The Computer Reads Aristotle's Protrepticus: Iamblichus Protr. VI-XII

and On the Common Mathematics XXI-XXVII¹

Introduction

The detection of layers of borrowed material in later Greek philosophy is often possible using multivariate analysis of everyday vocabulary. The methods have been adapted from those employed frequently by researchers from the University of Newcastle's Centre for Literary and Linguistic Computing: (http://www.newcastle.edu.au/school/hss/research/groups/cllc/).²

For ancient Greek all verbs, nouns, adjectives and pronouns have been reduced to a single form (except where verbs employ more than one root).³ Adverbs formed regularly from an adjective, as well as comparatives and superlatives from the same root, are listed under the nominative masculine singular of the adjective. Regularly formed adverbs are treated as identical with their root adjectives. As in practice all nouns, and the vast majority of verbs and adjectives are excluded as being too dependent on subject matter, it is mainly the article and pronouns that are affected by this policy of excluding inflections. Analyses usually include many particles, prepositions, and conjunctions, with the article being easily the commonest 'word' included.

Ordinarily the commonest 200 or 250 words in a given selection of texts is determined, of which 80 to 120 are accepted as function-words potentially useful for any text in the genre regardless of subject

¹ Comments on this work are welcome; it employs tests that were relatively easy to employ thanks to generous earlier funding by the Australian Research Council (DP0986334). Obviously other stylistic criteria could have been used, some of them having authorship implications. The tests should be used alongside traditional scholarship, which has tended to focus rather on similarities in the technical philosophic vocabulary and on the concepts and theories that it underpins. It is not my intention that this kind of work should ever be replaced.

² In particular I use Intelligent Archive software to extract from texts (divided into blocks of a default size in the case of files large enough) the frequency of the commonest words (in terms of their percentage of all words); of these I normally use only function-words. I then make use of cluster analyses (usually through Minitab software), factor analysis (usually through SPSS software), and principal component analysis (PCA). T-tests (in Excel) are often used to determine the words that best distinguish between two authors or other obvious stylistic groups, though the computer calculates the discriminatory value of each word when assigning factors or principal components. One is always able to determine which words carry most weight in determining where a given block of text belongs, and so the philologist does not have to trust computer calculations in isolation and may draw attention to any special circumstances that might make a certain word an unfair test. Some earlier uses of my methods are available in print or online: H. Tarrant, 'Narrative and Dramatic Presentation in Republic III', in N. Notomi & L. Brisson eds. Dialogues on Plato's Politeia (Republic): Selected Papers from the Ninth Symposium Platonicum, Sankt Augustin: Academia, 2013, 309-313; 'Appendix 2: Report of the Working Vocabulary of the Doubtful Dialogues' (with T. Roberts), in Marguerite Johnson and Harold Tarrant (eds), Alcibiades and the Socratic Lover-Educator, London: Bristol Classical Press, 2012, 223-236; 'The Origins and Shape of Plato's Six-Book Republic', Antichthon, 46 (2012), 52-78; 'A Six-book version of Plato's Republic: Same Text Divided Differently, or Early Version?', ASCS 32 Selected Proceedings: Refereed papers from the 32nd Annual Conference of the Australasian Society for Classical Studies, Auckland, NZ, 2011. http://www.ascs.org.au/news/ascs32/Tarrant.pdf; 'The Mythical Voice in the Timaeus-Critias: Stylometric Indicators' (with E.E. Benitez, and T. Roberts), Ancient Philosophy 31 (2011), 95-120; 'The Theaetetus as a Narrative Dialogue?', in N. O'Sullivan (ed.) ASCS 31 Proceedings, 2010: classics.uwa.edu.au/ascs31/tarrant.pdf.

³ My modified texts treat all verbs as infinitives, all cases as nominatives, and all adjectives etc. as masculine, but it makes no difference in practice--one might equally print the article in any way that was convenient for the subsequent analysis.

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matter. This may be further pruned to eliminate terms whose frequencies may be skewed in literary presentation, such as first and second person pronouns that are common in dialogic rather than monologic prose. Exclusions will vary according to the group of texts under investigation, and one would be wise to exclude the preposition $\kappa\alpha\tau\dot{\alpha}$ when analysing material dealing with Aristotelian categories, and the numeral $\epsilon \zeta$ from data on Neoplatonist metaphysics.

