

The Instability of Rhythmic Syncope in Irish: Insights from Latin Loanwords

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1 Introduction

Rhythmic syncope, the deletion of alternating syllables from an iterative stress pattern, has attracted attention in theoretical phonology due to the difficulty parallel Optimality Theory (OT, Prince and Smolensky 2004 [1993]) has generating the pattern (Kager 1997, McCarthy 2008, Hao and Bowers 2019). It also appears that human language learners may have difficulty acquiring rhythmic syncope, since the advent of rhythmic syncope in Nishnaabemwin triggered a rapid and far-reaching restructuring of the grammar (Bowers 2019 and sources therein). Early Irish, the spoken and written language of Ireland before the thirteenth century (Stifter 2009:55), is another language that developed rhythmic syncope, doing so in the sixth century CE (Jackson 1953:143, McManus 1983:31, McCone 1996:127). As such, Early Irish promises to inform the typology of rhythmic syncope systems. Early Irish manuscripts contain indications that rhythmic syncope was no longer productive at the time they were written (Armstrong 1976; McCone 1985), but even the earliest of these manuscripts were composed some time after syncope began, and so cannot reveal how quickly syncope decayed. However, the flow of Latin loanwords into Irish around the time of syncope can diagnose whether rhythmic syncope decayed quickly in Irish. Simulations reveal that not very many loans entered Irish during the syncope period, which suggests that it may have been quite brief, in line with other cases of rhythmic syncope.

The paper will proceed as follows. Section 2 illustrates the syncope process and reviews prior evidence for when it flourished and declined. Section 3 introduces the Irish phonological processes that were applied to Latin loans and form the basis for how we estimate the flow of loans into Irish. Section 4 describes our corpus of loans. Section 5 describes how we simulate the flow of loans into Irish. Section 6 describes the results of our simulations, and section 7 discusses their interpretation. Section 8 concludes.

2 Preliminary Syncope Facts

Rhythmic syncope in Irish removed even-numbered non-final syllables when counting from left to right. Primary stress was assigned to the first syllable, though the first ver-

bal proclitic, if any, was omitted from the stress calculation (Thurneysen 1946:27-31, Stifter 2006:21-22). Initial stress, and the alternating character of deletion, are consistent with left-aligned trochaic feet. In familiar phonological terms, syncope simply targeted the weak branch of all non-final feet.

The sensitivity of stress to procliticization set up paradigmatic alternations like those in the native verb /to=ro=xar-adar/ ‘they fell’ (Bieler and Kelly 2004 [1979]:176§13.7) and its procliticized form /ko^{+voi}=to=ro=xar-adar/ ‘until they fell’ (Stokes and Strachan 1901:93, Ml. 36d13), shown in (1). Because our data is ultimately orthographic, we accompany phonological representations with the attested orthographic forms in ⟨angle brackets⟩.¹ Note that we follow the phonological convention of applying morpheme-specific rules first in derivations, even though in the history of Irish the change of proclitic /to=/ to [do=] occurred after syncope (Stifter 2014).

(1)	/ko ^{+voi} =to=ro=xar-adar/	/to=ro=xar-adar/	UR
	—	do=roxaradar	to=→do=
	ko=doroxaradar	—	Nasalization mutation (voicing)
	ko=(‘doro)(.xara)(.dar)	do=(‘roxa)(.radar)	Stress
	ko=(‘dor_)(.xar_)(.dar)	do=(‘rox_)(.radar)	Syncope
	[ko=‘dorxardar]	[do=‘roxradar]	SR
	⟨con torchartar⟩	⟨dorochratar⟩	Orthography

2.1 Prior Work on Rise and Fall of Syncope

Rhythmic syncope is generally thought to have emerged in the mid-to-late sixth century (Jackson 1953:143, McManus 1983:31). although there is some evidence for a slightly earlier date (Sims-Williams 2003:346). Direct support for 6th-century syncope is found in syncopated poetry by Colmán mac Lénéni, a poet who died in 606 (Carney 1971; Sims-Williams 2016 *inter alia*). Syncope also appears in Ogam stone inscriptions whose spelling dates them to the early seventh century (McManus 1986:2-4). This demonstrates that syncope could not have been initiated after the beginning of the seventh century.

That rhythmic syncope was eventually abandoned in Irish is not at stake here. Even a casual overview of the textual record highlights the decline of syncope in Irish. The earliest Old Irish manuscripts, composed from the seventh to tenth centuries, largely abide by rhythmic syncope patterns, though numerous exceptions occur. Middle Irish, generally held to have begun in the mid-tenth century, also attests many prominent deviations from the historically expected syncope patterns (see McCone 1997:163 ff. for a general overview of Middle Irish verbs). Finally, in the twelfth century the classical modern literary standard emerged, which featured widespread paradigm leveling to remove rhythmic syncope alternations. Indeed, “there are very few genuine survivals” of

¹We use the following abbreviations for glossing examples: ADJ = ‘adjective’, ACC = ‘accusative’, AGEN = ‘agentive’, DIM = ‘diminutive’, FEM = ‘feminine’, IMPV = ‘imperative’, MASC = ‘masculine’, NOM = ‘nominative’, NEUT = ‘neuter’, PL = ‘plural’, PCL = ‘proclitic’, PST = ‘past’, SG = ‘singular’. We follow the generative linguistics practice of marking ungrammatical forms with *. Since this conflicts with the historical linguistics use of * for unattested hypothetical forms, we mark such forms with †. Phonological forms are enclosed in [square brackets] unless specifically making a claim about underlying representations, which are enclosed in /slashes/. For a description of Irish orthography, see Stifter (2006).

many characteristic Old Irish alternations, including rhythmic syncope alternations, in any variety of the modern language (McCone 1997:191).

It would be a mistake to read the general adherence to rhythmic syncope patterns in Old Irish manuscripts as evidence that rhythmic syncope was still active in the seventh through tenth centuries. The Würzburg and Milan glosses (Stokes and Strachan 1901) have played a central role in recovering Old Irish grammar, and were composed before the ninth century. Nonetheless, these documents contain a number of deviations from the expected norm (Armstrong 1976). For instance, in (1) we saw that underlying /ko^{+voi}=to=ro=xar-adar/ surfaces as expected as [ko=dor_xar_dar] ‘until they fell’. However, we also find [kon=tor_x_radar] ⟨con-torchratar⟩ ‘they fell together’ (Stokes and Strachan 1901:148, Ml. 48c28), which is missing vowels from adjacent syllables, and so cannot be derived from /kom=to=ro=xar-adar/ via the original syncope process.

According to McCone (1985, 1997), these deviations are in fact early instantiations of innovative patterns that flourished in Middle Irish, and that were ultimately standardized in Modern Irish. This strongly suggests that Old Irish records partially reflect an ‘artificially fostered learned and literary standard’ (McCone 1997:167). It is impossible to know what the living spoken language of the Old Irish period was, but it is not beyond the realm of possibility that the innovations were already displacing the old patterns or had even become regular.

Such innovations can be found in texts still older than the Würzburg and Milan glosses. For instance, Latin [pug-ill-a:ri-a] ‘writing tablets (lit. ‘fist-DIM-AGEN-NEUT.NOM.PL)’ was borrowed via Vulgar Latin †[pug-l-a:ri-a] (McManus 1983:38), which underwent pre-syncope phonology (described in section 3) as in (2). For simplicity, we depict loan adaptations with phonological rules proceeding from a faithful source language representation, see Boersma (1998) and Boersma and Hamann (2009) for a more comprehensive approach.

(2)	pug-ill-a:ri-a	Latin
	pug-l-a:ri-a	Vulgar Latin
	/pugl-a:rij-a/	Irish UR
	puyl̪a:rija	Lenition
	puyl̪arija	Shortening
	poyl̪areja	Harmony
	poyl̪are_	Apocope
	po:l̪are	Compensatory Lengthening

The expected next stage of development for this word is that it would syncopate to †[po:l̪_re], and presumably at some time such a form existed. Strikingly, however, this word never shows syncope in any source. The earliest attestation of this word is dated to the turn of the seventh and eighth centuries, where it appears as [po:l̪-ər̪̪e] ⟨poolire⟩ (Bieler and Kelly 2004 [1979]:176§13.5).

What seems to have happened is that the Latin agentive suffix [-a:ri] was segmented off from this and other loans like Latin [osti-a:ri-us] ‘door man (lit. door-AGEN-MASC.NOM.SG)’, which became Irish [as̪̪̪t̪̪̪-ər̪̪̪e] ⟨aistire⟩. It then became a productive Irish suffix [-ər̪̪̪e], as seen by its application to native Irish roots as in [ex-ər̪̪̪e] ⟨echaire⟩ ‘groom (lit. horse-AGEN)’ and [ri:ṽ-ər̪̪̪e] ⟨rímaire⟩ ‘calculator (lit. ‘number-

AGEN)’ (Thurneysen 1946:172). Since sound change operates on phonetic forms without respect to morphological considerations (cf. Kawahara 2011, Bermúdez-Otero 2015), this suffix must have been subject to syncope, and Kelly (1990:232) shows cases where syncope occurred in this suffix. However, as [po:l-ər^je] ‘writing tablet’ and other early cases like [nɒd-ər^je] ⟨notire⟩ ‘scribe’ (lit. ‘note-AGEN’) (Stokes and Strachan 1901:678, Wb. 27d16) show, it clearly became immune to syncope. These forms indicate that rhythmic syncope no longer applied automatically and could even be overturned by the turn of the seventh and eighth centuries.

