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Phonemic segmentation as epiphenomenon

Evidence from the history of alphabetic writing*

Alice Faber
Haskins Laboratories

"we must not be misled in our ontology by the possibilities provided by our metalanguage". (Anderson 1985: 9)

1. Preliminary remarks

There is by now a large and convincing body of evidence that linguistic units representing acoustic or articulatory steady states need not be included as primitives in linguistic representations of phonological structure. Alternatives to such segments[1] being pursued in current phonological work include both larger units that in traditional analysis might be treated as more than one segment and single features that might be part of the representation of one or more segments in a word. Similarly, investigations of language use suggest that many speakers do not divide words into phonological segments unless they have received explicit instruction in such segmentation comparable to that involved in teaching an alphabetic writing system. Nevertheless, alphabetic writing, writing whose symbols represent individual segments, exists, and is learnable.

Paradoxically, then, alphabetic writing is based on a phonological unit that is arguably not a natural unit (see also Studdert-Kennedy 1987: 68). How is this paradox to be resolved? To the extent that the paradox has been recognized, the segmental nature of alphabetic writing has been taken as paramount: Alphabetic writing could not have evolved if the segmentation on which it is based were not natural, and, therefore, the existence of

alphabetic writing is itself evidence for the naturalness of phonological segmentation (Saussure 1959: 39; Öhman 1979: xviii; Studdert-Kennedy 1987: 68).

In the absence of a convincing explanation for the innovation of alphabetic writing that does not rely on the prior existence of segmentation ability in the human repertoire, explanations of this nature, however dissatisfying, cannot be rejected.[2] My purpose in this paper is to provide just such an alternative. After a brief review of some of the evidence regarding segments and segmentation ability, I will provide a detailed exposition of how the Greek alphabet might have developed. On the basis of this scenario, I will suggest that segmentation ability, rather than being a necessary precursor to the innovation of alphabetic writing, was a consequence of that innovation.

2. The status of phonemic segmentation

As already noted, most twentieth century approaches to phonological analysis rely on the idealization that the speech stream is divided into discrete segments, each representing an acoustic or articulatory steady state. Nevertheless, as is well known, there is no physical basis for this segmentation.[3] As a consequence, there is a long and often under-appreciated tradition of alternative approaches to phenomena not easily amenable to segmental analysis, most notably of phenomena not easily localized within a word (e.g., Harris 1944; Firth 1957; Palmer 1970).

Within "mainstream" theoretical phonology in the decade following the publication of Chomsky and Halle (1968) (SPE), one of the major innovations was the integration of the syllable into linguistic models. This integration was prompted by the more elegant and perspicuous treatment of stress in the newer models (Liberman & Prince 1977; McCarthy 1979; Hayes 1980) as well as by the range of apparently segmental phenomena conditioned by syllable position (Hooper 1972; Kahn 1976).[4] At least some of these alternatives refer also to constituents of the syllable (e.g., Halle and Vergnaud 1980: 93; Selkirk 1982; cf. Clements and Keyser 1983 and Hooper 1972):[5] the vocalic *nucleus*, the pre-nucleus consonantal *onset*, and the post-nucleus *coda*. The nucleus and the coda are generally grouped together as the *rhyme*. Just how these hierarchically arranged units should be related to previously hypothesized units like segments is not explicitly

discussed. Rather, it is assumed that syllable constituents dominate segmental nodes, so that a hierarchical syllable display can be unambiguously related to a distinctive feature matrix of the customary sort (Clements and Keyser 1983: 25), a column on such a matrix corresponding to a phonemic segment.

Given the demonstrable relevance of syllable components in phonological structure, maintenance of segments in syllable-based analyses is surprising. The rich inventory of English syllable types gives rise to a tacit feeling that the inventory of phonological primitives would be prohibitively large. To my knowledge, only Fujimura and Lovins (1978) have proposed an analysis based on demisyllables (approximately, onsets and rhymes) and extra-metrical consonantal affixes. As Fujimura (1980: 122) notes, the memory burdens imposed by an inventory containing c. 1000 elements would not be excessive; Browman's (1980) demi-syllable-based speech synthesis program requires c. 850 demi-syllables and affixes. This increased inventory size (relative to traditional analyses) is compensated for by a greatly decreased need for contextually conditioned phonological rules; Browman's model, for example, requires 20 rules.

One of the major European contributions to phonological theory has been an emphasis on the paradigmatic relationships among the segments of a language. Thus, for Trubetzkoy (1939), a phoneme is defined by its contrasts with other phonemes. From here it is a short step to the distinctive features introduced by Jakobson, Fant and Halle (1952), a formalization of the dimensions along which segments can differ or be similar. While the Jakobsonian distinctive features were based almost exclusively on acoustic properties of segments, virtually all current feature-based models rely on articulatory features.

In SPE, distinctive feature matrices were simply a two-dimensional array of rows representing features and columns representing segments. All of the specifications for one segment preceded any of the specifications for the next. This two-dimensional array has evolved in descendants of SPE, so that the rows are spread out in three dimensions (Clements 1985; Schein and Steriade 1986; Sagey 1986). And, given underspecification of feature values (Archangeli 1985), the notion of a column representing an individual segment is greatly obscured; individual feature specifications may, in underlying representation, precede other feature specifications, but, without the root node (Sagey 1986: 40–44, 275), to which all specifications for a particular segment are linked, it would be impossible to make precedence statements about segments independent of their featural constituents.

Statements about the syntagmatic relationships among individual features, independent of their putative segmental affiliation, are an integral part of the model of articulatory phonology being developed by Browman and Goldstein (1986, 1987, 1991). In this model, the primitives are articulatory gestures, represented on a gestural score, a two-dimensional matrix. In contrast to the [±F] values of more traditional distinctive feature models, gestures are either present or absent, and, as already noted, the temporal relationships among gestures on the same score are not constrained, but must be specified on a language specific, or even a style specific, basis.

