# METRICAL EXPECTATIONS IN THE ARS POETICA

Wilhelm Ott, whose work is already known to readers of this journal, has recently published a volume which describes the metrical structures of the *Ars Poetica.* *

The book deserves more than passing mention with regard both to its virtues and to a problem which its publication raises.

The virtues are largely self-evident. As the first of its kind, the book should be seen as an instructive example of how the computer can be used in the area of metrics. Faced with the vast amount of information produced by mechanical means, it is difficult to see how any subsequent researcher in this area can henceforth be satisfied with purely manual procedures.

After a very sensible introduction, Ott presents the fully scanned text of the *Ars Poetica*. This is a quite justifiable inclusion, since it allows the

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* Wilhelm OTT, *Metrischen Analysen zur Ars Poetica des Horaz*, Göppinger Akademische Beitrage, Nr. 6 (Verlag Alfred Kümmerle : Göppingen 1970), 122 pages.

reader to check exactly the text and scansion used for the subsequent summaries and indices.

The next section describes metrical characteristics of the following sort : the number and percentage of words, containing one syllable, two syllables, etc.; the number and percentage of these words where elision occurs, where prose accent and ictus coincide, where word ending and foot ending coincide; the range, mean, and standard deviation of verse length in terms of words, syllables and letters; the frequency distribution of prose accent in the various positions in the line.

The cases of elision are then described in great detail. Although a distinction between elision and ecthlipsis is not maintained, the material is given so fully that the reader can fairly easily make this and other possible distinctions.

The following section on the position and frequency of word juncture* is

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* The convention used for indicating the position of word-juncture is a good one and should be generally adopted. Within the line, there are 16 possible positions for word-juncture. Ott has simply numbered them from 1 to 16 as follows :

— 1 ⏑ 2 ⏑ 3 — 4 ⏑ 5 ⏑ 6 — 7 ⏑ 8 ⏑ 9 — 10 ⏑ 11 ⏑ 12 — 13 ⏑ 14 ⏑ 15 — 16 ⏓

Thus, no matter what the shape of the verse, the main caesura in the third foot, if it occurs, will always be point 10, and so on. If, for example, a spondee occurs in the first foot, this simply means that word-juncture does not and cannot occur at point 2.

most original section in the book. In addition to the frequency distribution of word juncture at each point in the verse, we are also given full information on all pairs of word juncture simultaneously occurring, and partial information on triplets. Further, the pocket in the back cover of the book contains 16 ingeniously arranged punched cards which afford the reader a means for self-help. Thus, for what it is worth, it can be easily ascertained that lines 36, 351, and 358 contain word juncture at points 1, 3, 5, 7, 9, and line 122 contains word juncture at points 2, 4, 6, 8, 10, 12. So far as I know, this sort of analysis has never been done previously. It is the sort of thing which would be extremely laborious without a computer, and it raises interesting possibilities which will be dealt with below.

Then follow a full description of the distribution of spondaic and dactyllic feet, a listing of all lines with initial spondaic words, and a repetition of the text classified according to the positioning of words at the ends of the lines.

The book concludes with two indices verborum. In the first, the words of the poem are arranged according to their metrical shape and position. In the second, the words with accompanying metrical shape and position are arranged alphabetically.

This book gives the answers to an extraordinary number of questions that may be asked about the metrics of the *Ars Poetica*, more answers than any other publication on metrics that I know. Further, it is clear that one can fairly easily extract from this volume the answers to many questions that have not been explicitly stated.

Nevertheless, the publication of this book raises a serious problem. Omitting the introduction, a poem of 476 lines has generated a volume of 110 pages, and this is only the beginning. As Ott says (p. 8) "Der relativ geringe Aufwand an manueller Vorbereitungsarbeit, der bei diesen Analysen und deren Veröffentlichung notwendig ist, würde es sogar erlauben, in durchaus absehbarer Zeit die gesamte lateinische Hexameterdichtung in dieser Form metrisch zu erschliessen."* Given another poem of equal length, Ott can now almost effortlessly produce a second volume of the same approximate size, and so on. The question is whether or not he should. The work is important and should be done. The expertise is now available and the major payoff will be apparent only when comparative work can be performed.