2.2 Significance of Latin Loans

The textual record leaves roughly a one and a half-century period when rhythmic syncope could have flourished between its development in the mid-to-late sixth century and the earliest indications of its loss at the turn of seventh/eighth centuries. Our goal is to estimate how much of this period syncope was active for. We can approach this fairly directly via Latin loan words, which entered Irish before the advent of syncope, and which continued to be borrowed until sometime long after the composition of the earliest manuscripts. If many loans entered Irish during the syncope phase of the language, this indicates that syncope was active for an appreciable amount of time. However, if few loans entered Irish during that time, this suggests either that syncope was not active for very long, or that the rate of borrowing had decreased.

3 Date Ranges via Process Application

In order to estimate how many Latin loans entered during the rhythmic syncope period, we use the Irish phonological processes that applied to each loan to obtain the possible periods in which it could have entered Irish. Fortunately, the data is remarkably granular, because before rhythmic syncope developed, Irish developed several phonological processes in quick succession. When these processes stopped applying to loan words, the result was an early group of loans that underwent the process, and a later group that did not undergo it. We exploit this information in simulations to search the space of possible loan timelines (see section 5).

The granular relative timing of loans also corresponds to fairly narrow date ranges in absolute time. One of the earliest processes, Irish voiceless stop lenition (discussed in further detail in section 3.2), almost certainly developed no later than the mid-fifth century CE. Many Christian ecclesiastical loans undergo lenition, and Prosper of Aquitaine’s chronicle for the year 431/432 (Mommsen 1892) presupposes the existence of a fledgling Christian community in Ireland. Assuming the ecclesiastical loans entered with the introduction of Christianity, lenition must have emerged shortly thereafter. If Christianity took root in 431/432, then putting the date for lenition at around 450 gives time for a body of ecclesiastical loans to accumulate before leniting.

This leaves roughly a century between lenition and syncope, and at most a few decades of separation between any intervening processes. The major milestones for dating the Latin loanwords in Irish are the replacement of [p] with [k] (henceforth

[p]→[k]), lenition, vowel harmony, shortening, compensatory lengthening, and rhythmic syncope. There were also ancillary processes whose (non)-application could diagnose whether a loan was borrowed around one of these milestones, such as the replacement of [st, ks, xs] with [s], post-nasal voicing of stops, and the simplification of [ns] and [nf] clusters. The following sections summarize the major milestones and any ancillary processes associated with them.

In addition to the processes that help date loans, there are some processes that have little evidentiary value but still must be discussed. Chief among these is apocope, which is known to have developed before syncope (McManus 1991:94-6), and is responsible for the lack of original final syllables, which were almost always case suffixes. Apocope cannot be used to diagnose loans because both early and late loans lack original final syllables.

For our purposes, the issue can be left at that, but for expository reasons, we must be able to provide a point where Latin final syllables are lost in the transition through Irish. We could in principle apply Irish apocope as a productive process to all loans, however, Irish-studies literature favors two competing alternatives, summarized by McManus (1984). The first analysis observes that in pre-apocope loans, Latin case suffixes were assimilated to Irish case marking. This pattern of suffix replacement is extrapolated to the post-apocope language, when Irish case suffixes had largely become phonologically empty. Thus, under this approach, Latin case suffixes get replaced with phonologically null morphemes during the adaptation process into Irish. The second analysis claims that the absence of Latin final syllables in later loans is due to Irish receiving words that had already been apocopated in British Latin. For the sake of consistency, we follow the first approach and replace Latin case suffixes with the Irish case suffixes that are appropriate for the time period.

Our data reflects additional processes besides the relevant ones discussed here (see McCone 1996 ch. 3-4), most prominently palatalization and the later reduction of word-medial syllables or closed word-final syllables. These orthogonal processes are included in derivations to preserve the relationship with the observed orthography, but further attention will not be given to them.

3.1 [p]→[k]

Several sound changes characteristic of Celtic languages resulted in Irish completely lacking /p/ prior to contact with Latin. As a result, Latin [p] was illegal in Irish and was replaced with [k] for some time, as illustrated by the adaptation of Latin [pa:sk-a] ‘Easter-NEUT.NOM.PL’ in example (3), drawn from McManus (1983:48).² Eventually /p/ became a marginal phoneme of Irish and the [p]→[k] replacement was no longer enforced, as discussed in section 3.2.1.

²The replacement of [p] with [k] is standardly analyzed as involving the following stages: [p]→[k^w]→[k]. In the shift from [k^w] to [k], the labial feature may be transferred to following short vowels. For details, see McCone (1996:118).

(3)	pa:sk-a	Latin
	/pa:sk-a:/	Irish UR
	ka:ska:	[p]→[k]
	ka:sk_	Apocope
	[ka:sk]	SR
	⟨cásc⟩	Orthography

When determining timelines, we conclude that a loan entered during this first period if Latin [p] is adapted as [k], its lenited variant [x], or [ɣ], which is a later unstressed variant of [x]. Latin [p] that is adapted as [p] indicates that the loan entered after the [p]→[k] period.

3.2 Lenition

The adaptation of Latin loans was affected by a confluence of consonant lenitions that originated not only in Irish, but also in British and even Proto-Celtic (McCone 1996:81-98 and references therein, see Iosad 2022 for discussion of the modern morphological lenition systems of Celtic languages). Lenition in the Celtic family appears to have developed in three waves. The first wave mapped post-vocalic voiced singleton stops [b, d, g, m] to [v, ð, ɣ, ̃v] in an early ancestor of several attested Celtic languages. The second wave debuccalized post-vocalic [s, s^w] to [h] and †[h^w] in only Irish and British (†[h^w] ultimately became [f] in Irish and [xw] in the descendants of British). During the third wave, postvocalic voiceless stops [t, k] were spirantized to [θ, x] in Irish, and were voiced to [d, g] in British.

The lenition of voiceless stops is the most useful for dating loans, since that is the only phase that is certainly contemporary with the period of contact with Latin. Irish spirantizing lenition is observed in many loans, as in example (4), which illustrates the adaptations of Latin [bakul-um] ‘staff-NEUT.NOM.SG’ as Irish [baxəl] ⟨bachall⟩ (Bieler and Kelly 2004 [1979]:176§13.5) and Vulgar Latin †[si:tul-a] ‘vessel-FEM.NOM.SG’ as Irish [sʲi:θəl] ⟨síthal⟩ (Lash 2021, S0050-82).

(4)	bakul-um	si:tul-a	(Vulgar) Latin
	/bakul-a:/	/si:tul-a:/	Irish UR
	baxula:	si:θul-a:	Lenition
	baxola:	si:θola:	Harmony
	baxol_	si:θol_	Apocope
	baxəl	sʲi:θəl	Other Rules
	[baxəl]	[sʲi:θəl]	SR
	⟨bachall⟩	⟨síthal⟩	Orthography

3.2.1 Separating [p]→[k] and Irish lenition

Irish lenition applied to some loans that entered after [p]→[k] ceased to be enforced, as seen in [parʲxʲə] ⟨pairche⟩ ‘parish’ (Stokes and Strachan 1901:632, Wb. 21a12) from Latin [pare:kia]. We illustrate the history of this word in (5). Here and elsewhere, ‘X’ marks processes that do not apply because the loan entered too late. We also include

two counterfactual derivations illustrating the expected outcome if the borrowing had happened earlier (column 2) or later (column 3).

(5)	pare:ki-a	pare:ki-a	pare:ki-a	Latin
	/pare:kij-a:/	/pare:kij-a:/	/pare:kij-a:/	Irish UR
	X	kare:kij-a:	X	[p]→[k]
	pare:xija:	kare:xija:	X	Lenition
	parexija:	karexija:	parekija:	Shortening
	parexeja:	karexeja:	parekeja:	Harmony
	parexe_	karexe_	pareke_	Apocope
	('pare)(.xe)	('kare)(.xe)	('pare)(.ke)	Footing
	('par_)(.xe)	('kar_)(.xe)	('par_)(.ke)	Syncope
	('par ⁱ)(.x ⁱ e)	('kar ⁱ)(.x ⁱ e)	('par ⁱ)(.k ⁱ e)	Other Rules
	[par ⁱ x ⁱ e]	*[kar ⁱ x ⁱ e]	*[par ⁱ k ⁱ e]	SR
	⟨pairche⟩	⟨cairche⟩	⟨pairce⟩	Orthography

3.2.2 Loans with British Lenition

Even more prominent in the loan data is the application of British voicing lenition, as in Latin [pa:triki-us] 'Patrick-MASC.NOM.SG', which appears as [pa:drəɡⁱ] ⟨Pátraic⟩ (McManus 1983:69), with Latin [t] and [k] being mapped to [d, g], respectively. The appearance of British lenition in Latin loans to Irish is standardly attributed to Irish borrowing Latin loan words from British speakers of Latin. Because so many loans show British voicing lenition and because other evidence of close cultural contact is so strong (see Bauer 2015:5-8 and references therein), most Latin loans in Irish are thought to have come through British Latin (David Stifter, p.c.).

