Correspondence and Reduplication in Language Play: Evidence from Tigrinya and Ludling Typology*

Melissa Frazier and Jesse Saba Kirchner

manuscript current as of November 7, 2011

Abstract

This paper provides an OT analysis of two language games in Tigrinya and extends this method of analysis to a database of 126 expansion ludlings (those games that involve the addition of phonological material to existing lexical items). The Tigrinya data compels the use of a surface-to-surface correspondence relation alongside an input-output one; a stratal analysis cannot account for the same data. One of the Tigrinya ludlings follows the most common type of ludling formation process – a consonant and reduplicative vowel are added to every syllable – and we propose that the ubiquity of this ludling type is predicted by the simplicity of its analysis, which requires only two ludling-specific OT constraints and no morphological component. Our discussion of ludling typology is the first quantitative analysis of this type and thus reveals new asymmetries and supports our conclusion that ludling grammars can deviate from natural language games in unexpected ways.

1 Introduction

What do language games tell us about language? Pound (1964: 1) opens his dissertation by saying, "By [the investigation of language games] it is thought that some light will be shed upon the average man's concept of his own language." This same idea has spurred many others (see §1.1) into investigating and cataloguing a wide range of language games in order to determine how these games operate and what they can tell us about language in general. We agree with Pound that the study of language games is relevant in determining what the layman knows about language in general, and we further argue that this knowledge is applicable to how we develop our linguistic theories.

In this paper we analyze two language games used in Tigrinya which involve the manipulation of prosodic categories and thus motivate the need for ludling-specific constraints that refer to these categories. Our analysis, couched in Optimality Theory, shows that the simultaneous use of correspondence between language game outputs and both underlying representations and natural language outputs is necessary to account for the attested forms. We also show that an analysis of reduplication as an emergent phonological repair best explains a common type of reduplicative behavior in language games.

Our method of analysis is supported by a typological study of language games. We present our findings from a database of ludlings that includes an array of patterns reported in the literature. This typology contextualizes the Tigrinya language games, allowing us to pinpoint the

* We are indebted to Eduardo Hugo Gil for first bringing this data to our attention and for working on a preliminary analysis with the first author. We would like to extend a gracious thank you to Mr. Ibrahim Abdelnour for discussing his native language, Tigrinya, with us at length. We also thank Bruce Hayes, Ruth Kramer, Michael Lefkowitz, Jennifer L. Smith, Rachel Walker, Paul Willis, Kie Zuraw, and audience members at the LSA Annual Meeting (2011) for providing helpful comments on this work.

aspects of them which are common and those which are almost unique. This typological information is significant for the study of language games in general as well as for theories such as de Lacy's (2002) idea of markedness constraints being best defined in stringency form, which here faces empirical challenges. By synthesizing the facts about two ludlings in an understudied language and about ludling typology as a whole, we are able to provide a unique view on how ludling grammars are defined and what makes common ludlings common and rare ludlings rare.

1.1 Ludlings: Description and Terminology

Language games have been documented for a variety of languages and cultures and serve a wide range of functions, including the concealment of speech from outsiders, religious or ritualistic purposes, and mere language play (see Pound 1964; Laycock 1972; Bagemihl 1988; Botne & Davis 2000). In Bagemihl's extensive study of *alternate languages*, he defines a typology of parasitic languages, those that make use of some "domains of linguistic structure" but differ in other domains as compared to the language spoken by those involved.[1] *Ludlings* (the term was coined by Laycock; we present Bagemihl's definition) are those language games that differ in the phonology, the morphology, or a combination of the two. This means that ludling and natural language have identical lexicons but that the output of each lexical entry in encrypted speech differs (in a predictable way as per new morphological and/or phonological requirements) from the output of the same item in unencrypted speech.

English Pig Latin (PL) is an example of a ludling which has been documented for more than a century (Chrisman 1894, Hirschberg 1913, Cowan 1989). In one variation of this language game, each English word is modified in the following way: the onset of the first syllable is moved to the end of that word and then [eɪ] is suffixed to this stem. Vowel-initial words are simply suffixed with [heɪ]. Sample data is in (1). PL employs two common ludling processes: rearrangement (via movement of an initial onset) and expansion (via the addition of [eɪ]). Both processes happen once per word.

(1) Basic Pig Latin data

		NLO	PL
single consonant onset	*pig*	pɪg	ɪgpeɪ
consonant cluster onset	*flamingo*	fləmɪŋgoʊ	əmɪŋgoʊfleɪ
no onset	*ant*	ænt	æntheɪ

The PL data gives us the opportunity to introduce some key terminology and abbreviations. Ludling outputs can be described by comparing them to the outputs of unencrypted speech. We call the later *natural language outputs*, abbreviated as NLOs. They are accounted for by the *natural language grammar*, NLG. Expansion ludlings involve the affixation of fixed or reduplicative segments, such as the [eɪ] in PL. We refer to these units as *cryptemes*.[2]

---

1 Bagemihl defines five domains: syntax, lexicon, morphology, phonology, and modality (e.g. spoken, whispered, drummed, etc.). He describes alternate languages that deviate in the lexicon, morphology, phonology, modality, and various combinations of these, but none that deviate in syntax.

2 "Crypteme" strictly means "phonological realization of encryption"; cryptemes are not necessarily morphemes. As we will see, some are best analyzed as the result of a different phonology which holds in the production of ludlings. The term crypteme was invented and introduced to us by Eduardo Hugo Gil.

The most common type of ludling (see §4), *iterative infixation ludlings* (IILs; Yu 2008), are those in which a crypteme is inserted once per syllable (or other unit smaller than the word). These ludlings employ expansion, like Pig Latin, but this expansion occurs iteratively – as often as needed based on the length of the unencrypted word. Many Spanish-speaking countries use a ludling called *Jerigonza* (see Piñeros 1998). In one version of this ludling, a [p] and reduplicative vowel are inserted after every vowel in the NLO, as shown in (2). As we will see below, one of the Tigrinya ludlings is essentially identical to Jerigonza.

(2) Spanish Jerigonza, as spoken in Colombia (Piñeros 1998: 61, using Spanish orthography; [n] becomes [m] in the form for *song* through standard nasal place assimilation.)

NLO	Jerigonza	Gloss
can.ción	càm.pa.cióm.po	*song*
ma.és.tro	mà.pa.ès.pe.tró.po	*teacher*
pá.ja.ro	pà.pa.jà.pa.ró.po	*bird*

The influence of NLOs on ludling outputs has been well established in the literature, and most authors (see §2.1) assume that NLOs serve as the input to ludling formation. Such analyses are essentially stratal or cyclical: the natural language grammar produces the NLO and then a ludling grammar acts on this form to yield ludling outputs. We show that this type of model cannot account for all of the patterns in the Tigrinya ludling and that instead both URs and NLOs must be able to influence ludling outputs (see §3.2.2).

1.2 Tigrinya

Tigrinya is a member of the South Semitic branch of the Afro-Asiatic language family and is primarily spoken in Eritrea. In this section we present some aspects of the phonology of Tigrinya that are relevant for the understanding of ludling formation and introduce the ludling data and description. See Leslau (1941), Pam (1973), Kenstowicz (1982), and Schein (1981) for general treatment of Tigrinya phonology. Due to the dearth of grammatical descriptions of Tigrinya, we are uncertain whether or not this language is best treated as having root-and-pattern morphology like some other Semitic languages, and so we do not refer to this type of morphology in the rest of this paper. This section ends with a discussion of what we have learned about Tigrinya from a native speaker consultant.

Tigrinya allows only CV and CVC syllables; epenthesis of [ɨ] repairs ill-formed syllables. However, [ɨ] cannot occur word-finally, and hence [i] is epenthesized when necessary at the end of a word. There is an additional natural language prohibition on word final sequences of the form [iCi] which causes them to surface as [ɨCi]. (See Bagemihl (1988) on the productivity of this pattern.)

Both true and false geminates occur in Tigrinya. False geminates arise from the concatenation of morphemes that begin and end with identical consonants, e.g. /mɨrak-ka/ *your (m.s.) calf* (Kenstowicz 1982). These geminates behave just like any other CC sequence, and can thus be split by vowel epenthesis. True geminates can occur underlyingly, or they can arise from various phonological and morphological processes. A relevant phonological process that creates true geminates is one of regressive assimilation that occurs to adjacent homorganic stops that differ in laryngeal features.

One way true and false geminates are distinguished is by whether or not a rule of post-vocalic spirantization applies. Singleton [k] and [q] become fricatives in post-vocalic position; this rule applies to the first [k] in a false geminate [kk] sequence, but does not apply to any true geminate, including those that arise from the regressive assimilation rule. In the Tigrinya ludlings, the distinction between true and false geminates is maintained in that true geminates are never split and never undergo spirantization.

(3) relevant phonological process of Tigrinya

syllable structure repairs:	
[ɨ]-epenthesis:	/kfat/ ⟶ [kɨfat] *open!*
[i]-epenthesis in word-final position:	/kælb/ ⟶ [kælbi] *dog*
spirantization of singleton [k]:	
underlying singleton:	/rækæb-æ/ → [ræxæb-æ] *he found*
first member of a false geminate:	/mɨrak-ka/ → [mɨraxka] *your (m.s.) calf*
no spirantization of geminate [kk]:	
underlying geminate:	/fækkær-æ/ → [fækkær-æ] *he boasted*
geminate formed via assimilation rule:	/sanduk'-ka/ → [sandukka] *your (m.s.) box*

The Tigrinya ludlings documented by Bagemihl (see (4) below) are iterative infixation ludlings. The first, which we call the *syllable ludling* (abbreviated as σ-Lud), follows a pattern very similar to that of Jerigonza – a [g] and reduplicative vowel are inserted after every vowel in the NLO (i.e. a crypteme occurs once for every syllable). The other variety, however, shows a more complex pattern that is only approximated by one other ludling we have found in the literature (see §4.3.2.4). In this language game, there is an additional [ɨgɨ] sequence that occurs after singleton coda consonants. We call this version the *mora ludling* (µ-Lud) because, descriptively, a crypteme occurs once for every moraic segment (except geminates, discussed in detail in §3.2).

(4) data of analysis: two ludlings of Tigrinya (Bagemihl 1987, 1988)[3]

	NLO	σ-Lud	µ-Lud	Gloss
CV	bɨtʃ'a	bɨgɨtʃ'aga	bɨgɨtʃ'aga	*yellow*
CVC	ʃɨm	ʃɨgɨm	ʃɨgɨmɨgɨ	*name*

We met with a native speaker of Tigrinya, Mr. Ibrahim Abdelnour, who was born in Asmara, Eritrea (the same home city of Bagemihl's native speaker consultant) and currently lives in the Washington, DC area. Mr. Abdelnour did not play the game himself but has vivid memories of it being used in the mid 1960s and into the 1970s. He says that during this time there was a general shift going on in Eritrean culture such that many people were moving away from some of the more conservative values that had been held, especially those related to traditional gender roles. He recalls that the ludling was primarily used by teenage females and

3 Throughout this paper, we use IPA symbols in the transcription of Tigrinya. This involves retranscription of data from some of our sources.

believes this was because they did not want to be understood by males.[4] When they would use the ludling, they spoke very quickly and could not be understood by outsiders. Mr. Abdelnour distinctly remembers the repetition of [g] sounds (though, as a non-user, he cannot be sure if he heard the σ-Lud or the μ-Lud). He further describes a common scenario in which the ludling was used: a girl would speak to another girl by starting with the Tigrinya word for "listen" (in ludling form) and would then go on to say something about a boy who was near by. These speakers would put complete phrases into ludling forms and not just individual words.

None of our sources on Tigrinya phonology mention stress, and this aspect of the language is important for our analysis of the ludlings, which makes use of foot structure. We thus discussed stress placement in 26 Tigrinya words (all of those words presented in Bagemihl) and 6 σ-Ludling forms with Mr. Abdelnour. Even though he was not a ludling-user in Eritrea, he understood the concepts of the game and, after some practice, was able to produce ludling forms that he felt sounded natural. He and the first author transcribed this set of words with stress. The second author was not aware of our transcriptions and made his own transcriptions from recordings of Mr. Abdelnour's speech. Our transcriptions were in agreement on the placement of primary stress for 21 of the 26 words. Mr. Abdelnour believes that stress is unpredictable in Tigrinya, and our data supports this claim. The words [ˈsɨnni] *tooth* and [ʕadˈdi] *city, country* have the same general form (and are likely both monomorphemic) and show different stress placements. For ludling forms, we were in agreement that there is alternating stress on every odd-numbered syllable, though we were not always in agreement about the placement of primary stress. The appendix provides all 26 words and 6 ludling forms as transcribed for stress by both authors.

1.3 Roadmap

In §2, we present our major theoretical proposals, including the introduction of a surface-to-surface correspondence relation that links natural language outputs to ludling outputs, a discussion of the relation between a natural language grammar and a ludling grammar, and the analysis of reduplication in the context of Optimality Theory. Our analysis of the Tigrinya ludlings, which relies on the use of the natural language-ludling language correspondence relation, is developed in §3. This section also includes a discussion of Bagemihl's previous analysis of these ludlings and of the typology predicted by the constraints we propose. A ludling typology as determined from our database of 126 expansion ludlings and its relation to our analysis is presented in §4, and §5 contains conclusions.

We believe this work is relevant to both the general theoretical phonologist and to those who study language games. Those who are not interested in the technical aspects of Optimality Theory should be able to get most of the information we write about language games from §§2.2, 3.3, and 4.

2 Theoretical Proposals

2.1 Surface-to-Surface Correspondence

In OT, faithfulness constraints traditionally demand similarity between the underlying and surface representations. Correspondence theory (McCarthy & Prince 1995) opens the door

---

[4] Bagemihl's consultant is male, so it is clear that the ludling was not limited to use by female teenagers.

for faithfulness constraints to demand identity between candidate surface forms and other forms besides the UR. Many different types of *surface-to-surface correspondence* – where the output candidates stand in a correspondence relation with some surface form – have been defined in the literature. The first of these, base-reduplicant, or BR-correspondence, allows for the comparison of one part of a surface form to another part of the same surface form. Other surface-to-surface correspondence relations compare the output candidates to some other surface form: OO-correspondence (Benua 1997; cf. Burzio 1994) compares a derived output to its base, OP-correspondence (McCarthy 2005) compares all members of an inflectional paradigm, and SB-correspondence (Smith 2006; see also Kenstowicz & Suchato 2006) compares borrowed words to the surface form of the source language.

One of the major applications of surface-to-surface correspondence is the analysis of opaque interactions. Opacity in morphologically derived environments can often be reinterpreted as a consequence of surface-to-surface correspondence with another form sharing a root or stem (see e.g. Burzio 1997 for analyses of many famous English morphological derived environment effects). A long and inconclusive struggle has been waged between surface-to-surface correspondence theories and cyclic theories which account for opacity in morphologically derived environments through the successive application of phonology in multiple cycles, strata, or levels. (See *inter alia* Kiparsky 1997, 2010, Scheer 2008, Bermúdez-Otero & Luís 2009, Bermúdez-Otero 2011, as well as non-OT cyclic work since Chomsky & Halle 1968.)

In the analysis of ludlings, it has commonly been acknowledged that ludling formation is based on natural language outputs (NLOs) and not on underlying representations. (See *inter alia* Ito et al. 1996, Wilbur & Petersen 1997, Piñeros 1998, Barlow 2001, Borowsky & Avery 2009; cf. Yip's (1982) use of an intermediate representation as a base for formation of Chinese ludlings.) All of these authors have (implicitly or explicitly) used a stratal framework, where the natural language grammar is responsible for generating the NLO, and this NLO is the input to the ludling grammar. For example, Piñeros (1998), who analyzes the Spanish ludling Jerigonza, develops an OT model where the Spanish NLO is the input to ludling formation and faithfulness constraints in the ludling grammar are defined as operating on a *Spanish-Jerigonza* correspondence relation. However, because in his model the NLO itself is the input, the *Spanish-Jerigonza* correspondence relation is indistinguishable from the IO-correspondence relation (assuming a stratal model where IO-faithfulness can be reranked across strata). The Base-Game correspondence relationship used by Barlow (1997, 2001) to account for Pig Latin is equivalent.

Evidence from Tigrinya gives further support for the necessity of a surface-to-surface correspondence relation in analyzing ludlings, and the incapacity of stratal or cyclic analyses to fully analyze them. In §3.2 we show that certain aspects of the Tigrinya ludling can only be analyzed by a model that employs the simultaneous use of IO-faithfulness and surface-to-surface faithfulness. For now, we introduce a generalized surface-to-surface correspondence relation appropriate for ludling formation: the *natural language-ludling language* correspondence relation (henceforth abbreviated as NL and diagrammed in (5)).

