VOWEL SHIFTS IN PERSIAN*

Margaret M. Hashemipour

1. Introduction

For centuries Persian maintained an equilibrium of alternating long and short vowels. Up until the Modern Persian period, the language went through a series of re-alignments which changed the number of segments in the vowel inventory, yet still supported a distinction of long and short vowels. The purpose of this paper is to motivate those vowel shifts within the historical development of Persian.

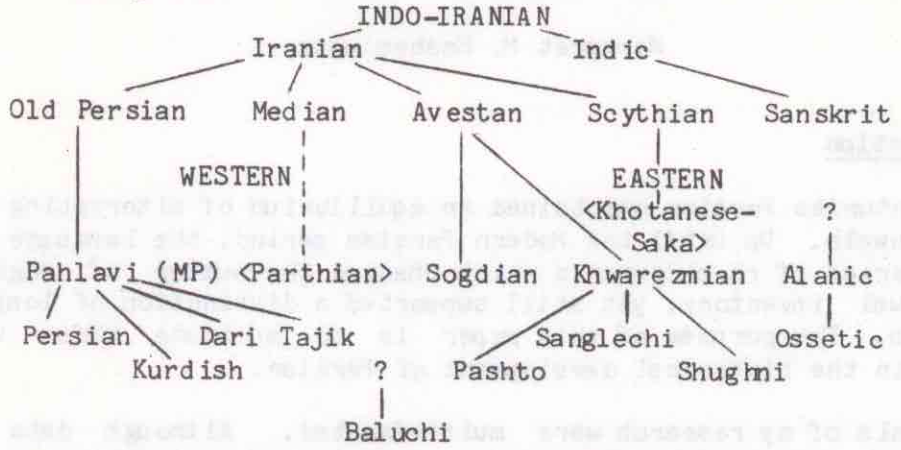
The goals of my research were multi-faceted. Although data are available to substantiate the vowel inventories of each period, a systemization of the vowel shifts of Persian is unavailable. As a result initially my task was to determine the exact inventories of distinct periods by reading transcribed manuscripts. Where sources were scarce, I supplemented them with comparative studies of other Iranian languages and dialects. Without this preliminary work, it would be impossible to discuss the internal machinery of the vowel systems or the dynamic forces of the vowel shifts in the history of the Persian language.

This paper is organized in the chronological order of the vowel shifts, beginning with Proto-Indo-European and ending with Modern Persian. In section two there is a short sketch of the historical background of Persian and the Iranian languages. Section three contains a characterization of the merger of Indo-European *e, a, o to the low vowel a, as is attested in the Indo-Iranian languages of Sanskrit (Burrow 1955, Mayrhofer 1972), Avestan (Windfuhr 1971) and Old Persian (Kent 1939). Section four treats the monophthongization of the Iranian period: ai>e: and au>o:. In section five I consider the evolution of the language from Middle Persian (MP) to Modern Persian. Two vowel movements upset the pattern of long and short vowels. I will argue that the account of the vowel shift from MP to NP must crucially include both vowel quantity and quality in order to comprehend adequately the internal mechanisms of the changes. Sections three, four and five will weigh the treatments of the shifts by generative phonology as opposed to particle phonology as developed by Sanford Schane (1982 and class lectures). Where possible I will present supporting (or incriminating) evidence to substantiate the arguments.

2. Historical background

Modern Persian is an Indo-European language of the Indo-Iranian family, whose history is traditionally divided into three stages: Old Persian, Middle Persian and New or Modern Persian. Table (1) is a family tree of Indo-Iranian languages (Voegelin 1965, Gershevitch 1968, Dresden 1970, Benveniste 1970). Languages with no known modern descendant are indicated by <>. The ancestral ties of Baluchi, an Iranian language spoken in Pakistan and Southeastern Iran, are unclear.

Table (1) Family Tree



Old Persian (OP) is but one of the languages of the Achaemenid dynasty which was established in 550 B.C. The Persians, named after their province Pars, were the ruling tribe of the empire. Other languages of the period were Median, Avestan (Av), and Scythian (Gershevitch 1968).

The Middle Persian (MP) era spans the years 300 B.C. to 950 A.D. The languages of this period are divided into a Western group consisting of Middle Persian (Pahlavi) and Parthian and an Eastern one consisting of Sogdian, Khwarezmian, Khotanese-Saka, and Alanic (Voegelin 1965, Dresden 1970). Darmesteter (1883) showed that Middle Persian (MP) is descended from the Old Persian of the Achaemenid empire.

The position of the other languages is less clear. Parthian is believed to be the descendant of the ancient language Median, of which little is known. Dresden (1970) cites work that links Sogdian, Khwarezmian, and ancient Avestan. Khotanese-Saka is a descendant of Scythian-Saka (Boyce 1968). The source of Alanic, ancestor of Modern Ossetic, is unknown (Dresden 1970).

The earliest written records of Pahlavi date from 700 B.C.; during this period, MP was used in religious and literary works. The translation of the Zoroastrian religious books from Avestan to Pahlavi took place during the Sasanian dynasty (224 A.D.-650 A.D.) (Mansouri, unpublished). There is also evidence that the MP language was used in secular poetry (Boyce 1968, Lazard 1971). The Middle Persian period ended with the Arab invasion of Persia in 950 A.D. and the influx of Arabic and Turkish influence on the Persian language.

The modern descendants of the Iranian stock also have East and West varieties. The Eastern languages are Pashto (spoken in Eastern Afghanistan), Baluchi (spoken in Western Pakistan, Southeast Iran). Other Eastern varieties are found in parts of Western India. Although Ossetic is geographically isolated, it is also an Eastern language. Western Iranian languages are Farsi or Persian (Iran); Dari or Kabul Persian (Afghanistan); Kurdish (Western Iran, Eastern Iraq and Turkey); and Tajik (Tajikistan U.S.S.R.) (Lazard 1970, Redard 1970 and Voegelin 1965). Other Iranian languages spoken in Iran are Luri, Bākhtiari,

Mazānderani, Gilāki, Gābri, Kumzai and Gurani (Mansouri unpublished, Voegelin 1965). Historical work on the latter languages has been limited.

3. Development of Indo-Iranian from Proto-Indo-European

I will maintain the vowel inventory of Proto-Indo-European reconstructed by historical linguists such as Beeler (unpublished), Lehmann (1955), and others.

(1) Proto-Indo-European Vowels

i:	u:	i	u
e:	o:	e	o
a:		a	

Proto-Indo-European Diphthongs

e:i̯	o:i̯	e:u̯	o:u̯	ei̯	oi̯	eu̯	ou̯
a:i̯		a:u̯		ai̯		au̯	

One of the first vowel changes noted in Sanskrit was that the mid and low IE vowels merged (Burrow 1955, Mayrhofer 1972): *e,o,a>a, *e:,o:,a:>a:. The merger affected both short and long vowels as well as diphthongs. Using orthography as a basis, Iranianists have postulated that both Avestan and Old Persian underwent the same process (Windfuhr 1971, Kent 1939). The examples in (2) are taken from Tolman 1910, Kent 1939, and Beeler unpublished.