Two methods of analysing selected vocabulary are employed, (a) factor analysis by principal component (or principal component analysis), which is designed to separate out different influences that affect function-word distribution within a given group of texts (e.g. in Plato a change to the language of myth rather than that of conversation will affect the rates of a number of words simultaneously, with negatives falling, the article rising, particles falling and certain prepositions rising; chronology will affect the rates of another group of words, most of them well known from studies antedating the use of computers);⁴ and (b) cluster analysis, designed to assign blocks of texts to families on the basis of a level of similarity. There are several methods of 'linkage' in cluster analysis, but I have usually used Ward's method, which is regarded as useful for this kind of linguistic analysis. As opposed to some others, and notably to 'single linkage', Ward's method tends to assign quite unusual blocks of text to one family cluster or another.⁵

In cluster analysis the dominance of the article (usually between 8% and 18% in texts examined here), and of certain conjunctions such as $\kappa\alpha i$ and $\delta \epsilon$ (which between them may account for nearly another 10% of vocabulary), mean that they may seem to have too much weight in the analysis, unless data are standardised: a process employing mean and standard deviation that gives all words an equal opportunity to influence results if they are relevant. For instance, in Plato the rate of the particle $\mu \eta v$ will have a more potent effect in separating late from early works than the much commoner $\kappa\alpha i$, so that, even though the variation in the latter as measured by the standard deviation may be greater *in absolute terms*, it will be smaller relative to the mean. My experience is that standardising data has usually tended to sort blocks of texts into groups that are more obviously relevant, but at times it may be quite appropriate that the article, for instance, often more than 10% of total vocabulary, should have *correspondingly* more weight than the adverb $\tilde{\epsilon}\tau_1$, well under 1%.

The critical issue with regard to these chapters of Iamblichus is to what extent their language is dependent upon that of an Aristotelian text, especially upon his *Protrepticus*. If he is not *linguistically* dependent upon Aristotle (or any other source) then one would expect our analyses to group the chapters with other Iamblichan material; in this case the bulk of the philosophy might still be dependent upon Aristotle. But linguistic dependence should lead to resemblances with comparable Aristotelian texts. The kind of linguistic dependence that I have in mind here would appear to be in evidence in the bulk of chapters VI to XII of Iamblichus' *Protrepticus*, where it is virtually certain that Aristotle is closely followed. In order to see whether linguistic dependence is obvious in this text one needs to compare it simultaneously with a selection of Aristotle and another selection of what one can presume to be real Iamblichus. Chapters 1-3 of book VII of the *Politics* plus chapters 6-9 of book

⁴ The key point here is that in a suitable group of texts, involving a representative sample of early and late material, with examples of both myth and conversational style in both the early and the late samples, one of the first two factors or principal components is likely to relate to the stylistic difference, while the other relates to the chronological difference. Each factor, or principal component, involves all the variables (words), but the weightings vary in accordance with the discriminatory power of each. The first factor, or principal component, will capture a difference between sets that is somewhat more obvious to the computer than the second or subsequent ones, and so on. The third may still be quite useful, but I have seldom found it worth analysing a fourth or subsequent factor in any detail.

⁵ Difference kinds of 'distance' are also used in these calculations, but I have seldom felt the need to use anything other than Euclidean distance.

X of the *Nicomachean Ethics* provided the Aristotle, and Iamblichus was represented by material from books II and III of the *de Mysteriis*. One expects chapters VI-XII of the *Protrepticus* to be grouped with, or look closer to, the Aristotelian material. In figure 1 is the result, given in the form of a dendrogram, a kind of family tree of linguistic resemblance, in which MinitabTM software has been asked for four clusters, to which it has allocated four colours:⁶



Fig. 1: Cluster analysis of Protrepticus VI-XII with Aristotle and Iamblichus

Cluster analysis has placed all known Aristotle in cluster 1 (red), separated at a notional level of resemblance of -61.39 from all Iamblichus, placed in cluster 2 (green). Chapters 6, 8, and 10 of *Protrepticus* have also been placed in cluster 1, while the short chapter 12 is allocated its own cluster (4, yellow)—something that happens rarely when analysis is by Ward's method, as here.⁷ This probably indicates the dangers of dealing with very short blocks of text, rather than anything about the provenance of the chapter. Chapters 7, 9, and 11 have been placed in cluster 3 (blue), closest to 12, but much closer as a whole to the Aristotelian material in cluster 1. This may simply mean that there was something distinctive about parts of the *Protrepticus*, not shared by the mature ethical treatises—an exoteric nature, or possibly a dialogic one. I might also have considered the possibility of greater Iamblichan involvement in these chapters, but for the fact that later analyses showed chapters 7, 9, and 11 to be somewhat less like Iamblichus than the rest.