(5) the NL correspondence relation (example from Tigrinya σ-Ludling)

natural language		ludling
/ʃɨm/		/ʃɨm/
↓ *IO-correspondence*		↓ *IO-correspondence*
[ʃɨm]	→ *NL-correspondence*	[ʃɨgɨm]

This correspondence relation is generally motivated by the literature that shows the importance of NLOs in ludling formation. For example, consider the production of *raked* in English Pig Latin. Based on the intuitions of both authors as well as other Pig Latin users who were questioned on the matter, the correct output of this word is [eɪktɹeɪ]. This output is surprising if we consider that the underlying representation of *raked* is most likely / ɹeɪk + d / and that [eɪkdɹeɪ] is a perfectly well-formed word of English. The appearance of [t] in the middle of the optimal output can be explained via the influence of the [t] in the NLO [ɹeɪkt]. As shown in tableau (6), the *ad hoc* constraint $*TD]_{word}$ is not violated in either candidate (as it would be violated by the candidate [ɹeɪkd]), and so there is no reason to differ from the UR unless the desire to be more like the NLO outweighs the desire to be like the UR.[5] This pattern is identical to the derivational pattern commonly called *overapplication*: a normal language process applies in an environment where it is not conditioned (in OT terms, due to the domination of surface-to-surface Faithfulness over IO-Faithfulness; Benua 1997).

(6) English Pig Latin

UR: / ɹeɪk + d / NLO: [ɹeɪkt]	IDENT(voi)-NL	$*TD]_{word}$	IDENT(voi)-IO
a. ☞ eɪktɹeɪ			*
b. eɪkdɹeɪ	*!		

As with Jerigonza, Pig Latin could be equally analyzed with a stratal approach that simply uses the NLO [ɹeɪkt] as the input. In such an analysis, the [t] is unsurprising in ludling forms as this segment is completely faithful to the input.

We discuss the predicted typology of NL-faithfulness constraints in §3.4, with examples from Tigrinya.

2.2 Relation between natural language grammar and ludling grammar

Ludlings appear distinct from non-ludling use of language in multiple ways. This

5 The goals of this tableau are not to account for the rearrangement and insertion pattern of Pig Latin nor to provide a definitive account of obstruent devoicing in English. For the sake of simplicity, we assume that voicing assimilation of the past tense morpheme in English is a reaction to a markedness constraint that penalizes a mismatch in voicing between obstruents that are either word-final or syllable-final. Our analysis with NL-correspondence is applicable to other analyses of English that make use of different URs and/or different markedness constraints. For example, our intuitions suggest that the [t] is actually syllable-final in this form: [eɪkt.ɹeɪ]. If this is true, then NL-correspondence is needed to account for the surprising syllable boundary instead of the devoicing of /d/ (cf. [eɪk.dɹeɪ]).

includes functional differences (e.g. the use of ludlings to conceal speech or for humorous purposes), as well as grammatical properties of ludlings which seem to diverge from their natural language (e.g. the vowel-initiality of all Pig Latin words). These properties raise the question of what relationship holds between the natural language grammar and the grammar that governs the ludling.

Conceptually there are many possible relationships. Perhaps the simplest option is to claim that there is no grammatical difference: in other words, the natural language grammar fully holds when speakers produce ludlings. Such views find expression at least as far back as Pound (1964: 55), who claims that "[ludling] speakers do not violate grammatical rules of their normal speech." Ludling words or phrases may be lexically marked in some way which will lead to their distinct production. For example, in OT terms we can suppose that ludling-specific constraints in CON are always present but usually inert in the natural language grammar. They will come into play only when underlying forms include a proper triggering morpheme. This appears to be the view of ludling grammar adopted by some authors (e.g. Borowsky & Avery 2009, Sanders 1999).

We make a different assumption, namely that the grammar which produces ludlings is distinct from the natural language grammar. In OT terms this means that different constraints may be present and different constraint rankings may hold in ludling production. It also means that ludlings may not involve any special morphology (although it does not rule out that possibility). A full argument for the choice between these two approaches (and the many other possibilities) is beyond the scope of this paper. We find empirical support from Tigrinya ludlings for the necessity of a ludling grammar which is crucially distinct from the natural language grammar. This approach is also suggested by the work of Bagemihl (1988) and other authors.

The next question that arises for such a theory is what the relationship is between the natural language grammar and the ludling grammar. Bagemihl proposes that the ludling grammar is distinct from but largely parasitic on the natural language grammar and lexicon. Rather than being an entirely separate language, ludlings are a kind of language within a language, which share much in common with the natural language but make crucial grammatical changes or additions. In fact much of the literature on ludlings assumes that ludling grammars differ minimally from the grammar of the language they are encrypting. For example, in their analysis of the Japanese ludling *zuujago*, Ito et al. (1996) emphasize that ludling outputs differ only as much as required by ludling-specific Cross-Anchoring constraints and that these outputs are otherwise identical to NLOs.

Piñeros's (1998) work opens the way for a less stipulative view of the relationship between natural language grammar and ludling grammar. The Spanish-Jerigonza relationship allows integration of crypteme-specific phonology into the overall constraint set of the language. We follow this approach and propose another move in this direction. We argue that any constraints can be reranked in the ludling grammar. Clearly, aspects of cognition, etc. will place limits how much reranking can occur and possibly even which types of rankings are more and less likely to appear in ludlings. Our claim is that theories of phonology and morphology can discern no generalizations as to impossible ludling constraint rankings or impossible differences between natural language grammar and ludling grammar.

We will show, with reference to data from the Tigrinya ludlings, examples of ludling forms being more marked than NLOs, NLOs being more marked than ludling forms, and of different repairs being used in NLOs as compared to ludling forms. These differences motivate the reranking of both markedness and faithfulness constraints when comparing the natural language grammar to the ludling grammar. To preview these claims: we note that unlike NLOs and σ-Ludling forms, μ-Ludling forms have no codas. This is captured best by promoting NoCoda in the grammar of the μ-Ludling.[6] The crypteme consonant [g] is best treated as an unmarked epenthetic consonant. This is not the least marked consonant in the natural language, and so its emergence as the unmarked consonant in a ludling context requires a reranking of relevant markedness constraints. Extra vowels are supplied by reduplication when possible and by epenthesis only when necessary, but vowel epenthesis is the preferred repair of the natural language. Faithfulness constraints must be reranked to account for this difference between the NLG and the ludling grammar.

In addition to the use of faithfulness constraints that operate on an NL-correspondence relation and the ability to rerank constraints, our method of ludling analysis allows for the creation of other ludling-specific constraints. However, we only need a few such constraints to analyze the facts of Tigrinya. We follow Piñeros who proposes a constraint Anchor(σ,Φ) that requires a syllable edge in one form to have a correspondent at a foot edge in another form. There is no reason to suppose that this is a natural language constraint; if undominated, such a constraint would either force all feet to be monosyllabic or would force insertion of extra material in order to turn a single syllable into a disyllabic foot (which is, of course, what ludlings often do). Even if this exact constraint is “unnatural”, it is formed with well-established prosodic categories. The formation of this constraint by ludling users suggests that these speakers are (subconsciously) aware of syllables, feet, and anchoring processes and can actively use this knowledge in language play. It is not necessary for there to be a natural language process that turns every syllable into a foot in order for people to figure out how to implement such a process in the concealment of speech. We do not find it necessary to propose the existence of any new ludling-specific markedness constraints for the analysis of almost all IILs. The Tigrinya μ-Ludling, which is unique, does require another ludling-specific markedness constraint (see §3.2.1), and other types of ludlings, such as rearrangement ludlings like Pig Latin, require other types of ludling-specific constraints.

This issue touches on one of the debates in the ludling literature: just what do ludlings tell us about natural language? We follow Pound (1964), *inter alia*, in acknowledging that ludlings can be informative of the *structure* of the language that it is encrypting, but we also follow Zwicky & Pullum (1987) in concluding the ludlings tell use nothing about the types of *processes* that can and cannot exist in natural language. Taking every input and moving the initial onset to the end of the word and then adding [eɪ] after that is not a possible natural language process, and our theory of phonology should account for this. But that same theory can include the concepts that would need to be put together in order for a speaker to figure out how to play with language in this way.

At this point our model of the ludling grammar leads to a fairly unrestrictive typology. We regard this as an advantage of our analysis: as we show in §4, this unrestrictiveness is validated by the typology of ludling forms.[7] Additionally, making use of unrestricted reranking of constraints allows us to minimize or, in the case of Tigrinya and other IILs, eliminate the morphological component of the ludling grammar. Thus, most iterative infixation ludlings are

6 Another option is to use a high-ranking NoCoda constraint that is subcategorized for ludling use only. We cannot discern any empirical difference between promoting markedness constraints and the addition of markedness constraints subcategorized for ludling use and thus consider these two options to be notational variants of each other.

7 In §4 we also show some ways that our analysis leads to a more restrictive typology than other methods of analysis.

optimizing relative only to the pre-existing UR and NLO being encoded, but what it means to be optimal in the ludling can be quite different from what it means to be optimal in the natural language.

2.3 Reduplication is emergent

Reduplication is often taken as a phenomenon triggered by the presence of a special underlying morpheme, usually called RED. This line of research develops the observations of Marantz (1982) around the affix-like properties of reduplicative morphology. In Optimality Theory, many authors have retained the device of a RED morpheme. The particular form which a reduplicant will take given the presence of such a morpheme is governed by correspondence theory; in particular, by the relative ranking of constraints in the Faith-BR family within the total grammar (McCarthy & Prince 1995, Spaelti 1999).

However, various authors have noted that the architecture of OT predicts the emergence of reduplicative patterns even absent special reduplicative morphology. Baker (2003) notes that the ranking DEP » INTEGRITY will lead to the employment of reduplication as a repair strategy in certain circumstances. Yu (2005) develops this idea further, under the name of compensatory reduplication, which Yu applies to a number of cases in which reduplication occurs without any morphological significance (including ludlings; Yu 2008). Saba Kirchner (2010) systematizes this idea of emergent reduplication in a framework called Minimal Reduplication, investigating its occurrence in phonologically conditioned and morphologically conditioned environments.

An example of phonologically-conditioned reduplication comes from Spokane, an Interior Salishan language (Bates & Carlson 1992). A repetitive affix [e] infixes in roots that begin with a complex onset, but triggers reduplication with roots that begin with a simplex onset:

(7) Infixation with complex-onset roots:[8]

/s-n-e̲-**qˀsip**-ls-t͡sút-min/ → sn**qˀ**-e̲-**splˀs**t͡sútn̉
NOM-in-R̲E̲P̲-long.time.ago-feeling-REF-INSTR — *second-hand store*

/s-n-e̲-**ptaχʷ**-mn/ → sn**p**-a̲-**táχʷ**m̉n̉
NOM-in-R̲E̲P̲-spit-INSTR — *spittoon*

(8) Reduplication with simplex-onset roots:

/e̲-**kˀʷulˀ**/ → **kˀʷ**-e̲-**kˀʷulˀ**
R̲E̲P̲-make — *made over and over*

/e̲-**ʃilˀ**/ → **ʃ**-e̲-**ʃilˀ**
R̲E̲P̲-chop — *chopped repeatedly*

The phonological explanation for this phenomenon is clear. Infixation and reduplication both serve to avoid an onsetless syllable which prefixation of [e] alone would create. In cases of a simplex onset, prefixation and infixation would both create an onsetless syllable, but reduplication avoids this. Thus we see infixation and reduplication here as competing repair strategies, which conspire in Spokane to achieve the same reduction in markedness.

8 Roots are given in bold. Data are presented here in IPA; cf. Americanist transcription in Bates & Carlson (1992).

A formalization of this analysis ranks ONSET above CONTIGUITY to cause infixation when necessary to avoid creating a syllable without an onset. When infixation does not suffice to solve this problem, as in candidate (d) below, another repair strategy must be chosen. The ranking DEP » INTEGRITY ensures that a segment will be reduplicated rather than epenthesized to provide the needed onset. Tableau (9) illustrates.

(9) Reduplication emerges in Spokane phonology

UR: /e-k̓ʷul'/	ONSET	CONTIGUITY	DEP	INTEGRITY
a. ☞ k̓ʷek̓ʷul'				*
b. tek̓ʷul'			*!	
c. ek̓ʷul'	*!			
d. k̓ʷeul'	*!	*		

Identifying reduplication as a process emergent from the grammar rather than one that is necessarily morphologically stipulated has important consequences for reduplicative ludlings such as those found in Tigrinya. There is no need for a reduplicative morpheme in these forms. This in turn removes the problem of accounting for the iterative nature of the reduplicative component in cryptemes such as those found in Tigrinya. This was noted by Yu (2008) in his analysis of the Spanish ludling Jerigonza and other iterative reduplicating ludlings. However, Yu retains the morphological component for these ludlings. For example, in analyzing the Hausa hábàʔábà game which inserts [bV] after every non-final syllable, Yu relies on a ludling morpheme with an underlying form of /b/. Iteration of that consonant is compelled through a constraint ALIGN(-b-,L,μ_{SH},R). Reduplication occurs as a markedness-reducing epiphenomenon.

A better analysis of iterative infixation ludlings extends the insight behind emergent reduplication further by eliminating the morphological component of the ludling altogether and recognizing that ludling forms are essentially different phonologically and not morphologically from their natural language correspondents (see further discussion in §3.1 on the Tigrinya ludlings and §4.3.2.3 on ludling typology). Our analysis of the Tigrinya ludlings does just this; working within the Minimal Reduplication framework outlined above, we account for the entire ludling formation process without reference to special ludling morphology.

3 Analysis of Tigrinya Ludlings

3.1 Syllable-Ludling

In one of the Tigrinya ludlings documented by Bagemihl, a [g] and reduplicative vowel occur for every syllable in the natural language output (see (10)). The *crypteme* in this case could be equally well defined as post-vocalic [gV] or pre-vocalic [Vg] (where [V] is a reduplicative vowel). We follow previous authors in describing the pattern as insertion of [gV] after every vowel, though our analysis applies to both descriptions (and cannot even distinguish between the two). An analysis of these ludling forms must account for why the crypteme has the shape [gV], why it occurs after a vowel, and why it occurs iteratively – once per every NLO syllable.

The analysis presented here retains many of the major insights of Bagemihl (such as the fact that the σ-Lud allows for coda projection while the μ-Lud does not) and closely follows the OT analysis of Jerigonza by Piñeros.

(10) Basic σ-Ludling data (cryptemes are underlined):

	NLO	σ-Lud	Gloss
CV	bɨtʃ'a	bɨgɨtʃ'aga	*yellow*
	s'æħifu	s'ægæħigifugu	*he wrote*
CVC	ʃɨm	ʃɨgɨm	*name*
	k'arma	k'agarmaga	*gnat*
	ʔɨntaj	ʔɨgɨntagaj	*what*

The post-vocalic and iterative placement of the crypteme can be accounted for with constraints of the ANCHOR family operating on the *natural language–ludling language correspondence relation* (NL) and FOOTBIN(σσ).

(11) ANCHOR(σ,Φ)L/R-NL (cf. Piñeros 1998)[9]:
Assign a * if the leftmost/rightmost segment of a syllable in the NLO does not have a correspondent at the left/right edge of a foot in the ludling output.

(12) FOOTBINARITY(σσ) (henceforth abbreviated as FTBIN):
Assign a * for any foot not composed of exactly two syllables.

When these three constraints (ANCHORR, ANCHORL, and FTBIN) are high-ranking, they demand that the CV and CVC syllables of the NLOs "stretch" to form disyllabic feet, as illustrated in (13). In order to maintain well-formed syllable structure, the satisfaction of FTBIN and the ANCHOR constraints leads to the violation of DEP (in the case of epenthesis) or INTEGRITY (in the case of reduplication), as shown in (14). As noted in §1.2, Tigrinya ludling forms appear to be produced with alternating stress, such that the first syllable of each foot is more prominent than the second (see the appendix). Stress is not marked in ludling forms for ease of reading.

