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Proto-Indo-European Long Vowels and Diphthongs with their Proto-Germanic Reflexes

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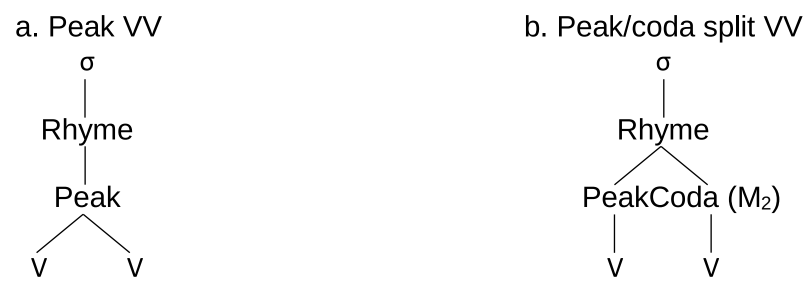
0. Introduction

The Proto-Indo-European (PIE) vowel system consisted of five short vowels, five long vowels, and six diphthongs: *ei, *ai, *oi, *eu, *au, *ou. As PIE developed into Proto-Germanic (PG), the number of diphthongs was reduced to an asymmetrical set of three: *ai, *au, *eu. As PG developed into Old English, the original diphthongs of PIE further reduced until they were eliminated. In this paper, I develop the OT constraint ranking necessary to derive the vowel system of PIE and its change into PG, employing the Split Margin approach to account for the sonority relationships within the diphthongs as well as to explain the non-occurrence of other potential diphthongs. I begin the paper with a short discussion of the possible structural representations of long vowels and diphthongs along with an outline of the constraints required for the analysis in section 1. In section 2, I provide an outline of the relevant vowels in PIE and in section 3, I develop the OT analysis of the vowels of PIE along with the rerankings necessary to move from PIE to PG. Section 4 concludes the paper.

1. Structural representations and constraints

There are two potential structural representations[1] for what we consider to be long vowels and diphthongs. Our default is usually to consider both portions of the vowel/diphthong to be included within the peak or nucleus of the syllable. This is shown in (1a). We will find this to be the case with the long vowels of PIE. The second option (1b) parses the first part of the vowel/diphthong in the peak and the second portion of the vowel/diphthong in the coda. This second option will ultimately be the analysis of the PIE diphthongs. In both cases, the vowel/diphthong takes up two of the available slots in the rhyme.

(1)



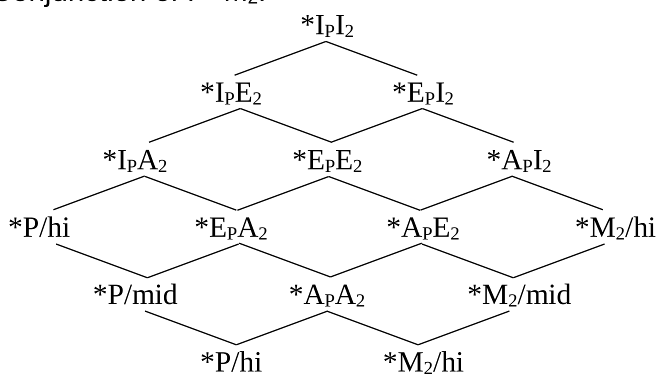
I have argued elsewhere (see Baertsch 2012 for a more thorough treatment of English) that in Modern English, the offglides of the tense vowels and the offglides of the diphthongs both pattern as though they are filling a slot in the coda (an M_2 position) and that Modern English does not allow branching peaks. In the current paper, I go back to the Proto-Indo-European (PIE) roots of English to examine the structure of the long vowels and diphthongs in PIE and

[1] Schane (1995:588) notes seven possible structures for an underlying sequence of vocalic segments, some of which are not relevant to our current purpose. An initial vocalic segment could be parsed as an onset consonant, and a sequence of two vocalic segments could either be fused into a short (monomoraic) monophthong or a short (monomoraic) diphthong. As the vowel sequences under consideration here pattern as long (bimoraic) vowels in the language, the latter two will not be considered here and as these sequences exist in the language independent of potential onset consonants, the former will also be eliminated from our analysis.

trace those vowels into Proto-Germanic as part of a larger study tracing the vowels into Modern English. In PIE, I find both branching peaks and peak-coda sequences of vocalic segments, indicating a change in the structure of the peak at some point in the history of English. This change occurred in the Middle English period and is thus outside the scope of the current paper.

