Morpheme-specific phonology as paradigmatic contrast: the case of Haitian pronouns

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Abstract

In Haitian Creole, pronouns have a long and a reduced form. Long forms generally reduce when adjacent to a vowel, but the third person plural pronoun *yo* [jo] 'they' has an exceptional behavior: it reduces to *y* [j] prevocalically (_V) but not postvocalically (V_), although coda [j] is phonotactically licit in the language. This paper proposes to analyze this puzzling pattern of morpheme-specific phonology as a case of paradigmatic contrast: *yo* cannot reduce to *y* postvocalically because it would be perceptually too similar to the morphologically minimally distinct short pronoun *l* [l] 'he/she/it' in this context. The paper provides evidence that Haitian [l] and [j] are indeed more confusable in coda than in onset and, in particular, that coda [j] is more often incorrectly identified as [l] than coda [l] as [j].

1. Introduction

Paradigmatic contrast (Kenstowicz 2005) describes cases where languages seem to conspire to avoid *pernicious homophony* or *similarity* between two forms in a morphological paradigm (see also Lofstedt 2010, Blevins and Wedel 2009). This paper proposes that a puzzling pattern of morpheme-specific phonology in Standard Haitian Creole (henceforth, Haitian) can be analyzed as a case of paradigmatic contrast motivated by similarity avoidance.

In Haitian, pronouns come with a short and a long form (Table 1). Historically, the long forms are related to French strong pronouns (Fattier 1995:138). Haitian is a French-based creole and many lemmas in the language are adaptations of 17th-18th century French (Valdman 2015). Short pronouns are a Haitian innovation. They are derived from the long ones by reduction.

Long pronoun	Short pronoun	Translation
mwen [mwɛ̃]	m [m]	'I'

ou [u]	w [w]	'you' (singular)
li [li]	l [l]	'he', 'she', 'it'
nou [nu]	n [n]	'we', 'you' (plural)
yo [jo]	y [j]	'they'

Table 1. Long and short pronouns in Haitian.

Generally, short forms can occur prevocalically (1a) or postvocalically (1b). However, the short form *y* 'they' has a more constrained distribution: it is available prevocalically (1a) but not postvocalically (1b), where only the long form *yo* may occur (Valdmann 1988:75 and fieldwork with five native Haitian speakers). To make the glosses more readable, only one meaning for semantically underspecified pronouns is shown (*li/l* 'her', *nou* 'we').

(1)   a. M/w/l/n/y ale.

        'I/you/she/we/they went.'

        b. Pòl wè m/w/l/n/*y.

        'Paul saw me/you/her/us/them.'

This paper proposes that the reduction of *yo* is blocked postvocalically because *y* 'they' would be perceptually too similar to the short singular form *l* 'he/she/it' in this context (2a), according to the logic of paradigmatic contrast. Blocking does not occur prevocalically (2b) because [l] and [j] are distinct enough in this context and therefore the [l]-[j] contrast alone can carry the functional load of the distinction between singular and plural pronouns.

(2)   a. Pòl wè l/*y.

        'Paul saw her/them.'

        b. L/y ale.

        'She/they went.'

Section 2 motivates the hypothesis that the conditioning of the blocking of *yo*-reduction is morphophonotactic, as opposed to purely morphological or purely phonotactic. Section 3 provides

preliminary motivations for the analysis of the Haitian pattern in terms of paradigmatic contrast and explains under which conditions the two main models of paradigmatic contrast (speaker-based vs. listener-based models) can derive both the general onset-coda asymmetry and the specific blocking of *yo*-reduction (as opposed to *li*-reduction) in coda position. Section 4 provides empirical evidence for the perceptual predictions of the paradigmatic-contrast analysis.

If on the right track, this analysis provides further evidence for the role of phonetic detail in shaping morphological paradigms (see also Lofstedt 2010) and more specifically for the interaction of perceptual similarity and functional load in explaining morpheme-specific phonology (see also Wedel et al. 2013).

2. A morphophonotactic restriction

Coda *y* 'they' is banned regardless of its grammatical function: complement of a verb (3a), complement of a noun (3b), and subject (3c). Therefore, the conditioning is phonotactic and not morphological or syntactic. (4) shows that the restriction against reduction in postvocalic position does not hold for other pronouns. The judgments reported here were obtained from five native Haitian speakers.

(3)   a. Pòl wè **yo/*y**.

Paul see them

'Paul saw them.'

b. Frè **yo/*y** la ap gade Pòl

brother them the IPFV look Paul

'Their brother is looking at Paul.'

c. Li nesesè pou **yo/*y** ta Pari

it necessary COMP them be Paris

'It is necessary that they be in Paris.'

(4)   a. Pòl wè **m/w/l/n**.

Paul see me/you/her/us

'Paul saw me/you/her/us.'

b. Frè **m/w/l/n** la ap gade Pòl

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brother me/you/her/us the IPFV look Paul

'My/your/her/our brother is looking at Paul.

c. Li nesesè pou **m/w/l/n** ta Pari

it necessary COMP me/you/her/us be Paris

'It is necessary that I/you/she/we be in Paris.'

The source for the blocking of *yo*-reduction is not purely phonotactic either: [j] can occur in coda position in the Haitian lexicon (e.g. *fotèy* [fotɛj] 'seat'). In the *Dictionnaire inverse de la langue créole haïtienne* (Freeman 1989), 425 lemmas with word-final, postvocalic [j] are listed. Also, based on the phonotactics of the language, if any glide pronoun was to be banned postvocalically, one would expect it to be *w* [w] 'you' rather than *y* [j] 'they': coda [w] is less frequent than coda [j] in the Haitian lexicon. Freeman (1989) lists only 16 lemmas with word-final, postvocalic [w]. Also, coda [w] is more marked than coda [j] across languages (see Kubozono 2005 on the [aj] vs. [aw] asymmetry in English, Japanese, Korean, and Romanian).