Since British lenition was not an Irish process, we cannot use British lenition to conclude that a loan entered Irish before any particular point, as we have done so far for [p]→[k] and Irish lenition. We can only be certain that loans showing British voicing lenition arrived in Irish after lenition happened in British. However, there are no loans that underwent British lenition and [p]→[k], which we take as suggesting that loans with British lenition arrived after [p]→[k]. It may be possible to further conclude that loans with British lenition entered after Irish lenition ceased to apply in loans, but as the next paragraphs will show, this is somewhat contingent on the status of geminates in Irish.

A straightforward interpretation of loans with British lenition is that lenition ceased to apply productively to new vocabulary, and that these loans were borrowed during the aftermath of lenition. This accounts for the striking failure of the post-vocalic voiced stops [d, g] derived by British lenition to lenite further to [ð, ɣ] in Irish. That is, under this interpretation of loans with British lenition, the history of Irish [nod] ⟨not⟩ 'mark, sign' (from Latin [nota] via British Latin [noda], found in Stokes and Strachan 1903:52, Sg. 3b17) follows the left-hand column of (6) instead of the counter-factual right hand column.

(6)	not-a	not-a	Latin
	nod-a	nod-a	British Latin
	/nod-a:/	/nod-a:/	Irish UR
	X	noða:	Lenition
	nod	noð	Apocope
	[nod]	[noð]	SR
	⟨not⟩	⟨nod⟩	Orthography

The plausibility of this interpretation rests on when post-vocalic singleton obstruents became legal in Irish. What is known is that original geminates were spelled differently than lenited obstruents in the post-vocalic environment in the Old Irish manuscripts.³ Furthermore, the earliest acoustic recordings of spoken Irish show that these former geminate obstruents were no longer phonetically long in the 20th century (Wheatley and Iosad 2021). What is not known is when the original geminates became singletons.

It is possible that Irish lenition was a chain shift, whereby singleton stops became fricatives and geminates simplified. Under this view, post-vocalic singleton obstruents were legal as soon as lenition developed. Importantly, if this happened, British loans like [pa:dræg^j] ⟨Pátraic⟩ ‘Patrick’ would not violate any phonotactic bans once lenition occurred.

Note that data from modern languages shows that even if a chain shift occurs in the alternation system of a language, it is liable to be underlearned (Zhang, Lai, and Sailor 2009; Zhang 2016; Zhang 2019; Nagle 2020). Even if loan adaptation occurs by applying native phonology to a representation that is essentially faithful to the source language, as argued by La Charité and Paradis (2002, 2005 *et seq*), it is not certain that a lenition chain shift would be enforced in loan words once it developed. So long as loans with British lenition entered after an Irish lenition chain shift began (see Jackson 1953 and many others), the voiced stops from British lenition should not be expected to be modified in Irish.

However, given that we only have evidence that loans with British lenition entered after [p]→[k], it is also possible that loans with British lenition entered before or during Irish lenition.⁴ Because post-vocalic voiced singleton stops had been mapped to fricatives by the first wave of lenition, the post-vocalic voiced singleton stops from British lenition would violate an exceptionless phonotactic constraint at this point. Since the British Latin singleton voiced stops did not spirantize in Irish, we must conclude that if they entered before degemination, then they must have been adapted as geminate

³For voiced obstruents, the original geminates were spelled using graphemes associated with voicelessness in other languages, as seen the unlenited spelling ⟨tocad⟩ ‘luck.MASC.NOM.SG’, which corresponds to [togəð] and comes from original phonological form †[tog:ed-as] (Thurneysen 1946:126). Lenited voiced obstruents were spelled using graphemes familiarly associated with voicing, as in the hypothetical lenited spelling ⟨togad⟩ for Old Irish [togəð], which would come from something like original †[toged]. Originally geminated voiceless obstruents could be spelled with doubled consonants, as in ⟨rucce⟩ ‘shame-NEUT.NOM.SG’ for Old Irish [ruk^je], which corresponds to an original phonological form †[ruk:ij-an] (Thurneysen 1946:92). Lenited voiceless obstruents were spelled with digraphs, as in the lenited spelling for hypothetical ⟨ruche⟩ for [ruk^je], from something like original †[ruke].

⁴Allowing loans with British lenition to enter during the Irish lenition period would seem to be incompatible with post-[p]→[k] loans showing Irish lenition, like [par^jx^je] ⟨pairche⟩ ‘parish’. Such a problem can be avoided by positing that such forms were borrowed from Continental varieties of Latin.

voiced stops. That is, instead of British Latin [paːdrig] ‘Patrick’ being faithfully borrowed as [paːdrig], it would have been borrowed as [paːdrigː].

While degemination could have been part of Irish lenition, it was not necessarily so, and later dates have been proposed.⁵ For instance, Stifter (2017:1199) lists degemination as occurring after syncope. As has already been pointed out, at first blush such a late date for degemination means that in the post-vocalic environment only fricatives and geminates were legal, so to avoid being spirantized, the voiced stops from British lenition must have been adapted as geminates. However, Stifter’s claim does not concern the date of an actual phonetic sound change, but when the ancestral geminate/singleton contrast must give way to the Old Irish unlenited/lenited contrast at the structuralist morphophonological level (David Stifter p.c.).⁶ We are not wholly convinced of a post-syncope date for degemination (and thus the probable end of lenition in loanword adaptation), since there are syncopated loans with unlenited [m] like Latin [kamisi-a] ‘shirt-FEM.NOM.SG’, which appears as Irish [kamʲsʲe] ⟨caimmse⟩ (McManus 1983:39) or Latin [memori-a] ‘death.monument-FEM.NOM.SG’, which appears as [memre] ⟨membrae⟩ (Lash 2021:S0027-20).⁷ These loans presumably entered after lenition and before syncope.

Nonetheless, not wishing to prejudice the case, we ran simulations reflecting both scenarios. In early degemination simulations, the timeline is fairly neat, with loans that undergo Irish lenition entering before the end of Irish lenition and loans undergoing British voicing lenition (or that otherwise fail to lenite) entering after Irish lenition. In late degemination simulations, loans that undergo British voicing lenition, or otherwise fail to lenite, may enter before Irish lenition, but not before the end of [p]→[k]. Ultimately, late degemination simulations did not produce materially different results, so

⁵McCone (1996:89) also tersely speculates that degemination was likely later than lenition, though ultimately it appears his proposal requires the same post-degemination entry for loans with British lenition as our initial proposal. To be concrete, McCone seeks to enforce Irish lenition of voiceless stops in ecclesiastic loans while assuming that Irish lenition happened much earlier than the first known formal Christian presence in 431/432 CE. That is, if Latin [parekia] entered long after lenition, there must be an explanation for why it appears in Irish as [paɾʲxʲe] ⟨pairche⟩ (Stokes and Strachan 1901:632, Wb. 21a12), instead of *[paɾʲkʲe]. McCone’s proposed solution is that degemination occurred some time after Irish lenition, so that at the time Latin [parekia] was encountered, post-vocalic [k] was illegal, but [x] and [kː] were not. Presumably because the perceptual distance was shortest between [k] and [x], voiceless singletons were adapted as fricatives instead of geminates.

Clearly, a different story must be told for the voiced stops from British lenition, which remained stops in Irish. Beyond simply stipulating that [x] was a better alternative to [kː] for [k], while [gː] was a better alternative to [ɣ] for [g], we can state that loans with British lenition entered after degemination. That is, before degemination Latin [k] was better adapted as [x] than as [kː], then degemination happened and British Latin [g] can be perfectly adapted as [g] instead of [ɣ]. This is equivalent to our original proposal that loans with British lenition were borrowed after lenition ceased to apply in loan words, albeit with stronger assumptions about the underlying time line.

⁶The reasoning for post-syncope degemination at the structuralist morphophonological level goes as follows. Prior to apocope and syncope, the original morphophonological opposition between geminates and singletons can still be posited. This is because lenition has a well defined surface post-vocalic environment, and so belongs to the phonetic/allophonic level. Once apocope and syncope occur, lenited phones lose their well defined surface distribution, and so must be treated at the morphophonological level. Without singletons to oppose geminates, the historical gemination contrast is no longer tenable, and so degemination is held to have occurred at the morphophonological level.

⁷Note that Latin [memori-a] was also borrowed before lenition, as seen in Irish [mʲeʷurʲ] ⟨mebuir⟩ ‘memory’ (Stokes and Strachan 1901:626, Wb. 20a5).

for the sake of simplicity, further discussion will proceed under the assumption of the early degemination scenario.

3.2.3 [f]→[s]

Some loans with [f] in Latin appear in Irish with [s], as in Irish [su:st] ⟨súst⟩ ‘flail’ (McManus 1983:29), from Latin [fu:stis]. These adaptations could have arisen by Latin [f] being mapped to Irish $\dagger[s^w]$, which had [f] as a lenited allophone, and was eventually delabialized to [s].⁸ These adaptations could also have been the result of [f] being directly mapped to [s].

Unfortunately, the current understanding of lenition as a gradually developed process makes it very difficult to date these loans. Recall that the lenition of [s] and $\dagger[s^w]$ is common to both the British languages and Irish. Taking these shared traits as evidence of inheritance puts the lenition of [s] to [h] and $\dagger[s^w]$ to $\dagger[h^w]$ in the ancestor of Irish and British.⁹ After this common development, Irish must develop many Irish-specific sound changes, many of which were not applied to Latin loans and so presumably happened before Irish began to borrow from Latin.