The approaches just sketched, converging on phonological representations in which segments *per se* play little, if any, role, also allow for more perspicuous treatment of a class of sounds that has been chronically insusceptible of principled treatment in segment-based models — diphthongs, affricates, and prenasalized consonants. These are sounds that, by their very nature, cannot be conceived of as single steady states. As a result of their inherently dynamic nature, their existence has given rise to long and, for the most part, fruitless discussions about whether each is best treated as "one segment or two", as a complex unit or a simple cluster.[6]

To summarize, there is little unambiguous structural support for positing segments as linguistic units. In particular, there is no need to appeal to segments in modeling ordinary language structure and use. Neither is there evidence that incorporation of segments into linguistic models leads to more satisfying or parsimonious analyses. In contrast, structural linguistic evidence suggests that models based on syllables and syllable components (either onset-rhyme or onset-nucleus-coda) might be more appropriate. However, there are spheres, notably reading, in which language users clearly do display an ability to recognize and manipulate segments.

The English alphabetic writing system encodes, albeit not always systematically, the segmental phonemic structure of English. While skilled readers may not always make direct use of the phonological coding inherent in an orthographic form, they clearly can do so in the case of rare or unknown words. Studies of the development of reading suggest that at least a minimal awareness of segmentation is necessary for English speaking children to learn to read (Mattingly 1972: 44). Small children tend to be much more proficient at syllable counting tasks than at phoneme (segment) counting tasks, while literate older children and adults can do both (Liberman and Shankweiler 1987: 207).

Given a correlation between segmental awareness and literacy (in a segment-based alphabet), the question arises whether segmentation ability, arising spontaneously as part of cognitive maturation, is an indication of reading readiness, or whether segmentation ability arises as a consequence of specific teaching. Liberman and Shankweiler (1987: 210) refer specifically to reading instruction, but widely available alphabet-related toys and books could easily contribute to incipient segmental awareness on the part of pre-school children. Nevertheless, children who are aware of the alphabet but who cannot yet read may interpret alphabetic symbols differently than do proficient readers. Read (1986: 51, 105) refers to two relevant types of studies. In one, conducted in Argentina, preliterate children interpreted each letter as representing a syllable. In another pair of studies, conducted in the United States, some beginning spellers were found to write consonants only, omitting the vowels.

Further relevant findings concern adult populations. Morais et al. (1986) studied adult illiterates and students in adult literacy classes in Portugal. Recently literate adults outperformed illiterates on tasks involving phonemic segmentation, but not on comparable tasks involving non-linguistic segmentation (i.e., of notes in a melody). Similarly, Read et al. (1986) compared two groups of literate Chinese, those who had never been exposed to the *pinyin* Romanization, and those who had, even if they were no longer proficient in it. The *pinyin* group outperformed the non-*pinyin* group in tasks involving segment addition or deletion. Likewise, Mann (1986) found that Japanese elementary school children are less proficient than their American counterparts at performing segment-related tasks.[7] One basic conclusion can be drawn from these studies: segmental awareness is a result not of cognitive maturation but of exposure to a segment-based orthography; literacy itself is not sufficient.

Reading is clearly a metalinguistic ability. There are languages for which there exists neither a standard orthography nor a written literary tradition. Even some languages with long literary traditions (e.g., Amharic) have large numbers of illiterate speakers. Furthermore, the whole question of "functional" literacy suggests that there exist within literate populations substantial differences in reading proficiency. Thus reading competence cannot be equated with language competence in general. If segmentation ability results primarily (if not only) from exposure to segmental orthography, it too must be treated as a metalinguistic ability, and thus it cannot be ascribed to general linguistic competence.[8]

Language games have been observed in many cultures, and have often been seen as sources of evidence regarding linguistic structure. Language games generally involve systematic insertion of extraneous linguistic material and/or permutation of structural linguistic units. Some games are best defined on syllable components, while others are best defined on segments; in games defined on syllable units, initial clusters like *sp-* would act as a unit, while in games defined on segments, *s* and *p* could act independently. Bagemihl (1987), in an extensive survey of documented language games, reports that games based on syllables are far more common than games based on segments; the latter naturally presuppose segmental awareness on the part of their speakers. He further notes (1987: 36) that segment-based games are attested only in languages with alphabetic writing systems, suggesting that segmental awareness here too is dependent on exposure to alphabetic writing.

3. Alphabetic writing

The evidence just summarized suggests that, despite their intuitive appeal and longevity, segment-based analyses might not be optimally suited to represent language as a cognitive system. A careful examination of the complex relationship between orthographic and linguistic units is thus in order. This examination will proceed in two stages. First, I will motivate a typology of writing systems. Then, on the basis of this typology, I will discuss the extent to which the development of orthographic systems bears on the question of phonemic segmentation, and just what that bearing is. My goal is, in particular, to trace the development of alphabetic writing, since it is the existence of alphabetic writing that is used (implicitly or explicitly) as evidence for the universality of segments as a building block of language. My discussion is informed by the view expressed by O'Connor (1983: 441) that the structure of an orthography for a particular language reflects, albeit not always systematically, native speaker analysis of that language. A script created for a language *ex nihilo* will reflect both the level of appropriate units and the inventory of units at that level. In contrast, a borrowed script may inherit the level of units, but still reflect in some measure the inventory of the borrowing language.

3.1 *Typology of writing systems*

An *orthography* can be defined as a system of markings which can unambiguously cue a trained native speaker to produce acceptable utterances in that language (Faber 1990:620). Similar definitions are offered by Sampson (1985: 19) ("a given set of written marks together with a particular set of conventions for their use") and Daniels (1986: 1) ("the sets of marks by which utterances are notated so as to be precisely reproducible in the absence of the notator or the notator's instructions"). These definitions agree in referring to the arbitrary yet non-idiosyncratic nature of the signs and to the training involved in their interpretation, as well as in not restricting the linguistic level of the units. My definition further excludes notational systems that can be interpreted in arbitrarily many ways by speakers of the same language (or, for that matter, of different languages). Thus, the set of "iconic" international road signs does not represent an orthography, despite the relatively arbitrary nature of the symbols and their supposedly unambiguous semantics.