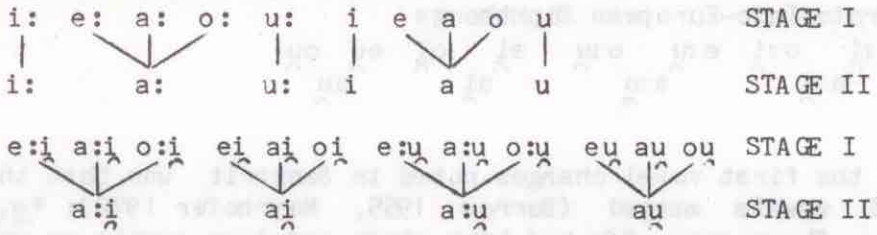
(2)

CHANGE	EXAMPLE	GLOSS
IE *e:>I-I a:	IE *me:>Skr ma:; OP ma:	'not'
IE *o:>I-I a:	IE *-do:->Skr da:; Av da:	'give'
IE *a:>I-I a:	IE *ma:ter>Skr ma:tar; Av ma:tar; OP ma:tar; NP madār	'mother'
IE *e>I-I a	IE *qe> Skr ča; Av ča; OP ča; NP če	'that'
IE *o>I-I a	IE *bhoros> Skr -bhara-; OP bara-	'bearing, bearer'
IE *e:i̯>I-I a:i̯	IE *dhe:i̯>Skr dha:ya, Skr dha:i̯na	'suckle' 'milk cow'
IE *ei̯>I-I ai̯	IE *eito> OP aita	'this'
IE *oi̯>I-I ai̯	IE *oiuo> OP aiva; Av aiva	'one'
IE *ai̯>I-I ai̯	IE *-tai̯ (bheretai)> OP -taiy (in vainataiy)	gloss not given
IE *e:u̯>I-I a:u̯	IE *-e:u> Skr -a:u; OP -a:u	'loc. sg.'
IE *a:u̯>I-I a:u̯	IE *na:u-> Skr na:us; OP na:u-; NP nav	'ship'
IE *eu̯>I-I au̯	IE *geus> OP daustar	'friend'

IE *ou̯>I-I au̯ IE *-ous> OP -au 'gen. sg.'

There is a consonant change which suggests that the merger of mid and low vowels was not an early process that distinguished Indo-Iranian from Proto-Indo-European. IE *ǫ,*ḡ palatalized when they preceded IE *i,e in Indo-Iranian languages, e.g. IE *leuq-(e) 'light'> Skr ro:čate: 'shines'; OP rauž; NP ruz 'day'(Beeler unpublished). Therefore, for the Skr word ro:čate: 'light' there must have been an intermediate stage *rauče in order for IE *ǫ to palatalize to č. This suggests that the initial inventory of Indo-Iranian contained the vowel [e], and that the merger of *e, a, o occurred later within Indo-Iranian (I-I), but before the split into Iranian and Indic. I postulate that Indo-Iranian underwent the following vowel shift.

(3) INDO-IRANIAN VOWEL SHIFT



The resulting vowel system, shown in STAGE II, contains the peripheral vowels i,a,u. An adequate characterization should be able to treat the merger in a unified fashion, i.e. what common characteristic did e and o lose (or gain) in order to merge? Also the explanation must explain why e and o moved toward sonority and did not instead merge with the high vowels i and u.

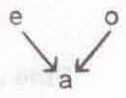
3.1. An account in generative phonology

The generative treatment of the merger should include the lowering and centralization of e and o.[2] However, there is no historical precedence to support the idea that the process occurred in two parts, i.e. e and o first lowered and then centralized or vice versa as shown graphically below.

(4)

Rather, the movement of e, o is diagonal, as seen below.

(5)



Therefore, any account of the merger should simultaneously lower and centralize e and o. I will review several possible generative treatments.

3.1.1. Segment redundancy rules

Many properties of vowels are predictable directly from the values of other features of a segment. For example, in Modern Persian, a vowel which is [-back], i.e. front, is also [-round]; and [+round] co-occurs with [+back]. Generative phonology represents these predictable features via segment redundancy rules in the lexicon (Chomsky and Halle 1968). The redundant features are marked 0, and rules map the 0 onto a + or - value.

It is unclear whether the idea of redundancy rules based in the lexicon is used in historical treatments. However, it is certain that for generative phonology it is desirous to omit features predictable from other features in phonological rules--synchronic or diachronic. This convention greatly simplifies rule writing. At this point, it is legitimate to assume that low vowels in Indo-Iranian are redundantly central, and that the redundancy is given in the segment structure rules of the lexicon. Moreover, we can assume, as posited in Stanley 1967, that the redundancy rules operate first to fill in the feature matrices of segments before the phonological rules apply.

The following phonological rule, which includes only non-redundant features, is a first attempt to characterize the merger of [e,o,a].

(6) Merger

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

The above rule does not give the correct results. It simply lowers [e] and [o]; it does not mention that when [e] and [o] merge, [e] loses its frontness, and [o] loses its backness and rounding. That is, the quality of the resulting segments, *e>a, *o>a and *a>a should be the same. The rule formulated above in (4) suggests that *e lowered to ä and *o lowered to O. There is no evidence that this is the case.

In order for generative phonology to achieve the correct results, the shift must assign the correct value for backness (and frontness), but then the generalization that low vowels are predictably central is missed. From the discussion above, we understand this fact to be given in the lexicon. It is legitimate to question the efficiency of stating the redundancy twice: once in the segment redundancy rule and once in the phonological rule.

The solutions to this problem are several. To eliminate the redundancy rules altogether is to lose an important generality, i.e. that some features are predictable. To have only one set of redundancy rules which only operate before the application of phonological rules is to miss the redundancies that may result after the features change. Stanley's (1967) suggestion is to extend the domain of the redundancy rules so that they apply both before and after the phonological rules. This extension casts doubt on the very nature of the generative grammar and its compartmentalization into lexicon, phonological component, syntax, etc. None of these solutions seem tenable. Questions of this type

are outside the scope of this paper, but nevertheless are intriguing.

3.1.2. Central vowels in generative phonology

Leaving aside the problems with redundant features, one may question the representation of central vowels. In generative terms low [a] is marked [+back, -round, +low]. However, there is no reason to believe that [a] has the same degree of backness of [u,o]. Moreover, this characterization warps the directionality of the merger, as well as the basic inventory of IE. It means that while [o] only lowered, [e] became both low and back. This formalization destroys the symmetry of the process.

(7) IE Vowels

i u
e o
a

Merger

e, o → a

Merger

V

$$\begin{bmatrix}-\text{high}\\-\text{low}\end{bmatrix} \rightarrow \begin{bmatrix}+\text{low}\\+\text{back}\end{bmatrix}$$

This dilemma results from the nature of the feature system.