The upshot of this is that the lenition of sibilants was too remote to give precise dates for these loans. While it is plausible that there were active alternations between $\dagger[s^w]$ and [f], or even just restrictions on where [f] could occur during the time of contact with Latin, we only know that mapping [f] to a sibilant could have been early. In fact, the best move is to limit [f]→[s] loans to the early portion of our time line. This is because all three of the eleven [f]→[s] loans that were eligible for lenition or harmony, underwent those processes.¹⁰ Accordingly, we treat loans that underwent this adaptation as entering no later than the immediately post-harmony period described in section 3.4.

3.3 Vowel Harmony

The next major process after lenition was vowel harmony (see section 3.4 for discussion of shortening, which began between lenition and harmony).¹¹ Vowel harmony applied from left to right across the word, causing non-low short vowels to agree with the following syllable for the feature [HIGH]. There were two restrictions on this process. First, [e, e:] did not trigger agreement in the preceding syllable. Second, [i, i:, u, u:]

⁸If [f]→[s] loans were borrowed with $\dagger[s^w]$, at some point they need to join the [s]→[h] morphological lenition pattern along with all but one of the native words that originally began with $\dagger[s^w]$ (see Iosad 2022 for a comprehensive discussion of lenition).

⁹There is some controversy over whether Irish and British form an Insular Celtic subgrouping (Schmidt 1977, Koch 1992, de Bernardo Stempel 2006, McCone 1996, Schrijver 1995, Schumacher 2004), but this does not affect the existence of a common ancestor for Irish and British.

¹⁰That is, Latin [furn-us] ‘oven-MASC.NOM.SG’ and [feri-a] ‘holiday-FEM.NOM.SG’ were evidently borrowed as $\dagger[s^{(w)}urn-as]$ and $\dagger[s^{(w)}erij-a:]$ before undergoing harmony and apocope to become the attested forms [sorn] ⟨sorn⟩ (McManus 1983:28) and [sʲerʲe] ⟨séire⟩ (McManus 1983:55), while Latin [flok-us] ‘fluff-MASC.NOM.SG’ may have become Vulgar Latin $\dagger[flo:k-us]$ (Petersson 1913) and become Irish $\dagger[s^{(w)}lo:k-as]$ en route to undergoing lenition and apocope to become the attested form [slo:x] ⟨slóch⟩ ‘snowflake’ (McManus 1983:55).

¹¹The diachronic literature on Irish typically treats vowel harmony as two processes: lowering or a/o affection and raising or i/u affection.

only triggered agreement in initial syllables, and could be blocked by an intervening voiceless consonant (McCone 1996:110).¹² Harmony is illustrated in (7), which shows the mapping from Latin [pult-em] ‘porridge.FEM-ACC.SG’ to [kolt] ⟨colt⟩ (McManus 1983:48).¹³

(7)	pult-em	Latin
	/pult-an/	Irish UR
	kultan	[p]→[k]
	koltan	Harmony
	kolt_	Apocope
	[kolt]	SR
	⟨colt⟩	Orthography

The fact that harmony applied iteratively from left to right, while targets were to the left of their triggers, meant that it was a self-counterfeeding process. In particular, high vowels in initial syllables could be followed by derived cases of the lowering trigger [o]. The subsequent development of apocope further opacated harmony by deleting many harmony triggers, as shown in (7).

A substantial body of literature discusses whether opacity is underlearned (Sanders 2003; Kawahara 2015; Andersson 2018; Jurgec 2019), and Kaplan 2008 argues specifically that self-counter-feeding opacity is unattested as a phonological phenomenon. However, we refrain from asserting that this self-counter-feeding opacity triggered underlearning of all aspects of the harmony process. That said, even if it was fully learned, Irish speakers had to permit some disharmonic sequences in surface forms. As was the case for lenition, the presence of surface disharmonic sequences opens the door to not adapting disharmonic loans that entered while harmony was being developed. For the sake of simplicity, we treat all disharmonic sequences as being faithfully adaptable once harmony began to appear, not just [i/u...o] sequences.

Due to the later application of vowel reduction in word-medial syllables, only initial and word-final syllables are informative for whether a word underwent vowel harmony.¹⁴ To be concrete, we conclude that a loan was borrowed before harmony if the conditions for harmony were met in the initial or final (after Irish/British apocope) syllable and harmony applied. If the conditions for harmony were met, but harmony did not apply, we conclude that the loan was borrowed after harmony. Because Latin case suffixes were replaced by Irish case suffixes, Latin monosyllabic stems may or may not have met the harmony environment once Irish suffixes were applied. If harmony applied in Irish to monosyllabic stems, we assume that the environment for harmony was met. If, however, harmony did not apply in a monosyllabic stem, we assess the mor-

¹²McCone (1996:110) recognizes that the full account of which consonant sequences block vowel raising has not been worked out. Thurneysen (1946:47-49) gives a list of clusters that did not block raising: [nd, mb, v̄l, v̄r, ðv, dr, or gl]. Thurneysen also writes that intervening ⟨cc⟩ (= [k]) permits raising, but the evidence for this is equivocal at best. In cases where a vowel fails to raise, we only conclude that this is due to post-harmony borrowing if the intervening consonant is voiced, or a member of Thurneysen’s list.

¹³McManus (1983:48) erroneously claims that [kolt] ⟨colt⟩ ‘porridge’ comes from Latin [pult-a] ‘knock-2SG.IMPV’.

¹⁴See McManus (1991:94) for evidence from Ogam inscriptions that vowel harmony applied in word-medial syllables.

phonological paradigm of the loan to determine whether the environment for harmony could have been met, and date the loan accordingly.

3.3.1 Separating lenition and harmony

Loans with British lenition began to enter Irish before harmony was completed. For instance, Latin [kok^wi:n-a] ‘kitchen-FEM.NOM.SG.’ was adapted as [kugəɲ] ⟨cucann⟩ (McManus 1983:59). We can explain the raising of Latin [o] to Irish [u] as being the result of the harmony process enforcing raising due to the following high vowel.

The derivations in (8) provide the history of Irish [kugəɲ] ⟨cucann⟩ ‘kitchen’, as well as the counterfactual derivations illustrating the expected outcome if the word had been borrowed before lenition (column 2), or after harmony (column 3). These derivations follow the assumption that British voicing lenition only appeared in loans borrowed after Irish lenition (see section 3.2.2). If that assumption is abandoned, then we can only conclude that loans of this type entered Irish after [p]→[k] and before harmony.

(8)	kok ^w i:n-a	kok ^w i:n-a	kok ^w i:n-a	Latin
	kogi:n-a	koki:n-a	kogi:n-a	British Latin
	/kogi:n-a:/	/koki:n-a:/	/kogi:n-a:/	Irish UR
	X	koxi:na:	X	Lenition
	kogina:	koxina:	X	Shortening
	kugena:	kuxena:	X	Harmony
	kugen_	kuxen_	kogin_	Apocope
	kugəɲ	kuxəɲ	kogəɲ	Other Rules
	[kugəɲ]	*[kuxəɲ]	*[kogəɲ]	SR
	⟨cucann⟩	⟨cuchann⟩	⟨cocann⟩	Orthography

Note that the shortening of Latin [i:] to Irish †[i] is not informative for dating this word, because shortening began after lenition (McCone 1996:110-115), and continued through harmony and apocope before being ended by the development of compensatory lengthening (see section 3.4). The long duration of shortening is also the reason that in the second counterfactual derivation shortening has been implicitly applied in the apocope stage.

3.3.2 [st]→[s]

In the native vocabulary, inherited †[st] clusters became †[s:] and were subsequently degeminated to [s]. Many Latin loans were adapted similarly, as in Irish [kas^ləɫ] ⟨caisel⟩ ‘castle’, from Vulgar Latin †[kastil:um] (McManus 1983:58), or Irish [sraθər] ⟨srathar⟩ ‘pack-saddle’ (Stokes and Strachan 1903:290, Sg. 229a), from Latin [stra:tu:ra] or Vulgar Latin †[stratu:ra]. Though it would be natural to date such words as entering before lenition, Latin [stra:t-a] ‘street-FEM.NOM.SG.’ appears as Irish [sra:d^l] ⟨sráit⟩ (McManus 1983:54), with simplification of [st] to [s] but showing the potentially post-Irish lenition feature of British lenition of the stem-final consonant.

In order to preserve the intuition that [st] → [s] simplification was early, while not limiting these loans to entering before lenition, this trait is taken as evidence of adaptation before harmony in the simulations below. Faithful maintenance of [st] clusters is not taken as evidence of any date of entry (McManus 1983:54).

3.4 Shortening

Vowel shortening in medial syllables probably pre-dates vowel harmony (McCone 1996:110-112), since Latin long vowels were shortened and harmonized as in (8). Despite this early beginning, vowel shortening is standardly thought to have persisted until compensatory lengthening re-introduced long vowels in word medial syllables.