But – and it is a big but – the resultant library of volumes will very quickly become unwieldy unless the accumulated material is itself submitted to the computer for further analysis, and the computer cannot use a printed volume. As in so much else, the computer has turned the logic of publication topsy-turvy. As a student of metrics who uses a computer, I should much prefer having Ott's work on magnetic tape in machine-readable form. On the other hand, our final audience is people, not computers, and not all of us have computers at our beck and call which will obediently print-out the results in people-readable form at any

* It should be noted that no manual typesetting was involved in the publication of the book. Cf. p. 8.

stage in the research process. As a result, those of us who do have computers are faced by a novel problem and a novel responsibility. It no longer makes sense to say that we will produce all our results in printed form. What then shall we publish ? No definite answer is forthcoming. The test is intrinsic interest, but this, like beauty, lies in the eye of the beholder. As an example of what can be done, however, the present volume, for me at least, is particularly valuable, and I am glad to have it. Further, the book is intended to stimulate the scholarly discussion of metrics, and it is to that honorable intention that the rest of this article is dedicated.

The following essay is statistical in nature, and, since it is confined within the limits of the *Ars Poetica*, its potential is extremely limited. One obvious possibility would be to compare one part of the poem with another, but this is the sort of thing which would be extremely laborious if based, as this discussion is, on the printed version of the book. The other obvious tack, to be pursued here, is to draw some contrast between what Horace may be expected to do in the *Ars Poetica* and what he actually does. This is analogous to what we do in tossing a coin 100 times, that is, we make an assumption concerning the resultant numbers of "heads" and "tails". If the actual results diverge markedly from our prior assumption, then we must conclude that our prior assumption was wrong and that the coin or the manner of tossing it has some qualities of which we were not previously aware. If our prior assumption has been reasonable (and this is always a subject for debate), then the result will have been surprising and, *ipso facto,* interesting.

Turning to the *Ars Poetica*, we are told that 261 of its 476 verses have a dactyllic first foot, and so on.* See Table 1 (cf. Ott, p. 51).

TABLE 1

| Foot | n | n/476 |
|---|---|---|
| 1 | 261 | .5483 |
| 2 | 223 | .4685 |
| 3 | 208 | .4370 |
| 4 | 175 | .3676 |

It is by no means clear why the comparative frequency of dactyls should decrease as one moves forward through the verse, nor is it clear why the particular frequencies found here occur, but it is reasonable to say that we have here a true description of this aspect of the *Ars Poetica.* Rather than speculate about these facts, we shall simply conclude, for the moment at least, that the *Ars Poetica* illustrates a tendency to use fewer and fewer dactyls as the verse moves forward and that this tendency may be precisely described or measured by the figures given. Instead, we shall advance the following statistical hypothesis : nothing more than the tendency described in Table 1 is necessary in order to account for the frequency distribution of the sixteen line-types found in the *Ars Poetica.* To clarify this statement, Table 2 presents the actual frequency

* One verse is also spondaic in the fifth foot, but we shall ignore that anomaly.

distribution found in the *Ars Poetica*. What the hypothesis states is that the numbers found in Table 2 can be derived (within reasonable limits) from the numbers given in Table 1. We now intend to test this hypothesis, but before doing so, we must define what we mean by "within reasonable limits".

TABLE 2

Frequency distribution of line-types in the *Ars Poetica*.

| Line-type | Number |
|---|---|
| 0000 | 31 |
| 0001 | 16 |
| 0010 | 34 |
| 0100 | 39 |
| 1000 | 49 |
| 0011 | 15 |
| 0101 | 35 |
| 0110 | 28 |
| 1001 | 37 |
| 1010 | 46 |
| 1100 | 41 |
| 0111 | 17 |
| 1011 | 25 |
| 1101 | 20 |
| 1110 | 33 |
| 1111 | 10 |
| | 476 |

(Under "line-type", 0 signifies spondee and 1 signifies dactyl. Thus, 0000 signifies the type of line whose first four feet are spondaic.)

In the first place, it should be understood that in statistical testing of this sort, we can never hope to prove that a hypothesis is true. All that we can ever do is prove that a particular hypothesis is false, that is, given a specific test, we can only conclude either that the hypothesis is false or that, so far as the specific test is concerned, the hypothesis has not been proven false. In the statistical world, truth is the residue after all the tests to prove falseness have failed.

Second, within this philosophically restricted terrain, there always remains a finite possibility of error. Our test may reject a true hypothesis as false (a Type I error) or it may fail to reject a false hypothesis (a Type II error). It is the pride of statistics that the magnitude of the risk of such errors can be precisely stated and that tests can be designed so as to minimize the risks of one or both of these errors, but the risks can never be totally eliminated.

