that it does not apparently show any intermediate forms of reduction (quality reduction, devoicing, etc.), but appears as a phonetically categorical state—either the vowel is present or deleted. This is unusual for a process that is ostensibly otherwise not yet phonologized (as can be surmised from its variation—pervasiveness in quick speech but lower rates in slow speech). Regardless,
usage-based approaches to reduction remain useful for understanding this phenomenon, given its prominence in *allegro* speech styles.

Despite the fact that vowel deletion in Kala appears to be totally categorical, I have not performed an in-depth analysis of this assumption. It is based on observation as well as preliminary acoustic investigation comparing cases of apparent deletion and cases that clearly lack deletion. However, future acoustic analysis should be done to quantify and confirm this finding. It remains a possibility that there is some remaining trace of vowel reduction, as has been shown for Lezgian (Chitoran and Babaliyeva 2007) with regard to devoicing, and effects on neighboring consonants in a case of what is traditionally regarded as vowel deletion. Until further detailed acoustic analysis can be done on Kala vowel deletion, I cannot rule out the possibility that such traces may exist. Nonetheless, if these traces do exist, they have not become evident to me at the time of this study.

The collection and processing of further data from Kala to be analyzed under a wider sociolinguistic lens may also provide insight into the prominence of deletion (or lack thereof). Currently, I cannot say much about deletion rates by demographic, such as age or gender. It would also be enlightening to include further data from Northern Kala dialects in future research, so that a more complete picture of deletion could be viewed alongside the data of the Southern dialect that is presented in this study. Overall, vowel deletion in Kala has several complexities that can only be appropriately addressed through further future investigation.
Chapter 4 details Southern Kala laxing of front vowels before consonants that are [+continuant] or [+nasal]. This effect can be quantified by both increase in frequency of F1 of /i/ and /e/ and decrease in F2, which has an overall centralizing result. This process may also trigger an optional laxing harmony, in which another front vowel in a following syllable or syllables also laxes. This harmony effect may apply iteratively across a word from left to right, although phonemic nasal vowels appear resistant to laxing.

This process of laxing shows some properties associated with non-reductive laxing in that it is conditioned by an adjacent consonant—presumably through assimilation, although what would be driving this assimilation is not clear. This laxing is not conditioned, as many of its Austronesian relatives are, as indeed many other alternating lax-tense pairs cross-linguistically are, by closed syllables. Nor is it conditioned, as laxing is in its closest relatives Jabêm and Bukawa, by just any consonant following the vowel in question. Its conditioning consonants can be defined by the features [+continuant] and [+nasal], the latter of which might be explainable due to a known increase in the frequency of F1 of a vowel (meaning lowering of the vowel) when nasalized through coarticulation before a nasal consonant. I know of no articulatory explanation for laxing preceding a [+continuant] consonant, however, despite the fact that nasals often pattern with continuants.

Kala laxing seems to show properties that do not perfectly fit the typological profiles of either reductive or non-reductive laxing, but it also shows an element that
does not belong to either—conditioning by a following [+continuant]. It is not triggered by unstressed syllables, nor is it associated with shorter duration of vowels.

Further research is needed to understand more than what I have investigated in this chapter. An evaluation of speech style might serve to place it more firmly in the category of reductive laxing if it were to demonstrate that degree of laxing is positively correlated with allegro speech style, even though it is not conditioned by unstressed syllables. As seen in Chapter 3, Kala apparently ignores stress conditioning in the case of vowel deletion, so it seems plausible that it might do so with regard to reduction in the form of laxing as well.