This raises the possibility that some loans could have entered too late for harmony to apply, but early enough for shortening to have applied. There are two examples that potentially could establish a post-harmony shortening period beyond a doubt, like Irish [iðən¹] ⟨idain⟩ ‘pure.PL’ (Stokes and Strachan 1901:700, Wb. 31c13), which is potentially from Latin [ido:neus], and Irish [fʲir¹mʲən¹ʲ] ⟨firmint⟩ ‘firmament’ (Stokes and Strachan 1901:115, Ml. 42b22), from Latin [firma:mentum]. Unfortunately, proceeding under that assumption would be controversial. Despite McManus (1983:59) attributing a Latin origin to [iðən¹], this is not a widespread conclusion (cf. the entry for ⟨idan⟩ in eDIL (2019) at <https://www.dil.ie/27179>, accessed July 27, 2022). Furthermore, though shortening and syncope could have removed [a:] from Latin [firma:ment-um] ‘firmament-MASC.NOM.SG’, the usual outcome of deleting a back vowel in Irish was a non-palatal cluster, but the spelling of the word in Irish as ⟨firmint⟩ clearly diagnoses a palatal cluster. We are thus inclined to accept an alternative analysis, whereby [a:] was deleted by syncope within Latin, producing †[firm_ment-um], and that the resulting [rm] cluster was palatalized in Irish by the flanking front vowels.¹⁵

3.5 Compensatory Lengthening

After the development of vowel harmony, Irish deleted dental and velar fricatives before consonantal sonorants [r, l, m, n], and lengthened the preceding vowel, as in the native word [kʲen¹ʲe:l] ⟨ceneel⟩ ‘race’ (Stokes and Strachan 1901:681, Wb. 28b1), from †[keneθl] (where the †[θ<t] has a reflex in Old Welsh [kenedl] ⟨kenetl⟩ McCone 1996:122). Example (9) illustrates this in the loan vocabulary for Latin [sign-um] ‘sign-NEUT.NOM.SG.’ (Lash (2021:S0022-78).

¹⁵Admittedly, this proposal suffers somewhat from the fact that Latin syncope typically did not affect short [a] or any long vowels (Adams 2013:90).

(9)	sign-um	Latin
	/sign-an/	Irish UR
	siynan	Lenition
	seyndan	Harmony
	seyn_	Apocope
	se:n	Compensatory Lengthening
	sʲe:n	Other Rules
	[sʲe:n]	SR
	⟨sén⟩	Orthography

Very few Latin loanwords met the environment for compensatory lengthening. Compensatory lengthening is instead a major milestone for dating Latin loans because it overrode vowel shortening in word medial syllables. Latin loans that preserve vowel length must have entered at some point after this development. For instance, Latin [alta:re] ‘altar’, after undergoing the later British change of [a:] to [ɔ:] (Stifter 2017:1200), maintained vowel length when it was adapted into Irish as [alto:rʲ] ⟨altóir⟩ (Stokes and Strachan 1901:527, Wb. 5b6).

The precise point after compensatory lengthening that vowel length began to be preserved is somewhat open to interpretation. If speakers of Irish did not recover the deleted fricative at the time of compensatory lengthening, vowel length would need to be specified in inputs, and faithfulness constraints to protect vowel length would need to be promoted. A second, more restrictive possibility, would only protect underlying vowel length before sonorants. On the other hand, if Irish speakers were aware of the deleted fricative, they could have maintained a grammar that enforced shortening and restricted word-medial long vowels to arising via compensatory lengthening.

It is unlikely that Irish speakers recovered the underlying fricatives and maintained productive compensatory lengthening. There was only one paradigmatic context that speakers could use to recover deleted consonants. Some verbs beginning with stop-sonorant clusters formed the past tense via initial consonant reduplication, which set up a CVCR sequence that triggered compensatory lengthening to CV:R. This can be seen in the past tense of [kre-n-əðʲ] ⟨crenaid⟩ ‘s/he buys’, which in the first person past tense became [ke:r] ⟨cér⟩ ‘I bought’ (Thurneysen 1946:428). The underlying historical progression leading to [ke:r] ⟨cér⟩ ‘I bought’ is laid out in (10).

(10)	kikra	Pre-lenition
	kixra	Lenition
	kexra	Harmony
	kexr	Apocope
	ke:r	Comp. Len
	⟨ke:r⟩	Orthography

By the time of the Early Irish manuscripts we find innovative reduplicated forms. These provide concrete evidence that compensatory lengthening was not acquired, and thus that vowel length in word medial syllables must have become contrastive. For instance, the reduplicating verb meaning ‘dig’ appears without consonant loss or a long initial syllable, so that /RED-klað-adar/ appears as [kexləðədər] ⟨cechladatar⟩ ‘they

dug’ (Stokes and Strachan 1901:526, Wb. 5a24), instead of compensatorily lengthened *[ke:ləðədər] or its syncopated version *[ke:ldədər].¹⁶

Unfortunately, we do not know whether the process was abandoned before or after the development of rhythmic syncope, which created a cavalcade of surface fricative-sonorant clusters. We only know that compensatory lengthening had progressed far enough before syncope that there are pre-syncope Ogam stone inscriptions which have solitary sonorants in place of etymological fricative-sonorant sequences (McManus 1991:96). These inscriptions establish that syncope and compensatory lengthening did not happen at exactly the same time, but they cannot tell us what the contrastive status of vowel length was in the grammars of speakers.

However, following our decisions to preserve granularity by recognizing a post-harmony shortening period and placing the entry of loans with British lenition after Irish lenition, we assume that Irish speakers had grammars that enforced a length contrast in all word medial syllables before syncope. That is, we analyze word-medial vowels that undergo shortening as entering the language before compensatory lengthening. Furthermore, we conclude that a loan was borrowed before compensatory lengthening if the Latin original meets the environment for compensatory lengthening and it is carried out. Meanwhile, loanwords that maintain vowel length word-medially are thought to have entered after compensatory lengthening restored the vowel length contrast. If a Latin original has a cluster that was made illegal by compensatory lengthening, and that cluster is not simplified, we conclude that it was borrowed after compensatory lengthening. That is, such a loan must have entered during or after the syncope period, which re-created these consonant clusters.

3.6 Syncope

As stated in section 2, rhythmic syncope targeted even-numbered non-final syllables when counting from left to right. The derivation in (11) illustrates the application of syncope to Latin [apostol-us] ‘apostle-MASC.NOM.SG.’ to create Irish [axsəl] ⟨axal⟩ (McManus 1983:48).

(11)	apostol-us	Latin
	/apostol-as/	Irish UR
	akostolas	[p]→[k]
	axostolah	Lenition
	axosolah	[st]→[s]
	axosol_	Apocope
	(‘axo)(,sol)	Footing
	(‘ax_)(,sol)	Syncope
	(‘ax_)(,səl)	Other Rules
	[axsəl]	SR
	⟨axal⟩	Orthography

¹⁶The form [ke:xləðədər] ⟨cechladatar⟩ also illustrates how the rhythmic syncope system had broken down by the time of the Old Irish manuscripts. If syncope had been applied to the reduplicated form starting in [kex...], we would expect to find *[kexldadar] or possibly *[kexəldədər] with regular epenthesis before stranded sonorants.

In the simulations in section 5, we take the removal of vowels from even-numbered non-final syllables as evidence that a word entered Irish before or during the syncope period. Vowels may be deleted from other syllables, as in /kon=to-ro-xar-adar/ → [kon=torxratar] ⟨con-torchratar⟩ ‘they fell together’ (discussed above in section 2.1), or more commonly, may fail to be removed from the expected syllables. Either of these deviations are taken as evidence of entry after the syncope period. See section 3.6.2 for further dating criteria using the adaptation of consonant clusters.

It is important to note that current approaches to loanword adaptation may make differing predictions for whether deletion would be enforced in new loans entering during the syncope period. Phonetic processing accounts of loan adaptation (Silverman 1992, Peperkamp and Dupoux 2003, Peperkamp 2005) highlight ‘perceptual deafness’ to non-native structures. Under such an approach, unfaithful loan adaptations are the result of the perceptual system mapping illegal percepts to native ones. Such a mechanism may not be able to enforce rhythmic syncope in new loans. In general, even if a language obligatorily has closed syllables, it is not clear that the perceptual repair to a string of light, open syllables, like CVCVCVCVCVC, would be deletion of every other syllable, producing CVC_CVC_CVC. Focusing specifically on Irish, within a phonological word, speakers had experience with strings of two light syllables, because the final two syllables of even-parity words did not feature deletion. For instance, underlying /e:gosavil/ was footed as (‘e:go)(savil) and thus surfaced (with vowel reduction in unstressed syllables) as [(‘e:g_)(səvəl)] ⟨écsamil⟩ ‘dissimilar’ (Thurneysen 1946:67). This makes the possibility of deletion as a perceptual repair more unlikely.

An opposing perspective is that loanword adaptation is the application of native language processes to an input that is reasonably faithful to the source language (LaCharité and Paradis 2002; LaCharité and Paradis 2005). This is the most plausible way for rhythmic syncope to be applied to loans that entered during its heyday. That is, if syncope in Irish speakers encountered a British Latin word like [abostol] ‘apostol’, they would construct a representation like /abostol/, foot it as (‘abos)(tol), and apply syncope to create [(‘ab_s)(tol)], which eventually reaches us as [abstəl] ⟨apstal⟩ (CITE). Under this approach, Latin loanwords would be expected to undergo syncope for as long as it remained an active part of Irish phonology.

3.6.1 Separating syncope and other processes

At least two loans may have entered between the beginning of compensatory lengthening and before the end of syncope. Latin [kandel-a:ri-us] ‘candle-AGEN-MASC.NOM.SG.’ appears in Irish as [kanˠdʲiːoːrˠ] ⟨caindl(e)óir⟩ ‘candle-bearer’ (Stokes and Strachan 1901:703, Wb. 24b32). This word shows both syncope and the retention of the long vowel [a:], which had been rounded to [ɔ:] in British before becoming Irish [oː]. The adaptation of this word is illustrated in (12), alongside counterfactual derivations for early (column 2) and late (column 3) entry. We use ↓ to mark a possible point of entry where the listed process does not apply.

