TWO ENGLISH VOWEL MOVEMENTS: A PARTICLE ANALYSIS

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Abstract

Two vowel movements in English affected pairs of long and short vowels. In the Open Syllable Lengthening (OSL) of Middle English, short vowels that were lengthened in open syllables merged with long vowels of the next lower height. In the Great Vowel Shift (GVS) of early Modern English, stressed long high vowels diphthongized and moved downwards, whereas nonhigh vowels shifted upwards. The paper argues that: 1) In order to understand the internal dynamics of OSL and GVS, one must take into account both length and tenseness. 2) The standard notation of generative phonology, although it can describe the two vowel movements, provides little insight into the mechanisms of the changes. 3) Particle notation, a novel representation of the internal structure of vowels and diphthongs, 'mirrors' directly the nature of the changes.

Prologue

Two vowel movements in English disrupted the symmetry of pairs of long and short vowels. These two different changes — the one touching short vowels, the other long ones -- occurred at two different times in the history of the language.

Middle English saw Open Syllable Lengthening (OSL). Short vowels in open syllables merged, upon lengthening, with long vowels one step lower in height: e.g. OE wicu > ME we:ke 'week'; mete > mɛ:te 'meat'; bacan > ba:ken 'bake'; wudu > wo:de 'wood'; flotian > flɔ:ten 'float'.

In early Modern English occurred the Great Vowel Shift (GVS). The dramatic changes that affected stressed long vowels are well-known.

High vowels diphthongized and moved downwards, whereas nonhigh vowels shifted upwards. Numerous alternations in contemporary English reflect this set of developments: e.g. divine, divinity; serene, serenity; sane, sanity; profound, profundity; verbose, verbosity.

Although vowel quantity is crucial for characterizing both changes—after all, OSL affected short vowels, and the GVS long ones—vowel quality has also to be considered if we are to arrive at a proper appreciation of the nature of these phenomena. I maintain that the seven long vowels and the five short ones of late Middle English are organized as in (1), where the members of each pair of high and mid vowels differ both quantitatively and qualitatively—that is, long tense is opposed to short lax. I assume that the qualitative differences are similar to those of Modern English: For tonality vowels (front unrounded and back rounded), the lax member of each pair is lower in height (and, perhaps, more centralized) than its tense partner.

(1) Middle English Vowels

i:	u:
I	U
e:	o:
E	O
ɛ:	ɔ:
a: a	

Traditional accounts of OSL and of the GVS (e.g. Jespersen 1909) refer to the quantitative side of the vowels, with little or no mention of their qualitative. In more recent treatments of the GVS (e.g. Chomsky and Halle 1968, Stockwell 1972, Wolfe 1972), the opposite happens. An exclusive tense/lax opposition is claimed for Middle English vowels; long/short differences are considered redundant and are, by and large, ignored.

My goals here are three-fold: First, I will show that neither long/short nor tense/lax, by itself, is adequate for understanding the internal dynamics of these Middle English and early Modern English changes. What we find instead is an intricate interplay of length and tenseness. Next, I will demonstrate that the standard notation of generative phonology, although capable of describing the shifts, fails to provide any real insight into the mechanisms underlying the changes. This deficiency follows from the current conception of features as independent traits. The notation has no way of showing the interrelationships among length, tenseness, and height, the essential parameters in the operation of OSL and the GVS. Finally, I will propose an entirely different way of looking at the internal structure of vowels, such that the notation will 'mirror' directly the nature of the changes. Furthermore, it will lead to novel interpretations of certain stages of OSL and of the GVS.

Open Syllable Lengthening: I

Beginning in the thirteenth century, an important timing change affected bisyllables in Middle English.[1] Stressed short vowels became lengthened in initial open syllables. This quantitative change was accompanied by a shift in vowel quality. The newly lengthened vowels (except for [a]) merged with the long vowels of the next lower height. Figure (2) illustrates these mergers.

(2) **Open Syllable Lengthening**

i: I e: E ɛ: a: a u: U o: O ɔ:

i: e: ɛ: a: u: o: ɔ:

A vowel pattern such as (1), where long/short and tense/lax enter into an interdependent opposition, provides a plausible account of the merger of a lengthened short vowel with the next lower long one. Acoustically, a lax vowel is quite similar to the tense vowel one step down. For example, [I] has a formant pattern not unlike that of [e]. What this means is that in languages where a tense/lax distinction is coupled with a long/short one, similar formant structures will be perceived differently depending on the length of the vowel: e.g. as lax high [I] when short, but as tense mid [e:] when long. However, should the quantitative link be disrupted, as it was in Middle English when the short vowels were lengthened, then the newly lengthened vowels would become associated with the tense vowels of the next lower height.[2]

Germanic scholars have generally assumed that up till the time of Middle English, pairs of long and short vowels differed only in quantity and that the short vowels were lowered either just prior to or else concomitantly with their lengthening. There is an acoustic explanation for this lowering if one assumes that short vowels were already lax by the Middle English period. After all, they are realized as such in the modern language, and there is no reason not to date this change to at least Middle English, if not before.[3]

Having provided the necessary background, let us try to formalize these changes. In (3) are three versions of a rule of OSL.

