The Extension of Language Universals: Constraints on the Function of Axial Reflection in Writing Systems with Special Application to Linear B
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THE EXTENSION OF LANGUAGE UNIVERSALS: CONSTRAINTS ON THE FUNCTION OF AXIAL REFLECTION IN WRITING SYSTEMS WITH SPECIAL APPLICATION TO LINEAR B

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0. INTRODUCTION. If lexico-semantic language universals are in fact explainable in a direct and non-trivial way in terms of human perceptual structures and psychological processing strategies (E. and H. Clark 1978), then it would be expected that the typological dimensions and hierarchical relations among values on those dimensions that prove salient in the formulation of such universals should generalize in fairly straightforward ways to yield universals governing other areas of systematic human sign use. The present paper establishes two such extended universals governing the form and function of the signs of (non-pictographic) writing systems. Drawing on ethnographic, linguistic, and psychological research, the following two universals are theoretically predicted: (a) Sign forms that differ primarily only in being vertical axial reflections (VAR) of one another (e.g. ← versus →) will be functionally distinct in a writing system only if sign forms differing primarily in being horizontal axial reflections (HAR) of one another (e.g. ↑ versus ↓) are functionally distinct. (b) Sign forms that differ by HAR will be permissible, non-distinctive variants only if sign forms that differ by VAR exist as non-distinctive variants.

These two universals are established empirically on the basis of a sample consisting of the following writing systems: Albanian (Elbasan); Armenian; Arsakid, Sassanid, Book Pahlavi; Battak; Berber; Brāhmī; Buryat; Cambodian; Carian; Coptic; Cree; Cypriot; Cyrillic; Devanāgarī; English (lower case); Ethiopic; Older Futhark; Georgian; Glagolitic; Gothic; Greek (local alphabets ca. 500 BC); Iberian; Indonesian (Kavi); Japanese (Katakana); Kharoṣṭhī; Korean; Laotian; Lampong; Lepontic; Lycian; Lydian; Lithyanite; Maldive; Manachaean; Messapic; Mongolian (Galik); Manchurian; Nabataean; Numidian (horizontal and vertical); Nubian; Ogham; Old Persian; Old Turkic Runes (Orhon and Yenisey); Pāli; Punic, Ras Shamra; Redjang; Ṣafatene; Sidetic; Sinaitic; Sinhalese; Sogdian; Somali; South Arabic; Tamil; Thai; Thamudic; Tibetan; Tocharian; Turdetanian; Uigurian; and Venetic.

The research for this small paper is part of a larger typological and linguistic study of writing sys-

tems (Justeson 1977; Stephens and Justeson 1978; Justeson and Stephens 1979; Justeson and Stephens in press). As a self-contained work it was suggested by a problem of long standing in Mycenaean Greek philology. Since it provides an unambiguous solution, it was thought appropriate to follow a problem oriented exposition.

1. THE PROBLEM. Linear B, the syllabary employed for writing Mycenaean Greek of the second millenium BC, possessed two syllabograms *34 and *35 which are mirror images of one another, taking on, at Pylos, the forms  and  respectively. The phonetic values of these signs have never been convincingly determined. In fact it does not seem that traditional philological and combinatorial methods are sufficient to determine even whether *34 and *35 are simply formal variants of one and the same sign, i.e. whether they are allographs of a single grapheme.

Lang (1959) suggested a value $\underline{ru_2}$ for both *34 and *35. Palmer (1963) suggested a palatalized consonant corresponding to the r of $\underline{ru_2}$, and expressed the opinion that the palatalized r series shows a tendency to spell /l/. He noted that interpreting *34-ke-u of Ta as lunkeus or lukeus "offer(s) words in the same category as ai-ke-u 'goat (motif)'," which he considers appropriate to the decorative features of tripods listed in Ta 709 and Ta 641. However, on the basis of the following two comparisons

(1) *35-ki-no-o $\stackrel{?}{=}$ a_3-ki-no-o

as well as

(2) *34-ke-u $\stackrel{?}{=}$ a_3-ke-u

*34 and * 35 are usually identified as "homophones" of $\underline{a_3}$, i.e. ai. Comparison (2) is strengthened by the fact that each word appears in a context describing tripods, in fact in a formula that is identical except for word order:

ti-ri-po-de ai-ke-u ke-re-si-jo we-ke Ta 641
ti-ri-po ke-re-si-jo we-ke *34-ke- u Ta 709

Comparison (1) is less self evident: ai-ki-no-o occurs in a context clearly describing a chariot without wheels (Se 879); *35-ki-no-o, however, occurs on the obscure Vn 02 from Pylos, which apparently lists items having to do with building construction or carpentry.