As a consequence, the correct generalization about the restriction on the short form *y* is neither purely morphological nor purely phonotactic but morphophonotactic: the short pronoun *y* is not licensed postvocalically. In other words, the Haitian pattern is a case of morpheme-specific phonology. In constraint-based frameworks, morpheme-specific phonology can be modeled with lexically-indexed phonological constraints (Pater 2009). In the case at hand, one could posit the lexically-indexed markedness constraint in (5) to account for the exceptional behavior of *y*: this constraint penalizes coda [j] only in case [j] is also the exponent of the third person plural pronoun.

(5) *Coda[j]$_{3d.pers.plur}$

Assign a violation to any candidate where [j] appears in coda position and is the exponent of the third person plural pronoun.

If this constraint outranks the constraint favoring the reduction of pronouns (*Coda[j]$_{3d.pers.plur}$ >> ReducePronoun) while the constraint protecting input segments from deletion outranks the general markedness constraint against coda [j] (MaxSegment >> *Coda[j]), the distribution of Haitian [j] is correctly derived. Coda [j] is generally allowed in coda position (due to MaxSegment >> *Coda[j]; see Table 2a), unless it is the exponent of the third person pronoun (due to *Coda[j]$_{3d.pers.plur}$ >> ReducePronoun; see Table 2b). To allow for the reduction of pronouns in general, ReducePronoun must outrank MaxSegment (ReducePronoun >> MaxSegment; see Tableau 2c).

	/fotɛj/	*Coda[j]$_{\text{3d.pers.plur}}$	ReducePronoun	MaxSegment	*Coda[j]
☞	[fotɛj]				*
	[fotɛ]			*!	

(a) *fotèy* 'seat'

	/frɛ#jo#la/	*Coda[j]$_{\text{3d.pers.plur}}$	ReducePronoun	MaxSegment	*Coda[j]
☞	[frɛjola]		*		
	[frɛjla]	*!		*	*

(b) *frè yo la* 'their brother'

	/frɛ#li#la/	*Coda[j]$_{\text{3d.pers.plur}}$	ReducePronoun	MaxSegment	*Coda[j]
	[frɛlila]		*!		
☞	[frɛlla]			*	

(c) *frè l la* 'his/her brother'

Table 2. Deriving morpheme-specific phonology with lexically-indexed markedness constraints.

3. Paradigmatic contrast

3.1. Background on paradigmatic contrast

Although an analysis using the constraint in (5) works and provides an adequate model of the blocking of *yo*-reduction in Haitian, this constraint is not entirely satisfactory on typological grounds. Allowing any markedness constraint to be indexed with respect to any lexical property results in massive overgeneration. For instance, one may imagine a language with a high-ranked *Coda[j]$_{\text{[b]-initial word}}$ constraint, where coda [j] cannot occur in words starting with a [b]. A restrictive theory of morpheme-specific phonology (or of lexically-indexed constraints) is needed to avoid overgenerating typologically.

Paradigmatic contrast is one well-motivated and restrictive mechanism that can derive morpheme-specific phonology. Paradigmatic contrast is well motivated because it establishes a connection between morphology and phonology in a principled way: a phonological process is blocked (or triggered) in case its application (or nonapplication) would result in pernicious homophony or similarity between the

members of a morphological paradigm. The motivation comes from a basic principle of communication that word-forms should be distinct enough to allow for a smooth communication. Paradigmatic contrast is also restrictive because it restricts the kind of word-forms whose similarity can block or trigger a phonological process: the two word-forms must belong to the same paradigm. This restriction to paradigms, i.e. to sets of word-forms that share a syntactic category, is not arbitrary: Wedel et al. (2013) show that neutralizing processes are more likely to be blocked in lexical minimal pairs that share a syntactic category than in lexical minimal pairs with divergent syntactic categories. The reason is that lexical minimal pairs are less likely to be strongly distinguished by morphosyntactic context than nonminimal pairs because their syntactic distributions are more similar.

Cases of paradigmatic contrast motivated by homophony or similarity avoidance have been reported in many languages, including ChiMwi:ni (Kenstowicz 2005), Dakehl (Gessner and Hanson 2004), Hungarian (Rebrus and Törckenczy 2005), Russian (Bethin 2012), Swedish (Lofstedt 2010), and Trigrad Bulgarian (Crosswhite 1999). This paper proposes that the restriction on coda *y* 'they' in Haitian provides another example of paradigmatic contrast. The third person plural pronoun *yo* cannot be reduced to *y* after a vowel because it would be perceptually too similar to the short third person singular pronoun *l* 'he/she/it' in this context.[1] However, *yo* can be reduced to *y* prevocalically because it is sufficiently distinct from *l* in this context. Section 3.2 provides preliminary motivations for this proposal, focusing more specifically on the prevocalic-postvocalic (or onset-coda) perceptual asymmetry. Section 3.3 focuses on how to derive the specific blocking of *yo*-reduction (as opposed to *li*-reduction).

3.2. Preliminary motivations for the paradigmatic-contrast analysis

Three preliminary facts make the paradigmatic-contrast analysis plausible. First, there is evidence that consonants are realized with less precision and are perceptually weaker in coda than in onset positions (Ohala 1990, Sussman et al. 1997, Redford and Diehl 1999). This general perceptual asymmetry might explain why reducing pronouns is more problematic postvocalically than prevocalically. Although the bulk of the evidence comes from major place contrasts (e.g. [p]-[t]-[k]), the onset-coda perceptual asymmetry is likely to extend to Haitian [l]-[j]. In Haitian, [l] is a clear, dental lateral and [j] is palatal (Valdman 2015). As such, the two sounds should differ along the second formant (F2), with [l] having a

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1   It should be noted that *yo*-reduction is also blocked in coda contexts where the singular pronoun is unavailable for semantic/pragmatic reasons. In (i), *rasanble* 'gather' cannot be construed with an object denoting a single entity (as indicated by # in (i)). However, *y* is still blocked in coda position after this verb (as indicated by * in (i)). This is not necessarily a problem for an analysis of the Haitian pattern in terms of paradigmatic contrast: patterns described as involving paradigmatic contrast are typically grammaticalized.

