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The shift away from the marked: Syllabic consonants in historical Czech

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This paper analyzes the process of resyllabification in historical Czech. We argue that the diachronic shift from non-syllabic liquids to syllabic consonants reflects a broader cross-linguistic pattern of phonological change, characterized by a move away from marked structures. Resyllabification is examined in verse texts from the 14th to the 16th centuries that adhere to a regular octosyllabic rhythm. Our corpus-based research reveals that this process is influenced by morphological structure, with word-medial liquids becoming syllabic before those in word-final and morpheme-final positions. We explain this two-step change as a shift along the licensing hierarchy, from more marked to less marked licensors.

1 Background

This paper investigates a syllabification algorithm, with an empirical focus on syllabic consonants in historical Czech. In Czech, syllabic consonants are restricted to liquids /r l/, and they occur in two positions where they are not adjacent to vowels: word-finally (CL#) and word-medially (CLC). Our research concentrates on instances where syllabic liquids arise as a result of the resyllabification of originally non-syllabic clusters. Examples of this diachronic process are shown in (1).[1]

(1) a. CLC → $CL_{\sigma}C$ slz**a**$_{\sigma}$, krv**i**$_{\sigma}$ → s**l**$_{\sigma}$z**a**$_{\sigma}$, k**r**$_{\sigma}$v**i**$_{\sigma}$ 'tear.NOM.SG; blood.GEN.SG'
b. CL# → CL_{σ}# n**e**$_{\sigma}$sl, P**e**$_{\sigma}$tr → n**e**$_{\sigma}$s**l**$_{\sigma}$, P**e**$_{\sigma}$t**r**$_{\sigma}$ 'he carried; Peter.NOM.SG'

Both structures in (1) have in common that the liquid is part of a rising-sonority (CL) cluster. According to the Sonority Sequencing Principle (SSP), rising-sonority clusters containing liquids are the default syllable onsets, with their unmarked position being pre-vocalic (see Selkirk 1984; Clements 1990; Zec 1995). However, in both structures in (1), the CL cluster is not followed by a vowel and is thus in a marked position. From this perspective, the diachronic change illustrated in (1) represents a shift away from marked structures.

The markedness of the CL{#/C} structures is evidenced by two diagnostics—frequency and implication (see Rice 2007)—as demonstrated in **Table 1**. This table compares the cross-linguistic distribution of the clusters in pre-vocalic (CLV) and word-final positions (CL#), based on generalizations in Greenberg (1978; generalizations 17 and 18) and observations made by Zec (1995). In general, unmarked CLV structures are more frequent than marked CL# structures: the former are attested in two language types in **Table 1**, while the latter only appear in one. Furthermore, marked CL# clusters, in which the final liquid is not a syllabic consonant, imply unmarked CLV structures, but not *vice versa*. There are languages, like Georgian or Polish, where both structures exist, and others, like Greek and Swedish, that only exhibit CLV but not CL#. A third possible language type, in which CL# exists but not CLV, is unattested. In sum, both frequency and implication confirm that the unmarked position for CL clusters is before a vowel.

CLV	CL#	
✓	✓	Egyptian Arabic, Georgian, Pashto, Polish, Romanian, Welsh
✓	–	Greek, Swedish, Serbian, Totonac, Wichita
–	✓	not attested

Table 1: Cross-linguistic distribution of CLV and CL#.

[1] In addition to liquids, nasals also can be syllabic in contemporary Czech. Since syllabic nasals are almost exclusively limited to recent loans, they are not the subject of our study.

The marked non-vowel-adjacent positions are either word-final (CL#) or word-medial (CLC), where the liquid is followed by another consonant. Applying markedness diagnostics to these two configurations, the results of which are indicated in **Table 2**, reveals that CL# clusters are less marked than CLC clusters. First, the less marked CL# clusters appear in two language types, as opposed to more marked CLC clusters, which are found only in one type. Second, the more marked CLC clusters imply less marked CL# clusters, but not *vice versa*. Both marked structures occur in Georgian, Pashto, and Polish. Languages such as Egyptian Arabic, Romanian, and Welsh exhibit CL# clusters but not CLC ones. No language is attested that has only more marked CLC clusters without having less marked CL# clusters.

CL#	**CLC**	
✓	✓	Georgian, Pashto, Polish
✓	–	Egyptian Arabic, Romanian, Welsh
–	✓	not attested

Table 2: Cross-linguistic distribution of CL# and CLC.

If we turn back to historical Czech, we find that both marked structures existed. These structures arose due to the deletion of Common Slavic high vowels (known as *jers* in the Slavic-oriented literature) that followed CL clusters (see, e.g., Bethin 1998 or Scheer 2011). The diachronic pathway from Common Slavic forms with jers (ь/ъ) to Old Czech forms with non-syllabic clusters, and finally to structures with syllabic consonants in Modern Czech, is illustrated in (2).

(2)

Common Slavic		Old Czech		Modern Czech	
slьza	→	slza	→	sl$_{o}$za	‘tear.NOM.SG’
neslъ	→	nesl	→	nesl$_{o}$	‘he carried’

Given the markedness hierarchy CL# ≪ CLC, we hypothesize that the resyllabification of Old Czech forms occurred in two phases, with the more marked CLC clusters being eliminated more rapidly than the less marked CL# clusters. This hypothesis was tested through a corpus study analyzing Czech texts written between the 14th and 16th centuries.

Section 2 outlines the method used to track resyllabification in written language, where the (non-)syllabicity of liquids is not marked in the orthography. We argue that the (non-)syllabic nature of CL{C/#} structures can be inferred by analyzing their behavior in syllable-based poetry, particularly in verses adhering to a regular octosyllabic rhythm. The results of this analysis are presented in Section 3, where corpus data confirm the markedness hierarchy. In Section 4, we propose that the cross-linguistic hierarchy underlying the observed diachronic

resyllabification in Czech can be explained within the framework of the licensing-based model developed by Cyran (2010). This resyllabification is also sensitive to morphological structure, a point further explored in Section 5. Finally, Section 6 concludes the paper.

