Bridges in the Iambographers

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On the fiftieth anniversary
of Knox's "Early Iambus"

I. Introduction

IT IS JUST HALF A CENTURY since the publication of Knox's famous paper "The Early Iambus."[1] Knox's work was at that time, and indeed still is today, far in advance of contemporary standards of metrical scholarship. He shows a sophisticated control over the classification and organization of philological data that has seldom been replicated in more recent work, and is almost alone in his awareness of the vital role of explicit hypothesis testing, particularly in his comparison of different styles of trimeter in order to substantiate posited metrical restrictions. Much of Knox's work has, unfortunately, been ignored,[2] and even those discoveries that are widely recognized, namely the two bridges associated with his name, have recently been called into question by an eminent authority.[3] It is not difficult to think of reasons that explain, if they do not excuse, this neglect and lack of appreciation. The style of Knox's exposition is compressed and generally difficult, and demands a considerable degree of concentration from the reader, especially as the subject matter is unusually intricate and complex. The 1932 *Philologus* article, although more accessible, is in fact inferior on a number of counts to the paper presented in 1926 to the Cambridge Philological Society.[4] Finally, Knox's somewhat over-systematic approach to textual criticism may have

[1] A. D. Knox, "The Early Iambus," *Philologus* 87 (1932) 18–39.

[2] An early exception is G. Perrotta, "Il poeta degli epodi di Strasburgo," *StItal* 15 (1938) 5, followed more recently by G. Morelli, "Studi sul trimetro giambico," *Maia* 13 (1961) 143–61 and 14 (1962) 149–61.

[3] M. L. West, *Studies in Greek Elegy and Iambus* (Berlin 1974) 113.

[4] "Iambica or the Origin of Porson's Law," *PCPhS* 133–5 (1927) 32–46. Knox later retracted this exposition ("Iambica: Corrigenda et Addenda," *PCPhS* 142–4 (1930) 11–12) in favor of the 'general law' that figures so prominently in the *Philologus* article. On the 'general law' see A. M. Devine and L. D. Stephens, "Semantics, Syntax, and Phonological Organization in Greek," to appear in *Classical Philology*.

served to erode confidence in his metrical work, where, however, his rigorously analytic methods are entirely appropriate.

Thus, the state of research is more or less as Knox left it fifty years ago. No coherent account of the exceptions to the bridges was elaborated to replace Knox's 'general law', with the consequence that, despite the welcome addition of new fragments, both the scope and the nature of the bridges have remained imprecise. No attempt has been made to test the reality of Knox's minor laws, at least one of which has crucial implications for our understanding of the trimeter. It will therefore be necessary for us to analyze and quantify the evidence of the texts *ex novo* in terms that will allow us to extend the scope of Knox's original observations and to extrapolate a number of general linguistic and metrical principles. We shall proceed to subject those principles to formal statistical evaluation; and finally exploit the validated principles for the light they can cast on various theoretical problems —in particular the much vexed question of the relationship of Wilamowitz's Bridge to Knox's Iamb Bridge.

II. Philological Observations

The data will be presented in terms of the occurrence of word-shapes at locations for which bridges and similar constraints have been suggested. The styles studied will be the iambic trimeter[5] of Archilochus, Semonides, and Solon (hereafter A.S.S.), and the choliambic trimeter of Hipponax (ed. West). For the purposes of comparison (and statistical testing in the next section), data are also cited from tragedy for the iambic trimeter, and from Callimachus (ed. Pfeiffer) and Herodas (ed. Cunningham) for the scazon. (Proper names are excluded.) In addition to distinguishing pre- and post-positives, it will also be necessary to classify non-appositive words as lexical and non-lexical,[6] since non-lexical words are,

[5] Since the corpus is small and the text less than definitive, a degree of caution is recommended for the assessment of this material. Related data from the tetrameter and epodes are not included.

[6] Lexical words are nouns, adjectives, and non-appositive verbs and adverbs; non-lexicals are words belonging to other grammatical categories (whether appositive or not). For a full discussion of the linguistic category of lexicality and its metrical significance at bridges (including those of Knox) see our "Semantics, Syntax and Phonological Organization in Greek" (forthcoming). To avoid needlessly complex formulations of the environments of the topic word shapes and structures, we have allowed the term 'lexical word' to include for left-hand environments headword plus postpositive and for right-hand environments prepositive plus headword, since the phonological boundaries involved are equivalent.

in general, less constrained than lexical words at a number of the bridges to be examined in this paper. On the basis of syntactic structure, non-lexicals can be interpreted as right-linking (like prepositives) or left-linking (like postpositives): thus in *ἀλλὰ μυρίαι* (Semon. 1.20) *ἀλλά* links right or forward onto *μυρίαι*, and in *ὄμμα τοὐμόν* (Eur. *Hipp.* 1208) *τοὐμόν* links left or back onto *ὄμμα*. The tetrasyllabic structure resulting from the syntagm *ὄμμα τοὐμόν* will be called a 'syntagmatic tetrasyllable'; similarly *ἀλλὰ μυρίαι* will be termed a 'syntagmatic pentasyllable', as opposed to the comparable structure without internal word boundary (*e.g. ἀπτερύσσετο*, Archil. 41.2), which will be termed a 'non-syntagmatic pentasyllable'.