(13) NLO syllables are mapped onto disyllabic feet in order to satisfy ANCHORR, ANCHORL, and FTBIN

a. CV syllable:

NLO:	[**C**			**V**]σ
	↓			↓
ludling:	[**C**	V	C	**V**]Φ

9 As defined in (11), these ANCHOR constraints are analogous to the I-ANCHOR constraints that operate on the input-output correspondence relation (see McCarthy 2000: 183); they require an NLO syllable edge to correspond to a ludling foot edge, but they do not require a ludling foot edge to correspond to an NLO syllable edge. In our analysis, constraints that demand that latter (i.e. constraints analogous to O-ANCHOR) would also be able to account for the Tigrinya data. We leave it to future research to determine with type of ANCHOR is best and if both are needed in the analysis of ludlings.

b. CVC syllable:

NLO:	[**C**	**V**			**C**]σ
	↓	↓			↓
ludling:	[**C**	**V**	C	V	**C**]Φ

(14) Crypteme placement

a. Hypothetical CV input (σ-LUD and μ-Lud):

UR: /ba / NLO: [.b₁a₂.]	FOOTBIN	ANCHORL -NL	ANCHORR -NL	DEP-C	INT-V
a. ☞ ($b_1a_2ga_2$)				*	*
b. ($ga_2b_1a_2$)		*!		*	*
c. ($a_2b_1a_2g$)		* (!)	* (!)	*	*
d. (ba)	*!				

b. Hypothetical CVC input (σ-Lud only):

UR: /bam/ NLO: [.b_1a_2m.]	FOOTBIN	ANCHORL -NL	ANCHORR -NL	DEP-C	INT-V
a. ☞ ($b_1a_2ga_2m$)				*	*
b. ($ga_2b_1a_2m$)		*!		*	*
c. ($b_1a_2mga_2$)			*!	*	*
d. (bam)	*!				

Following the Minimal Reduplication framework (Saba Kirchner 2010), reduplication is a repair process that results from the ranking DEP » INTEGRITY, making reduplication a better repair than epenthesis. In the Tigrinya ludling, FTBIN violations can be repaired by adding segmental material and this material takes the consistent form of an epenthetic [g] and a reduplicative vowel, meaning that INT-C » DEP-C and DEP-V » INT-V, respectively.

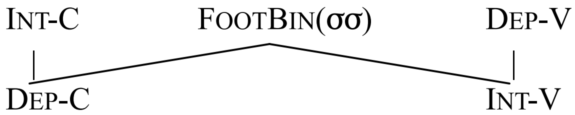
(15) consonant epenthesis and vowel reduplication in ludling forms (σ-Lud and μ-Lud)[10]

/bɨ₁tʃ'a₂ /	INT-C	DEP-C	DEP-V	INT-V
a. ☞ (bɨ₁gɨ₁)(tʃ'a₂ga₂)		**		**
b. (bɨ₁gɨ₃)(tʃ'a₂gɨ₄)		**	**!	
c. (bɨ₁bɨ₁)(tʃ'a₂tʃ'a₂)	**!			**

10 Whenever the underlying and surface forms are identical, as they are in *bɨtʃ'a* 'yellow', any violation of DEP-IO (or INT-IO) is necessarily a violation of DEP-NL (or INT-NL). In this and future tableaus, when faithfulness constraints are not specified for a correspondence relation, this means that the violation marks are identical for both the IO and the NL correspondence relations.

As established so far, the following ranking accounts for the insertion of a consonant and the reduplication of a vowel to fill out a disyllabic foot.

(16)

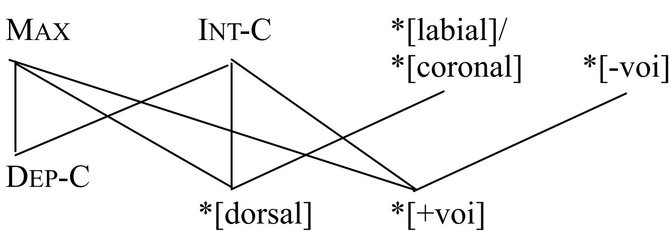


There are two logically possible ways to account for the fact that the epenthetic consonant is [g]: there could be an underlying segment /g/; or the constraint ranking could favor the realization of [g] when faced with the need to fill in the features of an epenthetic consonant. We find the latter option (which is also used by Piñeros (1998) in the analysis of Spanish Jerigonza) to be more parsimonious with an analysis that relies on emergent reduplication. This is implemented as follows. As shown in tableau (17), an emergent [g] occurs when the *[feature] constraints are ranked as in (18), indicating that [g] is the least marked consonant of the ludling grammar.

(17) [g] emerges as the least marked consonant (for simplicity, the *[feature] constraints only assign violation marks to an epenthetic consonant, as underlined in each candidate)

	$/b_1a_2/$	MAX	INT-C	*[lab]/ *[cor]	*[-voi]	DEP-C	*[dors]	*[+voi]
a.	☞ $(b_1a_2\underline{g_3}a_2)$					*	*	*
b.	$(b_1a_2b_1a_2)$		* !					
c.	$(b_1a_2\underline{k_3}a_2)$				* !	*	*	
d.	$(b_1a_2\underline{d_3}a_2)$/ $(b_1a_2\underline{b_3}a_2)$			* !		*		*
e.	--	** !						

(18) constraint ranking to account for epenthesis of [g]



The ranking in (18) is a ludling-specific ranking; there is no evidence that [g] is the least marked consonant in the natural language. By allowing ludling grammars to involve the reorganization of general constraints, we do not need to posit any underlying structure for the crypteme. Instead, its surface realization is predictable given the ranking established so far. The fact that natural language grammars can be altered in this unconstrained way predicts that cross-linguistic generalizations about markedness will not account for crypteme forms. Indeed, as we see in the typological findings presented in §4 this prediction is correct: natural language markedness scales demonstrably do not govern ludling markedness. This supports our approach to the fixed [g] in the Tigrinya ludlings as well as the more general claim that natural language constraint rankings may be rearranged in the ludling grammar.

If we took the opposite approach and proposed an underlying /g/, we could motivate the appearance of [g] in the ludling outputs easily enough. The difficulty would be in accounting for the appearance of a [g] *in every foot*. As shown in tableau (19), if an underlying /g/ appears multiple times on the surface, then INT-C violations must be tolerated at the expense of DEP-C, but this ranking cannot account for why the /g/ is reduplicated and not some other available consonant, as in candidate (b). Additionally, we will see in the following section that the Tigrinya data shows a dispreference for reduplication across a foot boundary, a fact which suggests that candidate (a) – the true output in terms of segmental form – fares worse than candidate (b) in terms of the ludling grammar.

(19) analysis with underlying /g/: no way to force iterations of [g]

	/bɨtʃ’$_1$a + g$_2$/	DEP-C	INT-C
a.	☞ (bɨg$_2$ɨ)(tʃ’$_1$ag$_2$a)		*
b.	☞ (bɨg$_2$ɨ)(tʃ’$_1$a tʃ’$_1$a)		*
c.	(bɨg$_2$ɨ)(tʃ’$_1$aʔa)	*!	

Another available option for forcing iterations of [g] is to use an ALIGNMENT constraint that requires a [g] to appear after every NLO vowel. As further argued in §4.3.2.3, this approach is unnecesarily stipulative and leads to a less restrictive ludling typology. The use of ANCHOR constraints goes hand in hand with emergent crypteme segments, be they reduplicative or epenthetic.

The ranking *[coronal] » *[dorsal] would not be possible if place feature markedness constraints are in a stringency relation to each other (see de Lacy 2002; Prince 1997a,b). According to de Lacy's (2002) proposal, there exist constraints of the form *{dorsal} and *{dorsal, labial, coronal} (following the POA hierarchy dorsal > labial > coronal > laryngeal, where '>' means 'is more marked than'), and these constraints are freely rankable. Because there is no constraint *{coronal} and no constraint that penalizes coronals without also penalizing dorsals, coronal consonants can never be more marked than dorsal consonants. Given that the ranking in (18) is necessary to account for the Tigrinya ludlings, we must conclude that place feature markedness constraints cannot be defined in stringency form.[11] Further evidence for this conclusion comes from the appearance of labials (Hume & Tserdanelis 2002 on Sri Lankan Portuguese Creole) and dorsals (Marlett 2010 on Seri) as default places of articulation in natural language processes. It thus seems that, even for natural languages, the POA hierarchy represents a tendency rather than an absolute. Neither stringency scales nor universally fixed rankings (i.e. *[dorsal] » *[coronal]) of constraints that ban place features can account for all patterns found in natural languages or ludlings. We return to a discussion of place feature markedness in ludlings in §4.3.2.2.

In summary, we have accounted for the Tigrinya σ-Ludling forms with ANCHOR

[11] De Lacy's arguments regarding the usefulness of *category conflation* (e.g. when a constraint like *{dorsal, labial, coronal} is high-ranking and thus dorsal, labials, and coronals are treated as equally marked by the grammar) are quite compelling. It is thus possible that CON includes both featural markedness constraints that are in stringency form as well as freely-rankable single feature markedness constraints, like *[coronal].

constraints as developed by Piñeros for the analysis of Spanish Jerigonza. These ANCHOR constraints require an NLO syllable to be "stretched" to form a foot. As FTBIN requires each foot to be disyllabic, an epenthetic consonant and reduplicative vowel are added to each NLO syllable in order fill out the ludling foot. This analysis does not posit any underlying form for the crypteme nor does it make use of constraints that specify the position of the crypteme. Instead, the shape of the crypteme ([g] and a reduplicative vowel) and its optimal placement emerge from the ludling grammar. This analysis is thus less stipulative than former rule-based analyses such as Bagemihl's or OT analyses with ALIGNMENT constraints such as Yu's because these analyses have to fully specify the shape of the crypteme ([gV]) as well as its position (post-vocalic) even when other descriptively correct options are available (e.g. a pre-vocalic [Vg]).

3.2 Mora-Ludling

3.2.1 Monomorphemic Words

As shown in (20) below, σ-Ludling and μ-Ludling forms are identical for words composed of only CV syllables. CVC syllables, however, are encrypted differently in the two ludlings. While the σ-Ludling produces forms that obey both ANCHOR constraints, we see that in the μ-Ludling each non-geminate coda consonant triggers the appearance of an additional disyllabic foot that begins with the original coda consonant, as in /ʃɨm/ → [(ʃɨgɨ)(mɨgɨ)]. For words with geminates, μ-Ludling forms match the expected forms of σ-Ludling (though Bagemihl does not provide any data for words with geminates in the σ-Ludling): each NLO syllable is mapped onto a disyllabic foot and the ANCHOR constraints are satisfied.

(20) Basic μ-Ludling data (cryptemes are underlined):

	NLO	σ-Lud	μ-Lud	
CV	bɨtʃ'a	bɨgɨtʃ'aga	bɨgɨtʃ'aga	*yellow*
	s'æħifu	s'ægæħigifugu	s'ægæħigifugu	*he wrote*
CVC	ʃɨm	ʃɨgɨm	ʃɨgɨmɨgɨ	*name*
	k'arma	k'agarmaga	k'agarɨgɨmaga	*gnat*
	ʔɨntaj	ʔɨgɨntagaj	ʔɨgɨnɨgɨtagajɨgɨ	*what*
CVC:V	sɨnni	*no data*	sɨgɨnnigi	*tooth*
	ʕakkat	*no data*	ʕagakkagatɨgɨ	*(kind of fruit)*

As noted by Bagemihl, the generalization that accounts for the differences between the σ-Ludling and μ-Ludling forms is that, in the μ-Ludling, all singleton coda consonants are strictly prohibited. The correct forms emerge from a grammar in which NOCODA dominates ANCHORR, as shown in (21). FOOTBIN(σσ) is still undominated (and so only candidates that fully satisfy it are considered), and deletion of segmental material (from either the input or the NLO) is not tolerated. Thus, the only way to satisfy NOCODA, FTBIN, and MAX-C is to create a new disyllabic foot from a single NLO coda consonant.

(21) CVC forms in μ-Ludling

UR: /ʃɨm/ NLO: [.ʃɨm.]	NoCoda	Max-C	AnchR-NL	Dep-C	Int-V
a. ☞ (ʃɨgɨ)(mɨgɨ)			*	**	**
b. (ʃɨgɨm)	*! W		L	* L	* L
c. (ʃɨgɨ)		*! W	*	L	L

The above tableau only considers candidates that include one crypteme ([gV]) in each foot even though the appearance of the crypteme is not demanded by any constraint. For the σ-Ludling, the undominated constraints AnchorR and AnchorL can only be satisfied by adding extra material in order to map each NLO syllable onto a disyllabic foot. However, AnchorR is not undominated in the μ-Ludling. Given that the winner incurs a violation of this constraint, there is another candidate that also incurs an AnchorR violation and fares better on the other relevant constraints, as shown in tableau (22).

(22) Encryption without a crypteme

UR: /ʃɨm/ NLO: [.ʃɨm.]	AnchR-NL	Dep-C	Int-V
a. (ʃɨgɨ)(mɨgɨ)	*	** (!)	** (!)
b. ☹ (ʃɨmɨ)	*		*

The winning candidate, [ʃɨmɨ] is clearly in violation of the spirit of the ludling: it does not include a crypteme and in fact does not include any insertion at all. While a rule-based analysis that posits a rule of inserting [gV] after every vowel and [ɨgɨ] after every singleton coda consonant or an OT analysis with ludling-specific Alignment constraints would have no trouble in getting to the correct output, such accounts would be purely stipulative. This leaves two options for a grammar that treats [ʃɨgɨmɨgɨ] as more optimal than [ʃɨmɨ]: either there is a /g/ in the input, i.e. there is a morphological component in the grammar of the μ-Ludling that specifies the crypteme as having a /g/; or there is some constraint that we have not yet considered that favors [ʃɨgɨmɨgɨ] even without a /g/ in the input.

The former approach (which we have already argued against for the σ-Ludling) faces another empirical problem with the μ-Ludling data. Tableau (23) shows that, if there is a /g/ in the input, [ʃɨgɨmɨgɨ] is the optimal output due to high-ranking Max-C. However, this solution only holds for monosyllabic NLOs. Consider instead the hypothetical input /ʃɨmʃɨm/, as shown in tableau (24). The winning candidate has a /g/ in each of the first two feet (thus satisfying Max-C) but incurs fewer violations of the Integrity constraints[12] by mapping the final CVC syllable onto only one foot, leading back to the original problem. An underlying /g/ needs only to be realized once to avoid Max-C violations, but the overall descriptive generalization of both the σ-Ludling and the μ-Ludling is that a [g] appears in every foot.

12 For simplicity, we treat all extra [ɨ]s as reduplicative and not epenthetic in tableaus (23)-(28) even though, as we will show below, the winning output does contain some epenthetic [ɨ]s.

(23) underlying /g/ cannot be deleted

UR: /ʃɨm/ + /g/ NLO: [.ʃɨm.]	MAX-C -IO	ANCHR -NL	INT-C -IO	INT-V
a. ☞ (ʃɨgɨ)(mɨgɨ)		*	*	***
b. (ʃɨmɨ)	* !	*		*

(24) underlying /g/ does not need to be realized iteratively

UR: /ʃɨmʃɨm/ + /g/ NLO: [.ʃɨm.ʃɨm.]	MAX-C	ANCHR -NL	INT-C -IO	INT-V
a. (ʃɨgɨ)(mɨgɨ)(ʃɨgɨ)(mɨgɨ)		**	*** (!)	****** (!)
b. ☹ (ʃɨgɨ)(mɨgɨ)(ʃɨmɨ)		**	**	****

It is thus clear that there must be some constraint that prefers [ʃɨgɨmɨgɨ] over [ʃɨmɨ] even when there is no /g/ in the input. At this time, we suggest two possibilities for what this constraint might be and discuss the merits of each constraint. We leave it to future work on other ludlings to determine which constraint (family) is better supported by cross-linguistic data.

One option is that the general process of ludling formation is different in μ-Ludling, i.e. it is not ANCHOR constraints that are driving the encryption process. Instead, this may reflect the influence of a new kind of constraint family, which we can call EXPANSION. These constraints are only operative on the NL correspondence relation, i.e. such constraints are only used in language play. The EXPANSION family requires some prosodic unit in the NLO to be mapped onto some equivalent unit with the added requirement that this unit be in a strong position. In the case of the μ-Ludling the relevant constraint, as defined in (25), requires that each mora in the NLO corresponds to a head mora (relative to the foot) in the output. When this constraint is undominated, the ludling outputs will have one foot for each mora in the NLO, as does Tigrinya μ-Ludling.

(25) EXPANSION(μ,Φ)-NL:

Assign a violation mark for each mora in the NLO which does not have a correspondent in the output that is the head mora of a foot.[13]

(26) analysis with EXPANSION

UR: /ʃɨm/ NLO: [.$ʃɨ^{μ1}m^{μ2}$.]	NOCODA	MAX-C	EXPAN (μ,Φ) -NL	DEP-C	INT-V
a. ☞ ($ʃɨ^{μ1}gɨ^{μ}$)($mɨ^{μ2}gɨ^{μ}$)				**	***
b. ($ʃɨ^{μ1}gɨ^{μ}m^{μ2}$)	* (!)		* (!)	*	*
c. ($ʃɨ^{μ1}gɨ^{μ}$)		* (!)	* (!)		
d. ($ʃɨ^{μ1}mɨ^{μ}$)			* (!)		