(12)	kandela:ri-us	kandela:ri-us	kandela:ri-us	Latin
	kandelo:r	kandelo:r	kandelo:r	British Latin
	/kandelo:rj/	/kandelo:rj/	/kandelo:rj/	Irish UR
	X	kandelorj	X	Shortening
	↓	—	X	Comp. Len
	(ˈkande)(,lo:rj)	(ˈkande)(,lorj)	X	Stress
	(ˈkand_)(,lo:rj)	(ˈkand_)(,lorj)	X	Syncope
	(ˈkanjdj)(,lj-o:rj)	(ˈkanjdj)(,lj-ərj)	kandəlo:rj	Other rules
	[kanjdjlj-o:rj]	*[kanjdjlj-ərj]	*[kandəlo:rj]	SR
	⟨caindleóir⟩	⟨caindler⟩	⟨candalóir⟩	Orthography

However, this case is controversial, because [kanjdjlj-o:rj] ⟨caindleóir⟩ may have been formed within Irish from borrowed morphemes, rather than the whole word being borrowed directly from Latin. That is, Latin [kande:la] ‘candle’ was borrowed into Irish as [kanjdjəl] ⟨caindel⟩ (Lash 2021, S0027-57), where the shortening of Latin [e:] indicates that it entered Irish before compensatory lengthening. Furthermore, the suffix [-o:rj] ‘AGEN’ was extracted from other Latin loans and was applied even to native roots, such as the word [foxjlj-o:rj] ⟨foichleóir⟩ ‘curator’ from [foxjəl] ⟨fochell⟩ ‘attention, heed, caring for’ (Thurneysen 1946:172).¹⁷ Concatenating /kanjdjel/ and the suffix /-o:rj/ produces /kanjdjel-o:rj/, which would undergo syncope to become [kanjdjlj-o:rj] ⟨caindleóir⟩. Although our model does not treat Irish-internal neologisms, in this case the distinction between borrowing and neologism is so faint that we include this word in our simulations.¹⁸

The second loan that could have entered in this time span is Latin [deprekatio:] ‘deprecation’, which appears either as Irish [dʲebrjəgo:dj] ⟨deprecóit⟩ (McManus 1983:68) or [dʲivjərgo:dj] ⟨dibercoit⟩ (CITE). Though at first blush neither form would seem to comply with the expected output of syncope, the vocalism of the latter is the expected outcome of epenthesis repairing sonorants stranded between consonants by syncope (Thurneysen 1946:70). Furthermore, similar variation is seen in the clearly pre-syncope loan of the Latin name [pa:triki-us] ‘Patrick-MASC.NOM.SG’, which appears both as [koθrəjje] ⟨Cothrige⟩ (Thurneysen 1946:571) and [kaθjərjje] ⟨Cathirge⟩ (McManus 1983:62, fn. 122). We date this loan to entering in either the syncope or compensatory lengthening periods.¹⁹

¹⁷This suffix remains productive even in the modern language.

¹⁸There are three other potential loans that lack a Latin vowel and retain a long vowel. Latin [tri:nita:t-em] ‘trinity-FEM.ACC.SG’ appears as [tri:ndo:dj] ⟨tríndóit⟩ (attested in a different case form ⟨tríndóit⟩) in Stokes and Strachan 1901:9, Ml. 2d2), Vulgar Latin [antita:t-em] ‘antiquity-FEM.ACC.SG’ became Irish [ando:dj] ⟨andóit⟩ ‘mother church’ (McManus 1983:61), and Latin [fe:ria:l-is] ‘pertaining to a weekday-MASC/FEM.NOM.SG’ appears as [fe:ro:lj] ⟨féróil⟩ (Lash 2021, S0058-40). However, syncope of front vowels in Irish triggers palatalization on the neighboring consonants (as seen in examples 5 and 12). The lack of palatalization of the medial consonant or clusters in these words indicates that the missing Classical Latin vowel was lost in either British Latin or Vulgar Latin.

¹⁹Two further loans have a similar consonant configuration but without the variation in vocalism. These are Irish [mʲedrəbəlj] ⟨metrapoil⟩ ‘metropolis’ (CITE Ml 106d6) from Latin [me:tropolis] and Irish [akrjəsʲənde] ⟨Acrisíondae⟩ (CITE Sg) from a Latin proper name [akrisione:]. We lack direct evidence of syncope and subsequent vowel epenthesis for these words, but we recognize the possibility that the observed forms could have been developed this way with subsequent metathesis. Accordingly, we allow these words to enter during both the pre-syncope and post-syncope periods.

3.6.2 Juxtaposed Consonants

The deletion of vowels via syncope created consonant clusters, some of which had been illegal in Irish and were repaired when they appeared in loanwords. McManus (1983:60-62) points out that some loanwords do not undergo these repairs, which is plausibly attributable to syncope having legalized them. Specifically, faithful adaptation of [ns, nf, ks] diagnoses entry after syncope, while a repair of Latin [nf] to Irish [v] diagnoses a pre-syncope loan. However, Irish and Vulgar Latin both repaired [ns, ks] to [s], making it impossible to determine anything about date of entry from these repairs. Furthermore, nasal-voiceless stop clusters [ŋk, nt] were often repaired by voicing the stop (see McManus 1983:61 for discussion). We analyze cases of voicing as evidence that a word entered the language before syncope. We cannot draw any conclusions from the failure of voicing to apply, because there are early loans that do not show voicing. For instance, Latin [intel:ekt-us] ‘intellect-MASC.NOM.SG’ appears in Irish as [in^hɛl^hʲux̪t̪] (intliucht) (McManus 1983:62), which has undergone syncope and shows evidence of a pre-syncope process known as u-coloring or u-affection (Hock 2019, McCone 1996:111-112).

In addition to the consonant clusters discussed by McManus (1983), syncope re-legalized the consonant clusters that were simplified by compensatory lengthening. Latin originals with these clusters are extremely rare in our loan data, but if they were faithfully adapted, it would be evidence for adaptation that occurred after syncope.

3.7 Local Summary

Our goal is to quantify how many loans were borrowed during the syncope period. We have exemplified the major processes that applied to loans, and we have shown that they applied in more or less discrete periods from one another. Because of this, the processes that applied to a loan can be used to diagnose when they entered. If a loan undergoes any of the pre-compensatory lengthening processes, it cannot have entered during the syncope period. Meanwhile, if a loan does not undergo shortening or maintains consonant clusters that were legalized by syncope, it could have entered Irish around or after the syncope period. If a loan undergoes syncope, it must have entered the language before syncope ended. If, however, a loan does not undergo syncope, it must have entered the language after syncope ceased to apply.

Section 4 provides further details on the corpus of loans that we use. Sections 5-7 discuss our model of how many loan were adapted at the phonological milestones demonstrated here.

4 Corpus Description

To get a meaningful picture of how many loans entered Irish during the syncope period, we must apportion loans to the various pre-syncope periods and the post-syncope period. Such a task requires a representative corpus of the early Latin loan vocabulary. Our primary source for this vocabulary is manuscripts containing Old Irish material. While there are multiple such manuscripts to choose from, most are in fact copies writ-

ten much later than the Old Irish period. We set the tenth century as a cutoff point in order to exclude material that entered the language much later than syncope, and included all loans from the contemporary Old Irish manuscripts before that date.

Fortunately, the recently available Corpus Paleo-Hibernicum (CORPH, Stifter et al. 2021), a searchable web-based lexicon of pre-tenth century Irish, has made searching for loanwords during this period straightforward. From CORPH, we draw on the material in the Milan (Stifter et al. 2021; Stokes and Strachan 1901) and St. Gall (Stifter et al. 2021; Stokes and Strachan 1903) manuscripts, which contain Old Irish glosses on Latin texts and specifically a large number of loanwords from Latin. They are standardly dated to the eighth or ninth centuries and the ninth century, respectively. We also draw from fifty-eight so-called “minor” glossed manuscripts dated to the seventh to the tenth centuries (Lash 2021) and the mid-eighth-century poems of Blathmac (Barrett 2021, see Stifter 2015 on the dating of Blathmac). To round out the picture of securely pre-tenth-century loans, we draw on the Thesaurus Paleohibernicus (Stokes and Strachan 1901, Stokes and Strachan 1903), which includes manuscripts not found in CORPH, including the eighth-century Würzburg manuscript (Kavanagh 2001). Beyond loans found in Würzburg, the Thesaurus Paleohibernicus provides two additional loans.

The above sources do not provide a complete sample of the early Irish loan vocabulary, because they do not contain many loans whose adaptations clearly point to a pre-syncope entry date.²⁰ We draw these loans from McManus (1983), which is a thorough, albeit not exhaustive, collection. Two loans from McManus in our corpus cannot be confidently dated to before syncope. We include them because it is theoretically possible that they entered before syncope.

The contributions of each source to our corpus are shown in (13), where loans are only counted towards the earliest source in which they are attested.