Knox's Iamb Bridge

1. Lexical iamb-shaped word ending in 5th longum preceded and followed by lexical words (type *φαρμάκων στυγεῖ πόσις*, Eur. *Andr.* 205): this structure, which is perfectly acceptable in tragedy, does not occur in A.S.S., nor in the choliambs of Hipponax except in 32.2 *κάρτα γὰρ κακῶς ῥιγῶ* where the first two words might constitute a right-linking non-lexical structure. In the choliambs of Callimachus the structure does occur rarely (195.11 *ἄγειν ὕλην*, *cf.* 191.34 and 195.33, *ἔχε χρείην* which is a fixed phrase).

2. Lexical iamb-shaped word ending in 5th longum, preceded by a monosyllabic prepositive and followed by another lexical word (type *καὶ μολὼν πόσις*, *Andr.* 990). This structure occurs sometimes in Semonides (1.9, 7.27, 7.29, 7.76, *cf.* 7.79, 19) and Solon (36.3); in Archilochus the only instance involves an elided disyllabic prepositive (*ὥστ' ὀνοῦ ῥάχις*, 21.1). It is also well attested in the choliambs of Hipponax (44, 58) and Callimachus (191.10, 191.44, 193.13, 194.7, 194.25, 194.30, 194.32, 194.52, 194.54, 194.102).

3. Lexical iamb-shaped word ending in 5th longum followed by a postpositive or left-linking non-lexical word (type *δοκῶ τι δρᾶν*, Eur. *Heracl.* 733). This structure does not occur in A.S.S., Hipponax, or Callimachus, but is found in tragedy.

4. Non-lexical iamb-shaped word ending in 5th longum not preceded by a prepositive and followed by lexical word (type *ἀπὸ στέγης*, *Andr.* 708). This structure occurs in all styles: Arch. 29.7, 44, 82.5; Sem. 1.2, 1.14, 7.63, 8.

Wilamowitz's Bridge

5. Lexical spondee-shaped word ending in 5th longum preceded and followed by lexical words (type *ἐξελοῦ κόσμον νεκρῷ*, Eur. *Hel.* 1279). This structure occurs neither in A.S.S. nor in the choliambs of Hipponax, although it is well attested in tragedy. Occurrence in Callimachus is precluded by the virtual absence of long 3rd anceps.

6. Lexical spondee-shaped word ending in 5th longum preceded by a monosyllabic prepositive and followed by another lexical word (type *εἰς οἴκους λαβεῖν*, *Andr.* 609). There are two examples of this structure in A.S.S. (Archil. 24.1, Semon. 7.60). At Archil. 23.13 *οὔδ' οἴων ἄπο*, the spondee-shaped word is non-lexical and is followed by a non-lexical word. There is probably also an example in the choliambs of Hipponax (50.2),[7] but it involves *muta cum liquida* in a proper name. Likewise in the choliambs of Callimachus, all the potential examples are ambiguous since they involve *muta cum liquida* (191.32, 194.22, 194.70, 194.78, 194.80, 195.25) and most likely belong at Observation 2 above, especially in view of the virtual absence of ischiorrogics.[8]

7. Lexical spondee-shaped word ending in 5th longum followed by a postpositive or left-linking non-lexical word (type *δείξειν ποτέ*, Eur. *Hipp.* 714). This structure does not occur in A.S.S., Hipponax, or Callimachus.

8. Non-lexical spondee-shaped word ending in 5th longum not preceded by a prepositive and followed by a lexical word (type *καίπερ τρέμων*, *Andr.* 717). This structure occurs neither in A.S.S. nor in the choliambs of Hipponax (for Archil. 23.13 see Observation 6 above).

Knox's Trochee Bridge

9. Lexical trochee-shaped word ending in 3rd anceps preceded and followed by lexical words (type *ῥᾷστος ἀνδρὶ δυστυχεῖ*, *Hipp.* 1047). This structure does not occur in A.S.S., and is still somewhat constrained in tragedy.[9] In Hipponax the only potential ex-

[7] The prosody of *muta cum liquida* in Hipponax has been much discussed *qua* criterion for establishing the authorship of the Strasbourg Epodes (Pack² 1749).