2 Recognition of syllable structure in written language

Cross-linguistically, various strategies exist to repair marked structures with CL clusters, including cluster simplification, vowel epenthesis, and syllabic liquids (see Côté 2011). All these strategies were applied in Old Czech, as reported by Trávníček (1935: 226–230) and Lamprecht et al. (1986: 77f.). For example, the marked forms *mo*[dl] 'idol.GEN.PL' and [blx]*a* 'flea' were replaced by the epenthesized forms *mo*[del] and [blex]*a*, while the marked cluster in *se*[dlk]*a* 'female farmer' was simplified to *se*[lk]*a*.

We focus on the third attested strategy, in which the liquids in marked structures became syllabic consonants. As the repair strategy involving syllabic liquids preserves the phonotactics of the clusters, it is less easy to trace in written language compared to cluster simplification and vowel epenthesis, which are reflected in writing.[2] Therefore, alternative methods must be developed to distinguish between syllabic and non-syllabic structures with CL clusters.

2.1 Octosyllablic verse

We build on the idea, previously discussed in the literature on historical Czech, that syllabic liquids were treated as units of verse, akin to vowels (see Gebauer 1894: §481; Komárek 1969: 128; Lamprecht et al. 1986: 77f.). Given that the prototypical verse scheme in Czech from the 14th to 16th centuries, when the resyllabification process was supposed to take place, is octosyllablic (Jakobson 1932), we examine the behavior of liquids in octosyllable-based poetry.

In octosyllabic verse, the number of syllables *per* verse is significant, irrespective of their weight or word stress position. Therefore, we employ a straightforward algorithm: if the liquid in CL{C/#} contributes to the octosyllable, then it is considered syllabic; if not, then it is not syllabic.

The proposed method for distinguishing between syllabic and non-syllabic liquids is applicable only to texts with a consistent syllabic rhythm. To identify such texts, we developed an automatic parser that detects sonority peaks and computes them for each verse. If the default principle is that the number of sonority peaks aligns with the number of syllables, then the octosyllabic rhythm is characterized by eight-peak verses. In sum, we examine the behavior of CL{C/#} only in those texts that, according to the sonority parser, exhibit a strong tendency toward an octosyllabic structure.

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[2] It is worth mentioning that syllabic liquids are occasionally marked in historical texts. For instance, they are written as geminates, i.e., *sm*<rr>*t* 'death' or *p*<ll>*n* 'full'. However, this orthographic representation is not consistent, neither across texts from the same period nor within a single text; see Komárek (1969: 97–101).

When assessing the proportion of octosyllabic verses—and evaluating the reliability of the given verse text for applying our method to track the resyllabification process—we initially configured the parser to compute only a subset of sonority peaks. Specifically, it was set to identify vocalic peaks (V-peaks). This setup was chosen because vowels are considered default syllable projectors, not only in Czech but also cross-linguistically.

The parser discriminates between two vocalic categories, following Parker's (2011) hierarchy of sonority: high vowels and non-high vowels, with the former being less sonorous than the latter. The vocalic inventory of Czech from the 14th to the 16th centuries is outlined in **Table 3**, in which IPA symbols are supplemented by the corresponding graphemes recorded in the historical texts under examination.[3]

	/segments/ = <graphemes>		
non-high vowels	/a aː/ = <a á>	/o oː/ = <o ó>	/e eː/ = <e é ě>
high vowels	/i iː/ = <i y í ý>	/u uː/ = <u ú ů>	

Table 3: Vocalic inventory of 14th–16th-century Czech.

The subdivision of vocalic segments into two sonority categories has implications for how vowel combinations are interpreted by the parser. Specifically, combinations of vowels with the same sonority level are interpreted as hiatuses, with each vowel counting as a separate V-peak, thereby projecting two syllables. For instance, in words like <neotpúščějí> in (3a) and <Marii> in (3b), hiatuses of non-high and high vowels, respectively, are identified.

(3) a. <n***eo***tpúščějí ni matcě>
/neotpuːʃt͡ʃejiː/ /ɲi/ /mat͡tse/
forgive.NEG.3.PL even mother.DAT.SG
'they do not even forgive the mother'
[DesHrad][4]

b. <Mar***ii*** plačíce silně>
/mariji/ /plat͡ʃiːt͡se/ /silɲe/
Mary.ACC.SG crying heavily
'[we hear] Mary crying a lot'
[HradMagd]

[3] In the 14th through 16th centuries the vocalic inventory underwent several changes, which however did not result in a reordering of segments with respect to sonority levels. For example, the merger of front high vowels, i.e., round /y/ and non-round /i/, is represented by the output /i/ in the table. For more details on the evolution of the vocalic system, see Kosek & Ziková (2022).

[4] The abbreviations in square brackets refer to the text from which the excerpt originates. These text identifiers are further explained in the abbreviation section.

Conversely, when vowels with different sonority levels are combined, only the vowel with higher sonority is counted as a V-peak. This algorithm aligns with historical grammars, which suggest that vocalic strings such as <ie> in (4a) or <ou> in (4b) corresponded to diphthongs, either rising or falling, respectively.