It is also possible that laxing occurs to greater degrees in more frequent words. This is a known effect in some languages, in which phonetic reduction in general happens more in more frequent words and phrases, in which contextual linguistic content is more predictable or more automatized (Bybee 2001; Bybee and Hopper 2001; Gregory, et al. 1999). Even though reduction makes words less distinguishable, the fact that a word is very common makes it more easily predictable, so the communicative penalty for laxing a vowel in a common word may be less severe. This would be an obvious next step to investigating Kala laxing triggers, but currently, the corpus of Kala material is not fully transcribed, so there is no way to determine word frequency at this time. In the future, if all archived materials are transcribed in full, this approach may become possible to determine if laxing is more common or more extreme in very common words.
It would be useful to have the same acoustic analysis as presented in Chapter 4 also done on high quality audio data from speakers of each of the three Northern dialects, as this would help determine whether this laxing process works in the same way in those dialects as it does in Southern Kala. If laxing has spread throughout the language in some way that is not evident from looking only at the Southern dialect, a wider lens that captures all dialects could lead to historical insights that would explain Kala’s unusual consonantal conditioning of laxing.

To conclude, I do not believe that Kala laxing fits well within the dichotomy of laxing patterns found in the literature, either amongst its Austronesian relatives or cross-linguistically. I currently know of no model or framework that clearly explains what is going on in Kala laxing, either in descriptions of quality change in reduction or in those concerned with non-reductive laxing. As shown in Chapter 3 with the issue of gradience and categoriality in vowel deletion, Kala laxing once again adds to the language’s trend of sound changes that lie in a liminal space between categories. This points to the importance of nuanced studies of sound changes in endangered and less documented languages, so that future theory can be informed by the data that may not yet be available.

Chapter 5 is an investigation of nasality in Southern Kala vowels. While Kala has contrastively nasal vowel phonemes that correspond in quality to a parallel set of oral vowels, it also has contextual nasalization of vowels preceding nasal consonants. In the quantitative study in Chapter 5, I use the A1-P0 measurement to quantify “nasality”. This measurement was shown to be significant for phonemic nasal vowels when it was
measured from the midpoint of a vowel segment, but could not be shown to be so in equivalent contextually nasalized vowels. However, when five equidistant points were analyzed, contextually nasalized vowels showed a steady increase in A1-P0 through the duration of the vowel, which was lacking in phonemic nasal vowels. Additionally, phonetically nasalized vowels were shown to have a greater degree of variation in A1-P0 values than phonemic nasal vowels. This was predictable based on observations (e.g. in Greenberg 1966) about greater levels of phonetic variability in non-phonologized processes than in those that are fully phonologized.

In the future, further investigation would benefit from an increase the size of the data sample (possibly across different speakers), as well as inclusion of additional acoustic correlates other than those featured here, since “nasality” as it is understood (acoustically, articulatorily, and perceptually) is far more complex than the measurement of one value. Previous literature on the topic of “degrees” of nasality onset (defined as degree of closure or openness of the velum and resulting airflow through the nostrils, in addition to oral airflow) may provide avenues for future research on Kala.

Some relevant studies include those by Carignan (2014, 2015, 2017) and Chen (1997), which indicate that “nasality” as a phenomenon is not simple but very multi-dimensional, in part due to the complexity of the human nasal cavities. Since no previous nuanced description of Kala phonetics or phonology exist that can be referred to, the nature of its nasal vowels is otherwise unstudied. Because nasality has different acoustic correlates cross-linguistically, it will be necessary to continue testing these data to find what markers define nasality acoustically specifically in Kala.
The present study presents a first-time phonological and acoustic description of nasality in vowels in Kala, which is an endangered and minority language. The challenges of acoustic methods in the context of linguistic fieldwork is distinct from those presented in more traditional laboratory environments, and working with speakers requires a novel approach to acoustic phonetics. This is in part due to practical, as well as cultural and interactional reasons, but also because many endangered languages have very little or no documentation or description of their phonetics (acoustic or otherwise), so cross-linguistic assumptions and conventions do not always play out.