[8] A. Ardizzoni, "Callimaco 'Ipponatteo'," *AFLC* 28 (1960) 3–16, is not able to explain the obviously non-random preponderance of V̆ plus *muta cum liquida*.

[9] Knox (*supra* n.1) 33–35.

ample is 102.10, which could equally belong in Observation 10 below, since a lacuna precedes the trochee-shaped word. The structure does occur in the choliambs of Callimachus (191.60, 191.92, 191.93, 218).

10. Lexical trochee-shaped word ending in 3rd anceps preceded by a prepositive, right-linking appositive sequence or other non-lexical word, and followed by another lexical word (type *καὶ πρὸς αἶπος ἔρχεται*, Eur. *Alc.* 500; *τόνδε παῖδα Θησέως*, *Hipp.* 51). This structure does not occur in A.S.S., but is found in the choliambs of Hipponax[10] (17, 29a, 36.2 with elision, 78.14) and of Callimachus (192.13, 193.38, 194.23, 194.28, 194.29, 194.71, 194.82, 194.101, 203.13). Callimachus allows this structure also in non-choliambic trimeters (200b.1).

11. Lexical trochee-shaped word ending in 3rd anceps followed by postpositive or left-linking non-lexical word (type *ἄνδρα γὰρ χρεών*, Eur. *Heracl.* 390). This structure does not occur in A.S.S. or Hipponax, but is found once in a choliambic trimeter of Callimachus (191.41) and once in a non-choliambic trimeter (196.45).

12. Left-linking non-lexical trochee-shaped word ending in 3rd anceps followed by lexical word (type *ὄμμα τοὐμὸν εἰσορᾶν*, *Hipp.* 1208). This structure does not occur in Semonides or Solon, but is apparently found once in Archilochus (24.10?), as it is in the choliambs of Hipponax (68) and Callimachus (194.92 [suppl.]).

13. Right-linking non-lexical trochee-shaped word or appositive sequence ending in 3rd anceps followed by lexical word (type *ἀλλὰ παρθένον*, *Heracl.* 489; *οὐ γὰρ ἐνδεής*, 589). This structure is admitted in all styles: Archil. 26.5, 26.6, 54.5 (*cf.* 31.1, 43.1); Semon. 1.4, 1.7, 1.20, 1.23, 7.31, 7.59, 7.80, 7.106, 7.110, 14.2, 36.9, 36.11, 36.22, 38.1, 38.3, 39.1; Hippon. 10.1, *cf.* 13.1, 14.2, 73.4, 79.8 (*cf.* 26.4); Callim. 191.36, 191.38, 191.59, 191.66, 192.8, 192.15, 192.16, 193.1, 194.37, 194.42, 194.66, 194.68, 194.88, 194.93, 195.23.

[10] Here is a case in which Hipponax in the choliamb is not as strict as A.S.S. in the trimeter, thus tending to disconfirm the general conclusion of Knox's introduction to his Loeb edition of Hipponax.

Porson's Bridge[11]

14. Lexical word of more than two syllables ending in long 3rd anceps followed by lexical word (type *ἐραστὴν πραγμάτων*, Ar. *Nub.* 1459). This structure does not occur in A.S.S. or in tragedy. In Hipponax the structure is well attested (9.1 *cf.* 36.4, 59.1, 60, 65, 78.11, 102.12, 104.50).

15. Lexical spondee-shaped word ending in long 3rd anceps followed by lexical word (type *ἄνδρας δεξιούς*, *Nub.* 834). This structure does not occur in any style.

16. Non-lexical spondee-shaped word ending in long 3rd anceps followed by lexical word (type *τούτου μανθάνειν*, *Nub.* 658). This structure does not occur in A.S.S. and only rarely in tragedy (*Alc.* 671, *Phoen.* 747). It is probably attested in the choliambs of Hipponax (6.2 [Knox *ὥστε*], 92.4 [suppl.]; 26.4 if pos. length.).

17. Lexical word ending in long 3rd anceps followed by postpositive (type *ἄρχειν γὰρ νεώς*, *Hel.* 1552). This structure does not occur in A.S.S. or in Hipponax, but is well attested in tragedy.

18. Monosyllabic prepositive in long 3rd anceps followed by lexical word (type *οὐ ῥᾳδίως*, *Andr.* 975). This structure does not occur in A.S.S., but is found in the choliambs of Hipponax (79.10) as is to be expected on the basis of Observation 14, and is common in tragedy.

Law of the Tetrasyllables[12]

19. Word of four syllables with heavy first syllable (type *τητωμένη*, *Hel.* 274). Such words do not occur at the end of the line in Solon and are relatively uncommon overall in Archilochus and Semonides.