An alternative explanation is that there is a constraint that directly requires the insertion

13 We follow Zec (1995) is assuming there is subsyllabic metrical structure such that the leftmost mora under a syllable is the strong mora, or head mora of that syllable. (Languages such as Spanish provide evidence that it is not always the leftmost mora that is the head mora (see Harris & Kaisse 1999), but there is no evidence against this claim to be found in Tigrinya.) The head mora of a stressed syllable is thus the head mora of a foot.

of a crypteme in order to form ludling outputs. Such a constraint is cross-linguistically justified in that every documented IIL makes use of epenthesis – there is no IIL in which the crypteme is purely reduplicative (Yu 2008). As defined below, CRYPTPERFOOT requires every foot to contain epenthetic material and is thus an *anti-faithfulness* constraint (Alderete 2001) that operates on the NL correspondence relation. While there have been many arguments against the need for anti-faithfulness constraints in the analysis of natural language morphophonemic processes, we find that these arguments do not extend to the realm of language games because the processes exhibited in language play are a superset of those processes exhibited by natural language (see previous discussion in §2.2).

(27) CRYPTPERFOOT (¬DEP/Φ-NL; cf. Alderete 2001)
Assign a violation mark for any foot that does not contain an epenthetic segment.

(28) analysis with CRYPTPERFOOT

UR: /ʃɨm/ NLO: [.ʃɨm.]	NOCODA	MAX-C	CRYPT PERFOOT	DEP-V	DEP-C	INT-V
a. ☞ (ʃɨgɨ)(mɨgɨ)					**	***
b. (ʃɨgɨm)	*!				*	*
c. (ʃɨgɨ)		*!			*	*
d. (ʃɨmɨ)			*!			*
e. (ʃɨmu)				*!		

To summarize the above discussion, we find that, even if there is an underlying /g/ used in Tigrinya ludling formation, there must be some constraint that either forces every NLO mora to head a ludling foot or that requires epenthesis in every foot in order to reach the correct ludling output for a CVC NLO syllable. We have suggested two ways to formalize these possibilities. We leave the choice between them open for now in order to clarify the more general point that the origin of the fixed crypteme consonant in these IILs must be phonological rather than morphological.

Given that we have rejected the approach in which the input contains a crypteme /g/, the appearance of [g] as the crypteme consonant in the μ-Ludling is accounted for in the same way as for the σ-Ludling.

For the lexical item used above, /ʃɨm/, it is impossible to tell if the [ɨ]s in the foot (mɨgɨ) are epenthetic or reduplicative. Based on evidence from the encryption of CVC syllables with other vowels, such as /k'ar̲ma/ → [k'agar̲ɨg̲ɨmaga], it is clear that these vowels are epenthetic. The sequence [ɨgɨ] consistently follows NLO coda consonants in μ-Ludling forms. This means that, while vowel reduplication is the preferred repair process of both σ-Lud and μ-Lud, there must be some constraint that penalizes reduplication in these particular forms. We propose a constraint of the INTEGRITY family that penalizes the splitting of a segment across a foot boundary, and tableau (30) demonstrates the ranking INT-V/Φ » DEP-V.

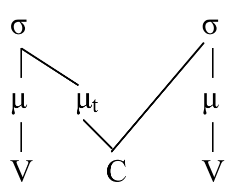
(29) INTEGRITY/Φ-IO: Assign a violation mark for any segment in the input that has output correspondents in different feet.

(30) Epenthesis in μ-Lud when no vowel available for reduplication

/k'a$_1$r.../	INT-V/Φ	DEP-V	INT-V
☞ (k'a$_1$ga$_1$)(rɨgɨ)		**	*
(k'a$_1$ga$_1$)(ra$_1$ga$_1$)	**!		***

Despite high-ranking NOCODA, geminates do appear in μ-Ludling forms. We propose that a geminate is protected via the nature of the mora that dominates it. Campos-Astorkiza (2004) argues that there are two types of moras: those that simply license segments, *positional moras* (μ_p), and those that denote timing, which we call *timing moras* (μ_t). The two can be formally differentiated in the following way: a positional mora dominates a segment that is not immediately dominated by some other prosodic unit. This applies to short vowels and short coda consonants (each immediately dominated by one mora and nothing else). Long vowels are dominated by two timing moras (each mora dominates a vowel that is immediately dominated by another prosodic unit, namely the other mora), and geminate coda consonants are dominated by one timing mora, assuming that the structure of a geminate is as shown in (31), where the mora dominates a segment that is also immediately dominated by a syllable node. Timing moras are protected by a special MAX constraint, which must dominate NOCODA in the Tigrinya μ-Ludling grammar. A candidate such as [(sɨgɨ)(nɨgi)(nɨgi)] that treats the geminate [nn] as a regular CC cluster (i.e. a false geminate) would still violate MAX-μ_t-NL (because the geminate is mapped onto a singleton) and would do worse on INT-V and DEP-C than the other candidates in tableau (33). Singleton coda consonants are not dominated by a timing mora, and so with these codas MAX-μ_t-NL is vacuously satisfied and NOCODA can assign fatal violation marks.

(31) Geminate structure:



(32) MAX-μ_t-NL (cf. Campos-Astorkiza 2004): Assign a violation mark for every timing mora in an NLO that has no correspondent in the ludling output.

(33) Geminates preserved in μ-Lud:

UR: / sɨnni / NLO: [sɨnni]	MAX-μ_t-NL	NOCODA
☞ (sɨgɨn)(nɨgi)		*
(sɨgɨ)(nɨgi)	*!	

This section has presented an analysis of monomorphemic words in the Tigrinya μ-Ludling that builds off of the analysis of the σ-Ludling: both ANCHORL and FTBIN are undominated and drive the basic expansion patterns. Consonant insertion and vowel reduplication are the preferred methods of adding extra phonological material, though vowel reduplication is prohibited across foot boundaries.

Unlike the σ-Ludling and the natural language itself, the μ-Ludling strictly forbids singleton coda consonants (while geminates are protected by Max-μ_t). This result is achieved by ranking NoCoda above AnchorR. However, this ranking is not enough to rule out the mapping of a CVC form (e.g. [ʃɨm]) onto a (barely encrypted) CVCV form, with a final reduplicative vowel and no epenthetic consonant (e.g. [ʃɨmɨ]). We showed that even putting a /g/ in the underlying form does not ensure that a /g/ will appear in every foot and thus proposed two possible constraint families that could rule out a candidate like [ʃɨmɨ]. If the Expansion family is the best constraint to use, NoCoda becomes irrelevant in this analysis (see tableau (26)); however, if CryptPerFoot is the best constraint, NoCoda is still needed to rule out any candidates with coda consonants (see tableau (28)). In order to simplify discussion in the following sections, we will treat the ranking of NoCoda over AnchorR as an integral part of the analysis.

3.2.2 Polymorphemic Words: The Need for NL-Faithfulness

Tigrinya exhibits a process of total regressive assimilation when homorganic stops that differ in laryngeal features are adjacent due to morpheme concatenation. This process results in the creation of a true geminate, and the geminate itself is encrypted as expected given the grammar developed so far. However, something else surprising occurs in these words: not only does the geminate appear in μ-Ludling forms, but the original singleton that was lost in the gemination process also appears. Sample data is given in (34), and the mapping of UR and NLO elements onto μ-Ludling forms is illustrated in (35).

(34) μ-Ludling data for bimorphemic words (cryptemes are underlined):

UR	NLO	μ-Lud	Gloss
sanduk'-ka	sandukka	saganɨgɨdugux'ɨgɨkkaga[14]	*your (m.s.) box*
sælit'-do	sæliddo	sægæligit'ɨgɨddogo	*is it (black) sesame?*
fɨlɨt'-ti	fɨlɨtti	fɨgɨlɨgɨt'ɨgɨttɨgi	*known (f.)*
kulit-do	kuliddo	kuguligitɨgɨddogo	*is it (a) kidney?*
kæbbæd-ti	kæbbætti	kægæbbægædɨgɨttɨgi	*heavy (pl.)*

(35) Both input C_1 and NLO geminate C_2 appear in ludling outputs:

UR:	sæ	li	t'	do
			↓	
NLO:	sæ	li		ddo
			↓	↓
μ-Lud:	sægæ	ligi	t'ɨgɨ	ddogo

The appearance of both the singleton [t'] and the geminate [dd] in this ludling form is straightforwardly accounted for with an analysis that makes use of both an IO and an NL correspondence relation. As shown in (36), Max-IO protects the underlying [t'] from deletion and Max-μ_t-NL protects the NLO geminate from deletion or degemination.

14 See §1.2 for discussion of the spirantization of velar stops in Tigrinya.

(36) MAX-IO protects input C_1; MAX-μ_t-NL protects NLO geminate C_2.

UR: /sælit' + do/ NLO: [sæliddo]	MAX-IO	MAX-μ_t-NL	NOCODA
a. ☞ (ligi)(t'ɨgɨd)(dogo)			*
b. (ligi)(t'ɨgɨ)(dogo)		*!	
c. (ligid)(dogo)	*!		*

This pattern can only be accounted for by the simultaneous use of input-output faithfulness and surface-to-surface faithfulness. A stratal analysis that allows for reranking at different levels cannot account for the appearance of both [t'] and [dd]. To show why, we will consider the two most salient options for how to position a ludling stratum.

The first option is the one proposed by Bagemihl for the analysis of the same data: a ludling stratum occurs after the natural language grammar (NLG), which may be composed of multiple strata. Thus, the output of the NLG is the input to ludling formation. In such a grammar, there is no motivation for the appearance of the lost singleton ([t'] in the example above). The NLG maps /sælit' + do/ onto [sæliddo], and the [t'] is lost. When the form [sæliddo] is submitted to the ludling stratum, there would be no reason for this grammar to insert a [t'] and the other material to fill out a foot, and we would expect to see [sægæligiddogo] as the encrypted form. (We return to Bagemihl's analysis in §3.3.2.)

Another conceivable option (though one that has not been proposed in the literature) is that a ludling stratum occurs after every stratum of the NLG. In this scenario, the NLG would first map /sælit'/ onto [sælit']. This form would be submitted to a ludling stratum, which would produce the form [sægæligit'ɨgɨ]. This form would then be affixed with [-do], and the newly formed word [sægæligit'ɨgɨ + do] would again undergo a ludling stratum. At this point two problems occur. First and foremost, there is no reason for the [d] of the suffix to geminate as it is post-vocalic, and thus this grammar would correctly predict the [t'] to appear in ludling forms but would incorrectly predict for the [d] to be a singleton. Second, it is hard to even determine how the ludling stratum would handle a form that has already been 'ludled'. Would the extra syllables created by the first ludling stratum also have to be mapped onto disyllabic feet (e.g. [sægæ…] → [sægægægæ…]? Or would the ludling stratum recognize that encryption has already occurred and merely encrypt the newly added suffix?[15]

Quite simply, a ludling stratum cannot be ordered in a way that allows ludling forms to retain both an underlying segment that does not appear on the surface and a surface geminate that is underlyingly a singleton. The influence of both the UR and the NLO on ludling outputs is analogous to what Steriade (1999) calls the *split-base effect*. She shows how the English word *remédiable* is formed with reference to both the morphosyntactic base *rémedy* and the phonological base *remédial*, and this analysis relies on the claim that complex words like *remédial* are stored in the lexicon (with stress placement) and thus readily accessible to the speaker. If NLOs, like English *remédial* or Tigrinya [sæliddo], are stored in the lexicon, it is unsurprising that they are used in ludling formation.

Even though most analyses of ludlings have assumed that ludling outputs are only influenced by NLOs, there is additional evidence in support of the influence of URs. Sherzer

15 Our analysis, as further developed below, predicts that the second option would happen as multiple [g]s are not allowed in a single foot in ludling forms unless one of the [g]s has correspondent in the NLO. Thus, the real problem with a grammar in which a ludling stratum occurs after every NLG stratum is that such a grammar cannot account for the gemination of the correct consonants when they are in a post-vocalic position.

(1970) documents a rearrangement ludling of Cuna (a Chibchan language spoken in Panama) in which the first syllable of a word is moved to the end. The word /mae/ *suck* is pronounced [maje], with an epenthetic [j] to prevent vowel hiatus, but the encrypted form is [ema] (*[jema]). If ludling forms were produced with reference only to the NLO, there would be no way to explain the deletion of [j] in this ludling output given that [j]-initial forms are attested in this language (e.g. [jala] *mountain*) and in ludling outputs (e.g. /ibja/ → [jaib] *eye*). In conclusion, not only is the simultaneous use of an IO- and an NL-correspondence relation necessary for the analysis of the Tigrinya ludlings, but this analysis is also well-supported by literature on derivational morphology and other ludlings.

Uniquely, underlying /g/ does not return in μ-Ludling forms when lost to gemination, as shown in the data in (37) and illustrated in (38)

(37) μ-Ludling data for bimorphemic words with assimilated /g/:

UR	NLO	μ-Lud		Gloss
ʕaddig-ka	ʕaddikka	...ddigikkaga	*...ddigigɨgɨkkaga	*you (m.s.) bought*
ʔaʔdug-ka	ʔaʔdukka	...dugukkaga	*...dugugɨgɨkkaga	*your (m.s.) donkeys*

(38) underlying /g/ that is absent in NLO does not appear in ludling outputs:

UR:	ʔa	ʔ	du	g	ka
NLO:	ʔa	ʔ	du		kka
μ-Lud:	ʔaga	ʔɨgɨ	dugu		kkaga
cf.	**ʔaga*	*ʔɨgɨ*	*dugu*	*gɨgɨ*	*kkaga*

The constraint OCP(C) penalizes adjacent (on the consonantal tier) identical consonants. However, there is clearly not an all-out ban on multiple [gV] sequences in the ludlings, as evidenced by forms like /ʔaga/ → [ʔagagaga] *towards* (Bagemihl 1988: 263).[16] The difference between forms like *towards* and those like *you bought* is that in the former, there is a [g] in the NLO [ʔaga], whereas in the latter the [g] only occurs in the UR and not in the NLO [ʕaddikka]. We can thus account for the grammaticality of multiple [gV] sequences in forms like [ʔagagaga] and the ungrammaticality of the same sequences in forms like [ʕagaddigikkaga] with the ranking MAX-NL » OCP(C) » MAX-IO, as shown in tableaus (40) and (41).

(39) OCP(C): Assign a violation mark for any sequence of adjacent identical segments. (Rose 2000, as "OCP-[C-Adj]", follows principle of *consonant adjacency*)

[16] Nor is there a ban on adjacent [g]s in the natural language. Mr. Abdelnour provides the example form [gaga] *a very dirty person*. Thus, OCP(C) » MAX-IO is a ludling-specific ranking.

(40) /g/ in input, but no [g] in NLO

UR: /...dug + ka/ NLO: [...dukka]	OCP(C)	*[lab]/*[cor]/ *[-voi]	MAX-IO
a. ☞ (duguk)(kaga)			*
b. (dugu)(guguk)(kaga)	*!		
c. (dugu)(gub/d/kuk)(kaga)		*!	

The combined effect of OCP(C) and *[lab]/*[cor]/*[-voi] thus prohibit the reappearance of a [g] lost to assimilation. Although MAX-IO is dominated by those constraints, higher-ranking MAX-NL preserves other instances of [g] which are present in non-ludling surface forms:

(41) /g/ in input and NLO[17]

UR: /ʔag$_1$a/ NLO: [ʔag$_1$a]	MAX-NL	OCP(C)	MAX-IO
☞ (ʔag$_2$a)(g$_1$ag$_3$a)		*	
(ʔag$_2$a)	*!		*

This section has shown that polymorphemic words in which regressive assimilation applies can only be encrypted with reference to both the underlying form and the NLO. This analysis requires the simultaneous use of NL-faithfulness and IO-faithfulness, which cannot be mimicked with a stratal analysis. This use of NL-faithfulness also allows for a straightforward analysis of OCP avoidance in certain forms – [g]s that appear in NLOs are protected by high-ranking MAX-NL and cannot be deleted, but /g/s that appear in underlying form only are deleted if they lead to OCP violations (due to the ranking OCP(C) » MAX-IO).