Employing the Split Margin approach (Baertsch 2002, among others) in the syllabification of these vowels, any segment parsed in peak position will violate some constraint in the Peak hierarchy and any segment parsed in the first coda (M_2) position will violate some constraint in the M_2 hierarchy. A Peak-M_2 sequence will also be subject to the set of conjoined Peak-M_2 constraints that govern the Rhyme. Constraints and any inherent rankings are shown in (2).

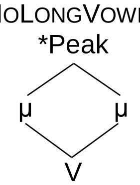
(2) Split Margin constraints (following Baertsch 2002)[2]
Peak hierarchy: … *P/hi >> *P/mid >> *P/lo
M_2 hierarchy: …*M_2/hi >> *M_2/mid >> *M_2/lo
Conjunction of P+M_2:



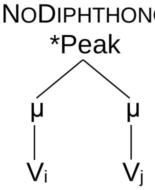
Within the peak, I adopt and modify Rosenthall's (1994) NoLongVowel (NLV) and NoDiphthong (NoDip) constraints[3], shown in (3). These two constraints apply only within the peak of a syllable.

A sequence of non-identical vocalic segments, if parsed within the peak of the syllable, will violate the NoDip constraint but a sequence of a Peak vocalic segment followed by an M_2 vocalic segment will not violate NoDip. A diphthong that extends beyond the Peak and into the M_2 slot will incur a violation of one of the conjoined P+M_2 constraints as well as a violation of the corresponding individual Peak and M_2 constraints.

(3) NoLongVowel



NoDiphthong



[2] The hierarchies and diagram here show only those constraints relevant to the vocalic segments. In the conjunction diagram, the abbreviation *A* stands in for any low vowel, *E* stands in for any mid vowel, and *I* stands in for any high vowel. Subscripts indicate the structural position of the preceding segment. The subscript $_P$ indicates that the segment is parsed as a peak segment and the subscript $_2$ indicates that the segment is parsed as an M_2 segment.
[3] Rosenthall's approach is couched in moraic phonology, therefore in his constraints every μ is immediately dominated by the σ node while in his discussion he makes explicit that his focus is on syllabic nuclei. As I am distinguishing here between vocalic segments within the peak vs. vocalic segments in the margin of the syllable, I have made explicit in my formulation of the constraints that these constraints govern only peak segments. They do not apply to M_2 segments.

Monophthongal long vowels, whether underlyingly composed of two independent, identical segments or a single long vowel will ultimately be merged into a single root node (Schane 1995) and, if parsed within the peak of the syllable, will violate the NLV constraint but will not violate NoDip. An alternative surface parse for two identical vocalic segments would be as a Peak segment followed by an M_2 offglide of the same vocalic segment. In such a parse, there is no violation of NoDip, but there is a violation of one of the conjoined $P+M_2$ constraints as well as a violation of the corresponding individual Peak and M_2 constraints[4].

2. The vowels of Proto-Indo-European

The Proto-Indo-European vowel system is hypothesized to consist of five short vowels, *i, *e, *a, *o, and *u, with two reduced vowels (*$ə_1$ and *$ə_2$). There were also five long vowels corresponding to the short vowels and six diphthongs as in (4). Bammesberger (1992: 44) notes that the diphthongs can be considered to be sequences of the non-high vowels followed by one of the high vowels. I treat these vowels as underlying sequences of such.

(4) PIE long vowels and diphthongs (Prins 1972: 38, Bammesberger 1992: 43-44)

*iː	*uː		*ai	*au
*eː	*oː		*ei	*eu
*aː			*oi	*ou

Given the existence of five short vowels, there are more possible long vowels/diphthongs than the six shown to be present in PIE and an analysis of the possibilities for such vowels must also take into consideration the missing possibilities. Hence, we consider in our analysis all 25 possible concatenations of the five short vowels in (5)[5].

(5) Potential 2-slot vowel combinations for PIE

ii	ie	ia	io	iu
ei	ee	ea	eo	eu
ai	ae	aa	ao	au
oi	oe	oa	oo	ou
ui	ue	ua	uo	uu

Within the list in (5), the existing long vowels/diphthongs have been highlighted. The remaining vowels must be excluded by the analysis. All of the diphthongs of PIE are falling in sonority, ending in a high vowel and all have as their first element one of the three non-high vowels. All five of the potential steady-state long vowels are represented in PIE as well. Of the thirteen vowels that do not occur in PIE, eight (*ie*, *io*, *ia*, *ea*, *oa*, *ua*, *uo*, and *ue*) would be rising in sonority and while rising sonority diphthongs do exist, they are more often monomoraic than bimoraic (Rosenthall 1994: 20). Two potential diphthongs (*ae* and *ao*) are falling in sonority, progressing from a low vowel to a mid vowel. The remaining four potential diphthongs (*ui*, *oe*,