(3) **Three different SPE-type rules for OSL**

(a) $$\begin{bmatrix} \text{V} \\ -\text{long} \\ \langle -\text{high} \rangle \end{bmatrix} \rightarrow \begin{bmatrix} +\text{long} \\ +\text{tense} \\ -\text{high} \\ \langle +\text{low} \rangle \end{bmatrix} / \text{ OSL}$$

(b) $$\begin{bmatrix} \text{V} \\ -\text{long} \\ \alpha\,\text{high} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{long} \\ +\text{tense} \\ -\text{high} \\ -\alpha\,\text{low} \end{bmatrix} / \text{ OSL}$$

(c) $$\begin{bmatrix} \text{V} \\ -\text{long} \\ n\ \text{high} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{long} \\ +\text{tense} \\ n\text{-}1\ \text{high} \end{bmatrix} / \text{ OSL}$$

Although these rules describe adequately the change, they present certain notational problems. The angles in (3a) and the alpha variables in (3b) are required only because the standard notation treats vowel height as two independent binary features. The angles and alphas are at best clumsy ways of showing that all vowels of a particular type (here the short ones) change their height by one degree. This difficulty is obviated in (3c), where height is viewed as an n-ary valued feature (Ladefoged 1971). However, the treatment of height is not my major concern with this notational system. The three variants fail equally to elucidate the nature of OSL. In each case, values have been changed for length, tenseness, and height. In no way do we see the interrelationships of these three features. There is no necessary connection between length and tenseness, nor between laxness and lowered height.[4] Yet it is precisely these interrelations that lie at the heart of OSL.

The Great Vowel Shift: I

An important set of changes affected stressed long tonality vowels in early Modern English. By the beginning of the sixteenth century, high vowels had diphthongized, become lax, and shifted downward one step, whereas mid and low vowels remained monophthongs but had been raised one degree in height.[5] These changes are shown in (4).[6]

(4) Great Vowel Shift (first part)

i:	e:	ɛ:	u:	o:	ɔ:
|	|	|	|	|	|
e͜i	i:	e:	o͜u	u:	o:

There are data suggesting that the GVS began with the raising of the mid vowels and that it was this raising that caused the high vowels to diphthongize. In some Northern British dialects, the back vowels have not participated in the GVS. These dialects still retain [u:] as the reflex of Middle English /u:/, but they have a front vowel as the reflex of Middle English /o:/. This fronting is known to have occurred prior to the advent of the GVS. These dialects demonstrate, then, that the diphthongization of a high vowel occurred only where there was a mid vowel of the same series beneath it (Carter 1975, Lass 1976). In the Northern dialects where the mid back vowel had been fronted, a space was left, so to speak, in the back series. Hence, there was no mid vowel to be raised and, consequently, no pressure placed on the high vowel.

Mid vowel raising not only caused diphthongization of the higher vowels, but it also enabled the lower ones to move up one step and thereby occupy the spaces vacated by the mids. However, the lowering and laxing of the original high vowels was a direct consequence of their diphthongization. Wolfe (1972) cites changes similar to the first part of the GVS in Old Prussian and in Czech. In those languages, too, long mid vowels become high, and the high vowels [i:] and [u:] are realized as [e͜i] and [o͜u], respectively. She concludes that, for all of these vowel shifts, diphthongization does not take place in the absence of laxing and lowering. There emerges, then, an 'inner coherence' to the

GVS: Raising and diphthongization are co-occurring processes, as are diphthongization and laxing/lowering.

In (5) are the rules presented by Chomsky and Halle (1968: 264-5) for the early stages of the GVS. They propose four rules: a rule of diphthongization (5a) [their 19b], that applies to high vowels; a rule of vowel shift proper (5b) [20], that interchanges the height of the high and mid vowels; a rule of laxing (5c) [21], that laxes the syllabics of the new diphthongs; and a rule of raising (5d) [22], that takes low vowels to mid.

(5) SPE rules for GVS (John Hart's dialect)

(a) Diphthongization

$$\emptyset \rightarrow \begin{bmatrix} \text{G} \\ \alpha\ \text{back} \end{bmatrix} \Big/ \begin{bmatrix} \text{V} \\ +\text{tense} \\ +\text{high} \\ \alpha\ \text{back} \end{bmatrix} \underline{\qquad}$$

(b) Vowel Shift

$$\begin{bmatrix} \text{V} \\ +\text{stress} \\ +\text{tense} \\ \alpha\ \text{high} \\ -\text{low} \end{bmatrix} \rightarrow [-\alpha\ \text{high}]$$

(c) Diphthong Laxing

$$\begin{bmatrix} \text{V} \\ -\text{low} \end{bmatrix} \rightarrow [-\text{tense}] \,/\, \underline{\qquad}\ \text{G}$$

(d) Vowel raising

$$\begin{bmatrix} \alpha\ \text{back} \\ \alpha\ \text{round} \end{bmatrix} \rightarrow [-\text{low}]$$

In (6) are found sample derivations for the dialect of John Hart.