⁶ The 'clusters' are determined according to the distance at which groups relate to one another; in practice that means that the three highest horizontal connecting lines will be those that separate distinct clusters. Had I asked for a fifth cluster there would have been a division of cluster 1 (red) into two, and so on. The shape of the diagram is not altered by demanding a different number of clusters.

⁷ I note that Hutchinson and Johnson do not postulate much of XII as being definitely Aristotle; this may mean that it has much the same hybrid status as the latter part of V, a complex status probably involving Porphyry as well as Iamblichus and Aristotle involving to judge from subsequent tests.

Hence the *Protrepticus* material resembled Aristotle rather than Iamblichus. This was no surprise, as other material in the *Protrepticus* is heavily dependent on source-texts, including works of Plato. It is thus worth asking to what extent such 'plagiarism' is present, as usually presumed, in the work *On the Common Mathematics (DCMS)*, the third work in a series of short Iamblichan books making up a coherent Pythagorean project, following after the *Protrepticus*. It has been debated since Merlan's impressive study⁸ whether the *DCMS* IV, or more accurately 15.6-17.29 (or 15.6-18.13), is a fragment of Speusippus, a thesis rejected by Tarán but accepted by Dillon.⁹ But even if it were not Speusippus, the language was clearly shown by Merlan to be distinctive, and would have to be attributed to *some* unidentified source.¹⁰ Chapter VI, however, follows word-for-word passages from the *Epinomis* and from *Republic* VII,¹¹ and much else has parallels with later authors that suggest that Iamblichus may have been following a well-known source. Chapter VII overlaps to a considerable extent with Iamblichus' own *Introduction to Nicomachus' Arithmetic* that comes fourth in Iamblichus project, and again contains some distinctive terminology. So Iamblichus' word-for-word borrowings from other authors are certainly possible at almost any point of the work, though there is no obvious parallel to the sustained use of Aristotle's *Protrepticus* in his own work of that title.

Philip Merlan claimed the bulk of *DCMS* XXIII for Aristotle's *Protrepticus*,¹² following the recognition of substantial parallels between chapter XXVI and the Aristotelian chapters of Iamblichus' *Protrepticus*. There is no necessity that this should entail the Aristotelian nature of the intervening chapters XXIV and XXV, but the possibility requires investigation. Iamblichus' failure to mention his principal sources (as opposed to the sources that *his* sources name) makes it hard to pinpoint the exact extent of borrowings. If Merlan (157) is right about the beginning of XXVII (84.21-85.27) being a strange borrowing from *de Partibus Animalium* 639a4-b5, with all the examples being changed to suit mathematics rather than biological sciences, then it also greatly increases the number of ways in which Iamblichus borrows, and complicates the issues to a high degree. But there is another possibility, namely that Aristotle himself has adapted something originally said in a lost work, possibly the *Protrepticus*, to suit his biological inquiries.¹³ Clearly we should expect some

⁸ From Platonism to Neoplatonism, The Hague, 1953, 3rd ed. 1968, 96-140.

⁹ L. Tarán, Speusippus of Athens, Leiden 1981, 86-107; John Dillon, *The Heirs of Plato*, Oxford 2003, 41-46; the passage includes the key verb δυσχεραίνω (17.10), on which see now H. Tarrant, 'The *Dyschereis* of the *Magna Moralia*', *Plato* 8 (2008), [Online], mis en ligne : June 2008, URL : <u>http://gramata.univ-paris1.fr/Plato/article81.html</u>; the verb is not otherwise found in this work of Iamblichus. ¹⁰ Another possibility that has been proposed is Heracleides Ponticus, K. Bringmann, 'Platons *Philebos* und

¹⁰ Another possibility that has been proposed is Heracleides Ponticus, K. Bringmann, 'Platons *Philebos* und Herakleides Ponticus' Dialog περὶ ἡδονῆς', *Hermes* 100 (1972), 523-30.