[4] Schane (1995) treats what I have identified here (a diphthong that spans peak and M_2 slots) as a vowel followed by a coda consonant rather than as a diphthong but notes also that this is a phonological distinction and may be phonetically indistinguishable from an offglide within the nucleus. As both $P+M_2$ and P+P sequences are more generally labelled as diphthongs, I maintain the use of the term diphthong for both.
[5] At this point, I will dispense with the * indicating a reconstructed form in order to simplify the presentation of the data and to avoid potential confusion among the various meanings of * — reconstruction of a segment in PIE, avoidance of a structure in the syntax of a constraint, violation of a constraint in a tableau.

eo, and *iu*) are equal sonority sequences where either both segments are high vowels or both are mid vowels.

3. Split Margin analysis

There are a number of inherent rankings within the Peak, M_2, and conjoined constraints. These are shown in the diagram in (2), above. With these in mind, we can begin our analysis with the steady-state long vowels of PIE. Starting with underlying sequences of two identical vowels, we can see in (6) that based on only the inherent rankings of the peak and margin constraints, a long peak vowel will always be the winning candidate. Because the conjoined constraint (in this case $*A_PA_2$) always dominates both $*M_2$/lo and *P/lo, the best parse of this sequence will be the long peak parse (6c). The other alternative, parsing the segments into peak position but separated by a syllable boundary (6b) incurs a double violation of the Peak constraint which results in a fatal violation of *P/lo. The long peak parse (6c), in contrast, has a single root and thus a single violation of the Peak constraint.

(6) Sequence of two identical low vowels[6]

	/aa/	IDbk	IDhi	IDlo	$*A_PA_2$	$*M_2$/lo	*P/lo	NLV
a.	$a_P\text{a̯}_2$				*!	*	*	
b.	$a_P.a_P$						**!	
→ c.	$a\!:_P$						*	*

As long as the NoLongVowel (NLV) constraint is dominated by the Peak constraint, the long peak parse will be the winning candidate. Changing the quality of the vowel will incur fatal violations of the Ident constraints. The result is similar when the sequence consists of two identical mid vowels (7) or high vowels (8). Consequences of changing the quality of the vowel are shown explicitly here.

(7) Sequence of two identical mid vowels

	/ee/	IDbk	IDhi	IDlo	$*E_PE_2$	$*M_2$/mid	*P/mid	NLV
a.	$[e_P\text{e̯}_2]$				*!	*	*	
b.	$[e_P.e_P]$						**!	
→ c.	$[e\!:_P]$						*	*
d.	$[a\!:_P]$	*!		*				*

	/oo/	IDbk	IDhi	IDlo	$*E_PE_2$	$*M_2$/mid	*P/mid	NLV
a.	$[o_P\text{o̯}_2]$				*!	*	*	
b.	$[o_P.o_P]$						**!	
→ c.	$[o\!:_P]$						*	*
d.	$[a\!:_P]$			*!				*

[6] Within tableaux, a subscript P indicates a segment has been parsed as a peak segment, a subscript 2 indicates a segment has been parsed as an M_2 segment, and $V\!:_P$ indicates a long vowel parsed entirely within the peak. A high ranking OCP constraint prevents two identical root nodes within a peak.

(8) Sequence of two identical high vowels

	/ii/	*I$_P$I$_2$	IDbk	IDhi	*P/hi	IDlo	*M$_2$/hi	NLV
a.	[i$_P$j$_2$]	*!			*		*	
b.	[i$_P$.i$_P$]				**!			
→ c.	[iː$_P$]				*			*
d.	[eː$_P$]			*!				*

	/uu/	*I$_P$I$_2$	IDbk	IDhi	*P/hi	IDlo	*M$_2$/hi	NLV
a.	[u$_P$w$_2$]	*!			*		*	
b.	[u$_P$.u$_P$]				**!			
→ c.	[uː$_P$]				*			*
d.	[oː$_P$]			*!				*

Moving on to the diphthongs, the picture becomes a bit more complicated. Taking as our example a sequence of a low vowel followed by a high vowel, a faithful parse surfaces in one of three ways. In (9a), we see a faithful parse in which the low vowel fills a peak position and the high vowel fills an M$_2$ position. This parse violates the *A$_P$I$_2$ constraint as well as the component constraints. It does not violate the NODIP constraint because the second segment is not in the peak. The bisyllabic parse in (9b) incurs violations only of the peak constraints, and the nuclear parse in (9e) violates the peak constraints in addition to the NODIP constraint[7]. The less faithful candidates in (9c) and (9d) run afoul of the IDENT constraints and are eliminated from consideration.