(6) GVS from Middle English to John Hart (derivation with SPE rules (5))

	ī	ē	ɛ̄	ū	ō	ɔ̄
(a)	īi̯			ūu̯		
(b)	ēi̯	ī		ōu̯	ū	
(c)	ei̯			ou̯		
(d)			ē			ō

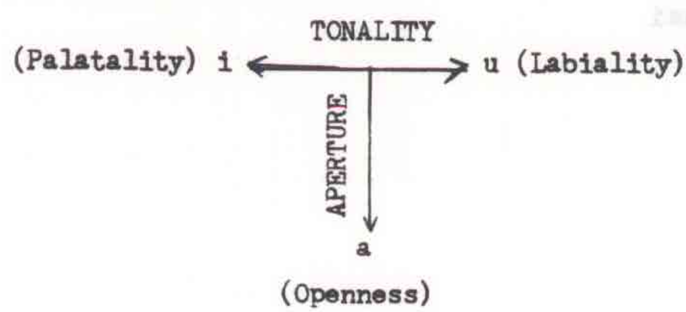
The rules of (5) present certain difficulties, both by themselves and in relation to one another. Consider, first, diphthongization. It is not uncommon for a long vowel, after diphthongizing, to exhibit a shortened syllabic and a homorganic upglide. Rule (5a) inserts, from outside, a glide that must be specified as homorganic to the vowel. The rule displays no correlation (other than the alpha variable) between the sequential properties of the diphthong and the simultaneous ones of the (long) tense vowel from which it originates. The relationships among the different rules are even more unenlightening. There is no connection between the raising of mid vowels and the diphthongization of high. Although the raising of mids and the lowering of highs have been collapsed as a unitary process (5b), different mechanisms initiated these changes. Raising is what started the whole movement, whereas lowering was a response to diphthongization. The two processes that are most similar (that is, the raising of mids and the raising of lows) are treated as separate phenomena. The only function of laxing (5c) is to adjust the output of diphthongization. Why does a 'diphthongized' (long and) tense vowel become (short and) lax? Whatever 'inner coherence' there is to the GVS is far from apparent with these four rules.

Particle Phonology

I present now an entirely different formal representation of vowels and diphthongs. In this system, segments are composed of one or more particles (Schane, forthcoming.) First, I will give the particle structure of various types of vocalic segments—monophthongs, diphthongs, long vowels, tense ones, and lax ones. Then, by applying particle analysis to the problems of OSL and the GVS, I will show how this theory accounts for relationships among different types of segments, how it elucidates the interactions of the various vowel processes, and how it circumvents the notational difficulties encountered in the standard framework.

The primitive phonological elements of particle phonology are very different from traditional distinctive features. There are three elementary particles--a, i, and u. Particles coincide exactly with neither segments nor features; rather, they partake of both of these entities. In isolation, the elementary particles correspond to the vowels [a], [i], and [u], but in combination, they represent phonetic traits. For i, the crucial attribute is palatality or frontness; for u, labiality or rounding; and for a, aperture or openness. Figure (7), in typical triangular fashion, depicts the segment-like and feature-like characteristics of the elementary particles.

(7) **Particle Structure**



Vowels other than [a], [i], and [u] are composed of combinations of particles. Table I presents the particle structure of ten simple vowels. (Traditional phonetic symbols appear in square brackets, whereas particle representations are unbracketed.)

Table I: Short Vowels

[i]	i	[u]	u	[ü]	iu		
[e]	ai	[o]	au	[ö]	aiu		
[ɛ]	aai	[ɔ]	aau	[œ]	aaiu	[a]	a

Table II: Diphthongs

[ai]	a i	[ei]	ai i
[au]	a u	[ou]	au u
[oi]	au i	[ea]	ai a
[eu]	ai u	[oa]	au a
[ue]	u ai	[ao]	a au

Table III: Long (Tense) Vowels

[i:]	i i	[u:]	u u	[ü:]	iu iu		
[e:]	ai i	[o:]	au u	[ö:]	aiu iu		
[ɛ:]	aai i	[ɔ:]	aau u	[œ:]	aaiu iu	[a:]	a a

Table IV: Lax (Short) Vowels

[I]	ai	[U]	au	[Ü]	aiu
[E]	aai	[O]	aau	[Ö]	aaiu
[æ]	aaai				

From Table I we can see how complex particles (i.e. combinations of two or more particles) define, in a fairly intuitive way, the different vowels. All front vowels contain the particle i, all rounded vowels have u, and all nonhigh vowels exhibit a.[7]

Vowel height is directly linked to the number of aperture particles. An additional occurrence of that particle produces a 'more open' vowel. Furthermore, this mode of representation can accommodate more than three degrees of height.

The standard notation, by straight-jacketing height into two binary features, handles awkwardly processes where vowels of differing height step up or down the height scale. This type of progression always requires reference to a complex set of variables (Chomsky and Halle 1968, Wang 1968, Yip 1980). In particle phonology, an upward shift of [e] to [i], and of [ɛ] to [e] (such as for the GVS) is simple to characterize: It is loss of an aperture particle.

Notice that particle notation contains a built-in 'markedness' system, where number of particles relates to degree of markedness. Thus, [a], [i], and [u], with one particle each, are the least marked vowels. For vowels of the same height, front unrounded and back rounded are equally marked, but front rounded is more marked. For vowels of the same series, lower height corresponds to greater markedness.[8]

Complex particles, in their role as monophthongal vowels, constitute unordered sets. (For convenience's sake, I list particles in alphabetical order.) On the other hand, the particle sets of the halves of a diphthong occur in sequence. Some common diphthongs are presented in Table II. The half-moon symbol denotes that the particle sets are ordered as listed, and it also specifies the nonsyllabic component. A comparison of Tables I and II reveals the ease with which particle notation accommodates relationships between monophthongs and diphthongs. Consider, for example, the common change whereby [ai̯] monophthongizes to [e] and [au̯] to [o]. I call this process fusion, because the separately occurring particles (of the diphthong) fuse or combine into a single complex particle (for the monophthong). Diphthong/monophthong pairings are nothing other than the temporal sequencing of particles--linear versus simultaneous realization. Furthermore, diphthongs that exhibit different sequences of the same combinations of particles must be linked to the same monophthong. For example, the diphthongs [eu̯] and [u̯e] of Old French were both monophthongized to [ö], while in some of the dialects of Ancient Greek, it was [oi̯] that evolved to [ö]. The very notion of fusion implies that a resulting complex particle contains, all and only, the particles of the input. Particle theory constrains, in the tightest possible way, relations between monophthongs and diphthongs.