 ¹¹ Epinomis 991d-992b, then 991b6-c3, then 986c4-d4 (pp. 20.22-21.15, 21.15-19, 21.21-22.5 Festa); *Republic* 537c-d, 536b, 527d-e, 521c-d, 523a-532d (pp. 22.5-28.14). Note that passages mostly appear in reverse order.
¹² Merlan, loc.cit. 141-159.

¹³ I here give the text of the Aristotelian work with the words that I do not consider significantly different in Iamblichus in bold: Πεπαιδευμένου γάρ έστι κατὰ τρόπον τὸ δύνασθαι κρῖναι εὐστόχως τί καλῶς ἢ (5) μὴ καλῶς ἀποδίδωσιν ὁ λέγων. Τοιοῦτον γὰρ δή τινα καὶ τὸν ὅλως πεπαιδευμένον οἰόμεθ' εἶναι, καὶ τὸ πεπαιδεῦσθαι τὸ δύνασθαι ποιεῖν τὸ εἰρημένον. Πλὴν τοῦτον μὲν περὶ πάντων ὡς εἰπεῖν κριτικόν τινα νομίζομεν εἶναι ἕνα τὸν ἀριθμὸν ὄντα, τὸν ὅὲ περί τινος φύσεως ἀφωρισμένης· εἰη γὰρ ἄν τις (10) ἕτερος τὸν αὐτὸν τρόπον τῷ εἰρημένο διακείμενος περὶ μόριον. Ώστε δῆλον ὅτι καὶ τῆς περὶ φύσιν ἰστορίας δεῖ τινας ὑπάρχειν ὅρους τοιούτους πρὸς οῦς ἀναφέρων ἀποδέξεται τὸν τρόπον τῶν δεικνυμένων, χωρὶς τοῦ πῶς ἔχει τἀληθές, εἴτε οὕτως εἰτε ἄλλως. Λέγω δ' οἶον πότερον δεῖ λαμβάνοντας (15) μίαν ἑκάστην οὐσίαν περὶ ταύτης διορίζειν καθ' αὐτήν, οἶον περὶ ἀνθρώπου φύσεως ἢ λέοντος ἢ βοὸς ἢ καί τινος ἄλλου καθ' ἕκαστον προχειριζομένους, ἢ τὰ κοινῆ συμβεβηκότα πᾶσι κατά τι κοινὸν ὑποθεμένους. Καὶ πρὸς τούτοις ὅσα τοιαῦτα τῶν λειπομένων παθῶν τε καὶ διαθέσεων· ἄδηλον γὰρ καὶ ἀρίσις, θάισις, καὶ πρὸς τούτως ὑσια τοιοῦτοις σῶτι λείτου μένων παθῶν τε καὶ διαθέσεων· ἄδηλον γὰρ καὶ ἀρώρτις καὶ κατὰ μέρος μὲν λέγοντες περὶ πολλῶν ἐροῦμεν πολλάκις ταὐτὰ · καὶ γὰρ ὅππος καὶ κυσὶ και κατὰ μέρος μὲν λέγοντες περὶ πολλῶν ἐροῦμεν πολλάκις ταὐτά· καὶ γὰρ ῦπποις καὶ κατὰ μέρος μὲν λέγοντες περὶ πολλῶν ἐροῦμεν πολλάκις ταὐτά · καὶ γὰρ ὅπαις και κυσὶ καὶ ἀνθρώποις ὑπάρχει τῶν εἰ- (25) ρημένων ἕκαστον, ὥστε ἐὰν καθ' ἕκαστον τῶν διαφέρεων, ὅσα ταὐτὰ μὲν ὑπάρχει τῶν εἰ- (25) ρημένων ἕκαστον, ὅσα ταὐτὰ μὲν ὑπάρχει τοῖς εἶδει διαφέρουσι τῶν ζώφυ, αὐτὰ δὲ μηδεμίαν ἔχει διαφοράν. ¨Ετερα δὲ ἴσως ἐστὶν οἶς συμβαίνει τὴν μὲν κατηγορίαν ἔχειν τὴν αὐτήν, διαφέρεων λέγη τις, πολλάκις ἀναγκασθήσεται περὶ τῶν οἶς συμβαίνει τὴν μὲν κατηγορίαν ἔχειν τὴν αὐτήν, διαφέρεων λέοι δὲ μηδεμίαν ἔχει διαφοράν. ¨Ετερα δὲ ἴσως ἐστὶν οἶς συμβαίνει τὴν μὲν κατηγορίαν ἔχειν τὴν αὐτήν, διαφέρειν (30) (639b.) δὲ τῆ κατ' εἶδος

influence of Aristotelian style in a case like this, but the influence would be more in evidence if the passage were virtually pure Aristotle.¹⁴