    (i) Pòl rasanble *y/#l.
    'Paul gathered them/him.'

smaller F2 target than [j] (see Recasens and Espinosa 2005 on F2 realisations of clear [l] across a range of languages). But F2 transitions are less reliable in coda than in onset as a cue to place of articulation (see Sussman et al. 1997 for discussion). Also, there is evidence that the contrast between [l] and [j] can be neutralized specifically in coda position (Proctor 2009:56). For instance, in Cibaeño Spanish, clear /l/ and /j/ are neutralized and realized as [j] in coda (e.g. *papel* [papej] 'paper') but not in onset (*papeles* [papeles] 'papers'; Guitart 1981). Proctor (2009:115-117) argues that reduction to the glide represents gestural reduction. Interestingly, Cibaeño Spanish and Haitian are spoken on the same island, the island of Hispaniola (in the Dominican Republic and in Haiti, respectively), and there have been many contacts between the populations of the two countries across history (Turits 2005). If [l] is also slightly gesturally reduced in coda in Haitian (maybe due to contact with the neighbouring Cibaeño Spanish speakers), then it is likely to become more similar to [j] in this position. In accordance with the idea that Haitian coda consonants with a front constriction may be articulatorily reduced and become similar to [j], word-final [ʒ] optionally changed to [j] in some words, giving rise to [ʒ]-[j] variants for some lemmas (e.g. *zoranj* [-ʒ] vs. *zorany* [-j] 'orange'; Valdman et al. 2017). This pattern of variation will be further discussed in section 3.2.

Second, the relevance of the onset-coda perceptual asymmetry to Haitian phonology has already been pointed out in previous works. For instance, Russell Webb (2010) and Author (2018) explained the asymmetric adaptation of the French rhotic in onset vs. coda contexts as perceptually motivated: they proposed that the French rhotic was deleted in coda when adapted into Haitian (e.g. French *la mer* [lamɛʁ] 'the sea' vs. Haitian *lamer* [lamɛ]) but maintained in onset (e.g. French *rêver* [ʁeve] 'to dream' vs. Haitian *reve* [ɣeve]) because it was more difficult to perceive in coda. Russell Webb (2010) argues that this perceptual difficulty is likely to have been strengthened by the fact that the first Haitian speakers had a Gbe linguistic background. Modern Gbe languages, a group of languages spoken in West Africa, are genetically related to the languages spoken by the slaves brought by the French in Haiti in the 17th and 18th centuries (Valdman 2015: 183). These languages constitute the substrate of Haitian Creole and are therefore likely to have played an important role in shaping the phonological patterns of Haitian. Gbe languages happen to lack coda consonants (Capo 1991) and, because phonotactics influence perception (e.g. Dupoux et al. 1999), the first Haitian listeners are likely to have had difficulty perceiving coda consonants in the French input. This general perceptual difficulty with coda consonants might be one of the sources for the ban against coda *y* in Haitian.

Finally, on the morphological side, preservation of number distinctions (singular vs. plural) underlies other patterns of paradigmatic contrast. For instance, in Trigrad Bulgarian, a regular phonological process of vowel reduction is blocked in contexts where its application would result in homophony between singular and plural neuter nouns (Crosswhite 1999). In addition, Albright and Fuss (2012:276-277) note that there is a crosslinguistic tendency to avoid number syncretism specifically and that keeping singular and plural forms distinct can be done at the cost of introducing syncretism in other domains (e.g. case and gender). Under the paradigmatic-contrast analysis of Haitian, the blocking of

yo-reduction is motivated by the same crosslinguistically robust requirement to maintain singulars and plurals distinct enough.

Other morphological contrasts should also be made perceptually less distinct by pronoun reduction in coda. Pairs *l-n* ('he/she/it' - 'we/you.pl') and *m-n* ('I' - 'we/you.pl') are particularly relevant, since phonological contrasts [l]-[n] and [m]-[n] involve minimally distinct phonemes ([l]-[n] only differ in manner of articulation and [m]-[n] only in place of articulation) and these phonemes are likely to be less distinct in coda than in onset.[2] Why is reduction of these pronouns not blocked in coda as well? The reason might be that *l-y* is a morphological minimal pair whereas *m-n* and *l-n* are not. *L-y* only differ in number (singular vs. additive plural).[3] But *l-n* differ in both number (singular vs. associative plural)[4] and person (third vs. non-third). *M-n* also differ in both number (singular vs. associative plural) and person (first vs. non-third). If perceptual distinctiveness is more strongly required for lexical minimal pairs than for nonminimal pairs (Wedel et al. 2013), then there is a rationale for *l-y* being treated differently (with reduction-blocking) from *m-n* and *l-n* (without reduction-blocking). In other words, an analysis of the Haitian pattern in terms of paradigmatic contrast does not necessarily overgenerate reduction-blocking processes in the paradigm of pronouns.

3.3. Two scenarios for the emergence of the Haitian pattern

The discussion so far explains why it might be undesirable to have both reduced pronouns *l* and *j* available postvocalically. However, nothing was said about why this situation should be avoided specifically by blocking the reduction of *yo*. This section addresses this question. The answer happens to depend on the specific way paradigmatic contrast is modeled, in particular whether the source of paradigmatic contrast is attributed to the speaker or the listener. This section considers each analytical option, in turn.

The speaker-based model

According to one line of analysis, dispersion effects such as paradigmatic contrast arise through speakers unconsciously favoring communicatively efficient linguistic patterns (e.g. Flemming 2017; see Crosswhite 1999 and Lofstedt 2010 a.o. for paradigmatic contrast specifically). These models assume a

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2 For [m]-[n] at least, there is perceptual evidence that the contrast is less distinct in coda than in onset in English (see Repp and Svatiskula 1988).

3 Y 'they' is a regular/additive plural: it refers to several individuals/objects that the speaker could individually refer to using l 'he/she/it' (Corbett 2000).

4 *N* 'we/you.plur' is an associative plural: it refers to a group that includes the speaker or the adressee (Corbett 2000).

listener-oriented speaker who cares both about minimizing effort on their part and maximizing clarity for the listener. The speaker is assumed to have a knowledge of how perceptually similar any two sounds are in any context and how words are related to each other morphologically. They use this knowledge to shape their productions according to the principles of communicative efficiency.