The interpretation of *34 and *35 as equivalent to ai would seem to be subject immediately to one simple test. In syllabaries signs with canonical V value, as opposed to signs with canonical CV value, tend to word initial position. My own counts indicate that 7 of the 13 occurrences of *34 are word initial and 5 of the 8 occurrences of *35 are word initial. These figures, however, cannot be taken as evidence either for or agains value as a canonical V sign, since the word initial relative frequencies of the seven other known Linear B V signs range from 95.23% for *85 au, to 34.87% for i, and only 14.25% for u, with mean word initial frequency for all V signs of 59.12%

On the basis of comparison (3)

(3) *34-ke-ja $\stackrel{?}{=}$ *35-ke-ja

both in the context of proper names (Fn 187 and Eb 871 respectively), an argument might be made that *34 and *35 are merely variants of one and the same sign, whatever its phonetic value. This consideration is, however, not compelling in itself, inasmuch as it cannot be ruled out a priori that, like the other so-called "homophones" (on "homophones" see Lejeune 1966), *34 and *35 actually have some values not in common. If *34 and *35 are taken as "homophones" of ai, this line of reasoning would be less likely, since it would entail a three-way "homophony" apparently requiring genuine free variation between *34 and *35 or at least an extension of the regular hierarchy of value inclusion which governs the use of other "homophonous" syllabograms. This hierarchy constitutes a typical markedness structure whereby one of the two "homophonous" signs can represent both its par excellence value and the special value of the other sign, but this second sign can only represent its special value. Either of these situations would be unparalleled in Linear B and would seem anomalous given the spelling conventions relating to facultative use of "complex" signs. However, since the identification of *34 and *35 as representing ai is by no means certain, they need not be construed as members of an unparalleled "homophony"-triple in order to avoid the interpretation of them as purely graphic variants: comparison (3) could be simply an instance of the typical behavior of normal "homophonic" sign pairs.

2. CHADWICK'S ARGUMENT. Chadwick (1973) advanced a different, purely graphical type of argument in support of the allographic interpretation of *34 and *35: "If they were distinct, this pair would be the only example

in the syllabary of the mirror image of a sign having a different value; no other sign pairs could be mistaken for each other if turned about a vertical axis" (Chadwick 1973: 386). The form and presuppositions of this neat argument should be considered in some detail. Given two analyses A_1 and A_2 such that A_1 entails a unique situation in the structural systems under analysis that A_2 does not, A_2 is to be preferred. The grounds for preferring A_2 are that it leads to a simpler, more regular system or permits a generalization to be expressed Such an argument form will carry more than merely aesthetic weight, however, only if there is some sound theoretical reason according to which one would expect the regularity or generalization in question to hold in the particular, restricted domain under investigation. In other words, how do we know that Chadwick's graphical generalization is not merely accidental? This suspicion is not allayed by the fact that the following, **contrary** observation is as valid for Linear B as is Chadwick's: If *34 and *35 were variants of the same sign, this pair would be the only example of all the attested variants for which mirror image forms would have the same value (as noted already by Palmer 1963:23).

3. A NEW APPROACH. I believe that a new argument can be made in support of Chadwick's position. It will take the form of adducing precisely the grounds needed to demonstrate the principled and non-accidental status of the generalization concerning the graphical structure of Linear B that Chadwick wishes to preserve by analyzing *34 and *35 as allographs. First we will look briefly at a principle of human perceptual organization which will motivate a universal of grapheme form of the implicational type. Then this universal will be evaluated typologically and shown to hold across the writing systems of the world. Finally, in conjunction with another property of Linear B, Chadwick's generalization will be deduced.