In a description which uses binary features, the number of distinctions possible within a phonetic property is related to the number of features used. In languages with the two features [high] and [low], three values are possible: [+high, -low], [-high, +low] and [-high, -low] (the combination [+high, +low] is excluded).

Where only one feature is used, as for backness, there is either a + or - value, i.e. [+back] or [-back]. Many languages commonly have front, central and back vowels, which cannot be characterized in a binary distinction. The following discussion will review two possible treatments of of central vowels within generative phonology. One solution supplements the feature system with an additional feature, another supports multi-valued features.

3.1.2.1. [front] as a feature

The feature front can be introduced to distinguish vowels which are [+front, -back], [-front, -back], and [-front, +back]. Such an inventory is represented in the following feature matrix.

(8)

	i	e	a	o	u
high	+	-	-	-	+
low	-	-	+	-	-
front	+	+	-	-	-
back	-	-	-	+	+

Using the feature front, the merger of I-I *e, a, o is formulated as below.

$$(9)\quad \overset{V}{[-\text{low}]} \rightarrow \begin{bmatrix} +\text{low} \\ -\text{front} \\ -\text{back} \end{bmatrix}$$

While the above rule accounts for the merger, two critical comments regarding the feature front must be made. Generally, front is a feature not accepted by most generative phonologists. Front is considered unnecessary, since intuitively it seems to be the inverse of back, and since rule (7) accomplishes the merger as well as (8). Secondly, the introduction of front is to subdivide into smaller units a single phonetic dimension, i.e. the relative retraction of the tongue. In fact, it may be more appropriate to regard the distinction front-central-back as scalar values of a unitary phonetic property, backness.

3.1.2.2. Scalar valued backness

Typically multi-valued features are used in phonetic representations, and binary features are employed in phonemic matrices. Contreras 1969 introduced the idea of n-valued features in phonemic analyses because certain conflicts in the simplicity of rule writing as well as inadequate descriptions result in a binary system. Another innovation in the Contreras article is the combined use of + and - with n values. n + 1 and n-1 are replaced by +n and -n respectively. Three values are possible: n, +n, -n. Let us examine, how the Contreras conventions would work in the merger of Indo-Iranian.

If backness is delineated on a multi-valued scale, then mid and low vowels would be characterized as:

e = [0 back] a = [1 back] o = [2 back]

The merger rule must increase the backness of e, and decrease the backness of o, i.e. +n for e > a and -n for o > a.

(10a) Merger

$$\overset{V}{\begin{bmatrix} -\text{low} \\ n\ \text{back} \end{bmatrix}} \rightarrow \begin{bmatrix} +\text{low} \\ +n\ \text{back} \end{bmatrix} \quad \overset{V}{\begin{bmatrix} -\text{low} \\ n\ \text{back} \end{bmatrix}} \rightarrow \begin{bmatrix} +\text{low} \\ -n\ \text{back} \end{bmatrix}$$

(Cond. where n<1) (Cond. where n>1)

Of course, the two rules in (10a) could be collapsed by the use of angled brackets as in (10b).

(10b) Merger

$$\overset{V}{\begin{bmatrix} -\text{low} \\ n\ \text{back} \end{bmatrix}} \rightarrow \begin{bmatrix} +\text{low} \\ \langle +n\ \text{back} \rangle_a \\ \langle -n\ \text{back} \rangle_b \end{bmatrix}$$

(Cond. a where n = 0; Cond. b where n = 2)

This formulation, at the most, awkwardly stumbles over the basic idea that both e and o lower and centralize to a. The rule is notationally inadequate because it fails to reflect the simultaneous convergence of

the three vowels. It seems counter-intuitive that a simple prose statement 'e and o merge to a' should require such a complex formalization.

3.2. Merger in particle phonology

Particle phonology sheds light on the Indo-Iranian merger. Where the primitives of generative phonology are distinctive features, those of particle phonology are elementary particles. i, u are tonality particles of palatality and labiality, respectively; a represents aperture. Segments are represented as complexes of particles such that front vowels contain the particle i, round vowels have u, and the number of aperture particles in a segment corresponds to vowel height. Markedness is inherently constructed within the theory since the number of particles tells the complexity of the segment.

Length in particle phonology is represented by an additional tonality particle, e.g. [i:] = i i. In the case of low vowels which show no tonality, length is indicated by an extra aperture particle, e.g. [a:] = a a. The half moon under a particle indicates that it is non-syllabic, i.e. the glide of a diphthong. Both the length marking particle and the glide particle are separated from the rest of the complex by a space to denote bimoric value. In the case of long diphthongs, as in IE, I-I, Skr and OP, a trimoric value is needed. This is written in particle notation as [e:i̯] = ai i i̯. It is without saying that long diphthongs are highly marked. The notation directly mirrors their complexity. In (11) the particle representation of the initial inventory of Indo-Iranian is presented.

(11) INDO-IRANIAN

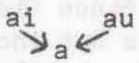
Short Vowels		Long Vowels	
[i]	i	[i:]	i i
[e]	ai	[e:]	ai i
[a]	a	[a:]	a a
[u]	u	[u:]	u u
[o]	au	[o:]	au u

Short Diphthongs		Long Diphthongs	
[ei̯]	ai i̯	[e:i̯]	ai i i̯
[ai̯]	a i̯	[a:i̯]	a a i̯
[oi̯]	au i̯	[o:i̯]	au u i̯
[eu̯]	ai u̯	[e:u̯]	ai i u̯
[au̯]	a u̯	[a:u̯]	a a u̯
[ou̯]	au u̯	[o:u̯]	au u u̯

Particle phonology addresses the questions raised by the generative treatment of the I-I merger. Particle complexes explicitly show the properties of the vowels; there are no hidden features to be understood via redundancy rules (cf. (11)). In addition particle phonology is concerned with a different set of redundancies, e.g. the correlation of length-tenseness-tonality, lowering and lax vowels, the bimoric value of long vowels and diphthongs. These predictable correspondences are captured in the notation by representing the sets of properties with the same primitive or punctuator, e.g. tonality particles additionally

indicate length and tenseness. The meaning of the particle symbols are therefore language specific and context dependent. At different points the symbols may be re-defined by reinterpretation rules (cf. section 5.5.2 where lax [I] is reinterpreted as [e]). The predictable correspondences of particle phonology are based on universal redundancies.

In particle phonology backness is not an underlying feature. The particle i represents frontness or palatality. The absence of the particle i shows that a vowel is not palatal, i.e. back. The particle u marks the vowel as round. The absence of u in a particle complex, indicates that the vowel is not round. Particle phonology distinguishes between the segments [e], [a], and [o] by means of tonality particles i and u. In this way the merger of [e,a,o] is not the lowering of [e] and [o] as is suggested in (6), but simply the loss or decay of tonality, as shown below.