Again, it was necessary to include both Aristotelian and Iamblichan material. While these should dominate, there would be no harm in adding small quantities of other authors, usually of intermediate date. Such additional material should be kept at a level where statistics programs would recognise the two main groups to be distinguished as being Iamblichan and Aristotelian. Three possible approaches to the tests emerged. First, the whole text of *DCMS* XXI-XXVII could be used, and divided into blocks of 500 or more words automatically. Second, one could test the individual chapters, making no allowance for what was supposedly Aristotelian material and what was not. Third, one could test the Aristotelian credentials only of what had been tentatively claimed as Aristotelian material.

The first method had several difficulties, illustrated by the following dendrogram (Fig. 2), from the initial cluster analysis. The same basic texts were used [Iamblichus *Protrepticus* VI-XII (expected to behave as Aristotle), Aristotle *Pol.* VII.1-3, Aristotle *EN* X.6-11, *DCMS* XXI-XXVII, and Iamblichus, *de Mysteriis* II and III, but fragments of Numenius *On the Good* were also added:



Fig. 2: DCMS divided into 700-word blocks - 93 function-words

Most unequivocally Aristotelian blocks were assigned to three closely related clusters, clusters 1, 4, and 5, in the left-hand division. This included only one DCMS block, the fifth of six, which was probably centred on chapter XXVI. But it included all blocks of the *Protrepticus*, suggesting a much more consistent use of Aristotle there than in DCMS. To the extent that most of the DCMS passage

διαφορῷ, οἶον ἡ τῶν ζώων πορεία· οὐ γὰρ φαίνεται μία τῷ εἴδει· διαφέρει γὰρ πτῆσις καὶ νεῦσις καὶ βάδισις καὶ ἕρψις. Διὸ δεῖ μὴ διαλεληθέναι πῶς ἐπισκεπτέον, λέγω δὲ πότερον κοινῆ κατὰ γένος πρῶτον, εἶτα ὕστερον περὶ τῶν ἰδίων θεωρητέον, ἢ καθ' ἕκαστον εὐθύς.

¹⁴ At this stage I am not sure how valuable it might prove to include *PA* in my tests.

and all material from Iamblichus' *de Mysteriis* appeared in the major right-hand division, this suggested considerable Iamblichan content in DCMS XXI-XXVII. But things were not so simple. Only the first block was in cluster 3 (blue) dominated by neat Iamblichus, most occurring in cluster 2 (green), which also housed a block of pure Aristotle, the Numenius material, and just two blocks of *de Mysteriis*. This therefore looked rather like an intermediate or anomalous cluster.

Sorting the DCMS material into chapters was clearly a desirable next step, though it should be appreciated that the chapters are of unequal length, and the smallest chapter (XXI: 144 words) fell far short of the necessary length for reliable results. Numenius was discarded at this stage (Fig. 3).



Fig. 3: DCMS divided by chapters, others into 600-word blocks - 92 function-words

Now the major group to the left contained all pure Aristotle, with only 3 chapters of DCMS appearing there, those already identified as having some Aristotelian content by Jaeger (26) and Merlan (23, 26). The presence here of chapter 27 seems to indicate more Aristotelian content than the partial overlap with *de Partibus Animalium* noted by Merlan and continuing for little more than one page out of four. Also interesting was the devotion of a separate cluster (3, yellow) to five out of eight blocks of the *Protrepticus*, and while it may be suspected that this is because these chapters are slightly less Aristotelian, principal component analysis was able to establish that they were, taken as a whole, hyper-Aristotelian. It was not a surprise that the brief Chapter XXI was assigned a cluster of its own, but chapters XXII, XXIV, and XXV were placed in the blue cluster with all material from *On the Mysteries*. It looked as if the language of Iamblichus was dominating here.

However, I was now conscious of the need to revise my list of function-words. It was one used previously for later Greek texts, but would benefit from revision with this particular selection of texts in mind. Here is an analysis where I selected 104 function-words from the commonest 250 in the group as a whole (fig. 4):



Fig. 4: DCMS divided into chapters, 500 word blocks - 104 function-words

Now only chapters XXI, XXII, and XXV are placed among the blocks of text exhibiting something akin to Iamblichan language.