(4) a. <sedmi hř***ie***chy úhlavnými>
/sedmi/ /fiɾ̥i̯ɛxi/ /u:filavni:mi/
seven.INS sin.INS.PL main.INS.PL
'[soul died] of the seven deadly sins'
[HradMagd]

b. <budem spolu rozml***ou***vati>
/budem/ /spolu/ /rozmlou̯vaci/
will.1.PL together talk.INF
'we will talk to each other'
[Lom]

The outlined algorithm for counting V-peaks, and consequently for counting syllables, was applied to a sample of 12 texts from the 14th to 16th centuries comprising 23,287 verses in total. The results are summarized in **Table 4**. The first two columns provide metadata for the analyzed texts, including a text identifier and the century of origin. (Notably, there is a disproportionate number of 14th-century texts compared to those from the 15th and 16th centuries—seven texts versus five. This imbalance aligns with Jakobson's 1932 observation that the octosyllabic verse style declined in popularity over time.)

source text	century	number of verses	V-peak verses	V_8-peak verses
[ModlKunH]	14th	153	93%	96%
[Leg]	14th	1,091	91%	99%
[Alx]	14th	1,420	90%	99%
[DesHrad]	14th	1,197	91%	96%
[HradMagd]	14th	1,008	89%	99%
[HradSat]	14th	542	89%	94%
[UmučRajhr]	14th	402	83%	96%
[AlxV]	15th	2,460	90%	88%
[LegKat]	15th	3,518	91%	94%

(Contd.)

source text	century	number of verses	V-peak verses	V_8-peak verses
[Had]	15th	2,989	91%	99%
[Lom]	16th	6,372	92%	99%
[Petr]	16th	2,135	90%	99%

Table 4: Proportions of verse types.

The remaining columns contain information about the number of verses. Specifically, the third column indicates the total number of verses in each text. The fourth column shows the proportion of verses in which all sonority peaks are projected by vowels, with no peak projected by a liquid. First, we present the proportion of such V-peak verses relative to the total number of all verse types. Then, within this subset, the fifth column displays the proportion of verses that have exactly eight vocalic peaks (V_8-peak verses). These verses are, by default, octosyllabic.

The proportion of verses comprising exactly eight vocalic peaks (shown in the rightmost column of the table) is crucial for determining whether the given text leans toward a regular verse rhythm. The proportion ranges between 88% and 99%, a span indicating that the selected texts exhibit a strong tendency toward octosyllabism. Consequently, they are considered reliable sources for analyzing historical resyllabification.[5]

Let us now turn to CL{C/#} strings, which contain sonority peaks projected by liquids (L-peaks). Recall that our objective is to ascertain the syllabicity of these L-peaks based on their contribution to the octosyllable structure. If the L-peak is counted together with V-peaks to complete the octosyllable, then the liquid is considered syllabic. Conversely, if the octosyllabic structure is fully satisfied by V-peaks alone, the liquid projects an extra L-peak, which, however, is not considered syllabic.

[5] V-peak verses that the parser evaluated as deviations from octosyllabism either have one peak less (i.e., seven peaks), or conversely, one peak more (i.e., nine peaks). However, upon closer examination, these "irregular" verses can often be reinterpreted as regular octosyllables. A typical situation for verses with seven peaks is that they contain combinations of vowels of different heights, like <au> or <ei>, which the parser evaluates as diphthongs, i.e., as one peak. However, if these combinations are found on an affix boundary, they can be interpreted as hiatuses, i.e., as two separate peaks. For example, the verse <p**r**o**to**ž z t**oho** n**a**uč**e**ní> [Lom] 'because there is a lesson from it', which was automatically parsed as having seven V-peaks (bolded), can be reinterpreted as a regular octosyllable because <au> is found on a prefix boundary (*na-učení* 'on-learning'), indicating a hiatus rather than a diphthong. On the other hand, an extra peak in a nine-peak verse is often caused by an orthographic convention in which the preposition 'in' is marked by either consonantal or vocalic graphemes <v> or <u>, depending on the graphics of the preposition's complement. For instance, the parser automatically evaluated the verse <s ml**y**n**á**ř**e**m **u** p**e**kl**e** p**o**t**o**n**e**š> [DesHrad] 'with the miller, you'll drown in hell' as having nine peaks (bolded), where the preposition 'in' is written as the vowel <u> before the complement starting with a labial plosive <p>. If this labial vowel is just a graphic variant of the consonantal preposition *v*, then the verse again fits into regular octosyllabism. The proportions of verses with exactly eight V-peaks (V_8-peak verses) listed in the table correspond to counts generated by the parser that have been manually corrected along these lines.

The method used to determine the syllabicity of liquids is illustrated by two rhymed couplets, shown in (5) and (6). Both couplets contain the word /slzi/ ‘tears’, having an L-peak in the word-medial position (projected by the lateral /l/). The example in (5) contains a couplet from the second half of the 16th century. The octosyllabic structure of the first verse is satisfied by eight V-peaks (bolded). The second verse contains only seven V-peaks, which, together with the L-peak in /slzi/, form an octosyllabic structure.

(5)	verse 1: 8 V-peaks	verse 2: 7 V-peaks + 1 syllabic L-peak
	b**u**d**e** fi**o**ɻk**iː** k**a**l**i**x p**iː**c**i**	(s**l**z**i**)$_{\sigma\sigma}$ n**a**d m**a**lv**a**z**iː** m**iː**c**i**
	will bitter cup drink	tears over beer have
	‘he will drink a bitter cup || crying tears over the beer’ [Lom]	

The second couplet in (6) is from an earlier period, dating to the second half of the 14th century. As in the previous example, the octosyllabic structure of the first verse comprises eight V-peaks. However, in this case, the second verse also contains eight V-peaks. Therefore, the L-peak in /slzi/ is not considered syllabic here.

(6)	verse 1: 8 V-peaks	verse 2: 8 V-peaks + 1 non-syllabic L-peak
	k j**e**fi**o** r**o**v**u** pɻi**ʃ**l**a** b**i**l**a**	**a**b**i** s pl**aː**t͡ʃ**e**m (s**l**z**i**)$_{\sigma}$ pr**o**l**i**la
	to his grave came was	in.order.to with cry tears spilt
	‘she came to his grave || so she would cry tears’ [HradMagd]	

To summarize, the proposed method tracks the distribution of CL{C/#} clusters in eight-peak and nine-peak verses: in the first case, the liquid is considered syllabic, while in the second case, it is non-syllabic because it forms an extra sonority peak. This observation implies that nine-peak verses containing L-peaks do not deviate from the regular syllabic rhythm but rather constitute regular octosyllables. The validity of this reasoning is supported by the proportion of L-peaks. Among the nine-peak verses, those with non-syllabic L-peaks constitute the majority, namely 58%.