In the following test, we define the phrase "within reasonable limits" by setting the level of significance at 95%. This means that we accept one chance in twenty of committing a Type I error.* Our hypothesis may now

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* We omit designedly the far more difficult matter of calculating the magnitude of the Type II error risk. In general, decreasing the size of one risk will increase the size of the other.

be specified in operational terms. Let us imagine four circles. On the center of each is mounted a freely spinning arrow. The first circle is divided and marked in such a way that 54.83% of its circumference is labelled "dactyl". We may assume that if the arrow of this circle is spun a great many times, its point will come to rest on an arc labelled "dactyl" about 54.83% of the time. Similarly, the second circle has 46.85% of its circumference labelled "dactyl", and so on. Let us now imagine that we spin all four arrows simultaneously and we note the results, and we perform this experiment 476 times. Quite simple arithmetic allows us to calculate our best estimate of the result. For example, we calculate the number of times that all four arrows come to rest on "dactyl" as follows :

$$476 \times .5483 \times .4685 \times .4370 \times .3676 = 19.6$$

In fact, the *Ars Poetica* contains only 10 lines whose first four feet are dactyllic. Is this divergence between 10 and 19.6 surprising and therefore interesting ? Happily, we can measure this divergence and see whether or not it is surprising. We do this by calculating chi-square for one degree of freedom (applying Yate's correction for continuity). The calculation looks like this :

$$\frac{(19.6 - 10 - .5)^2}{19.6} + \frac{(466 - 456.4 - .5)^2}{456.4} = 4.41$$

By looking at the proper place in the proper statistical table, we see that if the whole experiment were repeated 100 times, we should not expect to get so high a chi-square value in over 95 of the repetitions. This seems to be a reasonable definition of surprising, especially since we have already set our level of significance at 95%, and this result exceeds that level. Should we therefore, in accordance with our previously stated criteria, reject our hypothesis as false ?

The answer is "no", and while the reasons for this answer may seem sophistic, what follows is really the only proper way to proceed. Our hypothesis applies to *all* the line-types and not to any single one of them. Table 3 presents the chi-square values for all the line-types individually and taken as a whole. These values lie in a delightful sort of statistical limbo, and they deserve detailed comment. In the first place, we see that the most surprising and interesting divergence occurs in the case of the hitherto unsuspected line-type 0101. The percentile figure here indicates that so large a divergence would not be found 995 times in a thousand. If line-type 0101 had been the sole subject of our hypothesis, we should now reject that hypothesis as false with a high degree of confidence. Turning to the text and looking at all the verses of type 0101, I see no immediate reason for its unusual frequency. Only one of the memorable lines of the poem is of this type :

408 *natura fieret laudabile carmen an arte,*

but the surprise remains nevertheless, far greater than that aroused by the apparent avoidance of the totally dactyllic line. But here again, type 0101 was not the sole subject of our hypothesis.

TABLE 3

| Line-type | Actual | (Estimated) | Chi-Square | Percentile |
|---|---|---|---|---|
| 0000 | 31 | 40.7 | 2.274 | 90 - 95 |
| 0001 | 16 | 23.6 | 2.248 | 80 - 90 |
| 0010 | 34 | 31.6 | 0.123 | 20 - 30 |
| 0100 | 39 | 35.9 | 0.204 | 30 - 40 |
| 1000 | 49 | 49.4 | 0.003 | 2.5- 5 |
| 0011 | 15 | 18.3 | 0.414 | 40 - 50 |
| 0101 | 35 | 20.8 | 9.434 | 99.5- 99.9 |
| 0110 | 28 | 27.8 | 0.003 | 2.5- 5.0 |
| 1001 | 37 | 28.6 | 2.320 | 80 - 90 |
| 1010 | 46 | 38.3 | 1.471 | 70 - 80 |
| 1100 | 41 | 43.5 | 0.010 | 5 - 10 |
| 0111 | 17 | 16.2 | 0.006 | 5 - 10 |
| 1011 | 25 | 22.3 | 0.228 | 30 - 40 |
| 1101 | 20 | 25.4 | 0.999 | 60 - 70 |
| 1110 | 33 | 33.8 | 0.003 | 2.5- 5 |
| 1111 | 10 | 19.6 | 4.406 | 95 - 97.5 |
| | 476 | (475.9) | 24.146 | 90 - 95 |

The total chi-square value of 24.146 is not quite large enough to allow us to reject our hypothesis as false, even at the relatively modest level of significance which we have chosen. To be sure, we are quite close to the borderline. A slight increase of 0.500 in the total chi-square value would have been sufficient to cause rejection of the hypothesis. On the other hand, if we could remove somehow the extreme cases of 0101 and 1111, our hypothesis would look very good indeed. But such removal is exactly what we are not allowed to do in good statistical practice. Instead, if our result is so close to the borderline that it arouses suspicion (as is the case here), playing the statistical game properly calls for another sample to be tested. But we do not have another sample; there is only one *Ars Poetica.* Under the circumstances, we must say that this particular game is over; we made our wager and we won (or lost, depending upon how one views the result.)