In order to expand this study in the future, it may be helpful to take a broader methodological approach. Because of the intricate shape of the human nasal cavity, measuring nasality by one type of method alone would seem to be insufficient (Carignan 2019, Chen 1997). Other methods for the measurement of nasality in vowels lie beyond the indirect acoustics. One method that may be useful is airflow measurement (Ghio and Teston 2004), but this method can prove invasive with its use of masks. Other methods, such as nasoendoscopy, in which a fiberoptic camera is put through a participant’s nostril, are both invasive and expensive (McGowan 2019:755), and do not lend themselves well to the requirements of linguistic fieldwork. However, McGowan (2019) et al. propose a novel method to measure nasal airflow through the use of earbud headphones and a 3D-printed vinyl tube connecter. The earbuds are used to produce a tracer tone. This tone (20kHz) is used to measure nasal and oral cavity: when the velum is closed, the tracer tone is attenuated by the nasal cavity, but when the velum is open, the tracer tone is detectable using the same type of
microphone that is used to gather other acoustic speech data. The tone can then be
isolated in speech analysis software (e.g. Praat) (McGowan 2019:758). This is the type
of non-invasive, inexpensive method that is friendlier to fieldwork and offers a promising
angle of research in addition to more traditional acoustic methods. It may be possible to
implement such a method in future work with Kala speakers toward a clearer
understanding of the phenomenon of its nasal vowels.

Chapter 6 departs from the description and analysis of processes specific to
Southern Kala to take a broader typological view of dynamic processes in languages of
the Huon Gulf region and beyond. This survey ultimately included 50 languages, of
which 36 were Oceanic relatives of Kala and 14 were Papuan neighbors.

The basic goal of the survey was to place Kala in a wider typological context in
the region of the Huon Gulf and Peninsula, as well as nearby more inland areas. A
secondary goal was to evaluate whether it was possible that these processes found in
Kala might prove to be traits shared areally (in which case I predicted they would
appear across family boundaries, in both Oceanic and Papuan languages), which would
have been diffused through language contact in this region, given that Papua New
Guinea (and the Huon region in particular) is known for the richness of contact
situations between Oceanic and Papuan languages. An alternate prediction was that
Kala’s dynamic processes might be familial traits that have arisen in multiple genetically
related languages, in which case I predicted the processes would appear in Oceanic
languages, but not necessarily in Papuan neighbors.
The languages of this survey were coded for the presence or absence of the types of processes as those I investigated in Kala. Vowel deletion and vowel laxing were both somewhat common in the region, while nasality in vowels (including descriptions of contextual nasalization) was very uncommon. Even in the cases of vowel deletion and vowel laxing across Oceanic and Papuan languages, a closer evaluation of the individual properties of these languages shows that, although similar on a superficial level, languages vary in the specific properties of these processes. They also greatly differ from the way these processes work in Kala, whether in terms of environment, output, or other facets of the process. For this reason, it is not possible to conclusively state that any of these processes across languages are “the same” or similar enough to any degree that it is clear they have a common original, whether that may be through contact-induced diffusion, genetic inheritance, or even, as Blust (2007) proposed, due to family-internal systemic attractors toward an inherited preference for some system state (e.g. disyllabic word stems). I explore several possibilities for the result of this survey. It is possible that the descriptions for some languages of the region are not detailed enough in the domain of phonetics to make a parallel comparison to the processes that I have investigated in depth in Kala. Kala may show linguistic areal traits outside the realm of phonetics and phonology. One possibility is that language contact in the region may be more evident by looking at processes that are more solidly phonologized within the language(s), as many of the processes I have evaluated in Kala are ostensibly not yet fully phonologized in many respects. This is the case with vowel deletion, vowel laxing (including laxing harmony), and contextual nasalization. In the
future, it may be useful to take into account other phonological features of nearby
languages in attempting to determine a possible linguistic area, rather than beginning
with Kala as starting point.

Regardless of these possibilities, it has become clear that phonetic and
phonological description for many languages in the area are lacking. It is my hope that
the analyses of Kala phonetics and phonology in this work can contribute toward the
description and documentation of Kala in some meaningful way. I also hope that the
overview of the typological characteristics in the phonologies of its neighbors can
provide a more illuminating view of the complexities of languages in a part of the world
that is so linguistically diverse and deserving of further documentation and description.
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