Under this type of model, a possible scenario for the emergence of the Haitian pattern is the following. At an initial stage, only the long forms of pronouns (borrowed from French tonic pronouns) were available. Later, some speakers innovated and started reducing pronouns (arguably to reduce the effort and time necessary to produce the long forms). But they did it in a way compatible with the functional principle of maximizing clarity for the listener: this led them to block pronoun reduction for the morphological minimal pair *li-yo* 'he/she/it' - 'they' in contexts where the two reduced exponents would have been phonetically too similar, i.e. postvocalically (due to gestural reduction in this context). They did not ban the contrast between coda [j] and coda [l] across the lexicon because, in general, there are additional semantic/syntactic cues available to the listener to distinguish minimal pairs differing only in the presence of coda [l] vs. coda [j]. For instance, *mal* [mal] 'badly (adv)' and *may* [maj] 'link (noun)' have distinct syntactic categories and belong to distinct semantic fields.

Without further assumptions, this analysis cannot explain why sufficient distinctiveness between the two pronouns should be obtained specifically by blocking the reduction of *yo*. Indeed, there are at least two other ways to avoid a contrast between *l* and *y* postvocalically: blocking *li*-reduction only (rather than *yo*-reduction) and blocking both *li*- and *yo*-reductions. In speaker-based models of dispersion effects, the choice of a specific repair to insufficient distinctiveness is typically driven by nonperceptual considerations, e.g. minimizing articulatory effort (e.g. Flemming 2017). For instance, requiring both third person pronouns to be systematically unreduced postvocalically is effortful. Eliminating the poor *l-y* contrast should be possible at a smaller cost, i.e. by blocking the reduction of only one of the two pronouns.

However, the choice of blocking *yo*- rather than *li*-reduction cannot be motivated by a constraint penalizing articulatory effort: indeed, *y* [j] should be easier to produce than *l* [l] articulatorily (see Proctor's 2009 analysis of liquid-gliding as gestural reduction). This is not a fatal problem though, as long as other considerations beside effort can play a role, such as phonological markedness (in the sense of phonotactic probability). Previous studies have indeed shown that phonotactic probability influences speech production: phonotactic constraints that are less violated in the learner's input are less violated in the learner's productions (Goldrick and Larson 2008).

Phonological markedness can explain the preference of *l* over *y* in coda because, in Haitian, the type frequency of coda [l] happens to be higher than that of [j] and this should facilitate the processing of

coda [l] over coda [j] by the speaker. Among the 4821 lemmas ending in a consonant in Freeman (1989), 586 end in [l] (12%) and 425 in [j] (9%). The asymmetry in favor of [l] is likely to be actually stronger in the lexicon of Haitian speakers because the list of 425 lemmas ending in [j] in Freeman's dictionary includes lemmas with a variant ending in [ʒ] and, in some cases, this [ʒ]-variant is the most frequently used by Haitian speakers. For instance, although both *chatwouj* [ʒ] and *chatwouy* [j] 'octopus' are listed in Freeman's dictionary, *chatwouj* is preferred over *chatwouy*, according to Valdman et al. (2017). Among the 425 lemmas ending in [j], 103 have a [ʒ]-variant in Freeman (1989). Concretely, this means that, among Freeman's lexical entries, the number of lemmas actually ending in [j] in spoken Haitian is comprised between 322 and 425 (to be compared to the 586 lemmas ending in [l]).

Moreover, [l] is a dental consonant and dental is by far the most common place of articulation word-finally in Haitian: dentals account for 58% of word-final consonants in Freeman's dictionary (see Table 3).[5] This means that, given the phonotactics of their language, Haitian speakers should be more likely to produce dental [l] than palatal [j] in coda. The unmarkedness of coronals/dentals with respect to other places of articulation is also well documented across languages (Kang 2000).

Place of articulation	Consonants	Count	Frequency
Labial	p b m	589	12.0%
Labiovelar	w	16	0.3%
Labiodental	f v	188	3.8%
Dental	t d n s z l	2858	58.1%
Postalveolar	ʃ ʒ	319	6.5%
Palatal	j ɲ	453	9.2%
Velar	k g ŋ	492	10.0%

Table 3. Place of articulation in word-final position (count and type frequency based on Freeman 1989)

The listener-based model

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5 [ʒ]- and [j]-variants are counted as independent lemmas in this table.

An alternative line of analysis argues that dispersion effects such as paradigmatic contrast emerge through listeners' 'innocent misapprehension' and not as the result of speakers synchronically favoring more distinct sound patterns (e.g. Ohala 1990, Blevins 2004; see Blevins and Wedel 2009 on paradigmatic contrast specifically). For instance, Ohala (1990) argues that neutralization of stop place contrasts before a following stop is common crosslinguistically because listeners are likely to misperceive place contrasts in this position but not because speakers prefer to neutralize a contrast in contexts where it would not be distinct enough for the listener.

According to this line of analysis, the blocking of *yo*-reduction after a vowel in Haitian results from the patterns of misperception of the [l]-[j] contrast in this position: [j] is perceived as [l] more often than [l] is perceived as [j], resulting in Haitian learners inferring that only *l* is available as a short form postvocalically. In onset position, [l] and [j] are sufficiently distinct and therefore [j] is not misidentified as [l] as often as in coda position. Outside of the paradigm of pronouns, minimal pairs differing only by the presence of coda [l] vs. coda [j] are less likely to be misidentified because they are generally not in lexical competition. For instance, *mal* 'badly' and *may* 'link (noun)' have different syntactic categories and belong to different semantic fields: as a consequence, they are not expected to be confused in context (see Blevins and Wedel 2009). This explains why coda [j] may be banned as the exponent of the third person plural pronoun but not in the lexicon in general.

The hypothesis of a perceptual asymmetry favoring [l] over [j] is compatible with previous results on the coronal/dental bias in perception and lexical processing. For instance, in an ERP study on German, Friedrich et al. (2008) found that pseudowords with noncoronal place activate words with coronal place whereas pseudowords with coronal place do not activate as effectively words with noncoronal place. Ren and Austerweil (2017) show that one expects to observe a coronal bias in perception if coronal consonants are more frequent than consonants with other places of articulation. As shown in Table 3, dentals are more frequent than palatals in the Haitian lexicon and therefore a preference for [l] in perception is plausible in Haitian.