In the end, we are going to take refuge in a rather different strategem, for it is not at all self-evident that we, as philologists, must play out the game of statistics to the bitter end. Legitimate inference is a major goal for statisticians; it need not loom so large on our philological horizon. While we have no objection to proving something (if we can), we fulfill a major responsibility if we point out the noteworthy and interesting. From this point of view, there can be no doubt about our conclusion : given the hypothesis tested here, 0101 is the most interesting line-type in the *Ars Poetica.*

Turning to the second and final aspect of the *Ars Poetica* to be discussed here, we apply almost exactly the same technique and argument used above and so *brevis esse laboro.* As noted above, the most original section of Ott's book has to do with the position and frequency of word-juncture. Table 4 reproduces his data for the occurrence of word-juncture at particular points in the verse. Ott also lists (p. 45) the numbers and percentages of the 120 possible pairs of word-juncture occurring in the same line. Thus, for example, word-juncture at both point 7 and point 12 occurs in 189 verses. These data on page 45 will not be reproduced here.

TABLE 4

| Position | n | n/476 |
|---|---|---|
| 1 | 188 | .3950 |
| 2 | 63 | .1324 |
| 3 | 195 | .4097 |
| 4 | 293 | .6155 |
| 5 | 64 | .1345 |
| 6 | 61 | .1282 |
| 7 | 394 | .8277 |
| 8 | 78 | .1639 |
| 9 | 130 | .2731 |
| 10 | 274 | .5756 |
| 11 | 50 | .1050 |
| 12 | 226 | .4748 |
| 13 | 47 | .0987 |
| 14 | 243 | .5105 |
| 15 | 271 | .5693 |
| 16 | 35 | .0735 |

Just as in the case of Table 1, we shall not here attempt to plumb the mysteries contained in Table 4, but simply accept the facts in that table as given. Once again we state a statistical hypothesis : the random combinations of the figures in Table 4 are sufficient to account for the figures found on page 45 in Ott's book. Only very simple arithmetic is necessary in order to arrive at the expected values dictated by this hypothesis. For the random combination of word-juncture at point 7 and point 12, we simply multiply 476 by the fractions found in Table 4 opposite these points :

$$476 \times 0.8277 \times 0.4748 = 187.1$$

Since the actual figure is 189, this approach seems promising. The chi-square value for this finding is very small.

The rest seems straightforward enough. One can proceed to calculate all 120 theoretical values (which I have done) and then the 120 accompanying chi-square values (which I have not calculated). The latter is work for a computer, and I have not used a computer in this study. Rapid mental calculation of approximations to the chi-square values has been sufficient to show that our hypothesis must be rejected out of hand. That seems rather a pity, for the hypothesis seems to hold up very well for the vast majority of the 120 combinations. The few cases where the divergences are large, however, produce a chi-square total sufficient to invalidate our hypothesis at a significance level of 99.95% (which is as high as my statistical tables go).

Happily, ten of the twelve highest chi-square values occur in a single class of combinations.* This is the class of combinations where the points are

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* The other two cases are those lines containing word-juncture at point 13 and 16 and those containing it at points 3 and 8. In the former case, there are 10 such lines and the expected value is 2.4. In the latter case, there are 12 such lines and the expected value is 31.9.

adjacent to each other, that is, cases involving monosyllabic or metrically monosyllabic words. By the latter term, we mean simply bisyllabic words which have become metrically monosyllabic through elision. Further, nine of these cases concern short monosyllables. We may conclude than that something unexpected and therefore interesting is happening with regard to short monosyllables, and it is to these that we now turn.

Once our attention has been focussed upon short monosyllables as being somehow peculiar, there are other ways of examining their frequency. For example, utilizing the data in Ott's book, we find that the *Ars Poetica* consists of 7054 syllables. Disregarding the first and last syllables of each line,* leaves a total of 6102. Of these, we find that 2684 or 44% are metrically short. But of the 518 monosyllabic words that occur in the poem (including the metrically monosyllabic, but excluding initial and final monosyllables), only 107 or 21% are metrically short. Once again we may ask what is happening to the short monosyllables.