Table III depicts long vowels. For those short vowels represented by single particles (namely, [a], [i] and [u]), repetition of those particles denotes the corresponding long vowels in a straight-forward way. For other vowels, length is indicated by repetition of the vowels' tonality particles: Front vowels have i as their marker of length, and rounded vowels have u. A parallelism then emerges for all vowels of a given series: Thus, [e:] is distinguished from [e] in the same way that [i:] is distinguished from [i], etc. In the representation of both long vowels and of diphthongs, the space between particles formally denotes segments having bimoric value.

A comparison of Table III with the right half of Table II shows how particle phonology treats alternations between long vowels and diphthongs. Consider, for example, the common change where [e:] and [o:] diphthongize to [ei̯] and [ou̯], respectively. We have here examples of fission. The complex particle of a long vowel splits up into a shortened version of that vowel and an upglide. The tonality particle that originally represented length becomes the source of the glide and accounts for its homorganic quality. Because length has been transformed into a glide, the vowel automatically has become shortened.

Tables III and IV present long tense vowels and short lax ones. There has been a good deal of controversy concerning the articulatory correlates of tenseness and laxness--whether the distinction is due to differences in muscular tension, in the size of the pharynx, or solely in tongue height (Lindau 1978). Yet one thing is certain. In their placement in auditory space, the so-called 'lax' vowels (I will continue to use this term as a descriptive label) are more open and, perhaps, even more centralized than their tense partners (cf. Figure (1)). The property of openness is a function of the particle a. Hence, lax vowels will contain this particle, in addition to whatever other particles are necessary for indicating tonality and height.

But now a problem arises. The particle configurations of lax vowels overlap with certain other vowels of Table I. Thus, [I] coincides with [e], [U] with [o], etc. How is this possible? Each complex particle functions within its own network of contrasts, so that the interpretation of particles is sensitive to the system as a whole. (See also note 8.) For example, Spanish has neither length nor tenseness oppositions in its vowels. Its two front unrounded vowels, [i] and [e], would have the expected particle representations i and ai of Table I; the Spanish distinction is entirely one of height. In English, on the other hand, the difference between [i:] and [I] is the two-fold one of length and tenseness of Tables III and IV. Yet the fact that Spanish [e] and English [I] share the same particle configuration is not without interest. As we noted previously, these two vowel qualities have a surprising similarity.

The particle structures of Tables III and IV suggest an interpretation that will account for the doubly-marked long-tense and short-lax opposition of these vowels. In a representation such as i i [i:], length appears to appear twice: once, as the space between particles, and again, as the second occurrence of tonality. But it is possible to view the extra tonality particle, not so much as a redundant marker for length, but rather as an explicit indicator of tenseness. Then, for the representation i i, the space would continue to denote length, whereas the tonality particle would mark tenseness. For ai [I], on the other hand, the absence of space signifies a short vowel, while the aperture particle indicates laxness. There emerges, then, a dual opposition: presence versus absence of space (interpreted as 'long' versus 'short'), and tonality particle versus aperture particle (interpreted as 'tense' versus 'lax'.) This association of the tonality particle with tenseness is particularly appropriate in view of the fact that a tense vowel is generally considered to have 'more' tonality than its lax counterpart; thus, tense [i:] is, in some sense, more 'palatal' that lax [I], tense [u:] is more 'labial' than lax [U], etc. (Donegan 1978).

Open Syllable Lengthening: II

Let us look at OSL once again, but this time from the perspective of particle phonology. The relevant data are shown in (8).

(8) **OSL - Particle Analysis**

	[i:]	[I]	[e:]	[E]	[ɛ:]	[a:]	[a]	[u:]	[U]	[o:]	[O]	[ɔ:]
Stage I	**i i**	**ai**	**ai i**	**aai**	**aai i**	**a a**	**a**	**u u**	**au**	**au u**	**aau**	**aau u**
Stage II			**ai i**	**aai i**			**a a**		**au u**		**aau u**	

Stage I lists the vowels of Middle English prior to OSL. These are the same representations as in Tables III and IV: Long tense vowels are opposed to short lax ones. At Stage II, the short vowels lengthen. What this means is that tonality vowels acquire an additional tonality particle (i.e. their marker of length), whereas [a] picks up another aperture particle. Because of this change, lengthened tonality vowels will merge with long vowels one step lower.

Notice why this merger is inevitable. Consider, for example, [I] and [e:]. Both have ai as part of their particle configuration. In one case, the aperture particle represents laxness, and in the other, mid height. Yet both functions are manifestations of a common attribute: aperture. Precisely because of this dual function of the aperture particle, particle phonology predicts, unequivocally, that whenever there is merger of long tense vowels and short lax ones, the latter will become associated with those long ones one step down.