(9) Sequences of low vowel followed by high vowel

	/ai/	NODIP	IDbk	IDhi	*P/hi	IDlo	*A$_P$I$_2$	*M$_2$/hi	*P/A	NLV
→ a.	[a$_P$j$_2$]						*	*	*	
b.	[a$_P$.i$_P$]				*!				*	
c.	[aː$_P$]		*!	*		*			*	*
d.	[iː$_P$]		*!	*	*	*				*
e.	[a$_P$i̯$_P$]	*!			*				*	

	/au/	NODIP	IDbk	IDhi	*P/hi	IDlo	*A$_P$I$_2$	*M$_2$/hi	*P/A	NLV
→ a.	[a$_P$w$_2$]						*	*	*	
b.	[a$_P$.u$_P$]				*!				*	
c.	[aː$_P$]			*!		*			*	*
d.	[uː$_P$]			*!	*	*				*

While low vowel + high vowel diphthongs are quite common in the world's languages, diphthongs consisting of a mid vowel followed by a high vowel are considerably less common,

[7] The NODIP constraint is really a hammer of a constraint in that it does not distinguish which of the two segments constitutes the primary segment within the nucleus and it makes no sonority distinctions within that nucleus. It is equally violated by any sequence of non-identical segments within a nucleus. Breaking it into component constraints (perhaps through self-conjunction of the Peak hierarchy) that would distinguish the sonority levels of the components of the sequence would not solve the issue of the primacy of one segment or the other. Additional constraints would have to account for the selection of the primary peak segment. In addition, while the development of these diphthongs as we move in to the Old English period is outside the scope of this paper, there is evidence in Old English that the reflexes of these diphthongs (the OE long diphthongs) span the peak and M$_2$ position. We therefore do not pursue the deconstruction of the NODIP constraint here.

and this state is inherent in the ranking of $*E_PI_2$ >> $*A_PI_2$. PIE, however, did have mid-high vowel diphthongs, as we see in (10) and (11) with the back vowel in peak position and in (13) with the front vowel in peak position. As with the monophthongized candidates in (9), any candidate that lowers the second segment to a mid vowel or raises the first segment to a high vowel will run afoul of the relatively high ranking IDENT constraints and those candidates are not shown in these tableaux. Likewise, a parse in which both segments surface faithfully but in the peak would fatally violate the NODIP constraint and these candidates are also left out of the current tableaux. In the simpler case in (10) where both segments are [+back], the peak-M_2 candidate (10a) wins over the bisyllabic parse (10c) by avoiding parsing the high vowel as a peak. Attempting to increase the sonority slope of the sequence by lowering the mid vowel to low in (10b) fatally violates the IDlo constraint.

(10) Mid back vowel followed by high back vowel

	/ou/	IDbk	IDhi	*P/hi	IDlo	$*E_PI_2$	$*A_PI_2$	$*M_2$/hi	*P/mid	*P/lo
→ a.	$[o_P w_2]$					*		*	*	
b.	$[a_P w_2]$				*!		*	*		*
c.	$[o_P.u_P]$			*!					*	

When the two segments do not agree in backness as in (11), efforts to front the back vowel (11d) or back the front vowel (11e) likewise fail.

(11) Mid back vowel followed by high front vowel

	/oi/	IDbk	IDhi	*P/hi	IDlo	$*E_PI_2$	$*A_PI_2$	$*M_2$/hi	*P/mid	*P/lo
→ a.	$[o_P j_2]$					*		*	*	
b.	$[a_P j_2]$				*!		*	*		*
c.	$[o_P.i_P]$			*!					*	
d.	$[e_P j_2]$	*!				*		*	*	
e.	$[o_P w_2]$	*!				*		*	*	

The diphthongs in (10) and (11) are important as we move from PIE to Proto-Germanic (PG). In PG, the low back and mid back vowels merged. This sound change affected the short vowels which merged into /a/, and the long vowels which merged into /oː/. The change was reflected in the diphthongs as /ow/ lowering and merging with /aw/ and /oj/ lowering and merging with /aj/ (Ringe 2017: 170-171, Prins 1972). Ringe (2017) notes that there is some evidence that the long vowels first merged into /aː/ then later raised and rounded to /oː/. In our analysis here, this historical change is accomplished by a reversal of the $*E_PI_2$ and IDlo constraints. In PIE, the ranking is IDlo >> $*E_PI_2$ as in these tableaux and in PG, the ranking is $*E_PI_2$ >> IDlo, shown in (12). The demotion of IDlo is also consistent with the shift in PG from the PIE three-height vowel system to what Ringe (2017: 172) describes as the emergence of a vowel system contrasting only in [±high] and [±back].