Since we remain convinced of the basic soundness of our hypothesis (despite the evidence to the contrary), it still seems worthwhile to present Table 5, which contains the actual and expected values for monosyllabic

* From the nature of the case, our initial hypothesis has not allowed the formation of expected values for initial or final monosyllables. They actually number 198 and 35 respectively.

words in accordance with that hypothesis (now slightly modified.)** Here we find, despite the figures at points 4, 7 and 12, that the total number of long monosyllables is also rather less than that expected by our modified hypothesis. So we may now modify our question to read : where are all the monosyllables (especially the short ones) ?

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** The modification involves long monosyllables occurring in the second half of the foot. We can calculate the probabilities of a word just fitting the second half of a foot in accordance with our hypothesis by simply subtracting the probabilities of two successive (short) monosyllables. Thus, for example, the expected number of words extending from point 1 to point 3 is found as follows :

$$476 \quad ((.3950 \times .4091) - (.3950 \times .1324 \times /4097)) = 66.83$$

Since this group can now consist of either long monosyllabic words or words consisting of two short syllables, our hypothesis is modified by dividing the expected total in two parts according to the ratios given in Table 1.

TABLE 5

Actual and (Expected) Number of Monosyllabic Words

| Initial point | Short | Long |
|---|---|---|
| 1 | 6 ( 24.9) | 29 ( 30.3) |
| 2 | 17 ( 25.8) | |
| 3 | | 75 (120.1) |
| 4 | 5 ( 39.4) | 22 ( 17.3) |
| 5 | 3 ( 8.2) | |
| 6 | | 40 ( 50.5) |
| 7 | 11 ( 64.6) | 78 ( 50.7) |
| 8 | 5 ( 21.3) | |
| 9 | | 51 ( 74.8) |
| 10 | 1 ( 28.8) | 62 ( 74.6) |
| 11 | 5 ( 23.8) | |
| 12 | | 38 ( 22.3) |
| 13 | 4 ( 24.0) | 0 ( 0.0) |
| 14 | 50 (138.3) | |
| 15 | | 16 ( 19.9) |
| | 107 (399.1) | 411 (460.5) |

Given the low level of sophistication of our present inquiry, we can now conclude only by indulging in a spate of speculation.

In the first place, it is possible that our hypothesis is simply false in that it assumes a frequency of monosyllabic words in Latin which is much too large, particularly in the case of metrically short monosyllabic words. The hypothesis, however, has not been drawn from thin air; it is solidly based on Horace's practice in the *Ars Poetica.*

Secondly, it is clear that the hypothesis expects a far larger proportion of metrically short monosyllables than actually appears. Here, some remarks may be helpful. It is worth noting that our hypothesis calls for 59 cases where two short monosyllabic words would occur in succession. In fact, there are only 3 such instances (lines 153, 258, 272), and it is reasonable to conclude that such combinations have been avoided. Further, it is quite clear, that poets can and do lengthen naturally short syllables by position, but they cannot do the opposite. Hence, it may not be unreasonable to find that the ratio of short monosyllables will be smaller than expected.

Accepting the above, the small total number of monosyllables remains a problem. By now, the reader will have concluded that I view with suspicion the total number of initial (188) and final (35) monosyllabic words. It is worth noting immediately that far more monosyllables occur at the beginning of the line than at any other point. However, our major hypothesis has not allowed us to form expected values for the number of monosyllables at these points. Here are two subsidiary hypotheses concerning their total number which will straddle the objective.

The *Ars Poetica* consists of 7054 syllables. Eliminating the first and last syllables of each line, we are left with the 6102 syllables which have been the subject of our inquiry. Within these 6102 syllables, we have expected to find 859.6 monosyllabic words and we have actually found 518. Let us now project these findings to all 7054 syllables. On the basis of the first figure (859.6), we should expect to find 994 monosyllables. On the basis of the second (518), we should expect to find 599. The arithmetic mean of these two numbers (994 and 599) is 797.* The actual number of monosyllabic and metrically monosyllabic words in the *Ars Poetica* is 741, which is not, statistically speaking, terribly different from what we might have expected. Here, then, is our tentative conclusion : the random combination of the percentages given in Table 4 is sufficient to explain the occurrence of pairs of word-juncture in the *Ars Poetica*, with the exception of those pairs arising from the incidence of monosyllables. In the case of the latter, while the total number of monosyllables is about what may be expected, there is a tendency far greater than one might expect to place these words at the beginning of the line.**

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* To add a touch of mystery, the harmonic mean of these two numbers is 748.

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