3 Corpus data

This section presents the results of our corpus study analyzing the behavior of CL{C/#} clusters in octosyllabic verses. We demonstrate that word-final clusters transform into syllabic structures more slowly than word-medial clusters, as predicted by the markedness hierarchy introduced in Section 1.

3.1 Word-final context: CL#

The distribution of word-final clusters is summarized in **Table 5**. The numbers in the table represent the total amount of tokens with a given phonotactic structure recorded in eight-peak and nine-peak verses across the three centuries studied. For clarity, these absolute values are

also expressed as proportions. The same method of presenting corpus data is used for the other phonotactic types discussed below.

century	nine-peak verses (non-syllabic CL#)		eight-peak verses (syllabic CL_{σ}#)	
	tokens	proportion	proportion	tokens
14th	109	96%	4%	4
15th	131	92%	8%	12
16th	65	61%	39%	41

Table 5: Distribution of word-final clusters.

The table shows a shift in distribution toward eight-peak verses in the 16th century. However, even in the 16th century, CL# clusters still had a smaller share in eight-peak verses compared to nine-peak verses, at 39% versus 61%. This distribution suggests that the resyllabification of non-syllabic CL# clusters into syllabic CL_{σ}# clusters accelerated during the 16th century, and the process was far from complete by the end of this period.

Our findings contradict Lamprecht et al.'s (1986: 78) assertation that word-final liquids became syllabic as early as the 14th century. Instead, our data support the view that diachronic processes are gradual rather than categorical (see Bermúdez-Otero & Trousdale 2012).

3.2 Word-medial context: CLC

Unlike word-final L-peaks, word-medial L-peaks are present in eight-peak verses from the beginning of the observed period, dating back to the 14th century. As illustrated in **Table 6**, the proportion of CLC clusters in eight-peak verses consistently remains above 80% throughout the entire investigated period.

century	nine-peak verses (non-syllabic CLC)		eight-peak verses (syllabic $CL_{\sigma}C$)	
	tokens	proportion	proportion	tokens
14th	65	14%	86%	415
15th	126	18%	82%	562
16th	47	8%	92%	567

Table 6: Distribution of word-medial clusters.

At first glance, the behavior of word-medial clusters appears distinct from that of word-final clusters. Throughout the examined period, clusters with a syllabic liquid predominate, seemingly suggesting the absence of resyllabification in the word-medial context. However, this conclusion may be misleading due to the lack of distinction in **Table 6** between original syllabic structures inherited from Common Slavic and those resulting from the later resyllabification of originally non-syllabic forms.

Recall that the marked non-syllabic CLC clusters arose from the deletion of Common Slavic jers, which followed the liquid. The jer deletion is illustrated by the root 'tear' in (7), where the front jer ь originally followed the cluster *sl*. By contrast, the jer preceded the liquid in the root 'wolf' (*vьlk*). These pre-liquid jers are thought to indicate the syllabicity of the liquid, and this syllabicity was preserved even after the jer vowel before the liquid was deleted (see Bethin 1998).

(7)

Common Slavic		Old Czech	
*slьz	→	slz	'tear'
*vьlk	→	$vl_{o}k$	'wolf'

In sum, CLC clusters in Old Czech can be either syllabic or non-syllabic, depending on their etymology. Therefore, the high frequency of syllabic forms in eight-peak verses, as shown in **Table 6**, does not provide evidence of the resyllabification of marked non-syllabic structures.

To track resyllabification, we could not apply an approach similar to the one used for word-final clusters. Instead, it was necessary to identify the attested word-medial clusters based on their etymology.

Using etymological dictionaries (Kopečný 1981; Rejzek 2015), we compiled lists of syllabic $CL_{o}C$ roots that emerged after the loss of the pre-liquid jer and of non-syllabic CLC roots that formed after the disappearance of the post-liquid jer. Examples of both etymological root types are provided in **Tables 7** and **8**. These lists were then compared with the data generated by the parser.

$CL_{o}C$	**Common Slavic**	
√hrd	*gьrd	'proud'
√krčm	*kьrčm	'pub'
√krm	*kьrm	'food'
√mlk	*mьlk	'silent'
√vrch	*vьrg	'top'

Table 7: Etymological syllabic roots.

CLC	Common Slavic	
√blsk	*blьsk	‘light’
√jablk	*ablьk	‘apple’
√hlt	*glьt	‘gulp’
√krv	*krъv	‘blood’
√slz	*slьz	‘tear’

Table 8: Etymological non-syllabic roots.

When examining each etymological group separately, we documented roots like those listed in **Table 7** exclusively in eight-peak verses, indicating consistent syllabicity throughout the entire period, from the 14th to the 16th century. In contrast, etymologically non-syllabic roots display a notable shift in distribution, illustrated in **Table 9**, indicating resyllabification.

century	nine-peak verses (non-syllabic CLC)		eight-peak verses (syllabic $CL_{\sigma}C$)	
	tokens	proportion	proportion	tokens
14th	28	85%	15%	5
15th	24	51%	49%	23
16th	0	0%	100%	24

Table 9: Distribution of Common Slavic non-syllabic roots.

Table 9 illustrates the distribution of eight roots inherited from Common Slavic, where a jer followed the CL cluster. This group contains the roots listed in **Table 8**, along with three additional roots: √brn ‘tingle’ (< **brьn*), √krst ‘christen’ (< **krьst*), and √trv ‘last’ (< **trьv*). These roots are primarily found in nine-peak verses during the 14th century, reflecting the non-syllabic status of the liquid. However, a significant shift occurred in the 15th century, with nearly 50% of occurrences appearing in eight-peak verses. By the 16th century, their distribution was limited to eight-peak verses, indicating the completion of the resyllabification process in the word-medial position.