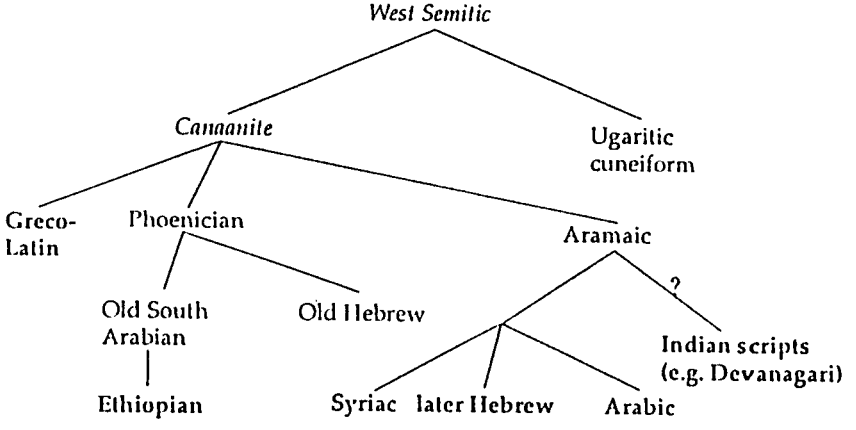

Figure 1. (Simplified) depiction of relationship among Semitic orthographies. Legend: italic-hypothesized, unattested scripts; plain-scripts representing primarily (or only) consonants; bold-scripts representing consonants and vowels.

3.1.1 *Terminology*

Definition of orthography provides a useful point of departure for discussion of orthographic systems. But it is not enough. Before attested orthographies can be classified in any meaningful typology, it is necessary to define both the dimensions along which they can differ and the resultant categories. Not to do so invites confusion. The debate over whether the 2nd. and 1st. millennium BC West Semitic scripts — Canaanite, Ugaritic, Phoenician, Aramaic, Old South Arabian, in plain type in Fig. 1,[9] but not their vocalized descendants, in bold type — are syllabaries (Gelb 1963; Swiggers 1983, 1984), alphabets (Naveh 1982; Daniels 1986), or neither (as I will argue shortly) hinges not on differing conceptions of the West Semitic scripts but rather on differing definitions of alphabet and syllabary. Except where noted, the following definitions are based on Sampson (1985: 32ff).

Logographic vs. Phonographic. Orthographies differ in whether the bulk of the symbols in the system, taken in isolation, are susceptible of semantic interpretation. The English symbol <d> has no inherent meaning, while the symbol <+> does. Systems in which symbols like the former predominate are *phonographic* while systems in which symbols like the latter predominate are *logographic*. Logographic systems code for the most part morphemes, as Sampson notes, and phonographic systems code units of sound.

Complete vs. Defective. An additional dimension along which orthographies vary is the extent to which they aspire to code all units of the relevant level. *Complete* orthographies code all (or virtually all) relevant units, while *defective* or *incomplete* orthographies omit some. Orthographies can fail to be complete in two distinct ways. The primary way in which orthographies can be defective is that certain units may simply not be represented. This sort of omission is the basis for the popular misstatement that Hebrew at one time didn't have any vowels. The earliest Hebrew script, like the other West Semitic scripts already referred to, did not contain any symbols for vowel sounds, even though the language had a typologically normal inventory of vowels. Another way in which orthographies may be incomplete (one which will not be discussed further here) is that one or more phonemic contrasts may not be represented, the same symbol being used indifferently to represent two or more phonologically distinct units. Thus, the English digraph <th> is used for both voiced and voiceless interdental fricatives. In addition, it is fairly common for orthographies that are otherwise fairly complete not to indicate quantity and tonal contrasts, even in languages in which such contrasts bear a heavy functional load. As Sampson notes (p. 36), no orthography is ever truly complete. Most orthographies notate few or no non-contrastive features; indeed special purpose orthographies that do aspire to this level of completeness (e.g., narrow phonetic transcription) are notoriously difficult even for trained individuals to read fluently.

Syllabic vs. Segmental. Phonographic scripts differ with regard to the linguistic level that they code. Thus symbols in syllabic orthographies code syllables, and symbols in segmental orthographies code segments.[10] It is, I believe, plausible to claim that the syllable is a relevant linguistic unit for users of a syllabic orthography. But the parallel claim regarding segmental orthographies is less plausible. Certainly, users of a complete segmental orthography must, at some level, be aware of those units represented by its symbols. But, as noted in the previous section, some orthographies are systematically incomplete. And it does not follow that users of such defective orthographies are aware of units or contrasts that are not reflected in their orthography. In fact, the approprate implication may well be in the reverse direction; the failure of the early Semitic segmental orthographies to code vowels may indicate that users of these orthographies did not segment syllables like /ba/ into their constituent parts, despite their awareness of the similarity among /ba/, /bu/, /bi/, and even perhaps /tab/. Awareness of this similarity, while *prerequisite* to segmentation, does not, as noted above, imply exhuastive segmentation of the speech stream (cf. Mattingly 1987; Daniels, this volume). Rather, the vowel segments not coded in these orthographies constitute the background for the consonantal segments, which are coded.[11]

The question is not, and *cannot* be, whether users of early Semitic consonantal orthographies had the ability to recognize and manipulate the phonemic segments of their language. It is, rather, which abilities can be imputed to users of these scripts on the basis of the structure of the scripts. Segmentation ability presupposes an awareness not only of the similarity among /ba/, /bi/, and /tab/, but also of the similarity among /ba/, /ta/, and /ʔal/. It further implies localization of these similarities in the segments /b/ and /a/, respectively. Evidence that users of an orthography had one of these abilities (in this case, the first), does not speak to whether they had either (or both) of the other two; they may have, or they may not.