(13)	Source	Pre-syncope	Post-syncope	Either	Total
	Würzburg	36	17	78	131
	Blathmac	14	4	31	49
	Milan	18	11	40	69
	St. Gall	23	27	67	117
	Minor Glosses	23	10	38	71
	Thes. Pal.	0	0	2	2
	McManus	90	0	2	92
	Total	204	70	257	531

The corpus contains loans without Irish derivational morphology. For example, Irish borrowed [korp] <corp> ‘body’ (Stokes and Strachan 1901:581, Wb. 3a4), but we exclude Irish derivatives such as [korp-əx] <corpach> ‘corporeal’ (lit. ‘body-ADJ’) (Stokes and Strachan 1903:148, Sg. 125a5). We also exclude multiple case forms of the same loan. There is however some ambiguity in how to determine what counts as

²⁰An additional complication is that many of the loans in the early texts are literary and may have never been nativized or only existed in writing. A philological approach to such loans may be successful in determining when they entered Irish, but we do not attempt this here.

a separate loan. For instance Irish borrowed [u̯əldoːd̪] ⟨umaldóit⟩ ‘humility’ (Stokes and Strachan 1901:581, Wb. 13a17) from Latin [humilitaːtem]. From the perspective of Irish, [u̯əldoːd̪] must be a separate borrowing from the borrowing [u̯əl] ⟨umal⟩ ‘humble’ (Stokes and Strachan 1901:532, Wb. 5d27), since there is no native word formation process that creates nouns with this shape. However, [u̯əldoːd̪] ⟨umaldóit⟩ and [u̯əl] ⟨umal⟩ are transparently related by regular morphology in Latin, making these words a single loan from the Latin perspective. The conservative choice is to count loans from the Latin perspective, because our simulations rely on phonotactic frequencies drawn from the Latin nominal lexicon. This is also a reasonable assumption, since there was substantial familiarity with Latin, as evidenced by the replacement of Latin case suffixes with Irish ones during the borrowing process. For completeness, we also compiled the set of loans from the Irish perspective, resulting in 20 additional loans. The simulation results do not differ appreciably between these different collections.

An additional wrinkle is that the same Latin lexeme could be borrowed multiple times. For instance, Latin [apostol-us] ‘apostle-MASC.NOM.SG’ appears as a pre-[p]→[k] loan in Irish [axsəl] ⟨axal⟩ ‘apostle’ (McManus 1983:48) and as a post-[p]→[k] loan in [abstəl] ⟨apstal⟩ ‘apostle’ (Stokes and Strachan 1901:527, Wb. 5b17). In such cases we included both Irish words as separate borrowings.

Finally, 57 loans could not be dated purely mechanically, usually because they had inconsistent phonological cues to their date of entry. A typical case is [uespəsʲiən] ⟨Uespisian⟩ ‘Vespasian’ (Barrett 2021, S0005-114), which has no orthographic cues to the vowel length in Latin [wespasiaːn-us] ‘Vespasian-MASC.NOM.SG’, and so possibly underwent shortening (a pre-syncope change), but which is also clearly unsyncopeated. For each such inconsistent form we provided our best guess for the dates of entry by hand. In the case of [uespəsʲiən] ⟨Uespisian⟩ ‘Vespasian’, we disregarded the putative shortening, attributing it to Latin orthography omitting length marking, which is especially likely given the literary nature of a reference to a long-deceased Roman emperor. All data and source code is available at <https://github.com/bowersd/lat2sgaloans>.

5 Timeline Estimation Method

We seek to estimate when each Latin loan entered Irish. There are seven discrete blocks of time in which a loan could enter, corresponding to the processes reviewed in section 3 and the post-syncope period. In brief, we randomly assign loans to one of the possible dates of entry dictated by their phonological adaptations, then apply heuristic search methods to arrive at plausible timelines of borrowing.

Because the combinatoric space of possible dates of entry is very large, full consideration of all candidate timelines was not possible, and we used an implementation of the genetic search algorithm (Holland 1975, De Jong 1975, Yang 2021) instead. Genetic search maintains a ‘gene pool’ of parameter values, first by creating ‘mutations’, that is, random assignments of parameter values, from which the m most fit specimens according to an evaluation metric are selected. The gene pool then undergoes ‘recombination’, where the selected specimens swap parameter values between each other, and once again the m most fit specimens are retained. The search proceeds by iterating

between mutation and recombination phases until fitness no longer improves or a set number of generations has been reached.

In our implementation, the gene pool contained the 100 most fit time courses. In the mutation phase, each timeline was mutated 1,000 times. The mutation rate declined over successive generations, starting at 5% of changeable dates, and halving each time an iteration failed to introduce any mutations into the gene pool. In the recombination phase, each member of the pool created 20 offspring with each other member of the pool by randomly swapping dates of entry between them. The algorithm was halted when new members ceased to be added to the gene pool and the mutation rate was too low to change any dates, which typically occurred between the 40th and the 60th generation.

The measure of timeline fitness evaluates phonotactic balance within each period. Phonotactic balance is considered in order to favor timelines where the structural description for any particular Irish phonological process was not over-represented in any block of time.²¹ That is, while we know that loans that underwent [p]→[k] must have been borrowed during the [p]→[k] period, it would be a mistake to assume that only Latin words with [p] were borrowed during that time. To do this, we obtained the rates at which a set of phonotactic properties ϕ appeared in the Latin nominal vocabulary, using a comprehensive collection of Latin nouns provided by Adam Albright. We prioritize nouns because the loan vocabulary almost exclusively features nouns. We treated the phonotactic probability Φ_p of each period p in the timeline T as the joint binomial probability of the number of words in p bearing each phonotactic property $f \in \phi$. The probability of timeline T is straightforwardly the product of each probability Φ_p for all periods p .

The phonotactic set ϕ could conceivably contain all of the structural descriptions for the Irish processes discussed here. However, the structural descriptions overlap with each other, and would overemphasize the importance of some properties for fitness if left unmodified. Accordingly, we assigned overlapping cases to a single parameter whenever possible. See the online source materials for the actual implementation.

6 Timeline Estimation Results

We report the results of 20 simulations, 10 simulations each for the Latin-perspective and Irish-perspective datasets.²² For reference, we consider a naive model that does not attempt to provide phonotactic balance within periods, but instead evenly allocates loans between the periods in which they could have entered Irish. This results in a fairly equal allocation of loans to each period, as would be expected if the rate of borrowing was constant and all periods had the same duration. We find that the phonotactic model and the naive model diverge radically for the post-harmony shortening, compensatory lengthening, and syncope periods. This can be seen in Figure 1.

²¹It is reasonable to assume that the Latin loans were a fairly unbiased sample of the Latin lexicon. For instance, the frequency of the word initial segment of the Latin donor words is highly correlated to their frequency in the Latin nominal lexicon, with $R^2 = 0.68$.

²²For completeness we also ran 10 simulations on each dataset while allowing loans with British lenition to enter alongside, instead of after, loans showing Irish lenition. This only resulted in the lenition and harmony

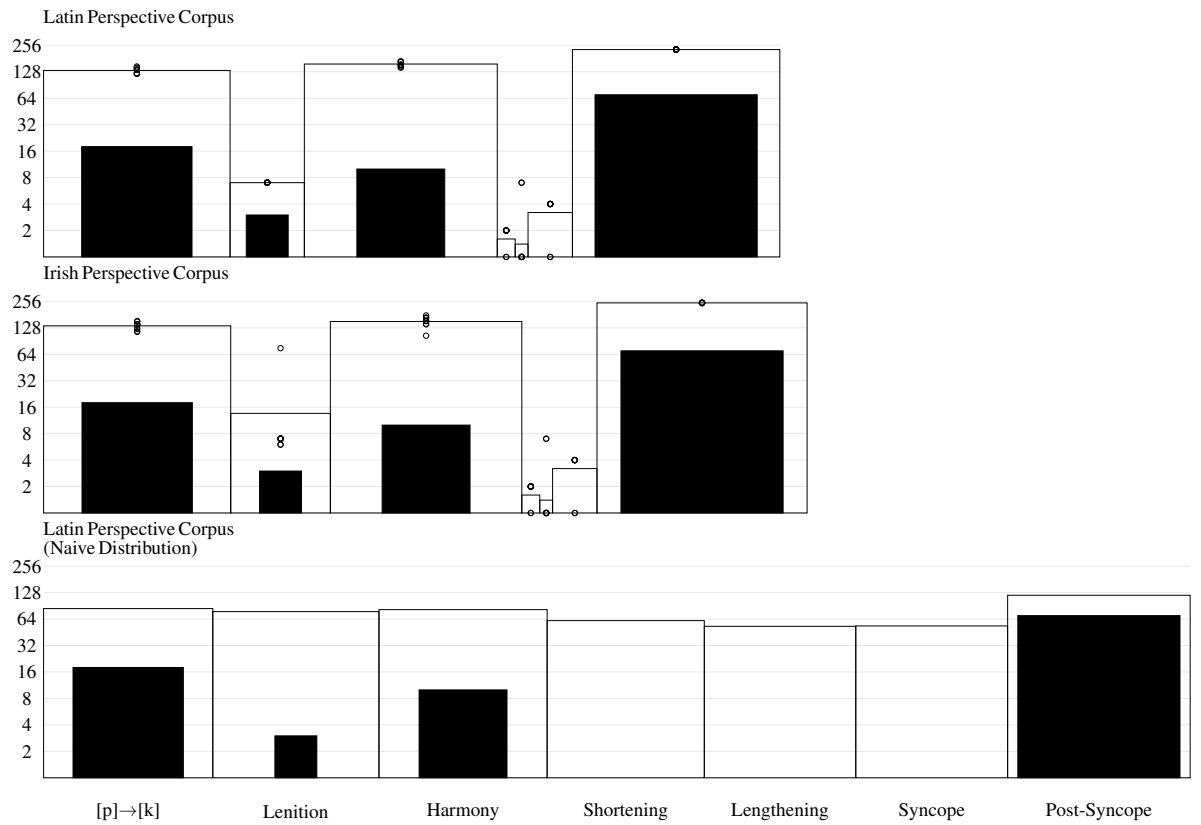


Figure 1: Loans allocated to each phonological period, faceted by sub-corpus. The vertical axis is on a logarithmic scale, and to avoid large negative values, raw values between 1 and 0 are rounded up to 1. Circles represent the number of loans assigned to a period by an individual run of the search algorithm. White squares represent the average loans assigned to a period, black squares represent loans that can only be assigned to a period. The length of a side of a square is proportional to the number of loans. The bottom panel represents an even division of loans over the periods they were eligible to enter, for the Latin perspective sub-corpus.