3.4 Summary

The corpus data show that historical resyllabification in Czech, documented in octosyllabic poetry from the 14th to the 16th centuries, mirrors the universal markedness hierarchy. More

marked word-medial structures (CLC) were eliminated more rapidly than less marked word-final clusters (CL#). The relationship between structural markedness and diachronic change is summarized in **Table 10**.

markedness	CL#	CLC	historical resyllabification
+ +	✓	✓	14th c.
+	✓	–	16th c.
–	–	–	Modern Czech

Table 10: Historical resyllabification in Czech and the markedness hierarchy.

In the next section, the relationship between the universal markedness hierarchy and the language-specific diachronic data is incorporated into the licensing-based model proposed by Cyran (2010).

4 Derivation of the markedness hierarchy

Violations of the SSP, reflected in non-syllabic CL{C/#} clusters, are traditionally interpreted in terms of extrasyllabicity. The offending segments—in this case, liquids—are represented as standing outside the syllable structure. These segments are skipped by the syllabification algorithm and attached to higher prosodic levels, typically at the prosodic-word level. For example, Rubach & Booij (1990; 1992) analyze Polish and Slovak this way. They show that the liquid in Polish words like *Piotr* 'Peter.NOM.SG' or *krwi* 'blood.GEN.SG' is non-syllabic, similar to its status in 14th-century Czech. From this perspective, the contrast between languages with non-syllabic CL{C/#} clusters and those without them is a matter of a parameter on extrasyllabicity: it is turned ON in the former and OFF in the latter.

While the extrasyllabic approach represents SSP violations, it does not explain the markedness hierarchy among them. Extrasyllabicity is inherently unlimited; there is no principle analogous to the SSP that regulates either the phonotactics of extrasyllabic segments or their number (see the discussion in Scheer 2004: Chapter 5). Therefore, it remains unclear why extrasyllabic consonants in the word-final position should be less marked than those in the word-medial position. The widely held assumption that this markedness contrast is due to an edge effect merely points to a general tendency, without actually explaining it.

Furthermore, edge effects involve external sandhi, where phonological processes apply across word boundaries. A well-known example is the process of *enchaînement* in French, in which word-final consonants link to word-initial vowels in fluent speech, resulting in regular syllabic onsets (Côté 2004). We might hypothesize that such sandhi linking was also active in Old Czech,

rendering word-final extrasyllabic consonants less marked than word-medial ones, since only the former can be regularly syllabified as onsets of following vowel-initial words.

Therefore, we might expect non-syllabic CL# clusters to be found more frequently before vowel-initial words, where sandhi linking is possible. However, this hypothesis is not supported by our corpus data. We identified 362 tokens ending in CL clusters. Of these, 305 tokens are found in nine-peak verses, indicating that 84% of all attested word-final clusters are non-syllabic. An examination of the right-hand context of these non-syllabic clusters reveals that only a minority (11%) are followed by a vowel-initial word contrary to what we would expect if sandhi linking was occurring.

In the following section, we argue that the hierarchy between less marked CL# clusters and more marked CLC clusters, which remains unexplained by an extrasyllabic approach, is predicted by the licensing hierarchy proposed by Cyran (2010).

4.1 Licensing implications

The licensing hierarchy, building on representational theories of Government Phonology (Kaye 1990; Charette 1990; Harris 1997) and Strict CV (Lowenstamm 1996; Scheer 2004), involves two essential variables, as illustrated in **Table 11**. The table distinguishes between two main types of licensed consonant clusters and two main types of corresponding licensors. The licensed consonant clusters differ in their sonority profiles—they exhibit rising sonority (CL) or falling sonority (LC) phonotactics. The licensors differ in terms of segmental content: they are either regular vowels (i.e., full vocalic slots, V) or prosodic slots without vocalic features ($V_{ø}$).

1. licensee:	a. falling-sonority LC	b. rising-sonority CL
2. licensor:	a. full V-slot	b. empty $V_{ø}$-slot

Table 11: Typology of licensed clusters and their licensors.

By default, the liquid corresponds to a syllable coda in falling-sonority clusters and to a syllable onset in rising-sonority clusters. In this model, the structural sonority-based contrast is implemented in terms of headedness. Simply put, both cluster types in **Table 12** form consonantal domains where the liquid depends on the domain head. Therefore, falling-sonority clusters are head-final domains ([L⇐C]), while rising-sonority clusters are head-initial domains ([C⇒L]).

The head (C) is licensed by a prosodic position that follows the domain, marked as V in **Table 12**. Licensing is either short-distance or long-distance, depending on whether the licensor follows a head-final or head-initial structure. Head-final clusters involve short-distance licensing, where the head C and the licensor V are adjacent, while head-initial clusters involve long-distance licensing.

[L⟸C] V	[C⟹L] V
head-final domain	head-initial domain
= short-distance licensing	= long-distance licensing

Table 12: Head-final vs. head-initial clusters.

The licensors form a hierarchy where full V-slots are unmarked and empty $V_{ø}$-slots are marked. The licensors' hierarchy captures the cross-linguistic observation that consonant clusters appear more frequently before vowels than before consonants or word-finally, with both these positions represented by an empty $V_{ø}$-slot after the licensed cluster.

The typologies of short- and long-distance licensing, and of marked and unmarked licensors, are mapped onto each other in **Table 13**. The horizontal arrow indicates an implication relation going from the marked to the unmarked licensor. Specifically, this relation suggests that if an empty $V_{ø}$-slot participates in a particular type of licensing, a full V-slot will as well. The vertical arrow represents that long-distance licensing of CL clusters implies the short-distance licensing of other cluster types in the same context. This implicational model correctly postulates that CL{C/#} clusters are the most marked structures. First, they involve the most difficult scenario where a distant domain head must be licensed by the marked licensor. Second, the most marked structures, CL{C/#} clusters, are conditional: they cannot exist independently of other structural types.

type of licensing	**type of licensor**	
	− marked V	**+ marked $V_{ø}$**
short-distance	LCV	LC{C/#}
long-distance	CLV	CL{C/#}

Table 13: Licensing implications.