Linear vs. Non-linear. Orthographies also differ in regard to linearity. In a *linear* orthography, the order of the symbols, either horizontally or vertically, iconically mirrors the order of the sounds that they represent. Thus,

in "phonetic languages" like Spanish, the letters in sequence reflect the sequence of sounds. In contrast, English orthography is not as linear. The contrast in the medial vowels of *cop* /kap/ and *cope* /kop/ is orthographically conveyed by the presence of final *–e* in the latter, so the vowel /o/ is represented by the discontinuous sequence of letters *o–e*. In more systematically non-linear scripts like Egyptian hieroglyphics or Korean Han-gul (Sampson 1985: 131), the placement of symbols may be governed by aesthetic rather than by linguistic principles. Other major non-linear scripts include two segmental scripts that are commonly and erroneously treated as syllabaries: Indian Devanagari (and allied South Asian scripts) and the Ethiopian script. While the organizational pattern of both is more or less syllabic, as Sampson (1985: 66) notes, the individual graphs clearly encode segmental information. However, as shown in Fig. 2,[12] the placement of the graphic modifications for vowel content in the Ethiopian script, represented here by Amharic, is such that a CV syllable may, depending on the vowel, be modified on either the left side or the right side of the symbol.[13]

Even those who recognize the linearity factor assume that the linearity of a phonographic script is less significant than the linguistic level encoded in its symbols. That is, the set of syllabic scripts *and* the set of segmental scripts can both be divided into linear and non-linear subsets. I would now like to propose an alternative view. In that view, linearity is hierarchically

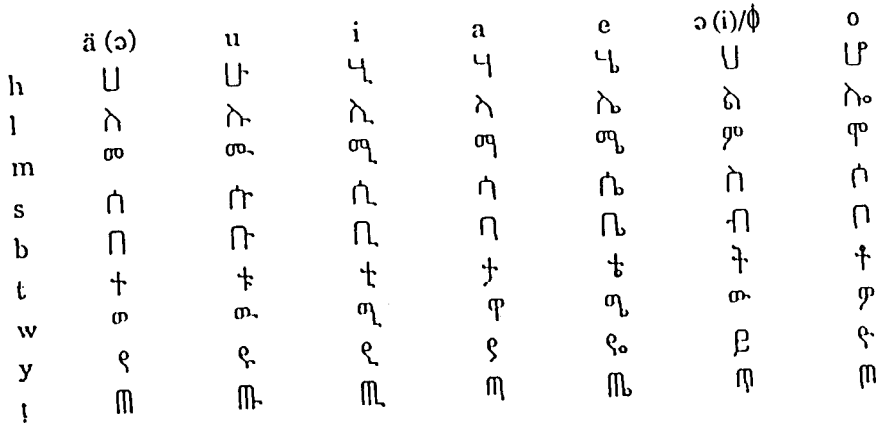

Figure 2. A subset of the Amharic orthography. Amharic, a Semitic language, is the national language of Ethiopia.

Figure 3. The segmentally coded, syllabically linear nature of the Ethiopian script, illustrated with the Amharic word LEBA 'thief'.

superordinate to the syllabic/segmental dimension. Furthermore, the linguistic level at which a script can be seen as linear is logically distinct from the linguistic level of the units that it encodes. Thus, the Ethiopian script encodes segments but is syllabically linear, while European scripts encode segments and are segmentally linear.

This property of the Ethiopian scripts is illustrated in Fig. 3 with the Amharic word /leba/ 'thief'. Note the non-linear mapping of graphs to segments, contrasted with the linear mapping of graphs to syllables. Of course, any segmentally linear script will necessarily be syllabically linear, while the reverse is not true.[14]

Alphabet. An *alphabet* can be defined as a script that is (relatively) complete and, in its ideal case, segmentally linear. By this definition, the early Semitic scripts, which encode for the most part consonants, are not alphabets; since they do not encode vowels, they are systematically incomplete. Likewise, the later Semitic systems that, like Arabic, do encode some vowels, are not, strictly speaking, alphabets, since they are syllabically rather than segmentally linear.[15] The diacritic markings that indicate vowel quality in Arabic, Hebrew, and Syriac may occur above, below, within or after (to the left of) the symbol for the preceding consonant sound.[16] I am, in effect, giving special definitional status to just those orthographies whose existence has been taken to reflect the innate naturalness of phonemic segmentation. The orthographies that I define as alphabets turn out to be those that have equally salient symbols for vowels and consonants. An English speaker unfamiliar with Russian will have no *a priori* intuitions about whether a particular Russian symbol represents a vowel or a consonant. One might say, then, that an alphabet is a script which treats vowels and consonants equally and that, in order to do so, a script must paradoxically recognize vowels and consonants both as separate and equal.[17]

In contrast, Daniels' (1986: 8) definition of an alphabet as a system in which "each character conveys information about just one segment"[18] implies that the primary subdivision of segmental scripts should be based not on properties of the sound-to-symbol mapping but rather on the visual autonomy of the symbols participating in it. Naveh's (1982: 11) functional definition of an alphabet as an orthography containing a limited number of symbols (20-30) that can be arranged in a fixed citation order (A B C D ...), which, like Daniels', includes the West Semitic scripts, is, I believe, inappropriate, in that it makes explicit reference to metalinguistic, perhaps pedagogical, facts rather than to the structure of the sound-symbol mapping. It should be noted that my disagreement with Daniels and Naveh concerns *only* whether the term "alphabet" should be restricted to complete, segmentally linear orthographies. I share Daniels' view that the Greek development of a complete, segmentally linear orthography, by whatever name, is not to be causally linked to the development of Greek, and hence Western, civilization. And, I most emphatically would not follow Gelb and, perhaps, Swiggers in treating those segmentally linear Semitic scripts that do not encode vowels as syllabaries. It is not an "either-or" question. The dimensions phonographic/logographic, syllabically/segmentally linear, complete/defective, and syllabically/segmentally encoded define five categories of phonographic orthographies, as illustrated in Fig. 4.