3.3 σ-Ludling and μ-Ludling Comparison and Summary

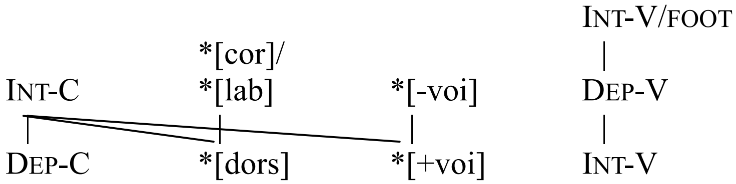
3.3.1 The Ludling Grammars

We have shown that the constraint ranking in (42) holds for both the σ-Ludling and the μ-Ludling. This ranking ensures that feet will always be composed of two syllables and that the left edge of every NLO syllable will have a correspondent at the left edge of every ludling foot. When extra material is needed to fill out a foot, any additional consonants will be [g] (as opposed to other epenthetic or reduplicative consonants) and any additional vowels will be reduplicative, with the exception that reduplication cannot occur across a foot boundary (resulting in epenthetic [ɨ]s when necessary).

---

17 The candidate (ʔag$_1$a) cannot win because it is not encrypted; this candidate violates both AnchorR and AnchorL because the two NLO syllables [ʔa] and [ga] are not stretched to form two different feet.

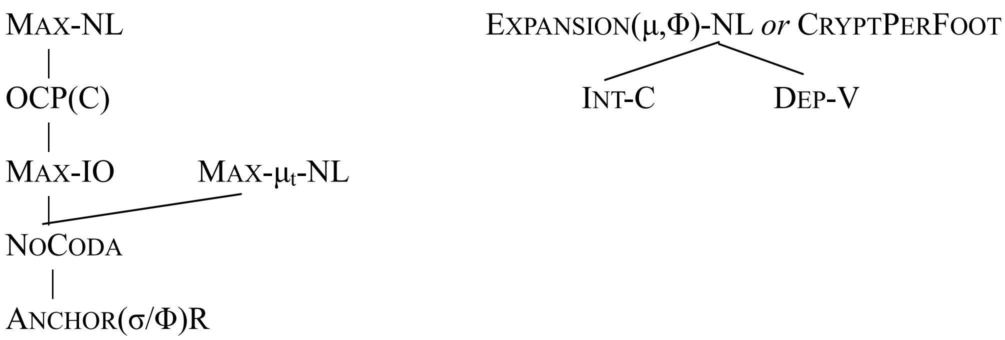
(42) Ranking summary for σ-Ludling and μ-Ludling:



FootBin(σσ) and Anchor(σ/Φ)L undominated.

Anchor(σ/Φ)R is also undominated in the σ-Ludling, which ensures that the right edge of each NLO syllable has a correspondent as the right edge of each ludling foot. Coda consonants are thus allowed in this ludling if they are present in NLO syllables. In the μ-Ludling, on the other hand, the rankings in (43) hold.

(43) Ranking summary for μ-Ludling only:



First, we see that Anchor(σ/Φ)R is crucially dominated in this ludling. This ranking is necessary because coda consonants in NLOs appear as onsets in μ-Ludling outputs. However, we saw in tableau (22) that the promotion of NoCoda was not enough to rule out a candidate that merely includes a reduplicative vowel after a coda consonant and hence no crypteme. For this reason we proposed the existence of constraints of either the form Expansion(μ,Φ) (each NLO mora must become the head mora of a foot) or CryptPerFoot (each foot must contain epenthetic material). One of these constraints must dominate Int-C and Dep-V in order to allow for as many epenthetic consonants and reduplicative vowels as necessary given the length of the NLO to be encrypted. These constraints assign violation marks in very different ways, and we showed in tableaus (26) and (28) that the use of CryptPerFoot must also be coupled with the ranking NoCoda» AnchorR, but that Expansion alone can account for the absence of coda consonants regardless of the ranking of NoCoda.

Second, the ranking of Max-μ_t-NL over NoCoda accounts for the appearance of geminates in ludling outputs even though such consonants occupy a coda slot. Finally, OCP(C) is sandwiched between Max-NL and Max-IO in order to account for the fact that adjacent [g]s (on the consonantal tier) are not allowed unless one of the [g]s has a correspondent in the NLO. Underlying [g]s are not protected.

It is clear that the μ-Ludling grammar differs from the natural language grammar more starkly than the σ-Ludling. It also requires the use of extra ludling-specific constraints as denoted by the need for either EXPANSION or CRYPTPERFOOT in addition to the ANCHOR constraints. We would thus expect this ludling to be harder to learn and to play. We also expect such a ludling to be rare, and indeed it is. In §4.3.2.4 we describe the only other ludling we have found that resembles the Tigrinya μ-Ludling. The σ-Ludling, on the other hand, is analogous to the most common type of ludling. The constraint rankings in (42) must thus be easy to learn and employ (ignoring the specific rankings of *[feature] constraints, as different ludlings use different epenthetic consonants).

3.3.2 Previous Analysis: Bagemihl (1988)

Bagemihl's dissertation provides the foundation for much of our analysis and discussion throughout this paper.[18] For example, he identifies the difference between the σ-Ludling and μ-Ludling as having to do with the fact that the σ-Ludling allows for coda projection while the μ-Ludling does not. Bagemihl develops an analysis in the context of stratal, rule-based phonology (following, e.g., Kiparsky 1982, Mohanan 1982). This analysis makes use of a "ludling stratum" that occurs between the lexical and postlexical strata. The ordering of strata can account for over- and underapplication in ludlings forms.

Given the differences in the theoretical framework used by Bagemihl and the one we use, it is no surprise that the two analyses are quite different – both in spirit and in the formalisms employed. Space permits us from detailing his analysis in full and all the ways that it differs from ours, and so in this section we will focus on the ways that our analysis covers more ground with fewer stipulations.

Bagemihl's basic analysis of the ludlings involves the use of epenthesis rules that insert [gV] after a nucleus. This means that the segmental content of the crypteme is specified as well as its placement as post-vocalic, even though ludling forms are ambiguous as to whether the contain a [gV] or a [Vg] crypteme. Our analysis treats this ambiguity as a function of the ludling grammar itself instead of an accident that appears on the surface – the combined work of high-ranking ANCHORR and DEP-V create optimal NLO to ludling form mappings that are ambiguous because both vowels in a given foot are actually correspondents of the NLO vowel. Given the large number of ludlings that have ambiguous crypteme placement (see §4.3), we find it advantageous that this ambiguity emerges from the grammar rather than forcing our analysis to resolve the ambiguity.

Furthermore, the fact that input segments lost to gemination reappear in the μ-Ludling and the fact that uniquely [g] does not reappear requires the use of floating segments at different levels of representation in Bagemihl's model. Bagemihl proposes that input segments are delinked at stem or word level but survive as floating segments and may be reinserted in ludling phonology. The use of floating segments adds a level of abstractness that is not warranted. These floating segments that reappear are all segments that are in underlying representations. Our analysis, which allows for a direct connection between surface forms and underlying representations at any stage of analysis can correctly account for why these segments may appear in ludling forms even if they are not in NLOs. Furthermore, without this direct connection with URs, Bagemihl had to make use of the distinction between a floating [g] and an anchored [g] to explain why a [g] lost to gemination does not reappear. He proposed that a floating [g] followed by a crypteme [g] violates the OCP, while an anchored [g] does not. Our analysis, on the other

18 See §4.1 for thorough discussion of Bagemihl's work on the categorization of language games.

hand, makes use of a general OCP(C) constraint which dominates MAX-IO and is dominated by MAX-NL. Thus, underlying segments can be deleted to satisfy the OCP, but segments that surface in NLOs cannot.

3.4 Typology of NL-Faithfulness and Examples from Tigrinya

In this section we consider the patterns that can result from the permutations of NL-Faithfulness, IO-Faithfulness, and Markedness constraints and show that most of these patterns occur in the Tigrinya ludlings when we examine some further phenomena documented by Bagemihl (1988).

The general patterns that can result from the various possible rankings of NL-Faithfulness can be described in the same terms as used by Benua (1997) for the interaction of OO-Faithfulness with IO-Faithfulness and Markedness constraints (henceforth abbreviated as F-OO/IO/NL and M). There is one major difference, however, and that is the fact that, following our model of ludling grammars, any constraints can be reranked in the ludling grammar as compared to the natural language grammar. Consider, for example, the situation described as *underapplication*, where F-OO » M » F-IO. There are two ways to achieve this type of underapplication in ludling grammars. One is with the analogous ranking F-NL » M » F-IO; the other is with a ludling ranking reversal of F-IO » M. The latter is not available in Benua's framework. In order to simplify discussion in this section, we ignore such ranking reversals and build off of a model in which F-IO and M constraints retain their dominance relations from the natural language grammar.

(44) Factorial typology with NL-Faithfulness constraints and examples from the Tigrinya ludlings

(a) *normal application*
ranking: M » F-IO, F-NL
example: spirantization of velar stops

(b) *underapplication:*
ranking: F-NL » M » F-IO
example: word-final [ɨ]-fronting

(c) *overapplication:*
ranking: F-NL, M » F-IO
example: *none found in Tigrinya*

(d) *TETRU (the emergence of the relatively unmarked):*
ranking: M-1 » F-NL » M-2 » F-IO
example: occurs when NLO ends in epenthetic [i]

Normal application, underapplication, and overapplication, as defined in (44a-c), describe how natural language phonological processes apply in the ludling; these processes can apply in just those environments in which they are normally conditioned, in fewer environments than in which they are normally conditioned, or in more environments than in which they are normally conditioned (respectively). TETRU, on the other hand, is a situation in which multiple markedness constraints interact with the different kinds of faithfulness constraints, yielding outputs which obey one markedness condition but violate another.

One example of normal application in the Tigrinya ludlings is that of spirantization of voiceless velar stops in post-vocalic position.[19] The word /mɨrak̲-k̲a/ *your calf* is produced as [mɨrax̲k̲a], with the first /k/ undergoing spirantization. In the Tigrinya μ-Ludling, this word is produced as [mɨgɨragax̲ɨgɨx̲aga], with both /k/s undergoing spirantization because both are post-vocalic in this output.[20] Thus, even in ludling outputs, all and only those /k/s that occur in post-vocalic position become [x]s, meaning that the markedness constraint that drives the spirantization process must be ranked above the relevant IDENTITY constraint(s) on both the IO- and the NL-correspondence relations.

As discussed in §1.2, [ɨ] does not occur word-finally in Tigrinya and so [i] is the normal epenthetic vowel in word-final position. The quality of epenthetic vowels in Tigrinya can be accounted for with the ranking *ɨ# » *[-back] » *[+back], where the undominated *ad hoc* constraint *ɨ# penalizes any [ɨ] in word-final position and the ranking *[-back] » *[+back] is needed to ensure that [ɨ] and not [i] is epenthesized in all other positions. We present two tableaus relevant to natural language epenthesis in (45).

(45) natural language epenthesis (all faithfulness constraints operate on the IO correspondence relation):

a. /kfat/ → [kɨfat] *open!*

$/kfa_1t/$	*[$_\sigma$ CC	MAX-C	INT-V	*[-high]	*[-back]	*[+high]	*[+back]	DEP-V
☞ kɨfat				*		*	**	*
kfat	*! W			*		L	* L	L
kat		*! W		*		L	* L	L
kifat				*	*! W	*	* L	*
ka_2fa_1t				**! W		L	**	*
ka_1fa_1t			*! W	** W		L	**	L

b. /kælb/ → [kælbi] *dog*

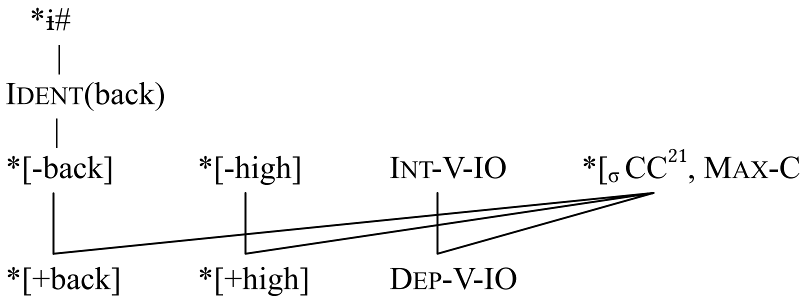
/kælb/	*ɨ#	IDENT(back)	*[-back]	*[+back]
kælbɨ	*!		*	*
☞ kælbi			**	
kalbi		*!	*	*

---

19 Uvular stops are also spirantized in Tigrinya, but we do not have any ludling data that shows uvular stops.

20 Recall that in our analysis there are no reduplicative consonants, and so the two [x]s in the winning output are not in correspondence with each other.

(46) rankings that account for natural language epenthesis:



The tableaus in (45) motivate the rankings in (46) if we consider a few additional pieces of information. First, tableau (45a) only shows that DEP-V is dominated by either INT-V or *[-high]. If we consider a hypothetical input of /kfit/, we would still expect epenthesis of [ɨ] and not reduplication of [i], and a tableau would show that DEP-V must be dominated by either INT-V or *[-back]. A conjunction of these two statements indicates that DEP-V is dominated by either INT-V or by both *[-high] and *[-back]. We present the ranking INT-V » DEP-V because this ranking straightforwardly captures the fact that epenthesis is the preferred repair to a syllable structure violation. Second, tableau (44b) does not motivate a ranking between *ɨ# and IDENT(back) (though it does indicate that both of these constraints must dominate *[-back]). If we consider a hypothetical input of /kælbɨ/ that would be mapped onto /kælbi/, we find that *ɨ# must dominate IDENT(back) in order to allow for the neutralization of the /i/ ~ /ɨ/ contrast in word-final position. To summarize, the ranking in (46) ensures that syllable structure violations will be repaired by epenthesis and never by deletion or reduplication and that the epenthetic vowel will be [ɨ] except in word-final position, where it will be [i].

As we have seen, [ɨ] is of course the epenthetic vowel of the Tigrinya ludlings, meaning that the ranking *[-back] » *[+back] still holds in the ludling grammar. Unlike the natural language, [ɨ] does occur in word-final position in the Tigrinya ludlings. In other words, word-final [ɨ] fronting underapplies in ludling forms. This underapplication occurs due to the high ranking of DEP-V-NL. As we see in tableau (47), epenthesis and reduplication of [i] in candidate (b) lead to same number of DEP-V violations as the winner and satisfy *ɨ#, but this candidate is ruled out by another (*ad hoc*) phonotactic constraint that is operative in Tigrinya (see Bagemihl 1988). The constraint *iCi# penalizes any word-final occurrence of the sequence [iCi], where C is any consonant, and is meant to capture the descriptive generalization that this sequence cannot be found in any NLOs or ludling outputs in Tigrinya.

(47) underapplication of word-final fronting in ludling forms (μ-Ludling)

	UR: /ʃɨm/ NL: [ʃɨm]	DEP-V-NL	*iCi#	*ɨ#	*[-back]	*[+back]
a.	☞...mɨgɨ	*		*		**
b.	...migi	*	*!		**	
c.	...mɨgi	**!			*	*

---

21 In order to simplify tableau (44b), we did not show any candidates that violate the syllable structure constraints that drive epenthesis in this word. A full tableau would show that *CC]σ has the same position as *[σCC.

When an [i] is epenthesized in Tigrinya, as in [kælbi] *dog*, the [i] is realized faithfully but is not reduplicated as expected in ludling outputs. Instead [kælbi] is encrypted as [kægælbɨgi] (σ-Lud) or [kægælɨgɨbɨgi] (μ-Lud). In both forms, the final syllable [bi] is encrypted as [bɨgi]. Thus, an encrypted form with reduplicative [i] in the word-final foot can be ruled out with a constraint *iCi#, which must dominate DEP-V-NL, as shown in (48)

(48) a TETRU effect: *iCi# is undominated (identical vowels in a single candidate are considered reduplicative)

UR:/kælb/ NL:[kælbi]	*iCi#	DEP-V-NL	*ɨ#	*[-back]	*[+back]	DEP-V-IO
a. ☞ ...bɨgi		*		*	*	**
b. ...bigɨ		*	* ! W	L	** W	* L
c. ...bigi	* ! W	L		** W	L	* L

The above tableau shows that DEP-V-IO is minimally dominated by *ɨ# (which dominates *[+back]). This gives the ranking *iCi# » DEP-V-NL » *ɨ# » DEP-V-IO, which is compatible with the TETRU ranking schema. Even though the Tigrinya ludlings normally favor vowel reduplication over vowel epenthesis, both available options for reduplication lead to highly marked structures. Hence, vowel epenthesis is the preferred repair for the encryption of words that underlyingly end in consonant clusters and thus have a word-final epenthetic [i] in the NLO.