All four structural configurations derived from the licensing implications are attested in 14th-century Czech, the earliest stage of the language in our corpus. For clarity, each configuration is exemplified in **Table 14**.

The most marked structures in the bottom-right corner of the table were eliminated by the resyllabification process, suggesting that marked licensors can no longer participate in long-distance licensing. The fact that this shift occurred in two steps, as documented by our corpus research, indicates two degrees of markedness, where empty $V_{ø}$-slots in word-final positions are less marked than those in other contexts. The entire diachronic process is summarized in **Table 15**. The process is exclusively applied to long-distance licensing, where the most marked empty licensors are excluded first, followed by the less marked ones.

type of licensing	type of licensor			
	−marked V	**+marked $V_{ø}$**		
short-distance	ve[r⇐ʃ]e	ve[r⇐ʃ]	sy[r⇐s]ký	‘verse.GEN.SG; verse.NOM.SG; Syrian’
long-distance	my[s⇒l]i	my[s⇒l]	[s⇒l]za	‘mind.GEN.SG; mind.NOM.SG; tear.NOM.SG’

Table 14: Licensing implications in 14th-century Czech.

−marked	**+marked**	**++marked**	**diachronic stage**
full V	final $V_{ø}$	medial $V_{ø}$	14th-century Czech
full V	final $V_{ø}$		15th–16th-century Czech
full V			Modern Czech

Table 15: Diachronic shifts along the licensors’ hierarchy.

The division of empty vocalic slots reflects the cross-linguistic observation that consonant clusters tend to behave differently in word-final and word-medial positions (see, e.g., Harris 1997; Scheer & Ziková 2010; Ulfsbjorninn 2017; Passino 2020). In the licensing model, this asymmetry is attributed to the weaker licensing potential of medial empty $V_{ø}$-slots compared to final ones.

In sum, the proposed implicational hierarchy of licensors (full V ≪ final $V_{ø}$ ≪ medial $V_{ø}$) accounts for the two-step nature of resyllabification in historical Czech. What remains to be explained is the repair mechanism employed during this diachronic change, involving syllabic liquids. This issue is addressed in the next section.

4.2 Syllabic liquids as licensors

Let us begin with the observation that CL clusters resist diachronic change when followed by vowels. For example, the genitive singular *bratra* ‘brother’ consists of two CLV sequences that remained unchanged throughout all diachronic stages of Czech. This suggests that full V-slots are consistently strong enough to provide long-distance licensing. From this perspective, structures with syllabic liquids (CL_{o}{C/#}), which replaced the original non-syllabic strings, function as equivalents of regularly licensed CLV sequences.

The idea of structural parallelism between clusters followed by vowels and those containing syllabic consonants has been proposed, for example, by Rowicka (1999; 2003), Scheer (2009),

and Scheer & Ziková (2017). According to these analyses, syllabic consonants differ from their plain counterparts in terms of prosodic size. These differences are illustrated in (8), where the non-syllabic liquid in (8a) is associated with a single C-slot, while its syllabic counterpart in (8b) branches into the adjacent V-slot.

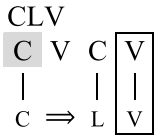
(8) a. non syllabic liquid

b. syllabic liquid

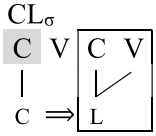
Other studies, such as Szigetvári (1999) or Scheer (2004), alternatively suggest that syllabic consonants branch to their left, and thus correspond to VC structures. However, as Polgárdi (2015) argues, these alternative proposals are not in contradiction, as the choice between CV and VC structures depends on the parameter settings of a particular language.

If the parameter for syllabic liquids in Czech is that they are right-branching structures, as in (8b), then the syllable shift from non-syllabic CL{C/#} to syllabic CL_{σ}{C/#} can be understood as the creation of a regular licensor for the CL cluster. The liquid-branching scenario is depicted in (9). The head-initial CL domain involves long-distance licensing, as the head (in gray) and its licensor (squared) are not adjacent. In Old Czech, this type of licensing could be provided by empty $V_{\emptyset}$-slots, but in Modern Czech, only full V-slots serve as regular licensors. These slots are either filled by vocalic segments, as in (9a), or they accommodate the segmental features of the adjacent liquid, as shown in (9b).

(9) a.



b.



As argued by Scheer (2007), the right-branching representation accounts for the intriguing asymmetry between word-final and word-initial positions. “Extrasyllabic” liquids were attested at both the right- and left-word margins in 14th-century Czech, but only those at the right margin shifted to syllabic consonants in the following centuries. This asymmetry is evident in the distribution of CL# clusters (e.g., *Pe*/tr/ ‘Peter’ or *mo*/fil/ ‘he could’) and #LC clusters (e.g., /rv/*áti* ‘to pluck’ or /lɦ/*áti* ‘to lie’), summarized in **Table 16**. The right side of the table repeats

the distribution of word-final clusters, illustrating the gradual shift toward eight-peak verses, which we interpret as evidence of a shift toward syllabic liquids. By contrast, word-initial liquids in #LC clusters remained non-syllabic throughout the examined period, as documented by their continued prevalence in nine-peak verses.

century	#LC		#L_{σ}C		CL#		CL$_{\sigma}$#	
	nine-peak verses		eight-peak verses		nine-peak verses		eight-peak verses	
	tokens	proportion	proportion	tokens	tokens	proportion	proportion	tokens
14th	13	93%	7%	1	107	96%	4%	4
15th	27	100%	0%	0	129	91%	9%	12
16th	15	100%	0%	0	65	61%	39%	41

Table 16: Distribution of initial and final clusters.

If syllabic liquids serve as licensors for long-distance licensing, their absence in the word-initial position is expected. #LC clusters form head-final domains and are regularly licensed either by the following vowel ([r⇐v]*áti* ‘to pluck’) or by the following empty $V_{ø}$-slot, which separates the LC cluster from the next consonant ([l⇐s]$V_{ø}$*tivě* ‘cunningly’).