Finally, several properties suggest why [e] and [o] merged with [a] and not with [i] and [u] respectively. [a], the optimally sonorant vowel, is in opposition with [i] and [u] the optimal tonality vowels. This contrast underlies the merger question. Donegan (1979:29) cites several processes that confirm that sonority is more basic than timbre or tonality, e.g. the tendency for sonorant vowels to retain syllabicity in the diphthongs of Skr. Reinterpreted in particle terms, in the merger [e] and [o] lost the 'weaker' or less basic particles of their complexes in favor of sonority.

After the merger of I-I, the three parameters of vowels: palatality, labiality and aperture, are in optimal contrast. The particle notation mirrors the maximum expression of tonality versus aperture. We will see in the following section that the three vowel system is not upheld. Through gradual change additional segments are introduced to allow a more maximal use of vowel space.

4. Development of Old Persian from Iranian

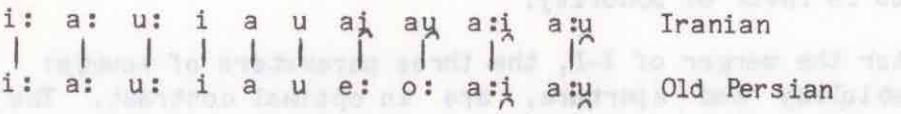
Traditionally the dissolution of the Indo-Iranian language family into the Iranian and Indic sub-groupings is based on certain developments in consonants, e.g. IE *bh> Skr bh; > Av, OP b. However, there is an interesting vowel movement which suggests that perhaps the groups were at best dialects rather than languages (Mayrhofer 1972).

Sanskrit has a long oral tradition which has preserved the pronunciation of the ancient language. In particular the Skr segments e: and o: are verified by the Hindu grammarians but who wrote them as the diphthongs aị and aụ. Using this information as well as internal processes within the language such as vowel gradation, sandhi and word formation, historical linguists account for the development of e: and o: via a process whereby aị and aụ monophthongized in Sanskrit.

Old Persian also has a monophthongization where ai > e: and au > o:. Some debate has centered around when the process occurred. This is because the OP documents do not contain a symbol for e: and o: but instead write ai and au like Sanskrit. I will follow Diakonoff's (1971) conclusion that e: and o: existed initially in OP. I maintain that the monophthongization occurred in the Iranian period, during which Sanskrit and Old Persian still had more linguistic contact than at later periods.

Diakonoff's conclusion is based on studies of the OP orthography. The Old Persian cuneiform, although principally based on the Phoenician/Aramaic alphabet, also used syllabograms borrowed from the Akkadian cuneiform. Three vowels, i, a, and u were written as well as diphthongs. Although, as Diakonoff points out, typically there is a high correspondence between pronunciation and writing, several arguments indicate that OP ai and au are to be interpreted as e: and o:. First, recall that Hindu grammarians saw a correspondence between written diphthongs and long mid vowels. Since Old Persian and Sanskrit were fellow Iranian languages, it is not inconceivable that the scribes of Old Persian would have adopted the similar practice. Moreover, Late Babylonian, Hebrew and Greek rendered Iranian *ahu, *au as /o:/ and *ai as /e:/ in borrowed place names (Diakonoff 1971). Each of the languages had diphthongs at the time of the borrowings. There is no reason to believe that the three former languages coincidentally monophthongized Iranian diphthongs to the same vowel. Therefore, I maintain that monophthongization occurred prior to OP. (12) is the characterization of the development.

(12) Monophthongization



4.1. Monophthongization in generative phonology

In generative phonology, the standard format for rule writing requires that monophthongization be regarded as a three-step process: a) one of the segments must assimilate some of the properties of the other; b) the assimilated segment must lengthen; c) then the other segment must be deleted.

(13) a) a → e / _ i a → o / _ u
b) e → e: / _ i o → o: / _ u
c) i → 0 / e:_ u → 0 / o:_

Since every instance of lengthening and deletion is preceded by assimilation, none of the rules are independently motivated. The characterization in (13) misses a generality, i.e. each step is equally dependent on the other steps, and that all three processes are simultaneous. Generative phonology also may account for processes like monophthongization with a transformational rule.

(14a) Monophthongization

$$\begin{bmatrix}+\text{syll}\\+\text{low}\end{bmatrix}_1 \begin{bmatrix}-\text{syll}\\+\text{high}\\ \alpha\text{round}\end{bmatrix}_2 \quad \overset{1}{\begin{bmatrix}-\text{high}\\-\text{low}\\ \alpha\text{round}\\+\text{long}\end{bmatrix}}, \quad \emptyset$$

There is no reason to assume that [a] is the preferred segment to assimilate and to be lengthened. The transformational format easily allows either segment to undergo the process as seen in (14b).

(14b) Monophthongization

$$\begin{bmatrix}+\text{syll}\\+\text{low}\end{bmatrix}_1 \begin{bmatrix}-\text{syll}\\+\text{high}\\ \alpha\text{round}\end{bmatrix}_2 \quad \emptyset \quad , \quad \overset{2}{\begin{bmatrix}+\text{syll}\\-\text{high}\\-\text{low}\\ \alpha\text{round}\\+\text{long}\end{bmatrix}}$$

The two rules have several problems. First, the lengthening of the vowel is not motivated in the formulation of the rule. Moreover, these formalizations lack the intuition that monophthongization is the amalgamation or 'fusion' of the properties of the two segments into one new vowel.

4.2. Fusion in particle phonology

The notation of particle phonology mirrors the relationship of Iranian ai, au and OP e:, o:. The particle representation of the segments is given in (15). Note the similarity between the diphthongs and the long vowels.

(15) [e:] ai i [aî] a î
[o:] au u [aû] a û

In the process of monophthongization the particles of the diphthong fuse into a single complex particle. Schane (1982) cites cases where Old French [eu] and [ue] fused to [ø̃] and where in certain dialects of Ancient Greek [oî] fused to [ø̃]. The same is true of Kurdish [ũ] and [õ] which are reflexes of MP ui and ue respectively. In particle phonology [eu̯], [u̯e], [oî] and [ø̃] are merely different sequences of the same particles.

(16) [eu̯] aiu̯ [u̯i] u̯i
[u̯e] u̯ai
[oî] aui̯
[ø̃] aiu [ũ] iu

What is crucial is that the resulting monophthong is represented by a complex particle that contains only and all of the particles of the

input diphthong (Schane 1982:55).

Fusion in Old Persian differs from that of Old French and Ancient Greek, because the former language retained the original bimoric value of the diphthong, where in the latter cases the mora count is not maintained. There is a means of accounting for the long version of fusion in particle phonology. First, we must examine other aspects of particle notation: the representation of long vowels in their unfactored form, as well as an additional process: cloning.

4.2.1. Factoring particle complexes

Long vowels have two representations in particle phonology. As seen previously in (11), length may be indicated by an additional tonality particle which is separated from the rest of the particle complex by a space to denote its bimoric value. Geminate vowels are shown by the sequence of two identical particle complexes (cf. (17) below).