In summary, we have shown how various permutations of the F-NL constraints can be described in the same ways that permutations of F-OO constraints were first discussed by Benua. In the Tigrinya ludlings, we have found examples of normal application, underapplication, and TETRU effects. While we have not found an example of overapplication in the Tigrinya ludlings, we did show such an example for English Pig Latin in §2.1, where the devoicing of /d/ overapplies in forms like [eɪktɹeɪ] from *raked*. The fact that we have found examples of all possible patterns that can be defined by the simultaneous use of F-NL and F-IO constraints supports the existence of an NL-correspondence relation.

4 Ludling Processes and Typology

Following the definition given by Bagemihl (1988), ludlings are a specific type of language game that involve the manipulation of the phonology and/or the morphology of a naturally occurring language. In this section we synthesize some of the diverse literature on this topic with a focus on the typology of ludlings in general and expansion ludlings (or those that involve the insertion of some crypteme) in particular. This section also includes some discussion of the broader phenomenon of *alternate languages* and of different ludling processes (in addition to expansion).

Our primary goals are to document ludling tendencies based on a database of 126 expansion ludlings that we have compiled from a variety of sources and to show how our method of analysis is consistent with these tendencies. This database shows that the Tigrinya σ-Ludling follows the most common type of ludling formation process. Thirty-eight ludlings (30% of all expansion ludlings; 39% of IILs) in our data base use a crypteme with reduplicative vowel (or full rime) that is ambiguously positioned either post-vocalically or pre-vocalically. The proliferation of this pattern is predicted by the simplicity of the grammar that accounts for it: ANCHORR/L(σ,Φ)-NL and FOOTBIN(σσ) are undominated and INTEGRITY, DEP, and *[feature] constraints are reranked according to the shape of the crypteme. The *[feature] constraints are freely rankable, and this accounts for the diversity of fixed consonants used in cryptemes. Other common patterns in IILs result from various rankings of the ANCHOR constraints. The uniqueness of the Tigrinya μ-Ludling is explained by the complexity of its grammar.

4.1 Alternate Languages

Bagemihl (1988: 1) defines alternate languages as "variant linguistic domains occurring alongside ordinary spoken languages, characterized by systematic manipulation of the phonological and/or morphological structure of the normal spoken language they are based on." Alternate languages are classified by exactly which domains of structure are adjusted, as shown in (49).

(49) Relation between alternate languages and natural languages (Bagemihl 1988)

- speech modification: differs in modality
  - example: whispered speech
- surrogate language: differs in modality and (hence) phonology
  - example: drummed Akan
- argot: differs in lexicon and optionally in morphology/phonology
  - example: Warlpiri ritual language *tjiliwiri*, where words are given opposite meanings
- ludling: differs in phonology and/or morphology
  - example: English Pig Latin

The terms *argot* and *ludling* are often used interchangeably in the literature, but we find it useful to distinguish between these two types of language play. An argot, as defined by Bagemihl, cannot be analyzed by adding or reranking OT constraints as it involves the use of new (and often unpredictable) lexical items. For example, Cockney Rhyming Slang (Anttila & Embelton 1995)[22] is a true argot and not a ludling according to Bagemihl's definitions. In this language game, a common word is replaced by a multi-word phrase that rhymes with the original word. Often, the rhyming element is then omitted when using the new slang formation. Users of this type of slang can say *plates* (from *plates of meat*) to mean *feet*. There is no general phonological or morphological relationship between *plates* and *feet*; rather one must memorize that the existing lexical item *plates* (and not, e.g., *cups*) can be used to convey the semantics of *feet*. Furthermore, there is no way to predict exactly what new slang term might be developed for words that have net yet undergone encryption. Speakers of Pig Latin, on the other hand, are able to encrypt any English word on the basis of learning the rules of encryption.

---

22 See also http://www.cockneyrhymingslang.co.uk/ for a description of Cockney Rhyming Slang and a dictionary of examples.

Of all alternate languages, ludlings enjoy the largest body of literature. This type of language play is common and occurs in a wide array of patterns. It is also the type of language play that seems the most fruitful for testing the predictions of various facets of linguistic theories of phonology and morphology due to the regularity of the relationship between ludling forms and NLOs. In §2.2 we laid out our claims about ludling grammars and their relation to natural language grammars and the predictions made by this relationship, and in §3.4 we discussed the predictions made by our specific analysis of Tigrinya ludlings. In this section, we present the broader picture of ludling typology, with a focus on IILs, and discuss how this typology relates to our proposals about ludling grammars.

4.2 Ludling Processes

Based on the extensive ludling surveys conducted by Pound (1964) and Laycock (1972), we can identify five categories of ludling processes, i.e. ways that ludling forms differ from NLOs. The relevant terminology is given with definitions and examples in (50).

(50) Common devices used in ludling formation (Pound 1964, Laycock 1972):

a. Expansion or affixation: The insertion of phonological material (a crypteme) that is not present in the NLO.
   - Spanish *Jerigonza*: libro *book* → lipibropo (Piñeros 1998)

b. Substitution: The replacement of phonological material in the NLO with new phonological material.
   - German: replace each vowel with <i>, *da sitzt 'ne Flieg' an der Wand* → di sitzt 'ni Flig' in dir Wind (Laycock 1972)

c. Rearrangement or transposition: The sequencing of segments in the NLO is modified.
   - English *back slang:* boy → yob (Oxford English Dictionary)
   - Telugu: balaka *boy* → kalaba *or* labalaka (Pound 1964)

d. Contraction: Phonological material from the NLO is deleted.
   - Javanese: silit ku kèpèt dilaten → lit ku pèt laten (Laycock 1972)

e. Graphophonemic: The names for letters that spell the word are used in ludling forms.
   - Hungarian: eső *rain* → klöpbaum émice klöpbaum ésmice klöpbaum őmice (Pound 1964)

Many language games utilize more than one system at once. For example, English Pig Latin (e.g. pig → [ɪgpeɪ]) is an expansion and rearrangement ludling. The graphophonemic game played with Hungarian in (49e) also utilizes expansion via the addition of <klöpbaum> and <mice> to each letter's name.

Following Bagemihl, it is clear that each ludling process involves a phonological and/or morphological deviation from NLOs. This means that all ludlings can be analyzed with the reranking of OT constraints (including ludling-specific constraints) and/or the use of a crypteme with underlying segmental material. We differ from both Bagemihl and Piñeros in that, while they identify the morphological domain as the primary difference between natural languages and ludlings, we have minimized the differences in morphology by showing that most IILs, the most common type of ludlings, can be analyzed without any changes in morphology (see further discussion in §4.3.2).

Graphophonemic ludlings are rare and may require some extra machinery in that speakers must access the names for orthographic symbols and may not actually make use of the surface forms of the words they are encrypting.

4.3 Typology of Expansion Ludlings

Of the five processes documented above, expansion (Laycock 1972) or affixation (Pound 1964) is by far the most common and is represented in a diverse set of languages. Furthermore, expansion is most commonly realized as iterative infixation. We refer to all ludlings in which encrypted forms contain more phonological material than unencrypted natural language outputs (NLOs) as *expansion ludlings*. We continue to use the terminology we introduced in previous sections: the phonological material used in expansion is called a *crypteme*; those ludlings that require a crypteme to appear once per some unit smaller than the word are called *iterative infixation ludlings* (IILs).

In order to further explore the typology of expansion ludlings, we compiled data from Pound (1964), Laycock (1972), and Botne & Davis (2000)[23]. We define each language game for the following variables: placement of crypteme (before or after) respective to some constituent (vowel, syllable, morpheme, word, etc.), syllable template of crypteme, and reduplicative elements of crypteme.

The positioning of many cryptemes is ambiguous and can thus be described in multiple ways. For example, if a VC crypteme is placed between a syllable onset and a vowel (e.g. /kæt/ → [kʌbæt]), this process could be described as insertion of [ʌb] after a syllable's onset or before a syllable's nucleus. There is no empirical reason to choose one description over another. We define the position of the crypteme in expansion ludlings as pre- or post- vowel, mora, syllable, morpheme, word, or orthographic symbol, as applicable. We do not define crypteme positions as relative to any other syllable constituent. Thus, we describe a form like [kʌbæt] as having a pre-vocalic [ʌb] crypteme.

Additional ambiguities with respect to not just crypteme placement but also crypteme shape can arise when reduplication is involved, as discussed above for the Tigrinya ludlings. For the σ-Ludling, the crypteme could be classified as a prevocalic [Vg] or a postvocalic [gV]. In our database, these ludlings are classified as having ambiguous crypteme placement and shape.

Syllable templates were defined by simple CV slots and complex onsets/codas were conflated with simple onsets/codas. For example a crypteme of the shape [kri] and one of the shape [na] are considered the same syllable template (CV), but a crypteme of the shape [nat] would be a different syllable template (CVC).

---

23 Both Pound and Laycock primarily document games that are played by speakers of European or Asian languages and include almost no languages of the Americas or of Africa. Botne & Davis provide a collection of data from Pound, Laycock, and other sources, including several languages of the Americas and Africa. We have not consulted the original sources from Laycock or Botne & Davis unless otherwise noted; Pound presents primary research. None of these sources document games played by indigenous languages of Australia, though six ludlings are documented from languages of New Guinea or New Zealand. It is clear that the use of ludlings is pan-cultural, but there is also a need for more data from languages of Africa, the Americas, and Australia.

Reduplication was found to occur for an onset consonant only, for a single vowel (syllable nucleus) only, or for an entire syllable rime. Because a rime may be composed of only a nucleus, ludlings that employ rime reduplication sometimes look like ludlings that employ nucleus reduplication. In languages that don't allow codas, nucleus and full rime reduplication will always lead to the same forms. We thus identify two main reduplication types: consonant and rime (with the latter including those games that only reduplicate a vowel and those that reduplicate an entire rime including optional coda consonants).

In many cases, the same language game was documented by multiple sources, and in other cases a single source treats similar variants of a language game as different language games. In order to avoid over-representation of single language games, we count as one game any variants that are spoken by the same linguistic group (e.g. American English) and have the same values for the variables defined above. For example, Italian speakers use an iterative infixation ludling with a crypteme that includes a fixed consonant and reduplicative vowel and that has ambiguous placement of pre-vowel or post-vowel. Four different fixed consonants have been documented for Italian: [p s z t]. Identity of a fixed consonant is not a variable we use to separate language games, and so these variants are counted as one game in our database.[24] The resulting database includes 126 expansion ludlings, 97 of which are IILs.

4.3.1 Noniterative Expansion

The 29 noniterative expansion ludlings in the database comprise those that attach some crypteme once per word. Each crypteme can be described as a prefix, suffix, circumfix, or infix relative to the NLO. There are two ludlings that use circumfixes of fixed segmentation and five that use infixes. These infixing ludlings place the crypteme after the first vowel, before the first vowel, before the final vowel, after the first syllable, or between two syllables (database includes one ludling per category). Two of the infixing ludlings use a crypteme with a reduplicative vowel; the other three use fixed segmentation.

Twenty-two noniterative expansion ludlings affix a crypteme to one edge of the word – six use a prefix and 16 use a suffix. This suffixing preference mimics the natural language preference for using suffixes over prefixes (e.g. Sapir 1921; Marantz 1988: 264; Hyman 2005). Of the prefixing ludlings, five cryptemes use entirely fixed segmentation (showing a wide range of structure: CC, CV, CVC, and CVCV) and one crypteme uses a single consonant [s] before vowel-initial words but [sV] (with reduplicative vowel) before consonant-initial words. Of the suffixing ludlings, twelve cryptemes use entirely fixed segmentation, and four use reduplication. Again, there is a wide range of crypteme shapes with fixed segmentation: C, V, CV, CVC, and polysyllabic forms. Of those that use reduplication, three cryptemes are a single syllable with a reduplicative rime and one has a complex polysyllabic form: [ənCəC], used in Gurage.

Due to the limited number of noniterative expansion ludlings, it is hard to draw firm conclusions about which patterns are more common than others. Many of these ludlings use cryptemes that have unique attachment locales and/or shapes. The few generalizations that are clear are that cryptemes are most commonly attached either at the beginning or at the ending of the word, with the latter being more prevalent, and that fixed segmentation is employed more often than reduplication. If we compare noniterative expansion ludlings to iterative expansion ludlings (discussed in the next section), we find the former are more likely to make use of

---

24 In §4.3.2 we discuss the types of consonants that occur in such ludlings, and so for these purposes we treat these four variants as distinct.

polysyllabic cryptemes or single segment cryptemes and are less likely to make use of reduplication.

Based on these tendencies, we suggest that noniterative expansion ludlings generally make use of a crypteme with underlying segmentation, unlike the Tigrinya IILs, and that this crypteme is best represented as either a prefix or a suffix (meaning its placement is handled by the same mechanisms that account for the concatenation of natural language morphemes). In the terms of our analysis, the difference between noniterative and iterative expansion ludlings is that the latter often make use of constraints of the ANCHOR family. These constraints force the mapping of some phonological unit onto a larger phonological unit (e.g. mapping a syllable onto a foot) and thus create a need for extra segmental material to be filled in (either with epenthesis or reduplication, as determined by the grammar). Noniterative expansion ludlings, on the other hand, do not make use of these ANCHOR constraints, and the only motivation for adding extra material (as compared to the NLO) must be that that material is there underlyingly as a crypteme. To put it succinctly, when ANCHOR constraints are used to build structure, ludling formation will always be iterative; consequently when structure is added non-iteratively, it must have another source.[25]

4.3.2 Iterative Expansion

In this section we take a closer look at the shape and placement of cryptemes in iterative infixation ludlings as found in our database of 97 IILs. We also show how our method of analysis is compatible with the majority of patterns found in iterative expansion ludlings and discuss how this type of analysis predicts for the common patterns to be common and for the rare patterns to be rare. In §§4.3.2.1-3 we focus on specific aspects of cryptemes: overall shape, identity of fixed consonants, and placement. In §4.3.2.4 we look at all of these aspects combined and discuss the asymmetries in IIL typology.

4.3.2.1 Crypteme Shape

As shown in (51), cryptemes in iterative infixation ludlings can be complex or simple syllables and can be composed of fixed or reduplicative material.

25 As discussed in §3.2.1, the EXPANSION and CRYPTPERFOOT constraints can also drive the need to fill in phonological material iteratively.

(51) Crypteme shapes in iterative infixation ludlings[26,27]

a. only fixed segments

i. single segment cryptemes (n = 2)

[m] (English)
[dʒ] (Albanian)

ii. monosyllabic cryptemes (n = 35)

[ælf] (English, US)
[ka] (Greek)
[ni] (Okinawan)
[lah] (Malay)

iii. polysyllabic cryptemes (n = 7)

<tagsa> (Hanunoo)
[kuti] (Spanish, Ecuador)
<igod> (English, US)

b. reduplicative segments

i. monosyllabic cryptemes with reduplicative consonants (n = 5)

[Cu] (Vietnamese)
[oC] (Estonian)

ii. monosyllabic cryptemes with reduplicative vowels or rimes (n = 39)

[zV] (Amharic, Ethiopia)
[pV(C)] (Portuguese, Brazil)
<grV> (Hausa)

iii. polysyllabic cryptemes with reduplicative vowels or rimes (n = 9)

[dVvV] (Finnish)
[denV] (Indonesian, Java)
<dV(C)qV(C)> (French)

Based on the counts provided above, there is a strong tendency for cryptemes to be the size of a single syllable and for that syllable to be composed entirely of fixed segments or for that syllable to include a reduplicative vowel or rime. Reduplication of consonants outside of full rime reduplication is rare, as are polysyllabic cryptemes. Single consonant cryptemes are the

---

26 As described above, syllable template was a variable used to determine if two different ludlings in our sources were categorized as two different ludlings in our database. Here, we simplify discussion by categorizing crypteme shape on the basis of number of syllables without reference to syllable template. If a crypteme shape is ambiguous due to reduplication, we only present the form that is given by our sources. See §4.3.2.3 for further discussion of ambiguous shape and placement.

27 Some ludling descriptions in our sources are not clearly specified as to whether phonetic syllables or orthographic ones are being used. We use square brackets for those cases where we are sure that the symbols used in our sources are phonological ones and angular brackets for those cases that are clearly orthographic or if there is doubt about the nature of the symbols. A capital C or V denote reduplicative consonants or vowels, respectively.

most rare – occurring for only two languages in our database.[28]

Our method of analysis, in which fixed segments occur because the ludling grammar treats these segments as the least marked and penalizes reduplication more than insertion, can account for all of these crypteme shapes with the possible exceptions of fully specified complex syllables and of polysyllabic cryptemes. Consider, for example, the Greek crypteme [ka]. This syllable can emerge as the optimal crypteme given the rankings INT-C » DEP-C; INT-V » DEP-V, and a ranking of *[feature] constraints that allows for [k] to be the least marked consonant and for [a] to be the least marked vowel. All of these constraints are already in CON – they simply need to be reranked in the ludling grammar in order to for [ka] to be the optimal syllable of the ludling language. See §4.3.2.3 for a caveat to this type of analysis.