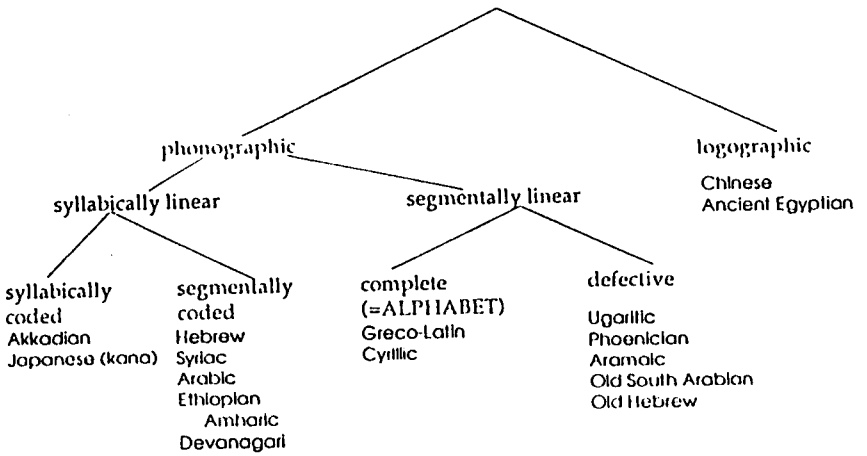

Figure 4. Some representative orthographies arranged according to the types defined in the text.

My focus on which of these categories contain orthographies that it is appropriate to label "alphabet" has no bearing on how orthographies in the other categories should be labeled.[19] Interestingly, Sampson (1985) offers no definition of alphabet, but uses the term at various points to refer to the Northwest Semitic scripts. In any case, the set of alphabets is clearly a subset of the set of segmental orthographies.

3.1.2 *Distribution of writing systems*

If the distribution of orthographic types is charted based on the number of users, alphabetic writing systems are by no means the most widespread. While alphabets are used by about a billion literate individuals,[20] worldwide, a comparable number use either logographic writing (Chinese) or syllabically linear systems, used in Northeast Africa (Ethiopian syllabary), Southern Asia (Devanagari and allied systems), and Japan. If the Arabic-based scripts (used for Farsi, Urdu, Pashto, Malay, etc., in addition to Arabic) which, as already noted, are syllabically linear when vocalized even though they encode segments, are included, the distribution of syllabically linear scripts is even greater. Thus, (*pace* Lotz 1972: 119) syllabically linear scripts (which he refers to as syllabaries) are not typologically marginal; both the Japanese true syllabary and the syllabically linear segmental scripts mentioned above have been quite stable for 1500 years and more.

The Greco-Latin scripts, including Cyrillic, while geopolitically of great importance, are more circumscribed demographically. And most of their expansion has occurred in the past 500 years. In the more distant past, the relative importance of syllabically linear scripts was much greater. The further back one goes in the history of writing, the greater the demographic preponderance of non-linear and syllabically linear scripts: Sumero-Akkadian cuneiform, and Linear B, used for Mycenean Greek,[21] were syllabically linear and incomplete; Egyptian hieroglyphic writing was, as already noted, non-linear.

Given the five-thousand year long, incompletely documented history of writing it is tempting, and, perhaps, natural to see, as does Gelb, a developmental, culturally maturational trend toward segmentally linear scripts — that is, toward alphabets as defined earlier. However, such a view would be inappropriate, not to mention ethnocentric. All known complete, segmentally coded orthographies (see Fig. 4) arose from the early West Semitic segmentally linear incomplete scripts (Sampson 1985: 77). All of these complete descendants maintained linearity — the Greco-Latin scripts

on a segmental level, and the vocalized Semitic scripts and the Ethiopian and Devanagari scripts (if Devanagari is, in fact, to be traced to West Semitic origins) on a syllabic level. Furthermore, the West Semitic segmentally linear incomplete script is the only known representative of its type. In order to attribute the innovation of either a segmentally linear script or of an alphabet to cultural maturation, we would need evidence of a recurrent pattern. While such evidence is not *in principle* impossible, it is, possibly as a result of an accident of human history, the case that each of these innovations is unique. It is thus *in practice* impossible to determine whether either innovation was a sign of cultural progress or merely the product of the special circumstances in which it took place. To the extent that explanations for these innovations can be based on the specific circumstances in which they took place, it is unnecessary, unparsimonious, and even imprudent to hypothesize more abstract, putatively causal principles.

3.2 *The Greek adaptation of the Canaanite system*

If it is only use of an alphabet that bespeaks awareness of phonemic segmentation, then it is worth examining the early development of the only alphabet ever known to have arisen spontaneously in human history, the Greek alphabet. The Classical Greek orthography of c. 400 BC, illustrated in Fig. 5, has seventeen symbols for consonants and seven for vowels. Several phonemic contrasts (/ŋ/ vs. /g/,[22] /a/ vs. /ā/, /i/ vs. /ī/, /ü/ vs. /ū/) are not directly represented, but, aside from these marginal 'defects', comparable to those observed in later adaptations of the orthography, the Greek alphabet departs from the ideal of a complete, segmentally linear orthography in two respects: (1) the rough and smooth breathing marks, post-classical innovations which denote /h/ and /ʔ/ onsets to an initial vowel, are written as diacritics *over* the letter representing the vowel: ἁ, ἁ. And, (2) there are symbols for two clusters /ks/ and /ps/, which, as Sampson (1985: 103) notes, following Allen (1974: 57), are the only two clusters to occur in coda position in ancient Greek.[23] The letters Ξ *ksi* and Ψ *psi* are used, however, even when the clusters are split by a morpheme boundary. The orthography of the earliest Greek inscriptions, which date from the eighth century BC, while archaic in some respects, is typologically comparable to that of later Greek, that is to say, alphabetic.