(12) Mid back vowel followed by high front vowel in PG

	/oi/	IDbk	IDhi	*P/hi	$*E_PI_2$	IDlo	$*A_PI_2$	$*M_2$/hi	*P/mid	*P/lo
a.	$[o_P j_2]$				*!			*	*	
→ b.	$[a_P j_2]$					*	*	*		*
c.	$[o_P.i_P]$			*!					*	
d.	$[e_P j_2]$	*!			*			*	*	
e.	$[o_P w_2]$	*!			*			*	*	

The back vowel merger did not affect PIE /ej/ or /ew/, as we can see in (13) for PIE and (14) for PG. In PIE, the mid front vowel surfaces as a peak-M_2 diphthong whether followed by a front glide or a back glide, analogous to the mid back vowels above.

(13) Mid front vowel followed by high vowel in PIE

	/ei/	*I_PI_2	IDbk	IDhi	*P/hi	IDlo	*E_PI_2	*A_PI_2	*M_2/hi	*P/mid	*P/lo
→ a.	[e_Pj_2]						*		*	*	
b.	[a_Pj_2]		*!			*		*	*		*

	/eu/	*I_PI_2	IDbk	IDhi	*P/hi	IDlo	*E_PI_2	*A_PI_2	*M_2/hi	*P/mid	*P/lo
→ a.	[e_Pw_2]						*		*	*	
b.	[a_Pw_2]		*!			*		*	*		*

However, the reranking of IDlo and *E_PI_2 in the development of PG causes no corresponding merger of the mid front diphthongs with the low diphthongs in (14). In both cases, the height of the mid vowel is protected by its frontness.

(14) Mid front vowel followed by high vowel in PG

	/ei/	*I_PI_2	IDbk	IDhi	*P/hi	*E_PI_2	IDlo	*A_PI_2	*M_2/hi	*P/mid	*P/lo
→ a.	[e_Pj_2]					*			*	*	
b.	[a_Pj_2]		*!				*	*	*		*

	/eu/	*I_PI_2	IDbk	IDhi	*P/hi	*E_PI_2	IDlo	*A_PI_2	*M_2/hi	*P/mid	*P/lo
→ a.	[e_Pw_2]					*			*	*	
b.	[a_Pw_2]		*!				*	*	*		*

The change that did affect these two diphthongs in the development of PG was a monophthongization of /ei/ to /iː/ that was not triggered by sonority. Ringe (2017: 151-152) cites a more general assimilation process that raised that PIE *e* > PG *i* when followed by a high front vocalic segment in the same or in an immediately following syllable. Assimilatory raising is also supported when we note that unlike the merger of the two non-high back vowels discussed above where the change affected the short vowels, long vowels, and diphthongs, there was no general raising of *e* to *i* here – it only affected /ei/. The resulting diphthong inventory in PG (*aj*, *ew*, *aw*) is therefore somewhat asymmetrical in that there is only one diphthong that travels from mid to high.

What that leaves us with is the group of diphthongs that are logically possible but that do not occur in PIE. We can group these diphthongs into two categories – those with a second element that is non-high and those with a second element that is high. When the second element is non-high, it doesn't matter if the sequence rises in sonority (*ie*, *io*, *ia*, *ea*, *oa*, *ua*, *uo*, *ue*), has a level sonority slope (*oe*, *eo*), or falls in sonority (*ae*, *ao*), the result is the same. Non-high vowels make much better peaks than M_2 elements and the winning candidate would be one that parses that second element as a peak. We see this in the tableau for *ao* in (15). Because *A_PE_2 dominates *P/mid, the preference is to parse such a sequence with the second element in peak position rather than in M_2 position. The other non-occurring sequences suffer the same fate.