20. Word of four syllables with heavy first syllable (type as in 19). At the beginning of the line such words do not occur in Solon or Archilochus and are relatively uncommon in Semonides.

[11] Occurrence in Callimachus of any structure covered in this section is precluded by the virtual absence of long third anceps in his verse (assuming tautosyllabic *muta cum liquida* in ambiguous cases).

[12] Knox examined tetrasyllables at the end of the line only, but there seems to be a comparable constraint also at the beginning of the line, hence Observation 20 (*infra*). Stop+liquid/nasal is counted as heavy, but the two examples of *ποιέω* in Solon (36.26 and 37.5) are assumed (with Knox) to have light first syllable (*cf.* the variation between light and heavy initial syllable for *τοιοῦτος* in Semonides). Knox (*supra* n.1) 27 divides the data

III. Significance Tests

Observations 1–20 above concern the occurrence of certain linguistic structures in certain metrical locations. These raw enumerations and classifications could be directly translated into laws that have general theoretical implications for our knowledge of Greek language and metre. Thus, the philological fact noted in Observation 6, namely that there are only two examples of a lexical spondee-shaped word preceded by a prepositive in A.S.S., immediately suggests a law that such structures are constrained in the early iambic trimeter. However, such a translation of philological observation into metrical law begs an absolutely crucial question, because philological observations are always potentially vacuous until proven significant, and, if a philological observation is vacuous, any law based on it will quite simply be false. The practical significance of this axiom is by no means trivial, even in cases such as Observation 17 (postpositive after Porson's Bridge), in which a linguistic structure is actually non-occurring in a metrical location. For it may be purely a statistical accident that a structure which is comparatively rare in the language does not occur in a relatively small sample. The statistical tests performed in this section are all designed to eliminate such chance effects and to ensure that the laws (here formulated as propositions to be tested) rest on genuine constraints.

All the propositions concern the existence of bridge constraints and the like that are either not present or present only in a weaker form in the tragic trimeter or (in one test) in the scazons of Herodas. Consequently, all the tests of the propositions share a simple and straightforward design. A class of linguistic structures,[13]

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on line initial tetrasyllables in Archilochus and Semonides into two categories according to the preceding word-shape, claiming that the constraint on long 3rd anceps in tetrasyllabic words applies only when a lexical or prepositive monosyllable stands immediately after the penthemimeral caesura. However, the total number of instances of tetrasyllabic words in this latter category is too small to allow statistical substantiation of any difference between the two categories. Furthermore, Knox is mistaken in his assumption that in the other category long 3rd anceps is unconstrained. Insofar as tetrasyllables with heavy first syllable occur at the end of the line, they are always verbal forms (but never prefixed or compound verbal forms); there is one instance of a proper name: *Γορτυνίης*, Archil. 24.2 By contrast, nominal forms are slightly more frequent than verbal forms in tragedy. Of tetrasyllabic words with light first syllable that stand at the end of the line, 33% are nominal forms in A.S.S. and 25% in tragedy.

[13] In two cases (Propositions 1 and 4) the corpus of trimeters has been used in order to obtain a large enough sample. This procedure is in principle less satisfactory, because it fails to control for a number of potential sources of variation.

called the reference class, is identified such that it contains a subclass of structures that is hypothesized to be constrained; this subclass is referred to as the test structure. The relative frequency of the test structure within the reference class in the style hypothesized to possess the constraint, called the test style, is then compared to its relative frequency in the style hypothesized to lack that constraint, called the control style. Thus, in the test of Proposition 5 below, the reference class consists of all molossus-shaped structures, the test structure of syntagmatic molossus-shaped structures, the test style is A.S.S., and the control style is tragedy. The aim of the test is to determine whether the differences between the test style and the control style (in this case between A.S.S. and tragedy) in the frequency of the test structure (syntagmatic molossus) reflect a genuine difference or arise simply from chance.

The test is presented in a 2×2 table in which the first row represents the test style and the second row the control style, and the first column the test structure and the second column the other structures in the reference class. The numerical entries are the occurrence frequencies of the respective structures in the samples of the test and control styles. For the iambographers, the sample is the extant corpus, for tragedy it is the 1253 trimeters of Euripides' *Helen*. The p number indicates whether the test establishes a statistically significant difference in the table or not. p represents the probability that a difference as large as or larger than that observed between the test style and the control style would be due to chance. A value of p less than .05 (*i.e.* 5%) is considered significant: it means that there is less than a 5 in 100 chance of misinterpreting a random phenomenon as significant. When a direct calculation of p would be prohibitively complex, the test statistic χ^2 is given, from which a very close approximation to p may be obtained from standard statistical tables. The larger the value of χ^2, the smaller that of p; any value of χ^2 greater than 3.84, which corresponds to $p=0.05$, indicates a statistically significant difference.