		Greek	Canaanite
A.	a/ʔ	A	𐤀
	b	B	𐤁
	g	Γ	𐤂
	d	Δ	𐤃
	e/h	E	𐤄
	w	(F)	𐤅 (𐤆)
	z	Z	𐤆
	h(ē)	H	𐤇
	tʰ	Θ	𐤈
	i/y	I	𐤉
	k	K	𐤊
	l	Λ	𐤋
	m	M	𐤌
	n	N	𐤍
	ks/ts	Ξ	𐤎
	o/ʕ	O	𐤏
	p	Π	𐤐
	s	(Ϻ)	𐤑
	q	(Ϙ)	𐤒
	r	P	𐤓
	s	Σ	𐤔
	t	T	𐤕
B.	u	Y	(𐤖)
	pʰ	Φ	Φ*
	kʰ/ks	X	Ψ*
	ps/kʰ	Ψ	Ψ*
C.	ō	Ω	
	#ha	ἁ	
	#ʔa	ἁ	

Figure 5. The Greek alphabet with its Canaanite precursor, represented by an Old Aramaic script. Parenthesized Greek letters are found in archaic materials only, and are not preserved in Classical Greek. Parenthesized Canaanite symbols represent deviations from the Semitic citation order. Group A includes Greek letters adopted directly from a Canaanite source and mirroring the source citation order. Where two values for these letters are given, the first one represents the Greek value and the second the Semitic value. Group B contains letters based on Semitic prototypes that were added to the end of the Greek alphabet. The alternate values represent variation in early Greek orthographic traditions. The starred source symbols are potential South Arabian symbols for Greek letters which have no obvious Canaanite prototype. Group C represents indigenous Greek developments.

The accepted wisdom, in, e.g., Jeffery (1961), is that the Greeks adopted the Phoenician alphabet in the eighth century BC, shortly before the oldest attested inscriptions. However, in light of the vast increase in recent years in the size of the Greek and Phoenician inscriptional corpora (as summarized in, e.g., McCarter 1975), as well as increased sophistication in dating inscriptions in all relevant languages, the situation is less clear.

Isserlin (1983) notes a lack of scholarly consensus regarding the time of the borrowing (eighth century BC, as argued by Jeffery, or eleventh century BC, as suggested by Naveh (1972)), the geographical context of the borrowing (Aegean, Levant, or Asia Minor), and the orthographic source of the Greek alphabet (Phoenician, Aramaic, or (unattested) Canaanite; Kaufman 1987). As all of these potential sources were typologically comparable in all relevant respects, I will, for present purposes, refer only to Canaanite.

Any explanation for the development of the Greek orthography must take into account that the development was essentially complete by the time of the earliest Greek inscriptions; there are no traces available either of Canaanite (Phoenician or Aramaic) representation of vowels comparable to that attested in Greek[24] or of Greek material in which vowels are not represented. Furthermore, all of the symbols which represent Greek vowels (with the trivial exception of the late Ω) are derived from Canaanite letters for sounds that were, at best, marginal in Greek: /ʔ h ʕ y w/. While it is, indeed, possible that these symbols were deemed superfluous by the importers of the Canaanite system, and thus used for sounds not represented by that system, it is not necessary to base an explanation for the structure of the Greek alphabet on the unattested existence of an unknown genius.

The names of the Greek letters *alpha*, *beta*, etc., meaningless in Greek, have clear sources in a Canaanite acrophonic tradition, whereby each sound is associated with an object whose name begins with that sound. This fixed order of a traditional, invariant list is comparable to modern radio alphabets like *able*, *baker*, *charlie*, etc. As Sampson (1985: 101) demonstrates, conclusively to my mind, transmission of the Canaanite script, using the acrophonic principle would have led to the *mis*interpretation of several Canaanite consonant symbols as representing vowels instead. The Canaanite words *ʔalpa* 'cow', *he* '?', *yoda* 'hand', and *ʕayna* 'eye', standing for 𐤀/ʔ/, 𐤄/h/, 𐤉/y/, and 𐤏; /ʕ/, would have been perceived by speakers of a language in which, as in Greek, these sounds did not occur, as beginning in [a], [e], [i], and [ɑ], respectively.[25] Thus, Phoenician [ʔalpa], with an initial [ʔ] became Greek [alpa], with no [ʔ]. Identification of [a] and [ɑ] with Greek /a/ and /o/ is plausible,[26] and the use of 𐤉 *yod* for /i/, not implausible from a phonetic point of view, may be related as well to the near absence of /y/ in Greek and to early Canaanite scribal practices like those observed for Ugaritic, in which <y> occasionally represented /i/. The form of Υ *upsilon* appears to be based on the archaic Canaanite 𐤅 *wau*,

whose place in the early Greek alphabetical order was filled by Ϝ *digamma*, the shape of which is in turn based on Canaanite 𐤉 *yod* (Allen 1974: 45).[27]

4. Implications

In this paper, I have demonstrated that it is necessary neither to impute to users of West Semitic consonantal scripts segmentation ability, as commonly understood in psycholinguistics research, nor to appeal to such ability to explain the Greek innovation of alphabetic writing. In fact, segmentation ability as a human skill may have been a direct result of (rather than an impetus to) the Greek development of alphabetic writing. Thus, the existence of alphabetic writing can not be taken *eo ipso* as evidence for the cognitive naturalness of the segmentation that it reflects. Given this conclusion, it is necessary to pose the question of why virtually all linguists have fallen prey to what Ladefoged (1984: 92) has, in a comparable context, referred to as a phonemic conspiracy. That is, we as linguists feel that, because we *can* describe linguistic systems in terms of phonemic segments, we *must* do so. That we are influenced in this practice by the structure of the alphabets that we use in our ordinary lives is obvious. As far as I know, every technical linguistic tradition that refers to segments arose in an alphabetic milieu or was influenced directly by such a tradition. There is no segmental analytic tradition not supported in this way by an orthographic tradition. In contrast, the indigenous Chinese linguistic tradition, described by Halliday (1981), has as phonological primitives syllable *initials* and *finals*, that is, onsets and rhymes. This analytical division is not supported by the logographic Chinese orthography, a lack which strengthens the force of the analysis.