However, asymmetric identification of coda [j] as coda [l] is not sufficient to derive paradigmatic contrast. Indeed, there are two meaning-form mappings that are compatible with the conclusion that only *l* is available as a short form after a vowel. One of them is the meaning-form mapping attested in Haitian: among *l* and *y*, *l* is the only short form available postvocalically and its meaning is singular. The other meaning-form mapping corresponds to a case of syncretism: among *l* and *y*, *l* is the only short form available postvocalically and its meaning is ambiguous between singular and plural. Because learners likely use contextual information to disambiguate singular and plural meanings for pronouns when the two pronouns are similar, they should infer that what they perceive as [l] postvocalically can mean either 'singular' or 'plural' rather than only 'singular'. In other words, without further assumptions, this approach straightforwardly derives syncretism but not paradigmatic contrast.

One way to derive paradigmatic contrast is to posit a bias against homophony on the part of learners in addition. This bias could lead learners to discard all the evidence pointing to a plural meaning for what they perceive as *l* postvocalically, resulting in unreduced *yo* being the only possible exponent for the plural pronoun postvocalically. To account for why learners prefer the singular over the plural meaning as the unique meaning of *l* in postvocalic position, different explanations are available. Learners could be reluctant to let *l* alternate with *yo* and prefer to have it alternate with the phonetically closer *li*, in accordance with Steriade's (2009) P-map principle. Alternatively, the choice could be guided by morpheme frequency: singular nominals are generally more frequent than plural ones across languages (e.g. Greenberg 1966) and therefore a singular interpretation should be more likely than a plural one for an ambiguous pronoun.

Summary

The two main concurrent models for paradigm contrast can both derive the Haitian pattern in principle, although their predictions differ slightly. For the speaker-based model, the perceptual contrast between [l] and [j] must be less distinct in coda than in onset (H1). Combined with a speaker's preference for more distinct contrasts, this derives the onset-coda asymmetry. To explain why *yo-* rather than *li-* reduction is blocked, other factors such as phonological markedness must play a role as well. For the listener-based model, listeners must misidentify coda [j] as coda [l] more often than they misidentify coda [l] as coda [j], onset [j] as onset [l] and onset [l] as onset [j] (H2). Hypothesis (H2) derives the loss of *y* [j] in coda position. To explain why this loss results in paradigmatic contrast rather than syncretism, other factors such as homophony avoidance on the part of listeners must also play a role.

(H1) Haitian [l] and [j] are less distinct in coda than in onset.

(H2) Haitian coda [j] is more often misidentified as coda [l] than coda [l] as coda [j], onset [j] as onset [l] and onset [l] as onset [j].

4. Perception study

Section 3 has provided preliminary motivations for the analysis of the Haitian pattern as paradigmatic contrast. The goal of this section is to provide additional evidence for this analysis, focusing more specifically on the perceptual side of the account, i.e. hypotheses (H1) and (H2). The evidence comes from a perceptual study on the identification of Haitian [l] and [j] in onset and in coda positions.

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4.1. Methods

Stimuli

A native Haitian speaker (female) was recorded uttering 120 nonce words of the shape {l, j}VC (with [l] and [j] in onset) or CV{l, j} (with [l] and [j] in coda). C was chosen among the six Haitian oral stops /p t k b d g/ and V was chosen among the five Haitian oral vowels /i u e o a/. To control for the effect of the following consonant on the similarity of [l] and [j] in CV{l, j} words, three carrier sentences were used: *Mesyè* X *begwè, Mesyè* X *dezole*, and *Mesyè* X *goche*. In order to limit the number of stimuli to 120, only a subset of the 120 nonce words occurred in each of the three carrier sentences. Nonce words containing [p] or [b] occurred in the carrier sentence *Mesyè* X *goche.* Nonce words containing [t] or [d] occurred in the carrier sentence *Mesyè* X *begwè.* Nonce words containing [k] or [g] occurred in the carrier sentence *Mesyè* X *dezole.*

Recordings were done in a sound-attenuated booth, using a head-mounted Shure SM35-XLR microphone connected to a computer. The recordings were made using the Audacity software, with 44 kHz/16 bit sampling. The distance (approx. 5 cm) to the microphone was held constant across the recording session. In order to control for the effect of stimulus intensity, the amplitude of the sound files was equalized and scaled to a maximum peak value equal to one. The sound files were then mixed with speech-shaped noise with two different signal-to-noise ratios (SNR): 3 dB and -3dB. The goal of this operation was to test the robustness of the effect of syllabic position in different noise conditions: a condition where the signal is louder than the noise (3dB) and a condition where the noise is louder than the signal (-3dB). In order to keep the duration of the experiment relatively short, each participant was exposed to only one of the two noise conditions.

Task

The perceptual study was based on a forced-choice word identification task, run online. The 120 sentences were presented in randomized order to participants. On each trial, participants were asked to identify which word they heard among two choices (a [l]-word and a [j]-word). For instance, they would hear *Mesyè Bal goche* and be asked to check BAL or BAY depending on the word they heard. All participants indicated that they wore headphones or earplugs while taking the test.

Participants

A total of 67 participants took part in a perception study based on a forced-choice word identification task, run online. Participants with different language backgrounds were recruited in order to test for the robustness of the effect of syllabic position across different categories of listeners. The experiment was run online in order to make it easier to recruit Haitian listeners. Unfortunately, we were able to recruit only two Haitian listeners. The other participants were American English listeners and French listeners.

French was chosen due to its similarities with Haitian. In both languages, [l] is clear (i.e. with a relatively high F2 target) and therefore potentially confusable with [j]. Also, [l] and [j] have similar distributions in Haitian and French: they are allowed word-initially and word-finally in both languages. As in Haitian, there is an asymmetry favoring word-final [l] over word-final [j] in the French lexicon, although this asymmetry is probably stronger in French. For instance, Lexique 3.80 (New et al. 2007) contains 6415 lemmas with word-final [l] but only 1021 lemmas with word-final [j] (see section 3.3 on Haitian). All in all, French listeners are expected to behave similarly as Haitian listeners, and maybe with a stronger [l]-bias in coda position.