(17)	[i:]	i i	[ii]	i i
	[e:]	ai i	[ee]	ai ai
	[u:]	u u	[uu]	u u
	[o:]	au u	[oo]	au au
	[ū:]	iu i, iu u	[ūū]	iu iu
	[ō:]	aiu i, aiu i	[ōō]	aiu aiu

The long vowels seen in the first column are factored complexes where all redundant particles are eliminated with the exception of the tonality particle. Factored and unfactored complexes are notationally equivalent. Using the unfactored complexes of [e:] and [o:] I give (15) again in (18)

(18)	[e:]	ai ai	[a͡i]	a i͡
	[o:]	au au	[a͡u]	a u͡

Therefore, the particle representation of [e:] and [o:] is a duplicate of the diphthongs [ai] and [au] with the space punctuator being located between the two copies. The doubling is a result of the retention of the bimoric count, shown by the space punctuator. In this sense, the punctuator mirrors the duplication.

4.2.2. Cloning

In the unfactored complexes, it appears that the particles of each mora have traded particles, i.e. each assimilated or copied the properties of the other. The process of assimilation in particle phonology is the creation of a clone. For example, the labialization or palatalitization of the syllabic segment of a diphthong may be the result of the cloning of the labiality or palatality of the nonsyllabic elements, e.g. au̯ > ou̯ or ai̯ > ei̯. Similarly, a vowel may increase in tonality under the influence of a nearby labial or palatal vowel. An example exists in the difference between formal and colloquial New Persian: fNP holu - cNP hulu 'peach', fNP hädieh - cNP hedieh 'gift'; fNP sebil - cNP sibil

'moustache'.

In the case of Ir aj > e: and aw > o: both the low vowel and the glide underwent cloning, i.e. cross-cloning.

(19) a j ==> ai ai

a w ==> au au

Cross-cloning in the case of monophthongization is a type of fusion which is capable of retaining the original mora count of the segments. Another descriptive name is: bimoric fusion.

The cross-cloning of MP and the monophthongization of Old French, discussed earlier, are similar because they are both fusion processes, yet they are different in the resulting vowel quantities. Nevertheless, the quantity difference can be explained within reason. By the time monophthongization happened in Old French, the vowel length distinction had disappeared (Schane personal communication). Therefore, fusion only could consist of the conservation of the qualities of the two segments. On the other hand, in Iranian, a vowel length distinction did exist, and therefore fusion conserved both the vowel qualities and quantity of the segments. As Donegan (1978:117) explains for Japanese bimoric fusion: "...what starts out as two moras ends up as two moras".

The two types of fusion are shown graphically in (20).

(20) Fusion: u↔ai ==> aiu [õ]

Cross-Cloning: a ⟩⟨ i ==> ai ai [e:]

In summary, particle phonology adds insight into the fusion process of Iranian. Using the notation and processes already justified by other phenomena, we are able to describe and explain the creation of long [e:] and [o:].

5. Development of Modern Persian from Middle Persian

I propose that the vowel inventory of Middle Persian (MP) is organized as shown in (21), where the high vowels differ both in quantity and quality. [i:,u:] are long tense vowels opposed to the short lax vowels [I,U].

(21) Middle Persian Vowels

```
i:        u:
   I   U
e:        o:
     a  a:
```

Some of the vowels of MP have been reconstructed by Barr (1936) Nyeberg (1964) MacKenzie (1971) and others. The script of the ancient

texts is derived ultimately from that of the official Phonecian/Aramaic cuneiform of the Achaemenian empire. It has some twenty-one characters with ligatures three of which directly indicate vowels: a, i, u. Iranianists have taken at face value the idea that the orthographic symbols for MP i, a, u reflect phonological reality. The Aramaic alphabet indicated only a quantitative difference between vowel pairs such as short and long i,u. Comparative evidence and morphological constructions provide further evidence as to the pronunciation of vowel segments. Barr (1936), Lazard (1963) and MacKenzie (1971) have given conclusive evidence of the existence of [e:] and [o:]. However, there is no proof of short [e,o]. A comparative study of MP and Kurdish establishes my reconstructed inventory in (21).

5.1. Kurdish

The vowel inventory of Kurdish (Kd) supports the opposition of long-tense and short-lax in Middle Persian. The Kd and MP vowels are given in (22) (MacKenzie 1961, Bedir Khan, et al 1970). In addition to five long and three short vowels, Kurdish has front rounded vowels which are the result of the later monophthongization of ue or ui.[3]

(22)

Kurdish Vowels		Middle Persian Vowels	
i:	u:	i:	u:
I	U	I	U
e:	o:	e:	o:
ō		a	a:
a	a:		

Where other modern Iranian languages have undergone vowel shifts, Kurdish has retained the basic inventory of MP vowels. Compare the following cognate sets of MP, Kd and NP.

(23)

MP	Kd	NP	GLOSS
pi:r	pi:r	pir	'old'
dil	dIl	del	'heart'
be:	be:	bi	'without'
aze:r	ze:r	zir	'under'
du:r	du:r	dur	'far'
kurd	kUrd	kord	'Kurd'
guftan	wUtin	goftān	'to say'

Note that where MP e:, o: shifted to NP i, u, Kd retained e: and o:, e.g. MP be: > NP bi, Kd be:. More importantly, Kurdish shows an opposition of long tense and short lax in high vowels, exactly as hypothesized for MP. The Kd vowel inventory supports the quantitative-qualitative hypothesis. At the very least, Kd [I] and [U] demonstrate that lax vowels are not foreign to Western Iranian languages.

5.2. Supporting theoretical arguments

The internal reconstruction of lax vowels and the contrast of quantity and quality finds supporting evidence in articulatory facts as well

as in phenomena from other languages. First, the lax vowels re-initiate the maximal use of vowel space. Certainly this facilitates perceptual processing. Moreover, the introduction of laxness in short vowels creates an optimal opposition with tense, long vowels. This tense/long - lax/short contrast is one which is attested in many languages.

5.3. Modern Persian spoken in Iran

Modern Persian (NP) and Pahlavi (MP) show marked similarities. The vowel inventories of NP and MP are shown in (24) (MacKenzie 1971); (25) characterizes the phonological changes; examples are given in (26) (personal data).

(24)

Iranian Persian Vowels			Middle Persian Vowels		
i		u	i:		u:
				I	U
e		o	e:		o:
	ā	a		a a:	

(25) Changes to be accounted for

1. i:>i
2. e:>i
3. I>e
4. a>ā
5. u:>u
6. o:>u
7. U>o
8. a:>a

(26) Data

MP	NP	GLOSS	CHANGE
gul	gol	'flower'	u>o
ro:z	ruz	'day'	o:>u
so:san	susān	'lily'	o:>u
bu:f	buf	'owl'	u:>u
pe:ra:mo:n	piramun	'around'	e:>i, a:>a,o:>u
nigu:n	negun	'upside down'	i>e, u:>u

(27) shows my analysis of the vowel shift from Pahlavi to Modern Persian. The first stage involves a merger of long vowels. Ultimately length is lost in STAGE II. Moreover, short lax [I] and [U] are lowered.