If a significant difference is established, we are then confronted with the question of the interpretation of that difference: what constraints or preferences for which structure(s) obtain in which style(s)? For, logically, any one or a combination of some or all of the four cells of the table could be subject to a differentiating effect. In practice, the test structure and the test style have been defined metrically and linguistically so that the only theoretically reasonable assumption is that the differentiating factor is a constraint operating on the upper left cell of the table, *i.e.*, on the test

structure in the test style. Thus, in the interpretation of the test of Proposition 5 below, it would hardly be reasonable to attribute the statistically significant difference to a special preference for syntagmatic molossi in tragedy or to a constraint on non-syntagmatic molossi in tragedy, or to a combination of both, etc.: the only interpretation consonant with what is already known about the various styles of the trimeter and about syntagmatic structures in the Greek language is that the syntagmatic molossus is constrained in the style of A.S.S.

Finally, the degree of constraint can be measured by the odds ratio in the table, *i.e.*, the odds against the occurrence of the test structure in the control style divided by the odds against its occurrence in the test style. (The odds ratio is equal to 1 when there is no difference between the two styles in regard to the test structure.) By comparing the odds ratios for two different but correlative test structures in their respective reference classes, we can determine whether they are equally constrained or one is more constrained than the other (see Proposition 7). This method opens up a number of new possibilities in metrical research.

Propositions

1. That the non-occurrence of lexical iamb-shaped words ending in 5th longum preceded and followed by lexical word (type *φαρμάκων στυγεῖ πόσις*, *Andr.* 205) is statistically significant.

	rate per 100 trimeters
A.S.S.	0.00
tragedy	3.03

Test result: positive. $p = .000094$.[14]

2. That the structure prepositive+iamb-shaped word ending in fifth longum (type *καὶ μολών*, *Andr.* 990)[15] is more constrained than the structure without internal word boundary in A.S.S.

	syntagmatic cretic	non-syntagmatic cretic
A.S.S.	10 (27.03%)	27
tragedy	70 (40%)	105

[14] *I.e.*, if the rate were the same in A.S.S. as in tragedy, then one would expect to find zero occurrences in only one out of every ten thousand samples of the same size as the extant corpus of A.S.S. (more precisely 94/100,000). $p = (.9697)^{301}$.

[15] The ratio of the type *ἀπὸ στέγης* (Proposition 3) to the type *καὶ μολών* (Proposition 2) is slightly higher in A.S.S. than in tragedy.

Test result: negative, or, more precisely, indeterminate owing to small sample size. $\chi^2 = 2.187$. Odds ratio: 1.8.

3. That the structure non-lexical iamb-shaped word (excluding enclitics and those preceded by a prepositive)+iamb/pyrrhic-shaped word at the end of the line (type *ἀπὸ στέγης*, *Andr.* 708), although occurring in A.S.S., is more constrained than the same structure in tragedy.

	syntagmatic diiamb	non-syntagmatic diiamb
A.S.S.	7 (8.14%)	79
tragedy	27 (20.93%)	102

Test result: positive. $\chi^2 = 6.351$. Odds ratio: 2.846.

4. That the non-occurrence of lexical spondee-shaped word ending in 5th longum, preceded and followed by lexical word (type *ἐξελοῦ κόσμον νεκρῷ*, *Hel.* 1279) is statistically significant.

	rate per 100 trimeters
A.S.S.	0.00
tragedy	3.19

Test result: positive. $p = .000057$.[16]

5. That the structure prepositive+spondee-shaped word ending in 5th longum (type *εἰς οἴκους*, *Andr.* 609), although occurring in A.S.S., is more constrained in A.S.S. than the corresponding structure without the internal word boundary.

	syntagmatic molossus	non-syntagmatic molossus
A.S.S.	3 (7.50%)	37
tragedy	63 (34.81%)	118

Test result: positive. $\chi^2 = 11.661$. Odds ratio: 62.5.

6. That the structure non-lexical spondee-shaped word (excluding enclitics and those preceded by prepositives) ending in 5th longum +iamb/pyrrhic-shaped word (type *καίπερ τρέμων*, *Andr.* 717) is more constrained than the same structure without the internal word boundary in A.S.S.

	syntagmatic $\bar{S}\bar{S}\breve{S}\bar{S}$	non-syntagmatic $\bar{S}\bar{S}\breve{S}\bar{S}$
A.S.S.	0 (0.00%)	12
tragedy	26 (26.53%)	72

[16] See *supra* n.14; here $p = (.9681)^{301}$.

Test result: positive. $p = .032$.[17] Odds ratio (corrected for continuity): 9.137.