American English is less similar to Haitian, both phonotactically and acoustically. In particular, the front glide does not occur independently word-finally but only as the second element of diphthongs [aɪ], [eɪ], and [ɔɪ]. Also, word-finally, English [l] is not clear but dark (Sproat and Fujimura 1993). Because of these differences, American English listeners are likely to perform more poorly on the task than Haitian and French listeners. The lexical asymmetry favoring word-final [l] over [j] is also found in English. For instance, the Carnegie Mellon Pronouncing Dictionary [cmudict.0.6], accessed via the NLTK toolkit (Bird et al. 2009), lists 7463 lemmas with word-final [l] vs. 1571 lemmas with word-final [j]. However, because [l] is acoustically different in English and in Haitian, it is not clear how this lexical asymmetry will influence identification of Haitian [l] vs. [j] by English listeners.

The 28 English-speaking participants were recruited through Amazon Mechanical Turk (10 in the condition with SNR=-3 dB, 9 in the condition with SNR=3dB). The 37 French-speaking participants were recruited through the mailing list of the CNRS' *Réseaux d'information sur les sciences de la cognition* (20 in the condition with SNR=-3dB, 17 in the condition with SNR=3dB). The two Haitian-speaking participants (both in the condition with SNR=-3dB) were recruited via the Facebook page of *La Flamille*, a group of students in the Faculty of Applied Linguistics of the *Université d'Etat d'Haïti*. All participants gave their informed consent.
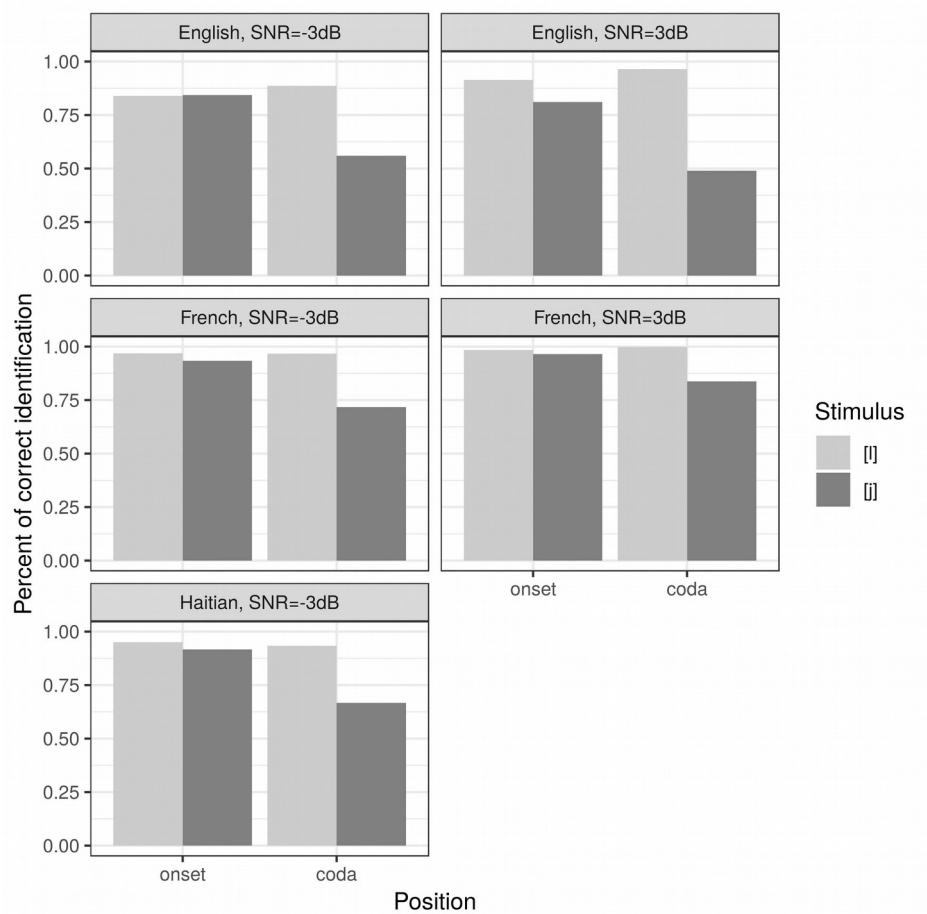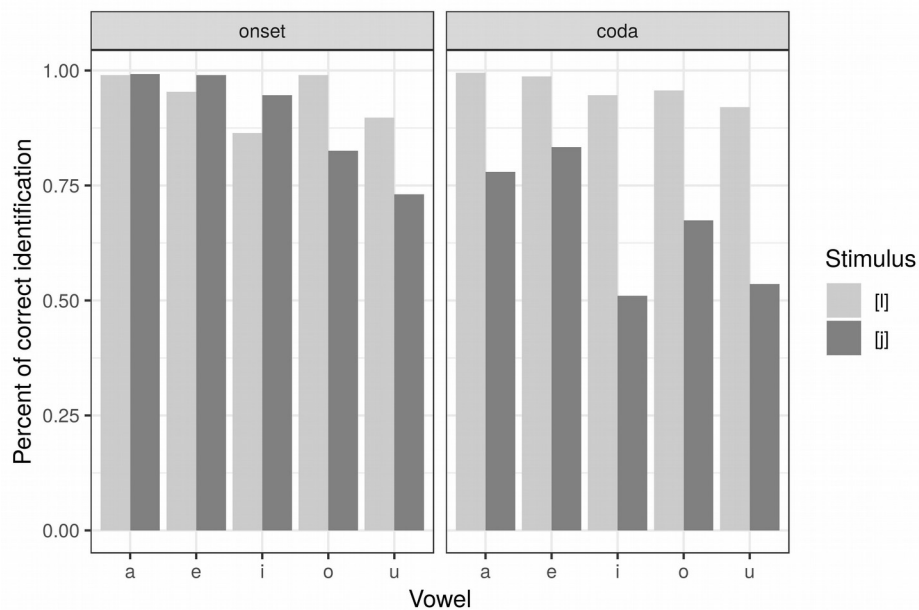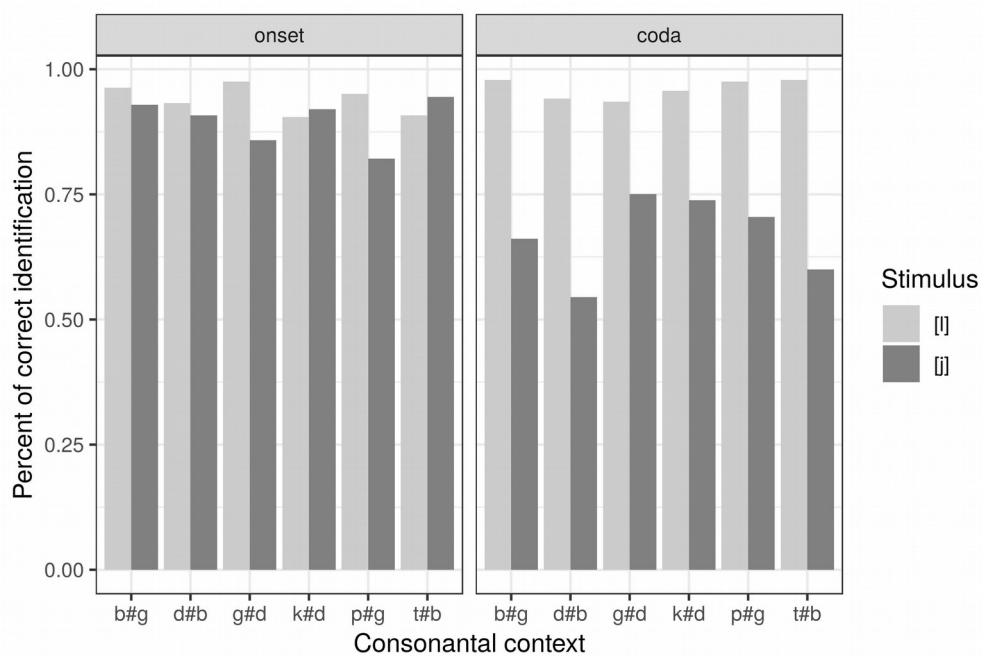
Figure 2. Percent of correct identification as a function of the target consonant's position (onset vs. coda) and identity ([l] vs. [j]) and listener condition.