Compare the particle analysis to the standard treatment as exemplified by the rules of (3). There, in addition to lengthening, changes are required in tenseness and in height. In the particle analysis, the only necessary modification is one of length. The other changes are direct consequences of the addition of one of the tonality particles. Because an extra tonality particle can indicate both length and tenseness, when length is added the vowel simultaneously becomes tense. Once it is tense, the aperture particle (that was always there and that formerly indicated laxness) can now represent only lowered height.

Herein lies the key to the so-called 'lowering' of lengthened short vowels. What happens is much more subtle. The tense/lax opposition is firmly integrated with the long/short. When shortness goes (because of lengthening), laxness must go too. The intrinsic lower quality of lax vowels gets reinterpreted as a height difference.

Notice that OSL not only shows correlation between laxness and lowering, but it also lends support to the particle treatment of height—notably, that there can be multiple occurrences of a. For example, the lax mid front vowel [E] has the particle configuration aai; here, one of the aperture particles indicates mid height and the other stands for laxness. This is the situation at Stage I in (8). When the length distinction is obliterated at Stage II, both aperture particles come to represent height, and aai (now lengthened to aai i) is interpreted as a low front vowel.

The Great Vowel Shift: II

Let us see now how long/short and tense/lax interact in the GVS. Previously, we noted that the initiating impulse was the raising of mid vowels. Curiously enough, a similar raising had occurred, at least twice before in the history of the language. In Primitive Germanic, short [e] had been raised to [i] whenever there was a high vowel ([i] or [u]) in the following syllable.[9] Also, in Primitive Germanic, the Indo-European diphthong /eî/ had been raised and monophthongized to [i:]. This change is analogous to that of the raising of the short mid vowel, except here the conditioning element is not a vowel in the following syllable, but the adjacent nonsyllabic. The raised vowel and nonsyllabic were then realized as a long vowel. A similar monophthongization and raising occurred in Middle English: [eî] and [oû] became [i:] and [u:], respectively.

The raising of [e] to [i] by a following high vowel or glide is an instance of height assimilation. In particle notation, the change from [e] ai to [i] i is characterized as loss of an aperture particle. In what way can this loss be construed as an assimilation? What we have here is a change toward heightened tonality. Higher vowels (and upglides) have greater tonality than lower vowels of the same series (Donegan 1978). That is, [i] (or [î]) is more 'palatal' than [e], which, in turn, is more so than [ɛ]; [u] (or [û]) is more 'labial' than [o], which, in turn, is more so than [ɔ]; etc. These tonality scales have a natural representation in particle phonology. Each addition of an aperture particle 'dilutes' tonality, whereas loss of that particle intensifies it. In the change from [e] to [i], the loss is conditioned by the lone tonality particle of the following vowel or glide; this particle causes the preceding vowel to become more like it—hence, an assimilation. An upward shift in height always leads, then, both to decreasing aperture and to increasing tonality.[10]

How do these raisings relate to the GVS, where it is stressed [e:] (and also [o:] in dialects where it was not previously fronted) that underwent raising? In particle notation, the only difference between monophthongal [e:] ai i and diphthongal [eî] ai î lies in the

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syllabicity/nonsyllabicity of the second tonality particle. We have just seen how this particle may induce loss of an aperture particle (hence, heightening of tonality) in a preceding mora. The GVS raising of [e:] to [i:] is analogous, once again, to the earlier raisings of [ei̯] to [i:] and of [e] to [i] when followed by [i] in the next syllable. In all cases, the complex particle ai is followed by the particle i in the next mora. Notice how this second mora can represent different things: the high vowel of a following syllable, the glide of a falling diphthong, or length/tenseness. Yet, by no means do we have here a random collection of entities. High vowels, upglides, and tenseness are all manifestations of heightened tonality. It is this unifying property that is made visible in particle notation.

The fact that upgliding is one aspect of heightened tonality is significant also for the diphthongization of long high vowels. It is evident that if there was not to be merger, the high vowels had to do something to get out of the way of the advancing mids. If they could have moved higher, they probably would have, thus obeying the impetus for heightened tonality. But [i:] and [u:] cannot be raised further without becoming glides, which may indeed have something to do with why they diphthongized. In any case, diphthongization is the high vowels' answer to a heightening of tonality. Diphthongization (or fission) splits apart the properties of a monophthong and serializes them. The second tonality particle of the long vowel, unable to cause raising in the preceding mora, instead is highlighted as a separate component of heightened tonality.

Raising and diphthongization, as implementations of heightening of tonality, depend crucially on a vowel system where long/short and tense/lax are interdependent parameters. The extra tonality particle, in its role as tenseness, is the element behind heightened tonality, but this same particle, as a component of length, provides the necessary 'outside' environment for raising as well as the source of the upglide for diphthongization.[11]

Some additional processes comprise the GVS—the raising of low vowels to mid, and the lowering and laxing of the two diphthongized high vowels. The raising of [ɛ:] to [e:] and of [ɔ:] to [o:] augments tonality and so is consistent with the other processes of this type. However, the lowering of diphthongs is quite another matter. Yet this change too depends, once more, on the long/short and tense/lax interdependence. Diphthongization turns a long vowel into a short vowel and a glide. Because we have a system that links length to tenseness, and shortness to laxness, the short vowel of a derived diphthong has to be lax. Hence, in such a system, [i:] and [u:] will diphthongize to [Ii̯] and [Uu̯], respectively. In particle analysis, this means that a derived short vowel automatically acquires an aperture particle—that is, i i and u u, upon diphthongizing, must become ai i̯ and au u̯, respectively.