5 The role of morphological structure

Up to this point, we have analyzed the syllable shift in terms of the markedness hierarchy that distinguishes between word-medial and word-final positions. However, syllabification may also be influenced by the underlying morphological structure of these positions, as discussed for example by Harris (1983) for Spanish, Rubach (1990) for German, and Booij (2000) for Dutch. Since both positional types of consonant clusters—medial and final—can be morphologically simplex or complex, we now consider whether their morphological structure affects their diachronic change.

In Section 3.2, we examined roots such as *slz* ‘tear’ containing morphologically simplex clusters (CLC). Recall that their resyllabification proceeded quickly and was completed by the 16th century. Alongside these simplex clusters, there are also complex ones (CL-C) involving the concatenation of a consonant-initial suffix to a CL-final stem. Examples include *bra*/tr-s/*tvo* ‘brethren’, *nesmy*/sl-n/*ý* ‘meaningless’, and *sprave*/dl-n/*ý* ‘fair’, among others. Although these complex clusters also underwent a syllable shift, the resyllabification process was slower and remained incomplete in the 16th century. **Table 17** illustrates the different trajectories of the syllable shift, comparing the distribution of simplex root clusters (left) with complex clusters at the stem-suffix boundary (right).

century	CLC		$CL_{\sigma}C$		CL-C		CL_{σ}-C	
	nine-peak verses		eight-peak verses		nine-peak verses		eight-peak verses	
	tokens	proportion	tokens	proportion	tokens	proportion	proportion	tokens
14th	28	85%	5	15%	11	100%	0	0%
15th	24	51%	23	49%	52	96%	2	4%
16th	0	0%	24	100%	33	65%	18	35%

Table 17: Distribution of CLC vs. CL-C.

Word-final clusters, as discussed in Section 3.1, can also be either simplex or complex. Morphologically complex clusters appear in verbal forms like *ne*/s-l/ 'he carried', where a past-participle marker /-l/ is suffixed to a consonant-final verbal stem. Unlike in word-medial clusters, the resyllabification process in word-final clusters does not differ significantly based on morphological complexity. The analogous behavior of simplex and complex clusters is evident when comparing data from the 15th century, as shown in **Table 18**. During this intermediate period, we recorded 61 instances of simplex clusters (CL#) and 80 instances of complex clusters (C-L#), both of which show similar proportions of non-syllabic and syllabic liquids, that is, 90% and 93% of non-syllabic forms versus 10% and 7% of syllabic forms. By contrast, these proportions differ significantly when comparing simplex (CLC) and complex medial clusters (CL-C), as shown in **Table 17**. In the 15th century, complex word-medial clusters remain predominantly non-syllabic (96%), while simplex clusters are more evenly distributed between non-syllabic (51%) and syllabic forms (49%).

century	CL#		CL_{σ}#		C-L#		C-L_{σ}#	
	nine-peak verses		eight-peak verses		nine-peak verses		eight-peak verses	
	tokens	proportion	proportion	tokens	tokens	proportion	proportion	tokens
14th	44	98%	1	2%	63	94%	4	6%
15th	55	90%	6	10%	74	93%	6	7%
16th	16	53%	14	47%	49	64%	27	36%

Table 18: Distribution of CL# vs. C-L#.

In sum, the resyllabification trajectory is influenced by the morphological structure in word-medial clusters, but not in word-final clusters. Morphologically simplex word-medial clusters, inherited from Common Slavic roots, showed even variation between non-syllabic and syllabic forms in the 15th century, with their resyllabification completed by the 16th century. In contrast, complex medial clusters (CL-C) were predominantly non-syllabic in the 15th century, and their resyllabification continued throughout the 16th century. These complex clusters thus follow the same diachronic pathway as word-final clusters.

The pattern in which word-medial strings at morpheme boundaries exhibit the same phonological behavior as strings in the word-final position is attested cross-linguistically. A well-known example is the post-nasal /g/-deletion in English (see Bermúdez-Otero 2011). This process targets /ng/ clusters in both word-final and word-medial positions, the latter only if they involve a morpheme boundary. Compare the contrast between the forms *si*/ng/ [ŋ] and *si*/ng/*-er* [ŋ] on the one hand, and the form *fi*/ng/*er* [ŋg] on the other, where the word-medial cluster is not at the boundary and is thus preserved. Another example of this boundary-sensitive pattern is obstruent devoicing in German (Rubach 1990), which occurs word-finally (*Ha*/nd/ [nt] 'hand') and word-medially at a morpheme boundary (*Ha*/nd/*-lich* [nt] 'handy'), but not morpheme-internally (*Ha*/nd/*l-ung* [nd] 'treatment').

This pattern is typically explained by the fact that morpheme boundaries can pass through the morphology-phonology interface, making them visible to phonological computation. This boundary visibility is accounted for in various ways, including boundary phonemes, co-phonologies, and cyclic parsing; see Scheer (2010) for a comprehensive overview.

Turning back to the diachronic process in Czech, we observed that words like *bratr-stvo* 'brethren', where the cluster /tr/ occurs at a morpheme boundary, and words like *trv-at* 'to last', where the cluster is part of the root, followed slightly different evolutionary trajectories. If the resyllabification process is derived from the licensors' hierarchy, as we proposed, these observations suggest that word-medial clusters appear in two different licensing environments. In simplex root clusters, long-distance licensing is provided by the most marked licensor, specifically a medial empty $V_{ø}$-slot ([C⟹L]$V_{ø}$C). By contrast, morphologically complex clusters are parsed in two phonological cycles ($_2(_1$…CL)-C…). The head-initial CL domain is parsed in the first cycle, where it is licensed by a less marked licensor, the morpheme-final empty $V_{ø}$-slot. In other words, the first cycle of the complex structure ($_2(_1$…CL)-C…) corresponds phonologically to [C⟹L]$V_{ø}$.