7. That the structure prepositive+spondee-shaped word ending in 5th longum is more constrained than the structure prepositive+ iamb-shaped word ending in 5th longum in A.S.S. (types as in propositions 5 and 2).

	prepositive +spondee-s.w.	prepositive +iamb-s.w.
A.S.S.	7.5%	27.03%
tragedy	34.81%	40.00%

Test result: positive. $\chi^2_{\text{homog.}} = 7.883$.[18] The ratio of the left to the right hand column is smaller in A.S.S. than in tragedy. This fact emerges when the odds ratios for Propositions 5 and 2 are compared.

8. That the structure non-lexical spondee-shaped word (excluding enclitics and those preceded by prepositives) ending in 5th longum +iamb/pyrrhic-shaped word is more constrained in A.S.S. than the structure non-lexical iamb-shaped word (excluding enclitics and those preceded by prepositives) ending in 5th longum+iamb/ pyrrhic-shaped word (types as in Propositions 6 and 3).

	non-lexical spondee-s.w.	non-lexical iamb-s.w.
A.S.S.	0.00%	8.14%
tragedy	26.93%	20.93%

Test result: negative, or, more precisely, indeterminate owing to small sample size. $\chi^2_{\text{homog.}} = .5869$.

9. That the non-occurrence of lexical trochee-shaped word ending in 3rd anceps, preceded and followed by lexical word (type *ῥᾷστος ἀνδρὶ δυστυχεῖ*, *Hipp.* 1047), is statistically significant.

	lexical trochee s.w. between 2 lexicals	lexical trochee s.w. not between 2 lexicals
A.S.S.	0 (0.00%)	26
tragedy	10 (12.82%)	68

Test result: positive. $p = .048$.

[17] Here and at Propositions 9, 10, 12, 15, and 16 the exact probability is calculated from the hypergeometric distribution.

[18] For the theory of this test statistic see J. L. Fleiss, *Statistical Methods for Rates and Proportions* (New York 1973) 109–17.

10. That a lexical (or enclitic) trochee-shaped word may end in 3rd anceps when preceded by a non-lexical trochee-shaped word or trochee-shaped appositive combination (type *καὶ πρὸς αἶπος*, *Alc.* 500) in Hipponax, but not in Semonides or Solon.

	non-lexical boundary preceding	non-lexical boundary following
A.S.S.	0 (0.00%)	19
Hipponax	5 (41.67%)	7

Test result: positive. $p = .0047$.

11. That the structure non-lexical trochee-shaped word or appositive combination ending in 3rd anceps followed by a cretic/dactyl-shaped word or syntagm (type *ἀλλὰ παρθένον*, *Heracl.* 489) is more constrained than the corresponding structure without internal word boundary in A.S.S.

	syntagmatic pentasyllable	non-syntagmatic pentasyllable
A.S.S.	19 (55.88%)	15
tragedy	38 (62.30%)	23

Test result: negative. $\chi^2 = 0.372$.[19]

12. That the non-occurrence of lexical spondee-shaped word ending in 3rd anceps and violating Porson's Bridge (type *ἄνδρας δεξιούς*, *Nub.* 834) in Hipponax is significant.

	lexical spondee-s.w.	other violations
Hipponax	0 (0.00%)	10
Herodas	2 (16.67%)	10

Test result: negative. $p = .286$.

13. That a tetrasyllabic word with heavy first syllable (type *τητωμένη*, *Hel.* 274) is more constrained than a tetrasyllable with light first syllable at the end of the line in A.S.S.

[19] *I.e.*, in more than a third of the cases such a difference or a larger one would arise purely by chance. Granted that any significant difference would have been due to constraints on the syntagmatic type, two conclusions could logically be drawn from this test. Either the syntagmatic type is unconstrained in tragedy and therefore in A.S.S., or it is constrained in A.S.S. and therefore still constrained in tragedy. The second alternative is supported by the persistence (in a relaxed form) of Knox's trochee bridge in tragedy (see *supra* n.9). Both syntagmatic and non-syntagmatic pentasyllables are about twice as common, in terms of line rate, in A.S.S. as in tragedy (syntagmatic: A.S.S. 6.31 per 100 trimeters *vs* tragedy 3.03; non-syntagmatic: A.S.S. 4.98 per 100 trimeters *vs* tragedy 1.84).

	⏑̄⏑̄⏑̄⏓	⏑̆⏑̆⏑̆⏓
A.S.S.	12 (13.19%)	79
tragedy	72 (41.38%)	102

Test result: positive. $\chi^2 = 21.933$. Odds ratio: 4.647.

14. That a tetrasyllabic word with heavy first syllable (type as in 13) is more constrained than a tetrasyllable with light first syllable at the beginning of the line in A.S.S.