Before moving on to the discussion of the estimated cessation of loans in the compensatory lengthening-syncope period, note that the phonotactic model is sensitive to the number of loans that must be assigned to any particular period. These obligatory loans are represented by the black square at the base of each period in Figure 1. What we see in the results of the phonotactic model is that the size of the white square representing the total number of loans assigned to a period roughly reflects the size of the black square inside it. By contrast, the naive distribution assigns similar amounts of loans to all periods. The higher sensitivity to obligatory period members displayed by the phonotactic model underscores its ability to build a representative set of loans by adjusting for the phonotactic properties of the members assigned to the period. For instance, a period like [p]→[k] with a well-established core of 18 loans should be expected to have many more members than the rhythmic syncope period, which has no core members.

7 Discussion

Our key concern is whether rhythmic syncope was a flash-in-the-pan phenomenon, which we term the ‘brief-blip’ hypothesis. The paltry number of loans assigned to the syncope period is certainly consistent with the brief-blip hypothesis. If rhythmic syncope was only active for a very short time, then it is plausible that very few loans would have entered during the window in which it would have affected them.

The briefest possible blip for rhythmic syncope is a single generation. Concretely, assume generation *g* of speakers who exaggerated rhythmic reduction to near deletion, and a following generation *g'* who perceived it as categorical deletion, but failed acquire a rhythmic syncope grammar. Under this scenario, there would have been at most a couple of decades for generation *g* to innovate extreme reduction and adapt loans with rhythmic syncope. After that point, generation *g'* would comprise a significant proportion of the adult speech community, and would comprise the entirety of the students encountering Latin in Irish and British monasteries. Even if it is not yet known what grammar generation *g'* would have, if it did not enforce rhythmic syncope, they would not apply rhythmic syncope to fully vowel Latin words, and may even contest syncopated adaptations where the Latin original was known.

The brief-blip hypothesis is not the only possible explanation of the results. A low number of loans during a period could be due to a slackening of the rate of borrowing, which we dub the ‘slow-flow’ hypothesis. Under the slow-flow hypothesis, rhythmic syncope could have been productive for a reasonably long period of time; we would simply lack evidence of this productivity due to the fact that no loans arrived to bear its mark.

A possible point in favor of the slow-flow hypothesis is that it may be able to give a unified explanation for the lack of loans assigned through the post-harmony shortening, compensatory lengthening and rhythmic syncope periods. Under the slow-flow hypothesis, there could have been a generalized decline in borrowing throughout a broad period. In contrast, a purely chronological approach like the brief blip hypothesis

periods having roughly equal numbers of loans assigned to them.

must make the not unreasonable argument that the post-harmony shortening period was quickly ended by the compensatory lengthening period, which was quickly followed by the rhythmic syncope period.

Caution is in order, however, because a decline in borrowing would ideally coincide with a broader cultural rupture, but the evidence points to closer ties being formed. To be specific, the relevant rupture period would begin in roughly the tail end of the 5th century, and would ideally last until at least the beginning of the 7th century. The only problem with this view is that during this time, the Christian church strengthened in Ireland and southern Britain (Flechner and Ní Mhaonaigh 2016), with many monasteries being founded during this time. This is particularly inconvenient for the slow-flow hypothesis, since ecclesiastic contexts were the main point of contact for Irish speakers with Latin. In light of the strengthening church, it would be unwise to insist on a break in contact between Irish and Latin.

It may be tempting to point to the traditional historiographical date for the fall of the Western Roman empire in 476 CE as sufficient evidence of cultural turmoil during this period. However, this is only a spurious correlation, primarily because the Christian church was relatively untroubled by the military breakup of Rome (Brown 1989). Furthermore, the actual dates for the decline of the Roman empire in the neighborhood of Ireland do not align well with this period, since imperial Roman authority ceased in Britain in 410 CE, and was tenuous in Gaul even before it catastrophically collapsed in 455 CE.

The most plausible way to reconcile the slow-flow hypothesis with deepening Irish-Latin contact is to postulate a shift to a more formal mode of contact. The thoroughly adapted loans that are assigned to the span including the [p]→[k] and harmony periods could be the result of early, oral, informal transmission. Meanwhile, the later loans could have come through more formal contact with writing and formal instruction in monastic settings. Continuing the riverine metaphor, the flow only slowed in the original channel because the current had been diverted into a new channel.

Under this scenario, many of the loans assigned to the post-syncope period by our model could have entered during the projected post-harmony doldrums. Since they entered during a period of formalized contact, it would not be surprising if these loans were exempted from native Irish phonology. This is not a wholly satisfactory resolution, because these relatively less adapted loans were still nativized in Irish, most saliently with palatalization, vowel reduction and morphological consonant mutations. The slow-flow hypothesis must still contend with why some processes were enforced, but rhythmic syncope was not. On the other hand, under the brief-blip hypothesis, rhythmic syncope was ephemeral and would not be expected to be a core part of loan adaptation.

None of these considerations is necessarily fatal to the slow-flow hypothesis. For this reason, the prudent choice is to adopt a hybrid perspective, whereby the rate of borrowing dwindled while syncope ignited and burned out quickly. What we certainly lack is positive evidence that rhythmic syncope persisted.

8 Conclusion

We have used a simple set of phonotactic heuristics to allocate Latin loans to periods in early Irish. By and large the model predictions concur with the intuitions of previous scholarship, in that there was a large group of loans that underwent early phonology, and another large group of loans that was exempt from early phonology. Specifically, our model spreads the early group of loans over several periods, before entering a pronounced lull during the compensatory lengthening-rhythmic syncope phase, and finally resuming borrowing in the post-syncope period.

An interesting suggestion from our model is that a large tranche of loans is allocated to the oldest [p]→[k] period instead of being evenly spread over the more general pre-lenition period. This may bolster a theory that serious contact with Christianity and Latin occurred substantially before the 431/432 Palladian mission mentioned by Prosper of Aquitaine (Esposito 1957; Koch 1990). It could equally well give some flexibility to the 450 date for lenition (also postulated by McCone 1996:89), which was placed at that post-431 juncture to allow for some time for conversion to Christianity. Of course, our results are also still consistent with lenition occurring around 450 and the [p]→[k] period simply ending before lenition.

Our simulations cannot definitively prove that rhythmic syncope was a flash in the pan. This is because there are competing explanations for the dearth of loans during the syncope period. These include the possibility that the slow-flow hypothesis is correct despite a deepening ecclesiastic presence in Ireland, or even the possibility that loan adaptation uses mechanisms like phonetic adaptation that may not enforce patterns like rhythmic syncope. Although we cannot disprove these alternatives, we note that there is certainly a lack of positive evidence that syncope was productive for a long time.

Setting aside this uncertainty, Irish is in good company if its rhythmic syncope system quickly lost productivity. For instance, in Nishnaabemwin innovative non-synopatory patterns are judged favorably by speakers who were children when extreme reduction crossed into deletion (Bowers 2019). Isačenko (1970, see especially pp. 95-6) shows that rhythmic syncope in Eastern Slavic collapsed immediately after it arose. Furthermore, in Mojeño Trinitario rhythmic syncope developed sometime between 1898 and 1957, but it is no longer productive in the modern language and fails to apply to approximately 40% of eligible vowels (Rose 2019).²³ In Southern Pomo, dates for the development of rhythmic syncope are not available, but Kaplan (2020; 2022) highlights innovative deletion patterns that suggest speakers carried out a re-analysis. With Irish being the newest potential member of the class of languages that quickly lost rhythmic syncope, the imperative to precisely establish the descriptive facts for rhythmic syncope only grows more urgent.

²³The failure of rhythmic syncope to apply in large swaths of the vocabulary is reminiscent of what is reported for the Tonkawa lexicon in Hoijer (1949). Strikingly, Hoijer's (1933; 1946) description also suggests that the morae of deleted vowels were preserved via consonant lengthening, in much the same way as Rose (2019) proposes for Mojeño Trinitario. See also Rose (2014) for a robust class of morphological exceptions to syncope. Note that further research has shown that classifier suffixes in Mojeño Trinitario are not wholly immune to syncope, contrary to what is claimed in the paper (Françoise Rose, p.c.).

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