(27) Iranian Persian

[i:]	[e:]	[a:]	[o:]	[u:]	[I]	[ā]	[U]	MP
	i:	a:		u:	I	ā	U	I
i		a		u	e	ā	o	II

5.3.1. The vowel shifts of Middle Persian in generative phonology

Given the distinctive features and the idea of redundancy, there are several ways to write the rules for the vowel shifts of MP. Two possibilities are given below in (28). One employs the features low and long, the other uses tense.

(28) FORMALIZATION I

STAGE I

$$\begin{bmatrix} V \\ +long \\ -low \end{bmatrix} \rightarrow [+high]$$

STAGE II

a $\begin{bmatrix} V \\ -low \\ -long \end{bmatrix} \rightarrow [-high]$

b $V \rightarrow [-long]$

FORMALIZATION II

$$\begin{bmatrix} V \\ +tns \end{bmatrix} \rightarrow [+high]$$

a $\begin{bmatrix} V \\ -tns \end{bmatrix} \rightarrow [-high]$

b $V \rightarrow [-long]$

In both formalizations, STAGE II must stipulate that lowering be crucially ordered before loss of length. Otherwise, all vowels would lower. One might consider collapsing STAGE I with rule a) of STAGE II with alpha variables. However, there is nothing historically to suggest that the two processes were simultaneous.

Using the judge of simplicity, the second set of rules is preferred over the first, since the vowel shift is stated with fewer features than in the first formulation. However, both groups fail to capture the motivation behind the MP vowel movements. Generative phonology does not provide a natural connection between the features high and long, and tense and high. Generally, lower vowels, i.e. [-high] have longer duration, i.e. [+long] (Donegan 1978:52, Schane personal communication). Moreover, it is difficult to see any correlation between the 'considerable muscular effort', and 'a deliberate, accurate, maximally distinct gesture' (definitions given for tense in Chomsky and Halle 1968:324) and vowel height. However, The relation of tenseness and high vowels is captured in theories such as Donegan's natural phonology and Schane's particle phonology.

5.3.2. A particle phonology analysis of Middle Persian

A particle analysis sheds light on the changes of MP. As mentioned in section 3.2, each particle is multi-functional. For example, the aperture particle a may indicate sonority and laxness. Tenseness and length are both represented by an additional tonality particle--in long vowels the extra particle is separated from the rest of the complex by a space, e.g. [i:] = i i. Also recall that because of the dual function of the primitives, the interpretation of a complex is context dependent. Note the relevant data for Iranian Persian in (29).

(29) Particle Analysis

[i:]	[e:]	[a:]	[o:]	[u:]	[I]	[a]	[U]	
i i ai	i	a a au	u	u u ai		a	au	MP
i i		a a		u u		ai a	au	I
i		aau		u		ai aai	au	II
[i]		[a]		[u]		[e] [ä]	[o]	NP

STAGE I is the merger or neutralization of long vowels. Particle phonology predicts that mergers involve simplification of complexes, i.e. the decay of particles. If two vowels merge, then the resulting vowel will be less marked. So i:+e:> i: is more likely than i:+e:> e:.

In STAGE II the tense/lax distinction disappears. This is exhibited in two ways. Length, and therefore tenseness are lost. Once the tense-lax opposition disappears, the particle a in [I] and [U] must be re-interpreted. Instead of laxness, it is associated with aperture in STAGE II, i.e. ai is re-interpreted as [e] instead of [I]. Phonetically the two segments are similar if not the same, but structurally they behave differently. Particle notation captures this ambiguity (Schane 1982 class lectures).

Note where generative phonology indicates a relationship between STAGE I and rule a) of STAGE II (cf. (28)), particle phonology says that there is a correspondence between the processes of STAGE II. The particle correlation is historically attested, but generative one is not. The generative notion is based on notation, where the particle insight is founded on the universal properties of tonality-tenseness-length.

5.4. A digression--low vowels

At this point, I will show how the contrast in quality of low vowels in New Persian fits into the quantitative-qualitative opposition in Middle Persian. MP distinguished between long and short low vowels phonemically. Formal NP, with the exception of poetry recitation and orthographic conventions, does not make a length distinction.[6] The only remaining evidence of the length contrast is the presence of two low vowels, which today are distinguished by a quality contrast. [ā] indicates a low slightly fronted central vowel which is the reflex of MP short a. Modern day [a], a reflex of MP a:, is a low back and slightly rounded vowel. In Iranian literature it is frequently represented as [a].

(30)

MP	NP	GLOSS
ko:si:dan	kusidān	'to strive'
nibistan	nevestān	'to write'
zarr	zār	'gold'
pe:ra:mon	piramun	'around'
za:nu:g	zanu	'knee'

Attempts to account for the quality change of long and short low vowels are scarce. However, by applying some natural concepts of the tendencies of vowels, we can understand what happened. Low vowels are lax by definition according to Donegan's (1978:49) principles of tenseness and intensity of color. Tenseness is the intensification of color. Since sonorant vowels lack high degrees of color (hence Donegan's label 'achromatic'), they are lax. This redundancy is indicated in particle notation by the multi-functional particle a; it may represent both aperture and laxness.

The fact that low vowels are only lax also implies the absence of a simple tense-lax contrast in the most sonorant group. As a result, languages undergoing the loss of length have several possibilities with respect to changes in low vowels. Either a and a: merge, as in Latin (Donegan 1978:49), or they diverge.

Divergence can result from the addition of palatality or labiality or both, onto either the short or long low vowel. In the case of Persian, MP short a added palatality to become NP [ā] while MP a: gained labiality to shift to NP [a]. In this fashion, the distinct tonality properties polarized the low vowels, and allowed the contrast in the low vowels to persist. I maintain that the pair of low vowels is parallel to the pair of high vowels. Just as short/long chromatic vowels differed in laxness or sonority prior to the loss of length, the low vowel pair exhibited a tonality difference. Each set has a contrast of quantity and quality at the MP. Given the addition of low vowels, we note a symmetry in the internal pattern of long and short vowels of Middle Persian.

5.5. Kabul Persian[7]

The standard dialect of Kabul Persian (KP) markedly differs from that of Iranian Persian. STAGE I does not involve a merger of long vowels, instead it entails the lowering of lax MP [I] and [U] to lax [E] and [O]. In STAGE II the length contrast is lost.