	⏑̄⏑̄⏑̆⏓	⏑̆⏑̆⏑̆⏓
A.S.S.	3 (21.14%)	11
tragedy	10 (66.67%)	5

Test result: positive. $\chi^2 = 5.992$. Odds ratio: 7.333.

15. That the structure prepositive in long 3rd anceps followed by cretic/dactyl-shaped word or syntagm (type *οὐ ῥᾳδίως*, *Andr.* 975) is more constrained than the corresponding structure without the internal word boundary in A.S.S.

	syntagmatic tetrasyllable	non-syntagmatic tetrasyllable
A.S.S.	0 (0.00%)	12
tragedy	24 (25.00%)	72

Test result: positive. $p = 0.041$. Odds ratio (corrected for continuity): 8.448.

16. That the structure lexical spondee-shaped word+lexical iamb/pyrrhic-shaped word is more constrained than a tetrasyllabic word with heavy first syllable at the end of the line in A.S.S. (types as in Propositions 4 and 13).

	disyllable	tetrasyllable
A.S.S.	0 (0.00%)	12
tragedy	40 (35.7%)	72

Test result: positive. $p = .00653$.

There remain a number of philological observations that do not lend themselves to statistical evaluation, owing to the rarity of the structure in question and the relatively restricted size of the extant iambographic corpus: the power of any statistical test would be negligible in these cases. The following observations belong in this category: 3, 7, 11, 12, 17.

IV. Some Generalizations

The tests of the propositions conducted above confirm a number of the restrictions that have been suggested for the trimeter of the iambographers by earlier metrists and reveal some important additional facts. First of all, the law of the tetrasyllables is established through Proposition 13, Knox's Iamb Bridge through Proposition 1, Knox's Trochee Bridge through Proposition 9, and Wilamowitz's Bridge through Proposition 12. Furthermore, Proposition 16 shows that Wilamowitz's Bridge is more strictly enforced than the law of the tetrasyllables, and Proposition 7 demonstrates that, for whatever reason (see below), Wilamowitz's Bridge is a stronger bridge than Knox's Iamb Bridge. Knox's Iamb and Trochee Bridges and Wilamowitz's Bridge all permit, in one form or another, structures involving appositive or non-lexical words; however, Propositions 3, 5, 6, 10, and probably 2 and 11 show that the iambographers, while allowing such syntagmatic structures, still prefer to avoid them, just as they exclude prepositives at Porson's Bridge (Proposition 15). Proposition 10 shows that the location of the non-lexical word boundary can also be a relevant factor: whereas both non-lexical trochee-shaped words and ditrochee-shaped words are permitted to end in third anceps, Semonides and Solon actively exclude ditrochee-shaped syntagmata in this position (Archilochus does allow such syntagmata, at least when the trochee-shaped word ending in third anceps is an enclitic [24.10]). A general 'principle of syntagmatic structures' may be extrapolated from the above which would be broadly applicable in Greek metre: syntagmatic structures are subject to constraints which do not apply, or apply less strictly, to the corresponding simple structures.

Hierarchical Relations of Styles and Structures

A number of the observations in the first section of this discussion, now that they have been statistically tested, can be used to rank the styles in a hierarchy of strictness. The clearest method for establishing such a ranking is the construction of an implicational scaling of the various styles according as they do or do not permit the different linguistic structures at the bridge locations. Table 1 is such an implicational scaling. In Table 1, − indicates that the structure defined by the observation does not occur, + that it does occur, NA that the rule is not applicable owing to the constraints on ischiorrhogics or on long 3rd anceps in general; when different

levels of constraint can be discerned, the relative strictness is indicated by suprascript numbers (1 representing a higher level of constraint than 2).

Observation	14	9	1	19	18	10	2	13
A.S.S.	–	–	–	–	–	–	$+^1$	+
Hipp. chol.	+	–	$+^1$	NA	+	+	+	+
Callim. chol.	NA	$+^1$	+	NA	NA	+	+	+
tragedy	–	$+^2$	$+^2$	+	+	+	$+^2$	+

Table 1

With the exception of Porson's Bridge in Hipponax, Table 1 constitutes a perfect implicational scaling: *i.e.*, the occurrence of a structure in a stricter style (higher on the vertical axis) implies its occurrence also in all less strict styles (lower on the vertical axis), and the occurrence of a structure in a style implies the occurrence in the same style of all structures standing to its right in the table. The table thus concisely presents a complex of hierarchical relations obtaining both between the different styles and between the different sub-restrictions of the three bridges.

The implicational relation seen in Table 1 between Observations 1 and 9 is confirmed by the fact that Knox's Iamb Bridge no longer applies in a style (tragedy) in which the trochee bridge still imposes a degree of constraint. On this evidence, the trochee bridge should be ranked as a more severe constraint than the iamb bridge.