But now an interesting tension arises. Whereas, phonetically, the syllabic part of the diphthong is a short lax vowel, the diphthong as a whole continues to function as part of the long vowel system. Observe, for example, the role of diphthongs in the set of long/short morphophonemic alternations (Chomsky and Halle 1968: 263): e.g. kīp, kept; lēv, left; kampār, kamparison; afein, afinite; pronouns, pronunsiasion. Even more paradoxical is the fact that in its function as a long vowel, the diphthong now corresponds to a mid vowel. These seeming paradoxes are resolved in particle notation. Notice that if these diphthongs were to monophthongize, [Ii̯] ai i̯ would become [e:] ai i, and [Uu̯] au u̯ would turn into [o:] au u. The association with mid vowels should not be surprising in view of the equivalence between [I] and [e], and between [U] and [o]. Hence, [Ii̯] and [ei̯] can be nothing other than variant notations of the same diphthong, as are [Uu̯] and [ou̯]. No separate 'lowering' is involved here, any more than it was for the lengthened short vowels of OSL. In both cases, laxness, in a bimoric situation, has been reinterpreted as lowered height. The equivalence of [I:] and [e:]—namely, ai i, for OSL is precisely paralleled by that of [Ii̯] and [ei̯]--that is, ai i̯, for this aspect of the GVS.

This analysis finds support in the manuscripts. The diphthongized reflexes of the Middle English high vowels are first recorded as ei and ou. There are no transcriptions showing diphthongization without 'lowering'. Recall the similar observations for Old Prussian and for Czech (Wolfe 1968). It is also of interest that John Hart specifically marks these diphthongs as ei and ou. Because the syllabic part of the diphthong is phonetically short and lax, Hart is careful to indicate that it is not tense; but because the diphthong as a whole continues to function in the set of long vowels (and, indeed, would become a long mid vowel if it were monophthongized), Hart transcribes the syllabics as mids. Hart's ei and ou, then, are the only transcriptions to capture satisfactorily both the phonetic and functional properties of these newly evolved diphthongs.[12]

Let us summarize the particle analysis of diphthongization by comparing it to the standard treatment. The latter, in order to convert [i:] to [ei̯], and [u:] to [ou̯], requires three rules (cf. 5a, b, c): diphthongization, vowel shift, and laxing. Diphthongization is the insertion of a homorganic glide. We have already noted how, in particle phonology, the glide need not mysteriously arise from without; rather, the length marker, or second tonality particle, of the long vowel is the source of the glide and of its homorganic quality. Next, lowering (whether or not it occurs in conjunction with mid vowel raising) is not a separate process, nor is laxing. In particle phonology, both happen in response to diphthongization. This process shortens the syllabic of the diphthong. Because of the interdependence of long/short and tense/lax, the derived short vowel must be laxed, and its more open quality, in the presence of an upglide, becomes associated with mid height.[13]

The particle analysis of the GVS appears in (9). Long vowels undergo a heightening of tonality: The mids and the lows each lose an aperture particle, whereas the highs diphthongize; the latter simultaneously acquire an aperture particle.

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(9) **GVS - Particle Analysis (from Middle English to John Hart)**

	[e:]	[i:]	[ɛ:]	[o:]	[u:]	[ɔ:]
ME	ai i	i i	aai i	au u	u u	aau u
		(i i̯)			(u u̯)	
JH	i i	ai i̯	ai i	u u	au u̯	au u
	[i:]	[ei̯]	[e:]	[u:]	[ou̯]	[o:]

Conclusions

An appropriate account of the mechanisms of change underlying both OSL and the GVS requires recognition of a vowel system such as that of (1) and Tables III and IV, where long/short and tense/lax are interdependent. Such a system is generally assumed to have evolved from that of Tables I and III, where only length is decisive and where pairs of long and short vowels are of the same quality. However, this type of system can be unstable (Wang and Chen 1975), and the superposition of qualitative differences onto the quantitative leads to more salient distinctions. At some point in the history of English, the system of Tables I and III had given way to that of Tables III and IV. This development must have occurred at least prior to OSL. Once long/short is linked to tense/lax, a change in either parameter induces a compensatory modification in the other. It is just such adjustments that lie behind what appears to be a lowering of height in the lengthened vowels of OSL and in the diphthongs in the first stage of the GVS.

What we call the Great Vowel Shift represents, in reality, a progression of changes that stretched over a couple of hundred years. Yet, scholars generally view the totality of events as a completed whole, as an entity possessing its own 'inner coherence'. Heightened tonality is the unifying force behind the GVS. Tenseness, as an exponent of tonality, provides the necessary context for this assimilatory change. Because tonality is linked to length, only long vowels are affected; short lax vowels are immune to the shifts.

If the accounts given here of OSL and of the GVS are essentially correct, the standard notation is inadequate for describing what happened; it fails to elucidate the underlying mechanisms. To expect a notational system to 'mirror' the nature of change is not a novel requirement. For example, Chomsky and Halle (1968: 305-8), in discussing their vowel features, consider how these features are to be used for characterizing palatalization in consonants. They compare their treatment of palatalization, which utilizes the features [+ high, - back], with the older feature [+ sharp]. The rules of (10) state that a consonant is palatalized before a high front vowel. Rule (10a) requires independent, unrelated features; (10b) does not.