Even though segment-based linguistic models are accurate in a wide range of cases, in particular in those in which syllable-constituent models reduce to segment models (e.g., CV syllables), the evidence that I have summarized in this paper suggests, however, that they are systematically limited in the extent to which they can model a wide range of linguistic data. These results lead to a challenge for future research, to develop and refine a rich set of non-segmental metaphors and notations, so that models based, like those sketched in Section 1 above, on different phonological primitives can be tested against a wide range of linguistic data, and revised appropriately.

NOTES

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1. I will use the neutral term segment in this paper to refer to an element representing a steady state, regardless of assumptions regarding its formal status (e.g., phoneme vs. allophone) in a linguistic model. By segmentation and segmentation ability I mean an exhaustive division of the speech stream into a sequence of segments; ability to recognize some segments does not imply segmentation ability in this, restricted, sense.

2. It has been argued on a utilitarian basis that incorporation of phonological segments in linguistic analyses is validated by the light shed by such analyses on complex phonological patterns (Halle 1964: 325; Anderson 1974: 6). But such arguments lose force in the absence of competing non-segmental analyses of comparable phenomena.

3. The segments identifiable in an acoustic waveform, to the extent that their boundaries are well-defined, are not isomorphic with the segments of phonological analysis or of alphabetic writing.

4. See the overview in Van der Hulst and Smith (1982).

5. See Fudge (1987) for an up-to-date review of evidence supporting a hierarchically structured syllable. Cf. Davis (1987).

6. For discussion of prenasalized consonants, see Anderson (1976), Browman and Goldstein (1986), and Herbert (1986). As Herbert notes, similar considerations apply also to affricates and diphthongs.

7. The older Japanese children could, in fact, perform some segment manipulation tasks, despite non-exposure to Romaji (Japanese written in the Western alphabet). As Mann notes, pedagogical use of a grid-like presentation of the *kana* syllable signs, in which signs for syllables containing the same vowel are listed in the same column, might provide a passive exposure to segmentation.

8. This is not to say that failure after appropriate instruction to acquire segmentation ability might not reflect an underlying deficit, as described by Liberman and Shankweiler (1987: 213).

9. A note on terminology is in order. Early Near Eastern textual material is available in four different segmental scripts: Phoenician, Aramaic, South Arabian, and Ugaritic. These represent texts in four distinct Semitic languages, but the historical relationships among the scripts (for which see Naveh 1982) do not mirror those among the languages. The Aramaic and Phoenician scripts diverged quite early (c. 1000 BC), so it is likely that they had a common ancestor, unfortunately unattested. The South Arabian script, used for inscriptions in now dead languages spoken on the Arabian peninsula, also developed from this common ancestor. The Ugaritic orthography, in contrast, is a segmental cuneiform. Its symbols do not resemble those of the other segmental orthographies, although its citation order was segmentally isomorphic with that of the Phoenician and Aramaic inventories. This suggests a still earlier orthographic tradition, which developed in two distinct ways. Strictly speaking, it is appropriate to use the term *Canaanite* for the script antecedent to the Aramaic and Phoenician scripts, and *West Semitic* for the segmental tradition antecedent both to these scripts and to the Ugaritic cuneiform, but this distinction is not maintained in the literature; Naveh (1982) consistently uses the term *West Semitic* where I would use *Canaanite*. In what follows, I will use the terms *Canaanite* and *West Semitic* for unattested segmental scripts isomorphic (*modulo* segment inventories) to the attested Phoenician, Aramaic, and South Arabian scripts.

10. Sampson treats the Korean Han-gul as an orthography that codes (distinctive) features; my omission of that category here reflects not disagreement with his analysis, but rather the irrelevance of this category for present purposes. It should be noted that analytic recognition of the featural basis of Han-gul does not imply a claim that Korean speakers make use of this sub-segmental information in decoding the script.

11. See Browman and Goldstein (1987: 11) for a discussion of the figure-ground metaphor as a structural representation for qualititative differences between consonant and vowel articulation within the model of articulatory phonology.

12. Non-English fonts in this paper are SuperGreek, SuperHebrew, Sabaean, Ethiopic, and Zakkur (based on a late ninth century BC Aramaic inscription), all copyright by Linguists' Software, and LaserPerfect Phonetique, copyright by Neoscribe International.

13. The non-linear nature of the Ethiopian script is masked by the subset of symbols presented by Sampson. In all cases, the symbols he shows have right-side vowel marking, preserving linearity. Modification for *-ə* and *-ā*, however, often shows left-side deviation from the neutral shapes. Note also that this modification may involve removal of material, as in ኧ <la>, or displacement of the graph, creating the illusion of left-side deletion, as in ጧ <t'a>. Sampson does not discuss Devanagari, but *conceptually* it is identical to the Ethiopian script; for details, see Whitney (1889: 9-14); cf. Mohanan's (1986: 195) description of the Malayalam orthography as "a syllabary that is 'phonemic'".

14. I have no information as to whether ambisyllabic consonants, consonants which constitute at one and the same time the coda of one syllable and the onset of the following one, occur in languages which are written syllabically.