The Classification of Wilamowitz's Bridge

The classification of Wilamowitz's Bridge has long been debated. The issues involved can now be identified with particular clarity in the light of what has been established above.

Propositions 13 and 14 establish the prosodic sensitivity of 1st and 3rd anceps over and above the traditional constraints on final heavy syllables in anceps position. If the initial syllable of the spondee-shaped word is strongly characterized by the same linguistic property as that to which anceps is sensitive in the initial syllable of the tetrasyllables, then it might be argued that Wilamowitz's Bridge was a purely prosodic constraint, entirely unrelated to Knox's Iamb Bridge. On the other hand, Proposition 1 establishes a high level of constraint against lexical iamb-shaped word beginning the third metron (preceded and followed by lexical

words). This constraint cannot, of course, be prosodic, but must be 'rhythmic' in the sense the term is used by Snell in his binary classification of bridges.[20] The rhythmic constraint could be formulated to include Wilamowitz's Bridge, as a general law against disyllables in this location. Such a formulation would render any prosodic factor superfluous for the explanation of Wilamowitz's Bridge.

Thus the problem of the classification of Wilamowitz's Bridge is reduced to the following: is it prosodic? is it rhythmic? or is it both? The evidence of the new, more particularized propositions allows us to go some considerable way towards solving this riddle.

Proposition 16 establishes that at the end of the line a spondee-shaped word followed by a disyllabic word is more constrained than a tetrasyllabic word with heavy first syllable. Proposition 14 establishes that, at the beginning of the line, tetrasyllabic words with heavy first syllable are constrained: but there is no evidence for any constraint on spondee-shaped words at the beginning of the line (in Solon 73.4% of all line initial disyllables are spondee-shaped words, whereas in a sample from *Helen* only 44% were found to be spondee-shaped words). Therefore we need two explanatory factors, one to account for the constraint in anceps positions, and the other to account for the reversal in the hierarchical relation between spondee-shaped words and tetrasyllables in the two respective locations. Of the various logical possibilities, the most straightforward solution posits a prosodic factor constraining tetrasyllables, and a rhythmic factor constraining spondee-shaped words (*qua* disyllables) at the beginning of the third metron but not at the beginning of the first metron. Therefore, Wilamowitz's Bridge must include a rhythmic component.

Proposition 7 establishes that lexical spondee-shaped words are more constrained than lexical iamb-shaped words after a prepositive which stands in 4th longum. The increased level of constraint can only be due to the difference between the two word shapes, that is, to a prosodic factor. The simplest assumption[21] is that, in addition to the rhythmic constraint against disyllables applying to both word shapes, the spondee-shaped word is also constrained in

[20] B. Snell, *Griechische Metrik*[3] (Göttingen 1962) 6.

[21] A theoretically possible alternative would be the assumption that, in the phonology of Greek, prepositives cohere less readily with a following spondee-shaped word than with a following iamb-shaped word. In that case, the evidence of Proposition 7 remains ambiguous, since the additional constraint on spondee-shaped words could then be due either to a direct rhythmic effect of the word boundary or to a prosodic effect of true initial position.

3rd anceps on account of a prosodic property of its first syllable (3rd anceps is, quite naturally, assumed to be more sensitive than 1st anceps). Therefore, Wilamowitz's Bridge must include a prosodic component.

In sum, we can establish the following classification of Wilamowitz's Bridge. Wilamowitz's Bridge shares with Knox's Iamb Bridge a rhythmic component, so that it is possible to formulate a general law excluding a disyllabic word beginning the third metron. But Wilamowitz's Bridge is distinguished from Knox's Iamb Bridge in that it is additionally motivated by a prosodic constraint, and thus ultimately related also to Porson's Bridge.

It has been known for almost two centuries that a heavy syllable at the *end* of a word is subject to severe constraint in 3rd anceps (Porson's Bridge). It is clear from Proposition 13, and more indirectly from the classification of Wilamowitz's Bridge, that heavy syllables are also constrained in 3rd anceps at the *beginning* of the word (in those word-shapes that can begin the last metron of the trimeter). Consequently, at least certain non-final positions in the word must be recognized as an independent metrically relevant phonological environment. This fact will have to be integrated into any theory of Greek prosody, whether it is based exclusively on duration, like the more traditional approaches, or posits in addition a principle of stress.[22]

STANFORD UNIVERSITY
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[22] This task is beyond the scope of the present paper. For a complete discussion of the law of the tetrasyllables and related constraints in such a theoretical perspective see our forthcoming paper "Towards a Theory of Greek Prosody: the Suprasyllabic Rules."