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(10) **Palatalization of Consonants**

(a) $C \rightarrow [+\text{ sharp}] \;/\; \underline{\quad} \begin{bmatrix} \text{V} \\ +\text{ high} \\ -\text{ back} \end{bmatrix}$ (b) $C \rightarrow \begin{bmatrix} +\text{ high} \\ -\text{ back} \end{bmatrix} \;/\; \underline{\quad} \begin{bmatrix} \text{V} \\ +\text{ high} \\ -\text{ back} \end{bmatrix}$

Although both rules adequately describe palatalization, the second is more 'explanatory' to the extent that there is a direct mirroring between the 'palatalized' features and the 'palatalizing' environment.

Just as palatalization and vowel frontness share a common representation, so must vowel length and diphthongization, length and tenseness, upgliding and tenseness, laxness and lowered height. The standard notation accommodates none of these. Nor will a different set of (binary) features overcome these inadequacies. The deficiencies are inherent in the standard theory's conception of segments and features. This theory: (1) makes a sharp distinction between features and segments; and (2) treats features as autonomous phonetic properties; (hence, each feature occurs at most once). Because of (1), it cannot show relations between the inner structure of monophthongs and the components of diphthongs. Because of (2), it cannot connect laxness to lowered height, or tenseness to tonality.

I have proposed a different way of looking at vowels and diphthongs. Particle theory recognizes three primitive entities—the elementary particles a, i, and u. Particles: (1) exemplify particular vowel segments as well as features of vowels; (2) perform more than one function (and thus may occur multiply); and (3) have interpretations that are context-dependent. The dual segment/feature physiognomy of particles provides a simple account of alternations between diphthongs and certain monophthongs. Diphthong/monophthong pairings reflect differences in the ordering--linear versus simultaneous--of particles. Next, particles have more than one function. The particles i and u correspond to high vowels (when uncombined), upglides (when nonsyllabic), frontness and rounding (when combined into a complex particle), length and/or tenseness (in combination with tonality vowels). The particle a can correspond to the vowel [a], the downglide [a̯], lowered vowel height, length for central vowels, and laxness. But in neither case is it a question of arbitrary associations. In one instance, the various properties are manifestations of 'tonality', and in the other, of 'aperture'. Finally, the particular role that a particle performs depends upon other entities in the system. An extra occurrence of a tonality particle may indicate length as in Table III, but the same specification in a system with opposing lax vowels, denotes combined length and tenseness. By the same token, an aperture particle denotes laxness when opposed to tenseness; otherwise, it specifies height. In a system with few primitives, each element must perforce bear an increased functional burden.

Over two decades ago, Halle (1959) showed how classical phonemics,

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by hugging closely the phonetic terrain, failed to account for important sound patterns in language. He demonstrated the necessity for underlying representations of greater abstraction. I maintain that the standard distinctive features do not always characterize properly the underlying mechanisms of certain vowel changes. These inadequacies too stem from a too close association with phonetic substance. Particles, by reducing vowel properties to manifestations of tonality and aperture, classify vowels in a more abstract manner. This higher degree of abstraction lends a new perspective to the study of vowel sounds and of their evolution.

Epilogue

When the individual changes comprising the GVS have been played out, they add up to an impressive symmetric arrangement of shifting vowels. The principal stages are summarized in (11).

(11) GVS - Summary

Stage I	**i:**	**e:**	**ɛ:**	**a:**	**u:**	**o:**	**ɔ:**
Stage II	**ei̯**	**i:**	**e:**		**ou̯**	**u:**	**o:**
Stage III	**ʌi̯**			**ɛ:**	**ʌu̯**		
Stage IV	**ai̯**		**i:**	**e:**	**au̯**		

Stage I depicts the original Middle English long vowels. Stage II corresponds to John Hart's dialect. Stage III represents vowel patterns described in the mid-seventeenth century by the orthoepists, John Wallis and John Wilkins (Wolfe 1972). The new changes here are the centralization of [ei̯] and [ou̯], and the fronting of [a:]. Stage IV covers the remaining major changes: the raising of nonhigh front vowels, and the further lowering of the diphthongs. Notice the symmetries: Stage II involves shifts in height, Stage III in the front/back dimension, and Stage IV in height, once again.

The Chomsky and Halle (1968: 243) 'alpha-switch' rule for Modern English elegantly captures the symmetrical shifts for height. In particle phonology, the analog of alpha-switch is 'particle exchange'. Let us see how it handles all of these after-the-fact symmetries. The particle equivalents of the vowels of (11) are presented in (12).

(12) GVS - Summary - Particle Analysis

	[i:]	[e:]	[ɛ:]	[a:]	[u:]	[o:]	[ɔ:]
Stage I	**i i**	**ai i**	**aai i**	**aa a**	**u u**	**au u**	**aau u**
Stage II	**ai i̯**	**i i**	**ai i**		**au u̯**	**u u**	**au u**
Stage III	**a i̯**			**aai i**	**a u̯**		
Stage IV	**aa i̯**		**i i**	**ai i**	**aa u̯**		

At Stage II, the four nonhigh tonality vowels each lose an aperture particle, while the two (diphthongized) high vowels acquire one. At Stage III, the diphthongs each lose one of their tonality particles, and the vowel [a:] acquires particles for tonality (i.e. palatality).[14] Stage IV is a recapitulation of aspects of Stage II: Both nonhigh front vowels lose an aperture particle, while the diphthongs each acquire one.