(a) Effect of vowel context on the identification of [l] and [j] in onset and coda position, averaging across consonantal contexts, listener conditions, and participants.

(b) Effect of consonantal context on the identification of [l] and [j] in onset and coda position, averaging across vowel contexts, listener conditions, and participants (b#g holds for [_Vb#g] in onset and [bV_#g] in coda).

Figure 3. Percent of correct identification as a function of segmental context.

4.2. Results

Percent correct analysis

Figure 2 shows the effect of stimulus ([l] vs. [j]), position (onset vs. coda), and listener condition on listeners' ability to correctly identify the stimulus, averaging across segmental contexts and listeners.[6] Coda [j] appears to be the condition leading to the highest error rate across all five listener conditions, in accordance with (H2). The perceptual difficulty with coda [j] is not limited to a specific segmental context but appears to hold in each consonantal and vowel context, as shown in Figures 3a and 3b.

To assess the statistical strength of these effects, a mixed-effects logistic regression was fitted using R (R Core Team 2017) and lme4 (Bates et al. 2015). The dependent variable was the log odds of correctly identifying the stimulus. The model included position, stimulus, vowel context, consonantal context, listener condition, and the interaction of position and stimulus as fixed effects. The model also included a by-participant random intercept. Models with more complex fixed-effects or random-effects structures did not converge. In particular, it was not possible to include high order interactions between position, stimulus, and the other categorical variables of interest (vowel context, consonantal context, and listener condition) and get the models to converge. Concretely, this means that the model does not make it possible to statistically guarantee that coda [j] leads to the highest error rate in every condition.[7]

The summary of the model is reported in Table 4. The model confirms that, on average, identification is worse in coda than in onset (negative β) and with stimulus [j] than stimulus [l] (negative β). The model also shows a significant interaction of position and stimulus, confirming that the difference between [l] and [j] is larger in coda than in onset.

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6 There are five and not six listener conditions because the two Haitian listeners were both in the noise condition SNR=-3dB.

7 Additional models were run on subsets of the data and showed that coda [j] was significantly harder to identify correctly than the other stimuli for each listener condition in Figure 2.

The model also shows that identification is affected by segmental context and listener condition. On average, identification was found to be significantly better in the context of non-high front vowels [a e] than in the context of high or back vowels [i o]. The difference between non-high vs. high front vowels is compatible with previous results on the effect of vowel height on consonant-place identification (Lisker 1999, Alwan et al. 2011). Identification was found to significantly worse in [d#b] than in [b#g], [g#d], [k#d], and [p#g]. One possible interpretation of this finding is that identification of [j] was made harder when the target word contained a consonant sharing the same place of articulation as [l], i.e. dental. The presence of a dental in the same word may have biased listeners towards perceiving a dental word-finally. In line with this interpretation, identification of coda [j] also appears to be quite poor in the segmental context [t#b] (see Figure 3b). On average, French listeners were found to be significantly better at the task than English listeners, as expected based on the greater similarity between French and Haitian.