(15) Low vowel followed by mid vowel

	/ao/	IDbk	IDhi	IDlo	*A$_P$E$_2$	*M$_2$/mid	*P/mid	*P/lo
a.	[a$_P$o̯$_2$]				*!	*		*
→ b.	[a$_P$.o$_P$]						*	*
c.	[aː$_P$]			*!				*
d.	[oː$_P$]			*!			*	

While the relative ranking of *A$_P$E$_2$ >> *P/mid is largely fixed in the grammar, making the peak-M$_2$ parse of such a sequence difficult, the bisyllabic parse is not the only possibility. It is shown here because it demonstrates the preference for a peak parse of the second element in contrast to the tableaux above. Some additional possibilities that maintain a peak parse of that segment include parsing the first segment as a secondary articulation on the preceding onset consonant or as the second segment of an onset cluster (more likely with an initial high vowel than with a mid or low vowel as we see below), inserting a glide or glottal stop to break the hiatus environment, and shortening the sequence into a monomoraic peak diphthong or short monophthong. The actual resolution of such a sequence will depend on the ranking of additional constraints in the hierarchy and cannot be easily tested given the lack of native speakers of Proto-Indo-European.

The two remaining sequences consist of two non-identical high vowels (*iu* and *ui*). The constraint ranking developed in this paper returns a bisyllabic parse for these two sequences as well, as we see in (165). In this case, however, we cannot avoid a violation of *P/hi since the high vowel is the highest sonority segment in the syllable.

(16) Non-identical high vowel sequence

	/iu/	*I$_P$I$_2$	IDbk	IDhi	*P/hi	IDlo	*M$_2$/hi	NLV
a.	[i$_P$w$_2$]	*!			*		*	
b.	[i$_P$.u$_P$]				**!			
c.	[uː$_P$]		*!		*			*
d.	[iː$_P$]		*!		*			*
→ e.	C[j$_2$u$_P$]				*		*	

We do, however, have evidence to support an onset cluster analysis in this case. PIE allowed onset clusters consisting of consonant followed by a nasal, liquid, or glide. We see, for example, **si̯uH-i̯é-* ‘sews’ with a high front glide followed by a peak high back vowel and **su̯id-ské-* ‘get into a sweat’ with a high back glide followed by a peak high front vowel. Similarly, a high vowel followed by a non-high vowel forms an onset cluster with the preceding consonant as in **ti̯ég*^{w}*-e-* ‘feel shame before’ (Cooper 2014: 338). As the second segment of an onset cluster is also an M$_2$ segment (Baertsch 2002), the constraint ranking already established is sufficient to select an onset cluster (16e) as the winning candidate in such a sequence.

4. Conclusion

This paper has provided a principled account of the long vowel and diphthong inventory of PIE, including a discussion of the resolution of potential vocalic sequences that do not surface as diphthongs in PIE. Written from the perspective of the Split Margin approach to syllabification (Baertsch 2002 and later), this analysis explicitly addresses the preference for falling sonority diphthongs and for those diphthongs to terminate in a high vowel in preference to a mid vowel. It also shows that while the M$_2$ Hierarchy prefers high sonority segments over lower sonority segments in coda position, interaction with the Peak Hierarchy prevents very high sonority segments (mid and low vowels in this case) from surfacing as codas. Historically, the change from PIE to PG is signaled by the demotion of the IDlo constraint below $*A_P E_2$ resulting in the merger of PIE **ei* into **ai* and of PIE **eu* into **au*. This was part of a larger weakening of the [±low] distinction in PG. Monophthongization of **ei* to **iː* was shown to be the result of assimilatory raising rather than a sonority-based change. As PG developed into Old English, the three remaining diphthongs that were inherited from PIE continued to change. The first of these changes was a monophthongization of **ai* into *ā* early in the period followed by **au* > *ǣo* > *ǣa* and **eu* > *ēo* (Ringe & Taylor 2014: 170-173). Then Old English *ǣa* > *ǣ* and *ēo* > *ȫ* > *ē* fairly early in the Middle English period (Prins 1972: 90), eliminating the last of the diphthongs inherited from PIE. However, during the Old English period and especially during the Middle English period new diphthongs were emerging and many of those new diphthongs remain in Modern English.

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Karen Baertsch earned her PhD from Indiana University Bloomington in 2002. While at IUB, she held several posts at IULC, including Vice President in 1998 and President and Publications Business Manager in 1999 and 2000. She was co-editor of the first volume of IU Working Papers in Linguistics in 1999. Her publications include a number of works focusing primarily on syllabification and many employing Split Margin analyses of data from several different languages. She is currently an Associate Professor in the Department of Linguistics at Southern Illinois University Carbondale.