3.1. PSYCHOLOGICAL CONSIDERATIONS. We must begin by looking briefly at how human perception treats reflection about natural axes. (This discussion is based largely on E. and H. Clark 1978.) The physical environment provides the human perceptual apparatus with its natural dimensions: the force vector of gravity defines the vertical axis and the local surface of the earth the horizontal plane. These natural dimensions are reflected in the basic vocabulary of human languages.

Furthermore, the natural dimensions are not equipollent. As Bierwisch (1967) has shown for German, height dominates width, and width dominates thickness. These dominance relations are confirmed by the early perceptual strategies of young children. Very importantly for our purposes, Rudel and Teuber (1963) have shown that children learn to distinguish shapes contrasting in respect to reflection about a horizontal axis more easily than shapes contrasting in respect to reflection about a vertical axis. Conversely, we would expect that shapes symmetrical with respect to reflection about a vertical axis (VAS) will be preferred over shapes symmetrical with respect to horizontal axial reflection (HAS). Indeed,over half a century ago Boas (1927) observed in striking confirmation of this dominance relation that in "primitive" art VAS predominates greatly over HAS. This too is based on the nature of the physical environment where HAS is rare, due to the fact that most objects and organisms must be supported from below, and where, for organisms, bilateral symmetry and thus VAS is common. We may also note that the forms of the Linear B signs conform to Boas's observation. If we cross-classify the 90 signs according as they do (+) or do not (-) show VAS or HAS, we obtain Table I

Table I

	+VAS	-VAS
+HAS	10	5
-HAS	38	42

Not only does +VAS dominate in overall frequency, but two-thirds of the +HAS signs are also +VAS as well, whereas only about one-fifth of the +VAS signs are also +HAS.

3.2. THE FUNCTION OF AXIAL REFLECTIONS IN SCRIPTS. The preceding discussion leads us to expect that, if the hierarchy of vertical and horizontal dimensions in human perception is in fact as fundamental as it seems, it should also be reflected in the use of sign forms in writing systems. We are concerned here with three variables: the use of sign forms that differ primarily only in regard to VAR; the use of sign forms that differ primarily only in regard to HAR, and finally the function of each kind of axial reflection: the function is to

produce allographs if the occurrence of such reflection results only in non-distinctive variants with the same phonetic value (allographs); it is graphemic if it produces distinct signs having different phonetic values (graphemes).

The perceptual hierarchy we have noted leads to the following two predictions:

(4) VAR will be graphemic only if HAR is graphemic.

The generalization in (4) is clearly the principled basis for Chadwick's argument that we are seeking. The second prediction is the converse of (4)

(5) HAR will be allographic only if VAR is allographic.

The generalization in (5) clearly stands in contradiction to the logical basis of the counter-argument advanced above against Chadwick's position, since it is equivalent to the proposition that if a script has only one kind of non-distinctive axial reflection in its sign forms, it will be the VAR kind.

How do predictions (4) and (5) stand up when tested against the actual usage of axial reflections in a substantial number of diverse non-pictographic scripts? The test will take the form of converting (4) and (5) into explicit typologies. Both generalizations are logically material implications of the form A implies B; such implications are tautologously equivalent to the denial of the conjunction of A and not-B. Any of the other three possible conjunctions can be true and still satisfy the implication. Accordingly, we set up two typologies of scripts. Typology 1 corresponds to prediction (4) and classifies the graphemic contrasts of each script into the following four types: a) both VAR and HAR are graphemic, b) neither VAR nor HAR is graphemic, c) HAR is graphemic but VAR is not, and finally d) VAR is graphemic but HAR is not. Typology 2 classifies the allographic variants of each script in the same way. Thus if our predictions (4) and (5) are to be confirmed, we will have to find that no script has graphemic VAR without also having graphemic HAR. Similarly, we will have to find that no script has allographic HAR without also having allographic VAR. Of course, we do not expect that there will be absolutely no exceptions; rather it is only necessary that the excluded types (graphemic -HAR & +VAR; allographic -VAR & +HAR) should occur in the scripts of the world with significantly less than chance frequency.