15. But (*pace* Gelb 1962; Firth 1948: 126) they are not syllabaries either. See below for further discussion.

16. See Morag (1972) for the origins and structure of these diacritic vocalization systems.

17. While my definition of alphabet might not accord with popular, non-scientific usage (it is common to speak of the Hebrew or the Arabic alphabet), it is, I think, justified. Popular usage, it should be noted, does not provide any term but alphabet for the writing system of a literate culture, except, perhaps, for "picture writing" and "hieroglyphics" in reference to the Chinese and Egyptian systems.

18. Mohanan (1986: 197), in a very different theoretical context, offers a compatible definition of an unmarked writing system as one in which each orthographic distinction corresponds to exactly one phonemic distinction in the lexical alphabet; the lexical alphabet is the set of symbols in underlying phonological representation.

19. Labeling the West Semitic scripts syllabaries may involve a non-standard notion of syllable. If the orthographic form <qblt>, representing /qVbbVltV/, is interpreted as a sequence of four syllable signs, then <b> must be taken as representing /.bbV./ and <l> as /.l./, implying a counter-intuitive syllabification /qV.bbV.l.tV/. This is reminiscent of the articulatory syllable of Kozhevnikov and Chistovich (1966: 129ff), which takes as a production unit a vowel and all consonants intervening between it and the preceding vowel (or the beginning of the utterance), differing only in treating /l/ as a discrete syllable.

    Hayward and Hassan (1981) describe a curious syllabically linear orthography which was developed for Oromo (Galla), a Cushitic language of Ethiopia, in the 1950's by Shaikh Bakri Sakalo but which never replaced the Amharic-based orthography for that language. The Shaikh's system, unlike the general Ethiopian system, explicitly differentiates single from geminate consonants, writing *babba* <ba-bba>. Mohanan (1986) notes similar syllabifications by Malayalam speakers, both literate and nonliterate.

20. The relative usage of orthographic types was computed on the basis of population figures and literacy rates in the current *World Almanac*: for example, given the population of Myanmar (most recent estimate 38,000,000 people) and a reported literacy rate of 66%, 25,080,000 Burmese use a segmentally coded, syllabically linear orthography. The literacy rates in the *Almanac*, especially for developed countries, are suspiciously high; the United States, for example, is reported to have 99% literacy.

21. For a description of Linear B, a syllabic script representing Mycenean Greek (c. 1500 BC), see Chadwick (1967: 75ff). The typological properties of the related script, Linear A, cannot be ascertained, since it has not been determined what language it represents (Packard 1974; cf. Gordon 1982: 43ff).

22. See extensive discussion in Allen (1974: 33ff).

23. I ignore here Z *zeta*, an affricate /dz/ in early Greek (despite its later Classical value of /zd/ [Allen 1974: 55]). This letter preserves the affricate value of its Semitic source 𐤆 *zain*, a value argued for in Faber (1985, ms). Likewise, use of Semitic 𐤎 *samekh* for Greek Ξ /ks/ (*ksi*) reflects the original affricate value /ts/ of the Phoenician symbol; the directly attested value for cognate sounds in related languages is exclusively /s/, but there is indirect evidence, summarized in Faber (ms), for an earlier affricate value.

24. The earliest attested West Semitic representation of vowels (the Akkadian syllabically coded system of course allowed representation of vowel sounds, although not in isolation) is in eighth century BC Aramaic texts in which some final vowels and etymologically long vowels are represented ([u]-quality vowels by 𐤅 /w/, [i] quality vowels by 𐤉 /y/, and [a] quality vowels by 𐤀 /ʔ/ or 𐤄/h/). See Bange (1961) for particulars, but with a different interpretation.

25. Comparable reinterpretations are extremely common in lexical borrowings; borrowed words are regularly restructured in accord with the host phonological system. So, for example, initial *sC*- clusters in English loans into Shona, a Bantu language of Zimbabwe, are regularly nativized with /i/; *spoon* becomes *ɛipunu* (Chikanza 1986: 20).

26. The differing values for A *alpha* and O *o*(*micron*) in Greek may constitute previously unrecognized evidence for the backing effect of /ʕ/ on an adjacent low vowel in Canaanite; comparable effects are commonly observed in Levantine Arabic dialects, even though in some Maghrebi dialects /a/ tends toward /ɛ/ in such a context. It is unlikely that the value [ɑ] for *ʕayn* reflects the Phoenician change of *á to [ɔ] in stressed, originally open syllables, which Harris (1939: 61) places earlier than the Greek adoption of the Phoenician orthography (on the basis of the letter name *iota*); *a in the Canaanite letter name is in a historically closed syllable and thus would not have been subject to this change. Cohen (1982) suggests that the semantic equation of Canaanite *ʕayn* and Greek *opthalmos*, both 'eye', might have led to the Greek value for O.

27. The remaining three symbols in Fig. 5 B represent sounds not found (or at least not written) in Phoenician. While Naveh does not note this, Φ *phi*, Χ *khi*, and in their archaic forms (not those forms given in Fig. 5) show a striking resemblance to early South Arabian characters Φ and Ψ, conventionally interpreted as representing /w/ and /h/ (/v/ is a conceivable alternate reading of the former). Φ *phi* presumably represented /p^h/; Allen (1974: 21) notes that the "classical" value was clearly /p^h/, but also (p. 23) the possibility of a dialectal pronunciation as /f/ as early as the sixth century BC. Χ *khi* and Ψ *psi* (more similar in their archaic forms) represented /ks/ and /k^h/ in the Western scripts from which the Latin script descended and /k^h/ and /ps/ in the eastern and classical scripts. At least some of the interchange between <w> and <y> symbols in Canaanite, South Arabian, and Greek reflects the Proto-Canaanite shift of *w→y word initially; the only instances of word initial /w/ in Classical Hebrew and Phoenician are in the morpheme ɯ- 'and' and in the letter name *wau*, all other instances of initial *w having changed to /y/. Thus, Hebrew *yɛlɛð* 'child' is cognate to Arabic *wald*.

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