Crypteme shapes such as English [ælf] or Finnish [dVvV] are unlikely to be optimal no matter the ranking of constraints already in CON. There are two possibilities for analyzing such ludlings that are compatible with our basic claims about ludling grammars. One is that there are ludling specific constraints that, when high-ranking, result in such cryptemes being optimal; the other is that these IILs do require a morphological component. In either case, ludlings that make use of complex cryptemes require extra machinery as compared to those with simple cryptemes. Only 27 of the 97 ILLs in our database make use of a crypteme that includes more than a single consonant and a single vowel (or reduplicative rime); the rarity of complex cryptemes is predicted by the fact that such ludlings make use of either ludling-specific constraints or of a morphological component, both of which may make them harder to learn and execute.

4.3.2.2 Fixed Consonants

As described above, the counts given here are based on data that conflates ludling variants with the same syllable template but different fixed segments. If we include identity of the fixed consonant as a separate parameter in counting monosyllabic cryptemes with reduplicative vowels or rimes, we can identify 60 different ludlings that follow this pattern. The segments used in such ludlings along with the number of times they appear in the data set are provided in (52).

(52) Consonants found in monosyllabic cryptemes with reduplicative vowels or rimes:[29]

p (14) b (5)			t (1) d (2)		k (2) g (5)
		dz (1)			
f (3) v (2)	ð (1)		s (5) z (5)	ʒ (1)	
			n (2)		
			l (3)		
			r (1)		
w (1)					

clusters: gr (2), ngr (1), lf (2), bl (1)

Some general patterns emerge from the above data: labials occur more often then other

28 An example of single consonant crypteme comes from an English game documented by Laycock (1972). The phrase 'going out today' becomes <goming mout tomdaym>.

29 One of the [p]s is a geminate. This was the only geminate used in a crypteme in our database.

places of articulation, obstruents occur more often than sonorants, a larger variety of voiced obstruents occur than voiceless obstruents, and [p] is by far the most commonly used crypteme consonant. These patterns do not directly correspond to general phonological claims about markedness relations among segment types. For example, dorsals have long been identified as relatively marked (Jakobson 1968) and coronals and laryngeals as less marked than other consonants (Lombardi 2002). Yet ludlings with a fixed [t] are rare and those with laryngeals are completely absent.[30] Another surprising aspect of the data above is the prevalence of voiced obstruents – especially [ð] and [ʒ] – which are commonly considered more marked than their voiceless counterparts (Keating 1984).[31]

Our claim that ludling grammars can treat segments that are cross-linguistically highly marked (such as [g]) as the least marked segment in encryption is supported by the fact that IILs have been found that employ a variety of fixed consonants, including voiced fricatives and laterals, as shown in (52). Thus, generalizations about segmental markedness that hold for NLOs do not account for crypteme shapes. As discussed in §3.1, the ludling grammar cannot produce default epenthetic segments that are generally highly marked if featural markedness constraints are in a stringency relation or in a universally fixed ranking.

The prevalence of [p] in cryptemes is discussed at length by Botne & Davis (2000). They propose that expansion ludlings – those that involve the insertion of a crypteme – can be divided into two groups: imposition and insertion. Insertion ludlings make use of a crypteme of fixed segmental content that is inserted "either following the syllable onset or between moras (p. 320)." Imposition games are those that make use of a monosyllabic crypteme that has a reduplicative vowel. These are exactly the games that are ambiguous with respect to crypteme shape and placement (i.e. prevocalic VC vs. postvocalic CV). They propose that such games are played by "imposing" some prespecified consonant onto a vocalic articulation and that this why the vowel is always reduplicated – because it is one vowel articulation.

While we agree with many of Botne & Davis's arguments as to why their analysis is superior to a templatic analysis (such as Bagemihl's), we remain unconvinced that there is a distinct split between imposition and insertion ludlings. It is true that many ludlings can be straightforwardly analyzed as having a consonant articulation imposed on a vowel articulation, but there are also several ludlings that make use of vowel reduplication but also have more complex crypteme shapes that would be hard to account for with an imposition analysis. Some examples include cryptemes of the shape <grV> (Hausa), [dVvV] (Finnish), and [denV] (Indonesian). The last example is particularly troublesome, as the imposition analysis would have to claim that the entire syllable [den] is imposed on a single vowel articulation.

Furthermore, there are indeed some ludlings that make use of consonant reduplication, and it is unclear if such ludlings should be treated as imposition or insertion ludlings when using Botne & Davis's classifications. Our analysis, on the other hand, treats vowel reduplication and consonant reduplication as two sides of the same coin; both allow for maximal satisfaction of the ANCHOR constraints used in the analysis of Tigrinya.

Finally, the imposition theory hinges on the fact that [p] is overrepresented as a fixed

---

30 On the other hand, highly marked segments like clicks, glottalized consonants, voiceless sonorants, etc. are never used. We leave it to future work to determine if this is a systematic omission from ludlings or due to that lack of these types of sounds in the languages that have been surveyed.

31 Many of these fixed segments occur in an intervocalic context, where voiced obstruents are considered less marked than their voiceless counterparts. It could thus be the case that the occurrence of voiced fricatives and stops is unsurprising. However, this would not explain the presence of [ð] or [ʒ] in place of the less marked [z] or the fact that in some cases the voiceless obstruents is more prevalent than the voiced one.

segment in cryptemes; a labial segment minimally impedes vowel articulation gestures and is thus ideal as an "imposed consonant". We find that the data does not fully support the asymmetry described by Botne & Davis. Labials in general are not over-represented – only [p] is over represented. The coronal fricatives occur more often than the labiodentals, and [g] occurs just as often as [b]. Furthermore, [m] is completely absent from the data, while [n] occurs twice. If the imposition theory is correct, we would expect to see more [m]s and [b]s, as these sounds allow for voicing to be maintained and require no tongue movement.

On the other hand, our analysis does not directly account for the fact that vowel reduplication is more common than consonant reduplication, and so we follow Botne & Davis in suggesting the imposition theory explains this fact. There is motivation in terms of ease of articulation to interrupt a vowel gesture with a consonant gesture, especially if the latter is labial. There is no articulatory motivation to interrupt a consonant gesture with a vowel gesture. In conclusion, we find that our method of analysis can account for a wider variety of IILs than the imposition theory, but that the imposition theory is useful to explain one asymmetry that is not accounted for with a factorial typology of the constraints that we use.

4.3.2.3 Crypteme Placement

Piñeros (1998) successfully accounts for the typology of crypteme placement in IILs based on three varieties of Jerigonza. The word *maestro* [ma.és.tro] 'teacher' can be encrypted as [ma.pa.es.pe.tro.po] (Colombia; post-syllabic crypteme), [tʃa.ma.tʃa.es.tʃa.tro] (Peru; pre-syllabic crypteme), or [ma.pa.e.pes.tro.po] (Costa Rica; pre- or post-vocalic crypteme). The Costa Rican variety positions cryptemes as in the Tigrinya σ-Ludling and thus both ANCHORR and ANCHORL are fully satisfied. In the Colombian and Peruvian varieties, only ANCHORL or ANCHORR are satisfied (respectively). Piñeros proposes that high-ranking CONTIGUITY(σ) can compel violations of a lower ranked ANCHOR constraint.[32]

(53) permutations of ANCHORR/L and CONTIG(σ) account for all varieties of Jerigonza

variety	example data	ranking
Peruvian (pre-syllable)	sol → tʃasol	ANCHORR, CONTIG(σ) » ANCHORL
Colombian (post-syllable)	sol → solpo	ANCHORL, CONTIG(σ) » ANCHORR
Costa Rican (pre/post-vowel)	sol → sopol	ANCHORL, ANCHORR » CONTIG(σ)

When we group IILs in our database by the position of the crypteme with respect to some constituent, we find a few more patterns than those of the Jerigonza varieties. Five IILs show unique patterns of crypteme placement: three place a crypteme after certain orthographic symbols, one places a crypteme after each morpheme, and another places a crypteme after each vowel and the word final consonant. The last of these is the only ludling we found that approximates the pattern of the Tigrinya μ-Ludling and is discussed in more detail in §4.3.2.4. These five IILs are excluded from the discussion below, leaving 92 IILs categorized by crypteme placement. We can extend Piñeros's use of ANCHORR, ANCHORL, and CONTIGUITY(σ) to account

32 Piñeros defines the constraint O-CONTIG(σ) as "The segments of a syllable in J[erigonza] standing in correspondence with the segments of a syllable in [the input] form a contiguous string." We can redefine this constraint as L-CONTIG(σ) in terms of the NL correspondence relation: "Assign a violation mark for each ludling syllable if the correspondents (in the NLO) of its segments do not form a contiguous string."

for all of the crypteme placements defined in (54).

There are four basic types of crypteme placement that appear in the database: post-syllable, pre-syllable, post-vowel, and pre-vowel. All cryptemes with reduplicative vowels or rimes that occur next to the vowel are ambiguous as to whether the crypteme is pre-vocalic or post-vocalic. As discussed in conjunction with the Tigrinya data, a form like [ʃɨgɨm] (from /ʃɨm/) can be described has having a prevocalic [ɨg] or a postvocalic [gɨ]. This also holds for some cryptemes that contain full rime reduplication and/or those that are polysyllabic. For example, French uses a post-syllabic crypteme of the form <dV(C)qV(C)> (Laycock 1972: 15), and thus the word *bien* is encrypted as <bien den qen> (with crypteme underlined). This crypteme could be equally well described as pre-vocalic <V(C)dV(C)q>: *bien* → <bien den qen>. Other types of ambiguous placement are documented in (54).

(54) crypteme placement in iterative infixation ludlings

a. pre-syllable (ANCHORR, CONTIG(σ) » ANCHORL)
- i. vowel-initial crypteme (n = 1)
  - [in] (Indonesian, Java)
- ii. consonant-initial crypteme (n = 15)
  - [pa] (Malayalam)
  - [kata] (Russian)

b. post-syllable (ANCHORL, CONTIG(σ) » ANCHORR)
- i. consonant-initial crypteme (n = 15)
  - [ra] (Bengali)
  - [fV] (Spanish, Mexico)

c. pre-vowel (ANCHORL, ANCHORR » CONTIG(σ))
- i. vowel-initial crypteme (n = 8)
  - <angl> (Bahnar)
  - [əns] (Tamajaq)

d. post-vowel (ANCHORL undominated)
- i. consonant-initial crypteme (n = 7)
  - [bi] (German)
  - <biya> (Amharic)

e. ambiguous placements
- i. post-syllable or pre-vowel (n = 5) (ANCHORL, ANCHORR, and CONTIG(σ) undominated)
  - [pVC] if post-syllable, [VCp] if pre-vowel (English, US)
    - [leɪt] → [leɪtpeɪt] 'late'
- ii. pre-syllable or pre-vowel (n = 3) (ANCHORL, ANCHORR, and CONTIG(σ) undominated)

[Cə] if pre-syllable, [əC] if pre-vowel (Mandarin)
[lúo] → [ləlúo] 'Lo (proper name)'

iii. post-vowel or pre-vowel (n = 38) (ANCHORL, ANCHORR » CONTIG(σ))
[dzV] if post-vowel or [Vdz] if pre-vowel (Greek, Greece)
[sxolio] → [sxodzolidziodzo] 'school'

Types (54c,d,e.i,e.ii) do not appear as Jerigonza varieties. Consider, for example, the pre-vocalic <angl> crypteme of Bahnar in (54c.i). Given the complexity of this crypteme, its segmental content is likely specified underlyingly, as discussed above. Its placement, however, allows for maximal satisfaction of both ANCHOR constraints at the expense of CONTIG(σ). The fact that this vowel-initial crypteme appears before the vowel and not after it allows for optimal syllable structure.

The post-vocalic cryptemes that do not make use of reduplication (type (54d)) provide an interesting challenge to our analysis so far. The placement of these cryptemes can lead to either ANCHORR or CONTIG(σ) violations. If the German [bi] crypteme is inserted into a CV syllable, the result [CVbi] violates ANCHORR (assuming the V of the NLO isn't [i]); whereas if this crypteme is inserted into a CVC syllable, the result [CVbiC] violates CONTIG(σ). Thus, ANCHORL alone is undominated and drives crypteme placement. This fact has consequences for how to analyze the shape of such cryptemes. Because the [bi] crypteme is a simple syllable, its shape could be accounted for by a grammar that treats [b] as the least marked consonant and [i] as the least marked vowel (as outlined in §4.3.2.1). However, such a grammar would not be able to choose among all the available ways of inserting a [b] and an [i] into an NLO syllable. A CVC word could appear as [CVbiC] and [CibVC] or [CVCbi]. We propose that the best analysis of such ludlings is to use a crypteme with underlying structure. The best way to satisfy ANCHORL and to realize a /bi/ crypteme while maintaining optimal syllable structure (no vowel hiatus and no adjacent consonants) is to map a CV form onto [CVbi] and a CVC form onto [CVbiC]. It is thus the case that IILs with fully specified post-vocalic cryptemes are a type of IIL that requires the use of a morphological component to the ludling grammar.

The cryptemes with ambiguous placements all make use of reduplication and fully satisfy both ANCHORR and ANCHORL; this is essentially the cause of the ambiguity in terms of placement. The differences among placement types (54e.i-iii) have to do with the ranking of DEP-V, DEP-C, INT-V, and INT-C. The Mandarin ludling with a [Cə]~[əC] crypteme prefers consonant reduplication (DEP-C » INT-C) and vowel epenthesis (INT-V » DEP-V), while the Greek ludling with a [dzV]~[Vdz] crypteme utilizes the opposite rankings. Additionally, CONTIG(σ) is fully satisfied by types (54e.i-ii). We further discuss the correlation between reduplication and ambiguous placement in the next subsection.

Because the ANCHOR constraints proposed by Piñeros are successful in accounting for all the crypteme placements found in IILs, we reject the use of ALIGNMENT constraints in the analysis of IILs as previously proposed by Yu (2008); see previous discussion in §§2.3 and 3.1. Constraints of the ANCHOR family are less stipulative and lead to a more restrictive typology. For example, an ALIGNMENT analysis of Costa Rican Jerigonza would make use of a constraint that demanded alignment between the right edge of each vowel and the left edge of each [p] (analogous to Yu's ALIGN(-b-,L,μ_{SH},R) constraint, with 'p' in place of 'b'). This analysis misses the fact that the placement of the crypteme is ambiguous. Any analysis with ALIGNMENT constraints will have to stipulate the shape and placement of the crypteme even when multiple shapes and placements are descriptively accurate, and a different type of ALIGNMENT constraint would be needed to account for each of the placement types given in (54).

4.3.2.4 IIL Typology Summary

Table (1) shows each IIL in our database (excluding the 5 IILs that show unique crypteme placements) as defined for the variables of crypteme placement and shape. In this table we conflate monosyllabic and polysyllabic cryptemes and instead define cryptemes by their initial segment (consonant or vowel) and by which segments are reduplicated (if any).

Table 1: IILs as classified by crypteme position and shape

	Position	Initial segment	Reduplication	Number of ludlings
unambiguous placement	post-syllable	C	none	12
	post-syllable	C	consonant	1
	post-syllable	C	vowel only	2
	pre-syllable	C	none	13
	pre-syllable	C	vowel or rime	2
	pre-syllable	V	none	1
	post-vowel	C	none	7
	pre-vowel	V	none	8
ambiguous placement	pre- or post-vowel	(depends on position)	vowel or rime	38
	post-syllable or pre-vowel	(depends on position)	rime	5
	pre-syllable or pre-vowel	(depends on position)	consonant	3

One generalization that emerges from the above table is that crypteme shape favors CV syllable structure. For example, all post-vocalic cryptemes are consonant-initial (avoids vowel hiatus) and all pre-vocalic cryptemes are vowel-initial (with a following consonant). There is only one vowel-initial pre-syllabic crypteme ([in], Indonesian), and the use of this crypteme leads to consonant clusters but never creates vowel hiatus. In general, the addition of a crypteme to an NLO will not lead to more marked syllable than what was already present in the NLO (see also Ito et al. 1996).