A sample of 56 writing systems was prepared for the evaluation of the graphemic typology 1. Because of the difficulty in obtaining adequate descriptions of allographic variation, the sample for the test of the allographic typology 2 was limited to 37 writing systems. These typologies are given in Tables II and III.

Table II

	+VAR	-VAR
+HAR	9	12
-HAR	2	33

Typology 1
Graphemic Axial Reflections

Table III

	+VAR	-VAR
+HAR	11	1
-HAR	10	15

Typology 2
Allographic Axial Reflections

Typologies 1 and 2 strongly confirm predictions (4) and (5). Although for Table II there are two exceptions, and for Table III one exception, the number of excluded types is significantly less than what would be expected if the predictions were not true. For Table II the chi-square is 11.4731 and is significant at the $p = 0.00069$ level; for Table III the chi-square is 8.8185, and is significant at the $p = 0.0034$ level. (The significance levels were calculated using the approximation of Hoaglin 1977.)

3.3. DISCUSSION OF EXCEPTIONS. The two exceptions to generalization (4) are instructive: indeed they are exceptions that "prove the rule". One of the exceptional

scripts is Numidian. The Numidian script is remarkable in that it appears in two varieties, one read in vertical columns from bottom to top, the other read horizontally in rows from right to left. Only the horizontal variety is of the exceptional -HAR & +VAR type; the vertical variety conforms to our generalization, being of the +HAR & -VAR type. (If a +HAR & -VAR type script is rotated through 90°, it will become a -HAR & +VAR type script.) There are three important characteristics of the exceptional horizontal variety of Numidian that support our contention that VAR is not a basic means of making graphemic contrasts. First, inscriptions in the horizontal variety are decidedly less frequent than inscriptions in the vertical variety; they are restricted to Thugga and the bilingual, Numidian - Punic, inscription of king Masinissa. Secondly, the left to right orientation of the horizontal variety may well be due to Punic influence; as argued by Meinhoff (1931:25): "Die hier beobachtete Schreibung ist offenbar die ältere, die in M(asinissa inscription) und T(hugga) nur in Anlehnung an punische Schreibung verändert ist." Third, and most importantly, there is only one pair of signs that contrast by VAR in the horizontal variety, those for m and s^2, and, furthermore, not all of the allographs of these two signs contrast in terms of VAR: whereas the unexceptional vertical variety of Numidian has the sign ⊓ for s^2 and ⊔ or ∪ for m, the horizontal has ⊐ or ↄ for m but ϵ in addition to ⊏ or C for s^2. Thus the first allograph for s^2 no longer contrasts with either allograph of m in terms of VAR. It should also be noted that the Masinissa inscription uses only the first variant of the m sign in contrast to the third variant for s^2, so that again the contrast in terms of VAR is removed, becoming now one of orientation and form (rectilinear versus curvilinear). All of these considerations demonstrate very clearly the special status of VAR contrasts: graphemic VAR is marked in respect to graphemic HAR.

The other exceptional script is the Celtic Ogham. The Ogham is remarkable inasmuch as it was carved along the edges of blocks of stone, i.e. in two planes, one at right angles to the other, so that it is really only the projection of the script onto a single plane perpendicular to the line of sight that creates graphemic contrasts in terms of VAR.

4. CONCLUSION. We have motivated theoretically and have confirmed empirically as overwhelming statistical tendencies two generalizations concerning the function of

reflection about vertical and horizontal axes in non-pictographic writing systems: 1) VAR is graphemic only if HAR is graphemic. 2) HAR is allographic only if VAR is allographic. The Linear B syllabograms *34 and *35 contrast only in respect to VAR. There are no syllabograms in Linear B that contrast only in terms of HAR. Therefore, we conclude, by the modus tollens, with a high degree of confidence, that *34 and *35 are not two different graphemes: they are non-distinctive variants of the same sign. As noted above, there are no allographic variants in Linear B that differ only by HAR; thus our conclusion is also consistent with the second universal: if there is only one kind of allographic axial reflection, it is VAR and not HAR.

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