	β	Standard error	z value	p value
(Intercept)	2.49	0.13	18.99	<.001
Position=coda	-0.36	0.04	-8.49	<.001
Stimulus=[j]	-0.84	0.04	-19.48	<.001
Position:Stimulus	-0.49	0.04	-11.67	<.001
VowelContext=[a]	0.84	0.09	9.17	<.001
VowelContext=[e]	0.91	0.09	9.74	<.001
VowelContext=[i]	-0.60	0.07	-8.65	<.001
VowelContext=[o]	-0.18	0.07	-2.40	<.05
ConsonantalContext=[b#g]	0.17	0.09	2.02	<.05
ConsonantalContext=[d#b]	-0.38	0.08	-4.81	<.001
ConsonantalContext=[g#d]	0.15	0.09	1.71	0.09
ConsonantalContext=[k#d]	0.18	0.09	2.12	<.05
ConsonantalContext=[p#g]	-0.03	0.09	-0.30	0.76
Listener=English,-3dB	-0.96	0.21	-4.63	<.001
Listener=English,3dB	-0.72	0.18	-3.93	<.001
Listener=French,-3dB	0.41	0.18	2.29	<.05
Listener=French,3dB	1.26	0.20	6.40	<.001

Table 4. Logistic regression: fixed effects. Negative β reflects poorer accuracy.

To summarize, these results support (H2), at least at a general level: on average, coda [j] leads to more identification errors than onset [l]/[j] and coda [l]. The results plotted in Figures 2 and 3 suggest that this prediction might be also be borne out within each segmental context and each listener condition separately, but the statistical model cannot guarantee it.

Signal-Detection-Theoretic analysis

The analysis in terms of percent correct does not make it possible to directly test (H1), which is stated in terms of perceptual distinctiveness. To test (H1), one can turn to Signal Detection Theory (SDT; MacMillan and Creelman 2005). SDT makes it possible to interpret data collected with a binary identification task in terms of perceptual distance and bias. The perceptual distance between two sounds is a measure of how distinct they are. Bias is a measure of the preference that listeners have for a specific response, independent of the stimulus. In SDT terms, the results established in the preceding subsection may be interpreted as follows: the perceptual distance between [l] and [j] (noted d') is smaller in coda than in onset (=H1) and there is a general bias to respond [l] over [j], which gets stronger when the contrast becomes less distinct.

To test this hypothesis, an equal-variance SDT model was fit to the confusion matrices in Table 5. These confusion matrices represent the number of times [l] was identified as [l] and as [j] and the number of times [j] was identified as [l] and as [j] in onset and coda positions (collapsing across listener conditions, segmental contexts, and participants). A probit regression model with binomial error was fit to the confusion matrices using the *glm* function in R. The reader is referred to Macmillan & Creelman (2005) for more details on SDT and the assumptions of this model.

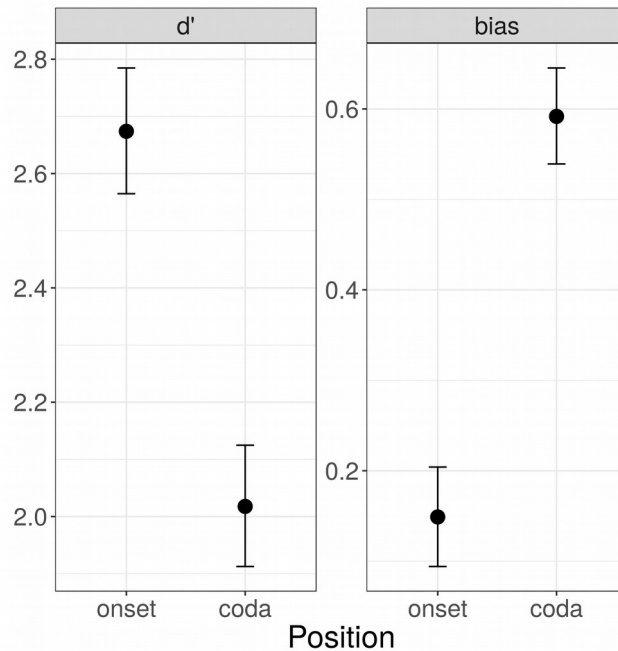| Position	Stimulus	Response	
		[l]	[j]
onset	[l]	1872	138
	[j]	236	1774
coda	[l]	1900	110
	[j]	680	1330

Table 5. Confusion matrices.

Figure 4. Perceptual distance *d'* between [l] and [j] and bias in favor of [l].

The perceptual distance *d'* and the bias in favor of [l] are plotted in Figure 4 (with 95% confidence intervals). A positive bias corresponds to a bias towards [l]-responses. The results support the hypothesis: on average, *d'* is larger in onset than in coda (beta=0.75, se=0.10 z=7.62, p<.001), and the bias in favor of [l] is smaller in onset than in coda (beta=-0.44, se=0.04, z=-11.36, p<.001). The results that the perceptual distance between [l] and [j] decreases in coda as compared to onset is compatible with the prediction of the speaker-based model of paradigmatic contrast.

4.3. Discussion

Hypotheses (H1) and (H2) are supported by the study. The results for the Haitian listeners should be taken with caution as there were only two Haitian participants in the study. However, they go in the expected direction. Another limitation of the study comes from the fact that it was not possible to statistically control for the effect of segmental context, listener condition, and participant in a single model, as models with all interactions did not converge. However, observation of Figure 2 and Figure 3 suggests that the effect of stimulus and coda position is robust across conditions.

The bias favoring [l]-responses in coda is consistent with the lexical statistics in the three languages. The fact that the bias was observed for American English listeners (see Figure 2) suggests that these listeners may have used their knowledge of English phonotactics when doing the task, despite the acoustic difference between English and Haitian coda [l].

5. Conclusion

Paradigmatic contrast is one of the mechanisms that can help constrain theories of morpheme-specific phonology. A puzzling pattern of morpheme-specific phonology involving Haitian third person plural pronoun *yo* was analyzed as a case of paradigmatic contrast: *yo* [jo] does not reduce to *y* [j] postvocalically to remain distinct enough from Haitian singular pronoun *l* [l] in this context. Morphological and phonetic evidence was provided to support the hypotheses underlying this analysis. On the morphological side, singular and plural meanings are particularly prone to avoid syncretism crosslinguistically, explaining why Haitian *yo* might be specifically targeted by paradigmatic contrast. On the phonetic side, Haitian [l] and [j] were found to be more confusable in coda than in onset and, in particular, coda [j] was found to be more often incorrectly identified as [l] than coda [l] as [j]. The perceptual results are compatible with the two main approaches to paradigmatic contrast, the speaker-based approach and the listener-based approach.

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