Unlike noniterative expansion ludlings which showed a clear preference for suffixation over prefixation, IILs show no preference for pre-syllable vs. post-syllable or pre-vowel vs. post-vowel placement. We suggest that the lack of an asymmetry in IILs results from the fact that all IIL cryptemes appear as infixes in words of long enough form; they are never true prefixes or suffixes. This fact contradicts Yu's (2008) claim that ILLs are predominantly suffixing. Yu does not provide evidence for this statement, but we believe that it is derived from his method of analysis (as discussed in the previous section) that stipulates all ludlings with an ambiguous pre- or post-vowel placement as having a post-vowel crypteme.

Table (1) shows that while ambiguity only results from reduplication, reduplication does not always cause ambiguity. However, reduplication is rare with unambiguous pre-and post-syllabic cryptemes. Recall from §4.3.2.3 that these ludlings require CONTIGUITY(σ) to dominate one of the ANCHOR constraints. In the terms of our analysis, when ANCHORR and ANCHORL are undominated, there are three ways to stretch a CV syllable onto a disyllabic foot: insert a pre-vocalic crypteme (CvcV), reduplicate the initial consonant and insert a vowel (CvCV), or reduplicate the vowel and insert a consonant (CVcV). This first option, which does not use reduplication, is used by the 8 ludlings that have an unambiguous pre-vocalic crypteme. The latter options, which do use reduplication that results in ambiguous crypteme placement, are used by 3 and 38 ludlings, respectively. There is thus a correlation between undominated CONTIG(σ) and dispreference for reduplication as there is a correlation between undominated ANCHORL/R and a preference for some type of reduplication (with vowel or rime reduplication occurring more often than consonant reduplication).

If we consider the Tigrinya ludlings in light of the above table, it is clear that the σ-Ludling follows a cross-linguistically common pattern (that of ambiguous post- or pre-vowel placement with vowel reduplication), which shows up in over a third of the IILs in our database. The μ-Ludling, however, is almost unique. We have found one other ludling in the literature that approximates this system. Pound (1964) describes a language game of English used in Jamaica in which [pV] is inserted after every vowel and <ipi> occurs after the word-final consonant letter. For example, *girl* is encrypted as *gipirlipi*. This game is one of the ludlings that was not included in the above tables because the placement of cryptemes is in some way sensitive to orthography. For both the Jamaica ludling and the Tigrinya μ-Ludling, we claim that the typological rarity of these games is directly correlated with the complexity of the grammar needed to generate them.

5 Conclusions

Our analysis of two ludlings in Tigrinya has made contributions to several aspects of phonological theory as it is used in the analysis of both natural languages and language games (especially IILs).

We found that ludlings are best analyzed by treating reduplication as emergent and by using a surface-to-surface correspondence relation to account for similarities between ludling outputs and natural language outputs. We thus introduced the NL-correspondence relation and suggested that this works best if NLOs are stored in the head and have representations that include even predictable information (as proposed by Steriade (1999) for the analysis of natural language). This result provides support for this type of analysis of morphologically complex words of the natural language. Additionally, the diversity of fixed consonants used in IILs provides an argument against the use of *[feature] constraints in stringency form or in a universally fixed ranking. Finally, the specific constraints used in our analysis support certain types of prosodic structures. First, we support the distinction between two types of moras – those that denote timing and those that license segments in certain syllable positions (timing and positional moras, respectively) – and this distinction is important in the analysis of true and false geminates in the Tigrinya ludlings. Second, we have shown that ludling-specific constraints (e.g. ANCHORR/L(σ,Φ)) make use of generally accepted constraint building blocks, including reference to the prosodic categories of mora, syllable, and foot. This shows that ludling users are at least implicitly aware of these categories and can manipulate them in language play.

With regard to ludlings, we have shown that the ludling grammar can differ in surprising ways from the natural language grammar. It is not always the case that the natural language grammar is minimally altered (i.e. only constraints that position or shape the crypteme are added or moved) in order to define the ludling grammar. With specific regard to expansion ludlings, we found that noniterative expansion ludlings generally need a morphological component (i.e. the shape of the crypteme must be specified underlyingly and its placement is treated just like the concatenation of any other affix and stem in the language) but that IILs generally do not need to appeal to morphology. Thus, the grammatical changes that occur in IILs as compared to the natural language are solely in the realm of constraint ranking (including the addition of ludling-specific constraints). This is likely related to the fact that IILs are the most common type of ludling – they are simpler to play in that users only need to manipulate one grammatical domain. The suppression of a morphological component is dependent on our use of ANCHOR constraints as opposed to ALIGNMENT constraints, and we showed that there is another advantage of this type of analysis. ANCHOR constraints lead to a more restrictive typology in terms of crypteme placement in IILs, and this typology is just restrictive enough to define all and only the types of crypteme placement we have found in IILs around the world.

References

Alderete, John (2001). Dominance effects as transderivational anti-faithfulness. *Phonology* **18**. 201–253.

Anttila, Raimo and Sheila Embleton (1995). The Iconic Index: From Sound Change to Rhyming Slang. In Raffaele Simone (ed.), *Iconicity in Language.* Philadelphia: John Benjamins. 87-118.

Bagemihl, Bruce (1987). Tigrinya speech disguise and constraints on spreading rules. *WCCFL* **6**. 1-15.

Bagemihl, Bruce (1988). Alternative phonologies and morphologies. PhD dissertation, University of British Columbia.

Baker, Adam (2003). Reduplication as minimal copying to fill empty prosodic structure. Paper presented at the University of North Dakota colloquium, June 12, 2003.

Barlow, Jessica (1997). A constraint-based account of syllable onsets: evidence from developing systems. PhD dissertation, Indiana University.

Barlow, Jessica (2001). Individual differences in the production of initial consonant sequences in Pig Latin. *Lingua* **111**. 667-696.

Bates, Dawn and Barry Carlson (1998). Spokane (Npoqínicn) syllable structure and reduplication. In Ewa Czaykowska-Higgins and M. Dale Kinkade (eds.), *Salish Languages and Linguistics: Theoretical and Descriptive Perspectives*. Berlin: Mouton de Gruyter. 99-124.

Benua, Laura. (1997). Transderivational identity: phonological relations between words. PhD dissertation, University of Massachusetts, Amherst.

Bermúdez-Otero, Ricardo (2011). Cyclicity. In Marc van Oostendorp, Colin J. Ewen, Elizabeth V. Hume, and Keren Rice (eds.), *The Blackwell Companion to Phonology*. Malden, MA: Wiley-Blackwell. 2019-2048.

Bermúdez-Otero, Ricardo and Ana R. Luís (2009). Cyclic domains and prosodic spans in the phonology of European Portuguese functional morphs. Paper presented at the Workshop on the Division of Labour between Morphology and Phonology & Fourth Meeting of the Network 'Core Mechanisms of Exponence.'

Borowsky, Toni and Peter Avery (2009). Dhochi: a Dholuo language game. *Australian Journal of Linguistics* **29**. 169-194.

Botne, Robert and Stuart Davis (2000). Language games, segment imposition, and the syllable. *Studies in Language* **24**. 319-344.

Burzio, Luigi (1994). *Principles of English stress*. Cambridge: Cambridge University Press.

Burzio, Luigi (1997). Cycles, non-eerived-environment blocking, and correspondence. Unpublished manuscript, Johns Hopkins University.

Campos-Astorkiza, Rebeka (2004). Faith in moras: a new approach to prosodic faithfulness. *NELS* **34**. 163-174.

Chomsky, Noam and Morris Halle (1968). *The sound pattern of English*. New York: Harper & Row.

Chrisman, Oscar (1894). Secret language of children. *Science* **23**. 18-19.

Cowan, Nelson (1989). Acquisition of Pig Latin: a case study. *Journal of Child Language* **16**. 365-386.

de Lacy, Paul V. (2002). The formal expression of markedness. PhD dissertation, University of Massachusetts, Amherst.

Harris, John and Ellen Kaisse (1999). Palatal vowels, glides, and consonants in Argentinian Spanish. *Phonology* **16**. 117-190.

Hirschberg, L. R. (1913). 'Dog Latin' and sparrow languages used by Baltimore children. *Pedagogical Seminar* **20**. 257-58.

Hume, Elizabeth and Georgios Tserdanelis (2002). Labial unmarkedness in Sri Lankan Portuguese Creole. *Phonology* **19**. 441-458.

Hyman, Larry M. (2008). Directional asymmetries in the morphology and phonology of. words, with special reference to Bantu. *Linguistics* **46**. 309–350

Ito, Junko, Yoshihisa Kitagawa, and Armin Mester (1996). Prosodic faithfulness and correspondence: evidence from a Japanese Argot. *Journal of East Asian Linguistics* **5**. 217-294.

Jakobson, Roman (1968). *Child language, aphasia, and phonological universals*. The Hague: Mouton.

Keating, Patricia (1984). Phonetic and phonological representation of stop consonant voicing. *Lg* **60**. 286–319.

Kenstowicz, Michael (1982). Gemination and spirantization in Tigrinya. *Studies in the Linguistic Sciences* **12**. 103–122.

Kenstowicz, Michael and Atiwong Suchato (2006). Issues in loanword adaptation: a case study from Thai. *Lingua* **116**. 921–949.

Kiparsky, Paul (1982). Lexical morphology and phonology. In I.-S. Yang (ed.), Linguistics in the Morning Calm. Seoul: Hanshin. 3-91.

Kiparsky, Paul. (1997). LP and OT. Paper presented at the LSA Summer Linguistic Institute, Cornell University.

Kiparsky, Paul (2010). Reduplication in stratal OT. In Linda Uyechi and Lian-Hee Wee (eds.), *Reality, Exploration, and Discovery: Pattern Interaction in Language and Life* (Festschrift for K. P. Mohanan). Stanford: CSLI. 125-142.

Laycock, Don (1972). Towards a typology of ludlings, or play-languages. *Linguistic Communications: Working Papers of the Linguistic Society of Australia* **6**. 61-113.

Leslau, Wolf (1941). *Documents Tigrigna: Grammaire et Textes*. Paris: Société de Linguistique de Paris.

Lombardi, Linda (2002). Coronal epenthesis and markedness. *Phonology* **19**. 219–251.

Marantz, Alec (1982). Re reduplication. *LI* **13**. 435–482.

Marantz, A. (1988). Clitics, morphological merger, and the mapping to phonological structure. In M. Hammond and M. Noonan (eds.), *Theoretical Morphology*. San Diego: Academic Press. 253–270.

Marlett, Stephan A (2010). Round vowel and dorsal consonant epenthesis in Seri. *Working Papers of the Summer Institute of Linguistics, University of North Dakota Session* **50**. 1-13

McCarthy, John J. (2000). Faithfulness and prosodic circumscription. In Joost Dekkers, Frank van der Leeuw, and Jeroen van de Weijer (eds.), *Optimality Theory: Syntax, Phonology, and Acquisition*. Oxford: Oxford University Press. 151-189.

McCarthy, John J. (2005). Optimal paradigms. In Laura Downing, Tracy Alan Hall, and Renate Raffelsiefen (eds.), *Paradigms in Phonological Theory*. Oxford: Oxford University Press. 170–210.

McCarthy, John J. and Alan Prince (1993a). Generalized alignment. In Geert Booij and Jaap van Marle (eds.), *Yearbook of Morphology*. 79-153.

McCarthy, John J. and Alan Prince (1993b). *Prosodic Morphology I: Constraint Interaction and Satisfaction*. Technical Report #3, Rutgers University Center for Cognitive Science.

McCarthy, John J. and Alan Prince (1995). Faithfulness and reduplicative identity. In Jill Beckman, Suzanne Urbanczyk and Laura Walsh Dickey (eds.), *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*. 249-384.

Monahan, K. P. (1982). Lexical phonology. PhD dissertation, MIT.

Pam, Martin (1973). Tigrinya phonology. PhD dissertation, City University of New York.

Piñeros, Carlos Eduardo (1998). Prosodic morphology in Spanish: constraint interaction in word-formation. PhD dissertation, Ohio State University.

Pound, Glen (1964). Phonological distortion in spoken secret languages: a consideration of its nature and uses. PhD dissertation, Indiana University.

Prince, A. S. (1997a). Paninian relations. Paper presented at University of Massachusetts, Amherst Colloquium.

Prince, A. S. (1997b). Stringency and anti-Paninian hierarchies. Paper presented at LSA Institute.

Rose, Sharon (2000). Rethinking geminates, long-distance geminates, and the OCP. *LI* **31**. 85–122.

Saba Kirchner, Jesse (2010). Minimal reduplication. PhD dissertation, University of California, Santa Cruz.

Sanders, Nathan (1999). Same-edge alignment with opposite edge effects. Paper presented at WCCFL 18, University of Arizona.

Sapir, Edward (1921). *Language*. New York: Harcourt, Brace & World.

Scheer, Tobias (2008). A lateral theory of phonology (vol. 2). How morpho-syntax talks to phonology: a survey of extra-phonological information in phonology since Trubetzkoy's Grenzsignale. Unpublished manuscript, Universite de Nice.

Schein, Barry (1981). Spirantization in Tigrinya. In H. Borer and J. Aoun (eds.), *Theoretical issues in the grammars of Semitic languages*. MIT Working Papers in Linguistics. 32-42.

Sherzer, Joel (1970). Talking backwards in Cuna: the sociological reality of phonological descriptions. *Southwestern Journal of Anthropology* **26**. 343-353.

Smith, Jennifer L. (2006). Correspondence theory vs. cyclic OT: beyond morphological derivation. *NELS* **36**. 531-546.

Spaelti, Philip (1999). Dimensions of variation in multi-pattern reduplication. PhD dissertation,

University of California, Santa Cruz.
Steriade, Donca (1999). Lexical conservatism. In Sung-Yun Bak (ed.) *Linguistics in the Morning Calm* 4, Selected Papers from SICOL-'97. Seoul: Hanshin. 157-180.
Wilbur, Ronnie and Lesa Petersen (1997). Backwards signing and ASL syllable structure. *Language and Speech* **40**. 63-90.
Yip, Moira (1982). Reduplication and CV skeleta in Chinese secret languages. *LI* **13**. 637-661.
Yu, Alan (2005). Toward a typology of compensatory reduplication. *WCCFL* **24**. 397-405.
Yu, Alan (2008). On iterative infixation. *WCCFL* **26**. 516-524
Zec, Draga (1995). Sonority constraints on syllable structure. *Phonology* **12**. 85-129.
Zwicky, Arnold and Geoffrey Pullum (1987). Plain morphology and expressive morphology. *BLS* **13**. 330–340.

Appendix: Tigrinya Stress

The following Tigrinya words were provided by Bagemihl (1988). We show stress in these words as determined by the speech of our native speaker consultant, Mr. Ibrahim Abdelnour. We only show primary stress for natural language forms. Where the authors disagreed on the placement of stress, we show both forms. For ludling forms, we show both primary and secondary stress and indicate variation where the authors disagreed on the placement of primary stress. We know of no other source that indicates stress placement in Tigrinya.

Gloss	Transcription	σ-Ludling Form
he wrote	s'æˈħifu	ˌs'ægæˌħigiˈfugu
yellow	bɨˈtʃ'a ~ ˈbɨtʃ'a	ˌbɨgɨˈtʃ'aga
what	ʔinˈtaj	ˌʔiginˈtagaj
gnat	ˈk'arma	ˈk'agarˌmaga ~ ˌk'agarˈmaga
name	ˈʃɨm	ˈʃɨgɨm
dog	ˈkælbi	ˈkægælˌbɨgi ~ ˌkægælˈbɨgi
your (m.s.) box	sanˈdukka	
Is it (black) sesame?[33]	sæliˈtudo	
known (f.)	fɨˈlɨtti	
Is it (a) kidney?	kuˈliddo	
heavy (pl.)	ˈkæbbætti ~ kæbˈbætti	
you (m.s.) bought	ʕadˈdikka	
your (m.s.) donkeys	ʔaʔˈdukka	
towards	ˈʔaga	
topic	næˈgær ~ ˈnægær	
donkey	ʔadˈgi ~ ˈʔadgi	
virgin	ˈdɨngɨl	
gun	ˈgɨns'ɨl	
kind of fruit	ʕakˈkat ~ ˈʕakkat	
your (m.s.) calf	mɨˈraxka	
tooth	ˈsɨnni	
our (powdered) incense	ʕɨˈt'anna	
city, country	ʕadˈdi	
Is it (stick) incense?	ˈʕuddo	
he is beating/killing	jɨˈx'ættɨl	
open (f.)	kɨˈfɨtti	

33 Bagemihl transcribes this word as [sæliddo], but Mr. Abdelnour produced the four-syllable form transcribed here. He indicated that this is an idiom that means *Is it completed?*