(31)

Kabul Persian Vowels		Middle Persian Vowels	
i:	u:	i:	u:
		I	U
e:	o:	e:	o:
E	O		
ā	a	ā	a

(32) Vowel Shift

[i:]	[I]	[e:]	[a]	[a:]	[o:]	[U]	[u:]	MP
i:	E	e:	ā	a:	o:	O	u:	I
i	E	e	ā	a	o	O	u	II

(33) Particle Analysis

[i:]	[I]	[e:]	[a]	[a:]	[o:]	[U]	[u:]	MP
i i	ai	ai i	aa	aa a	au u	au	u u	
i i	aai	ai i	aaai	aaau	aa u	aau	u u	I
i	aai	ai	aaai	aaau	au	aau	u	II
[i]	[E]	[e]	[ā]	[a]	[o]	[O]	[u]	KP

In STAGE I lax [I] and [U] are lowered by the addition of an aperture particle. This creates lax [E] and [O]. Length is lost in STAGE II. There is a great inter-relationship between the operation of STAGE I and STAGE II. Confusion would have resulted had the loss of length occurred first. It would have forced the re-interpretation of [I] (ai) and [U] (au); either the lax vowels would have merged with [e] and [o], or they subsequently shift to [E] and [O]. Since merger is averted in

KP, lowering occurs. The tonality of [I,U] is decreased further by an additional aperture particle. Thus [E] and [O] are produced, along with a four height distinction.

The shifts indicate something general about the development of vowel systems, which is mirrored in the primitives and punctuators of particle phonology. First is the correspondence of tenseness and length. Typically two results are possible with the loss of length. Either the tonality particle decays as in STAGE II (i i>i), implying the loss of length and tenseness. Otherwise the bimoric vowel monophthongizes, in particle notation the space punctuator is lost, accounting for the creation of a tense vowel (i i>ii). KP illustrates the first process.

The addition of sonority in the short vowels is a usual process. According to Donegan (1978) and Schane (1982 class lectures), [a] is the optimal vowel because of its sonority. There is a tendency for vowels with some degree of sonority, such as lax and mid vowels, to shift toward greater sonority. Therefore, it is not unlikely that some of the KP vowels would lower and create a more optimal vowel system.

Nor is it uncommon for lax vowels to be associated with vowels of the next lower height, through various phonological processes such as Open Syllable Lengthening of Middle English (Schane 1982). This basically supports the correspondence of lax vowels and lowering, and the fact that, in actuality, lowering may be considered a type of laxing. Ultimately in Kabul Persian the laxing process can be interpreted as one re-introducing a more optimal height distinction. In STAGE II the length alternation of MP is lost. That means that the KP system no longer contrasts between both quantity and quality, but now only has an opposition of quality, i.e. a distinction of height and tense/lax.[8]

What is atypical about the Kabul shifts is that they do not follow the tendency for mid vowels to become lax and lower first. This is contrary to Donegan's (1978:67) 'rich get richer' principle: "the vowel which is more susceptible to an increase of a given property is the one which already possesses that property to a higher degree." This is illustrated in Sardinian where Latin high vowels became tense: u,u — /u/, i,i -- /i/ however the mid vowels were laxed: o,o -- /O/, e,e -- /E/ (Donegan 1978:65).

This not problematic in a particle account. The theory is capable of recognizing the general tendency for laxing of short vowels in the languages discussed. In a particle analysis [I,U] and [e:,o:] differ only by an additional tonality particle in the long vowel: [I] = ai, [e:] = ai i, [U] = au, [o:] = au u. Using Donegan's principle, this means that [I] and [U] have as great a propensity to lower as [e:] and [o:]. Moreover, particle phonology considers the long mid vowels tense, and would not predict that they should become lax.

5.6. A comparison of Kurdish, Kabul Persian and Iranian Persian

An examination of Kurdish, Kabul Persian and Modern Iranian Persian shows both similarity and divergence. The first two languages are

similar because in them, non-low vowels did not merge. In NP, they did. Kabul and Iranian Persian are similar in that both lower MP lax [I,U], even though the modern reflex of the Middle Persian segments is different in the two languages. KP and Kd retained lax vowels in their inventory, whereas NP re-interpreted MP [I,U]. Additionally, KP and NP are alike because both lost vowel length whereas Kd retained the quantity contrast.

While it seems that the vowel system of Modern Iranian Persian is simpler than Kurdish and Kabul Persian, since NP has six vowels distinguished only by height, in some respects the development of NP has been more radical. NP lost the basic characteristics of Middle Persian, i.e. length and the tense-lax distinction. On the other hand, Kd and KP conserved all or fragments of the MP system, i.e. length remained in Kd, and the tense-lax contrast still remains in both KP and Kd.

6. Conclusion

I have systematized the vowel shifts within the history of Persian with the intent of motivating why the changes happened in the fashion they did. I have used historically attestable arguments as well as comparing other languages and employing theoretical reasons.

An examination of the generative analyses has shown several deficiencies. Some of the problems discussed were the misrepresentation of central vowels; the value and place of redundancy rules in a grammar; problems with the feature tense; and in several cases the inability to formally express phonological processes. However, with respects to this paper, one of the greatest inefficiencies is in the means to motivate a rule. Donegan's natural phonology and Schane's particle phonology are constructed to capture the universal properties of vowels. Particle notation takes a further step; by design, it mirrors the processes involved.

The Persian vowel shifts effectively exemplify how particle phonology incorporates universal tendencies of vowels. The theory aptly acknowledges how a five vowel system with alternating length converts into a six vowel system with a height distinction. That is, a series of qualitative changes precedes an ultimate quantitative change.

Another property of vowel shifts is the symmetry of change. Both palatal and labial vowels of the same height are similarly affected within each period of the shifts. For example, in Indo-Iranian both e and o merged; in Iranian both ai, a palatal diphthong, and au fused. In Kabul Persian both [I] and [U] were lowered, in Iranian Persian both [i:,e:] and [u:,o:] merged. Particle phonology is able to account for this symmetry in a simple and elegant fashion.

The overall evolution of the Persian vowel system is striking. Twice we saw mid vowels disappear--once in the merger of Indo-Iranian and once in the merger of Middle Persian. Twice we saw the mid vowels reappear--once in the monophthongization of Iranian and once in the lowering or re-interpretation of lax vowels now in Modern Persian. Herein we observe the continual movement of vowels and their inherent

property of change. The fact that a vowel system does not return to its initial state suggests that language change is neither mechanical nor absolute but rather a spiral, ever-developing behavior.

Footnotes

* I am grateful to Sanford Schane, Margaret Langdon, Sandra Chung, Michael Smith, Albert Bickford, and Chi-lin Shih for their helpful comments and criticisms on earlier drafts of this paper. Likewise, I thank my many Iranian and Kurdish friends and, in particular my patient husband, Ahmad Hashemipour, who read the data and shared their native intuitions and their knowledge of the history with me. All errors and omissions, of course, are my own.

1. The vowel symbols used are readily accepted by most Iranianists. I have chosen Crothers' (1978:140) representation of NP low vowels, where [ä] is a low slightly front vowel and where [a] is a low back slightly rounded vowel.