The idea of a phonological unification of both types of final empty $V_{ø}$-slots—word-final and morpheme-final—was first proposed by Kaye (1995) and more recently elaborated by Newell (2021). This proposal accounts not only for the different evolutionary trajectories of simplex and complex word-medial CLC clusters, but also for the similarity between complex clusters (*bratr-stvo*) and word-final structures (*bratr*). These two types of clusters pattern together due to the structural containment between them.

Morphological complexity affected the resyllabification of word-medial clusters but not of those occurring word-finally. This asymmetry can be explained by the different positions of the morpheme boundaries. In word-medial clusters, the boundary is always situated after the licensed CL domain (CL-C). By contrast, the boundary is inside the domain (C-L#) in forms like *nes-l* 'he carried'. That these past-participle forms behaved the same way as CL-final roots such as *mysl* 'mind' indicates that head-initial CL domains are either part of lexical representation (in roots) or are established through morphological concatenation (in past-participle forms).

The fact that a head-initial domain is formed between the suffix and the stem suggests that the morpheme boundary is not phonologically interpreted in past-participle forms. The suffix /-l/ is phonologically parsed together with the stem in a single cycle. As a result, these inflectional forms contrast with derivatives like *bra*/tr-s/*tvo* 'brethren', *nesmy*/sl-n/*ý* 'meaningless', and *sprave*/dl-n/*ý* 'fair', which undergo cyclic parsing. In Kaye's (1995) terms, the morphology of past-participle forms is *non-analytical*, while the morphology of these other forms is *analytical*.

6 Conclusion

In this paper, we have analyzed the diachronic process of resyllabification in historical Czech. We argued that this resyllabification illustrates a broader cross-linguistic pattern of phonological change, where marked structures, such as non-syllabic CL{C/#} clusters, are replaced by less marked forms, specifically those with syllabic liquids (CL_{o}{C/#}).

Our corpus study revealed phonological asymmetry between word-medial clusters that are morphologically simplex (and word-medial complex clusters. Furthermore, we demonstrated that complex clusters pattern similarly to word-final clusters (CL#), in that both configurations exhibit a slower shift toward syllabicity compared to simplex clusters in medial positions.

We explained this two-step diachronic process as a shift along the licensing hierarchy, from more marked to less marked licensors. The shift targets CL clusters that require long-distance licensing, which was initially handled by marked licensors, including the empty $V_{ø}$-slots. Over time, these $V_{ø}$-slots lost their licensing potential. This loss first affected the most marked slots in the medial position, followed by the less marked $V_{ø}$-slots in the final position, both word-final and morpheme-final. By the end of the diachronic process, only full V-slots remained as possible licensors. Since syllabic liquids have a CV prosodic structure, as we propose, they provide regular (unmarked) licensing for CL clusters that would otherwise be left unlicensed. This approach confirms that syllabic liquids played a significant role in repairing marked structures.

Lastly, we have shown that poetry, especially poetry with a regular rhythmic structure, is a reliable source for investigating historical phonology (see Hench 2017).

Abbreviations

ACC = accusative, GEN = genitive, DAT = dative, INF = infinitive, INS = instrumental, NEG = negation, NOM = nominative, PL = plural, SG = singular

[Alx] = Staročeské zlomky Alexandreidy (-Víd, -M, -Š, -H, -B, -BM, -O) [Old Czech Fragments of Alexandreis] (Vážný, Václav. 1963. *Alexandreida*. Praha: Nakladatelství ČSAV), [AlxV] = *Alexandreida – Svatovítský zlomek* [Alexandreis – Svatovítský fragment] (Vážný, Václav. 1963. *Alexandreida*. Praha: Nakladatelství ČSAV), [DesHrad] = *Desatero kázanie božie* [The Ten Commandments of God's sermons] (*Vokabulář webový: ediční modul*. Ústav pro jazyk český AV ČR, https://vokabular.ujc.cas.cz/moduly/edicni/), [Had] = *Hádání Prahy s Kutnou Horou* [Disputation between Prague and Kutná Hora] (Daňhelka, Jiří. 1952. *Husitské skladby Budyšínského rukopisu*. Praha: Orbis), [ModlKunh] = *Kunhutina modlitba* [Kunhuta's prayer] (*Vokabulář webový: ediční modul*. Ústav pro jazyk český AV ČR, https://vokabular.ujc.cas.cz/moduly/edicni/), [Leg] = *Legendy* [Legends] (Cejnar, Jiří. 1964. *Nejstarší české veršované legendy*. Praha: Nakladatelství ČSAV), [Lom] = *Instrukcí aneb Krátké naučení hospodáři mladému Šimona Lomnického z Budče* [Instructions by Simon Lomnicky] (Heřmanská, Kateřina. 2016. *Instrukcí aneb Krátké naučení hospodáři mladému Šimona Lomnického z Budče [edice a literárně historický rozbor]*. Praha: Charles University MA thesis), [HradMagd] = *Pláč Marie Magdaleny* [The cry of Mary Magdalene] (Vokabulář webový: ediční modul. Ústav pro jazyk český AV ČR, https://vokabular.ujc.cas.cz/moduly/edicni/), [Petr] = *Rozmloumáví Petra Svatého s Pánem* [The conversation of Saint Peter with the Lord] (Kolár, Jaroslav. 1959. *Frantové a grobiáni: z mravokárných satir 16. věku v Čechách*. Praha: Nakladatelství ČSAV), [HradSat] = *Satiry o řemeslnících* [Satire about craftsmen] (*Vokabulář webový: ediční modul*. Ústav pro jazyk český AV ČR, https://vokabular.ujc.cas.cz/moduly/edicni/), [LegKat] = *Život Svaté Kateřiny* [The life of Saint Catherine] (Hrabák, Josef & Vážný, Václav. 1959. *Dvě legendy z doby Karlovy*. Praha: Nakladatelství ČSAV), [UmučRajhr] = *Umučení rajhradské* [The martyrdom of Rajhrad] (Žampachová, Karolína. 2021. *Umučení rajhradské – edice a jazykový rozbor*. Praha: Charles University BA thesis)

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Competing interests

The authors have no competing interests to declare.

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