At every stage we find a reciprocal exchange of particles. A segment or group of segments loses a particular kind of particle, while that same type of particle is acquired by some other segment(s). It is as though there is a constant flow of energy moving throughout the vowels. The beauty of the Great Vowel Shift lies in this delicate balance.

FOOTNOTES

1. Grundt (1975) maintains that the lengthening in initial syllables took place as compensation for vowel reduction (i.e. shortening) that was going on in post-stressed syllables. She bases her hypothesis on work by Lehiste (1971), who shows that for bisyllabic words, an initially stressed open syllable and following unstressed syllable constitute a timing unit of relatively constant duration.

2. Grundt (1975) cites studies from several Germanic languages in support of the claim that the acoustic resemblance between a lax vowel and the next lower tense one explains their merger under neutralization of length; see also in this regard the formant charts of Lindau (1978).

3. Moore and Knott (1960) attribute a tense/lax opposition to the vowels of Old English; however, their view is not the predominant one. That Middle English scholars have not been particularly concerned with qualitative distinctions is not surprising in view of the fact that the orthography of that period and earlier marks only length differences.

4. A redundancy rule such as $[\alpha \text{ long}] \rightarrow [\alpha \text{ tense}]$ notes the relationship between long/short and tense/lax, but it goes no further. Why should these two features, in particular, co-occur so frequently?

5. I shall be concerned only with those changes described by Chomsky and Halle (1968: 259-66) for the dialect of John Hart, whose works on English spelling date between 1551 and 1579. Wolfe (1972) has done a thorough investigation of the manuscript evidence for the different phases of the GVS, and she comes to the conclusion that Chomksy and Halle's description of Hart's dialect reflects closely the beginning steps in this extensive set of developments.

6. Throughout, I employ [ei̯] and [ou̯] for Chomsky and Halle's [ēy] and [ōw], respectively. In the representation of long tense vowels, I normally use [i:], [u:], etc., but will resort to [ī], [ū], etc. (i.e. indicating tenseness only) when specifically discussing Chomksy and Halle's analysis.

7. In Schane 1973, I advocated a markedness system for vowels, whereby

palatality is primary for characterizing front unrounded vowels, labiality for back rounded, and aperture for [a]. In that study, I used the standard distinctive features. Although many of those ideas were seminal in the gemination of particle phonology, this new work is a radical departure from what was contained therein. Donegan (1978) also proposes palatality, labiality, and sonority (her term) as primary vowel traits. Her parameters are binary features, except for sonority (height), which is n-ary; moreover, she has separate features for length and tenseness. Anderson and Jones (1977) propose treating certain vowel qualities as complexes of a, i, and u. Their proposal, however, is quite different from mine. They allow hierarchic structure; thus, [e] and [ɛ] are differentiated as i dominating a and as a dominating i, respectively. Furthermore, they do not treat length or tenseness/laxness as complexes of vowels.

8. The central series of vowels is somewhat special. For languages with both [ʌ] and [a], the former is represented by one occurrence of the aperture particle, whereas the latter has two. Hence, the interpretation of particles (e.g. whether a represents [ʌ] or [a]) is system-dependent. The vowel [ɨ], being nonfront, nonround, and nonmid/low, contains only vocalicness (as do all vowels) but no elementary particles. This vowel is not particularly favored; in particle phonology, I attribute its unpopularity to lack of any elementary particles. I do not treat here nasalized vowels; they require a particle of nasality. The 'tense/lax' harmonic vowels of many African languages (Lindau 1978) would have the representations of Tables III and IV, but without the length component.

9. The reflex of Indo-European /o/ had merged with [a] in Primitive Germanic so that there was no short mid back vowel available for raising; however, some [u] were lowered to [o], thus creating new occurrences of that vowel.

10. There are two different means for augmenting tonality: either by the addition of a second tonality particle, or else by the deletion of an aperture particle. The former way accounts for the heightened tonality of tense vowels vis-à-vis lax, and the latter of higher vis-à-vis lower.

11. Stampe (1972), within the framework of Donegan, proposes that an increase of tonality underlies both raising and diphthongization in the GVS. I am aware of no other references to heightened tonality as the common denominator of these changes. Carter (1975) and Lass (1976) posit a single rule of vowel shift that causes vowels to become [+ raise], an instruction implemented as raising for nonhigh vowels and as diphthongization for high ones. Although Carter and Lass both recognize the unity of raising and diphthongization, a cover term [+ raise] provides no independent basis for this unification.

12. In addition to ou (<ME /u:/) and ō (<ME /ɔ:/), Hart has the diphthong ōu (<ME /ou/). I assume that the syllabic of Hart's ōu must have been long (and tense).

13. Subsequently, the diphthongs [ei̯] and [ou̯] become centralized and

are then further lowered to [ai̯] and [au̯], respectively. These changes represent a deliberate 'polarization' of aperture and tonality. Each half of the diphthong maximizes one of these properties (Donegan 1978, Stampe 1972).

14. See note 8 for the particle representations of [ʌ] a and [a] aa. The latter, as a long vowel, is aa a. When [a:] is fronted to [ɛ:], each mora acquires a palatality particle; the one destined for the second mora will replace the aperture particle as the indicator of length--that is, aa a will become aai i.

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