2. Allen (1953) cites that Skr a was phonetically a central vowel [ʌ] with an articulation slightly higher than Skr long a:. This finding may seem to simplify the generative analysis: now the merger only needs to centralize the vowels and not lower them as assumed in the text. Allen is quick to note that the pronunciation [ʌ] is an allophone of the phoneme /a/. In addition to the evidence presented by Allen (1953), we have no verifiable data to support the inclusion of [ʌ] in I-I. Most likely, this segment resulted from a later process within Sanskrit only. Other historical linguists who posit the merger as given herein are Burrow (1955), Wyatt (1970) and Mayrhofer (1972).

3. Some dialects of Kurdish have ü< MP ui, others have ö < MP ue. For convenience, I have included [ö] in the vowel inventory of (22).

4. With the establishment of lax /I/ and /U/ in MP, one might ask how and when did lax vowels enter into the Persian language. It is clear from the evidence given that they existed in MP. Earlier proof is scanty. Although it may be possible to hypothesize that /I/ and /U/ were also segments of OP, such an assumption cannot be solidly made. Therefore, it is reasonable to leave this question unanswered.

5. Sanford Schane has offered many suggestions for this analysis.

6. In Persian poetry where line length is determined by the number of syllables, certain segments are lengthened to produce the needed number of syllables. The lengthened vowels correspond to MP long vowels (personal data and Shaki 1957).

Modern Persian uses the Arabic alphabet which has symbols for the three vowels [i,u,a]. These signs are used to represent vowels which historically were long. The reflexes of MP short i, u, a are NP [e,o, ä], which are not written in the modern orthography. In this fashion Iranianists are able to trace the previous length of vowels.

7. Dari or Kabul Persian is the national language of Afghanistan. It is not be confused with a related but entirely different language, Pashto, spoken in the Pamir mountains of the same country. The two languages are genetically distinct: Pashto is considered to be an Eastern Iranian language while Kabul Persian is Western (Voegelin 1965).

8. Shin-ichiro Watanabe, personal communication.

References

Allen, W. Sidney. 1953. The phonetics of ancient India. London: Oxford University Press.

Barr, Kaj. 1936. Remarks on two Pahlavi ligatures. Bulletin of oriental studies 8.391-403.

Bedir Khan, Emir Djeladet and Roger Lescot. 1970. Grammaire kurd. Paris: Librairie d'Amérique et d'Orient.

Beeler, M.S. unpublished. Indo-European phonology: a syllabus. Berkeley: University of California.

Benveniste, Emile. 1929. Conservation de ê et ô en persan. Bulletin de la Société Linguistique de Paris 29.88:107-108.

Benveniste, Emile. 1970. Old Iranian. Current trends in linguistics 6:9-25.

Boyce, Mary. 1968. Old Iranian literature. Iranistik: Handbuch der orientalistik 2:1-31.

Burrow, Thomas. 1955. The Sanskrit language. London: Faber and Faber.

Chomsky, Noam and Morris Halle. 1968. The sound pattern of English. New York: Harper & Row.

Contreras, Heles. 1967. Simplicity, descriptive adequacy and binary features. Language 45.1:1-8.

Crothers, John. 1978. Vowels systems. Universals of human language, ed. by Joseph H. Greenburg. Stanford: Stanford University Press.

Darmesteter, James. 1883. Études iraniennes. vol. 1-2. Paris: University of Paris.

Diakonoff, I.M. 1970. The origin of the 'Old Persian' writing system and the ancient Oriental epigraphic and annalistic traditions. W.B. Henning Memorial Volume. ed. by Mary Boyce and Ilya Gershevitch. 98-124.

Donegan, Patricia Jane. 1978. On the natural phonology of vowels. Working papers in linguistics 23. Columbus: Ohio State University.

Dresden, Mark J. 1970. Middle Iranian. Current trends in linguistics 6.26-63.

Elfenbein, J.H. 1966. The Baluchi language: a dialectology with texts. London: The Royal Asiatic Society of Great Britain and Ireland.

Gershevitch, Ilya. 1968. Old Iranian literature. Iranistik: Handbuch der orientalistik 2.1-31.

Henderson, Michael M.T. 1975. Diglossia in Kabul Persian phonology. American Oriental Society Journal 95.651-654.

Kenstowicz, Michael and Charles Kisseberth. 1979. Generative phonology: description and theory. New York: Academic Press.

Kent, Roland. 1939. Old Persian: grammar, texts, lexicon. New Haven, Conn.: American Oriental Society.

Lazard, Gilbert. 1963. La langue des plus anciens monuments de la

prose persane. Paris: Libraire C. Klincksieck.
Lazard, Gilbert. 1970. Persian and Tajik. Current trends in linguistics 6.64-96.
Lazard, Gilbert. 1971. Pahlavi, Pârsi, Dari: les langues de l'Iran d'après Ibn al-Muqaffa'. Iran and Islam. ed. by C.E. Bosworth. Edinburgh: Edinburgh University Press.
Lehmann, Winfred Philip. 1955. Proto-Indo-European phonology. Austin: University of Texas Press and Linguistic Society of America.
MacKenzie, D.N. 1961. Kurdish Dialect Studies, vol 1. London: Oxford University Press.
MacKenzie, D.N. 1969. Iranian languages. Current trends in linguistics 5.450-477.
MacKenzie, D.N. 1971. A concise Pahlavi dictionary. London: Oxford University Press.
Mansouri, Mehdi. unpublished. Spatial characteristics of population in Iran-growth, distribution and density. PhD dissertation. Stillwater: Oklahoma State University.
Mayrhofer, Manfred. 1972. A Sanskrit grammar. ed. by Gordon B. Ford. University, Ala.: University of Alabama Press.
Meillet, Antoine. 1964. Introduction à l'etude comparative des langues indo-europeennes. University, Ala.: University of Alabama Press.
Nyeberg, Henrik Samuel. 1964. A manual of Pahlavi, vol. 1. Wiesbaden: Otto Harrassowitz.
Redard, Georges. 1970. Other Iranian languages. Current trends in linguistics 6.97-135.
Schane, Sanford A. 1982. Two English vowel movements: a particle analysis. Linguistic notes from La Jolla 11.48-67.
Shaki, Mansour. 1957. The problem of the vowel phonemes in the Persian language. Archiv Orientalni 25.45-55.
Stanley, Richard. 1967. Redundancy rules in phonology. Language 43.2.393-436.
Tolman, Herbert Cushing. 1910. Cuneiform Supplement. Nashville: Vanderbilt University.
Voegelin, C.F. and F.M. 1965. Languages of the world: Indo-European fascicle one. Anthropological Linguistics 7.2:190-218.
Windfuhr, Gernot L. 1971. Diacritic and distinctive features in Avestan. Journal of the American Oriental Society. 110-113.
Wyatt, William F. 1970. Indo-European /a/. Philadelphia: University of Pennsylvania.