Even so, it seemed fairer to test only the material believed by Hutchinson and Johnson to come directly from the *Protrepticus*, leaving only the occasional connective that they had chosen to exclude, more on the grounds that *some* connective was required. At this point I also removed the earlier part of *de Mysteriis* book II, on the grounds that several analyses had suggested that Iamblichus was there following a source somewhat consistently, from the end of his introduction to around word 3000. The main Iamblichus cluster (3: blue) now became more tightly knit (fig. 5):



Fig. 5: DCMS modified & divided into 500-word blocks - 101 function-words

Two out of five blocks of the selected material, the first and third, continued to look like plausible examples of Iamblichan language and were placed in cluster 3 (blue), the second block was placed mainly with material from the *Nicomachean Ethics* in cluster 2 (green), while the fourth and fifth blocks were coupled rather with material from the *Politics* and *Protrepticus* in cluster 1 (red). Does this result signify that Hutchinson and Johnson were a little too optimistic about the amount of straight Aristotelian material that could be extracted from chapters XXI-XXVII? Now at this stage I needed an additional tool. Blocks 1 and 3 of modified DCMS text were actually very close together, and constituted a sub-cluster with just four Iamblichan blocks. In these circumstances, the factors leading to their being separated off in this cluster may be quite minor, amounting to something more like 'background noise' than a real 'theme'. Principal component analysis was used to separate out those linguistic elements that appear to work together in making blocks look different. The Numenius file was put back, and a file contained the allegedly Speusippean part of DCMS IV was also added. The diagram produced as a result is given in figure 6:



Fig. 6: Principal Component Analysis, 101 function words

One may inspect which words pull a block of text in a particular direction (figure 7):¹⁵



¹⁵ Frequency of the prepositions $\dot{\alpha}\pi\dot{\alpha}$ and $\epsilon\dot{i}\zeta$ has maximal positive influence ($\gamma\dot{\alpha}\rho$ maximal negative influence) in placing *Mysteries* blocks at the far left of Fig.6, while $\gamma\dot{\alpha}\rho$ has maximal positive influence in placing Aristotle blocks to the right, while $\gamma\epsilon$ pulls somewhat right but maximally upwards. All words have *some* influence.

Fig. 7: loadings for individual items of vocabulary (j=final sigma)

In fact the second component seems of doubtful relevance to the questions before us. Below I sort the blocks of text according to the values calculated for them on the two components, and the familiar separation of Iamblichus from Aristotle is very much visible in the results for the first principal component (table 1):

Word	PC1	PC2	Word	PC1	PC2
Myst3 (10)	-5.97981	0.28412	DCMSh&j (5)	3.12881	-6.30093
Myst3 (3)	-5.80063	1.15831	ArPol7 (2)	2.81569	-4.21858
Myst3 (1)	-5.53374	1.69887	IambProtr (1)	2.82469	-3.77796
Myst3 (7)	-5.4113	0.73833	DCMSh&j (4)	2.38031	-3.66618
Myst3 (8)	-3.96306	0.16451	Myst3 (5)	-2.66566	-3.59672
Myst3 (11)	-3.35905	2.74307	ArPol7 (1)	2.54568	-3.41218
Myst3 (9)	-3.19356	1.11623	DCMSh&j (3)	0.38363	-3.21989
Myst2B (2)	-3.09647	-1.12483	DCMSh&j (1)	-2.42142	-1.92768
Myst3 (4)	-3.01143	3.81801	Numenius (1)	-1.12726	-1.67432
Myst3 (2)	-2.8819	-0.32557	ArPol7 (3)	4.5846	-1.64404
Myst3 (5)	-2.66566	-3.59672	Myst2B (2)	-3.09647	-1.12483
DCMSh&j (1)	-2.42142	-1.92768	NicEth (2)	1.62466	-0.97271
Myst3 (6)	-1.60036	-0.61623	DCMSh&j (2)	-0.27928	-0.91391
Myst2B (1)	-1.47221	-0.52346	Myst3 (6)	-1.60036	-0.61623
Numenius (1)	-1.12726	-1.67432	Myst2B (1)	-1.47221	-0.52346
DCMSh&j (2)	-0.27928	-0.91391	Myst3 (2)	-2.8819	-0.32557
DCMSh&j (3)	0.38363	-3.21989	NicEth (4)	1.22268	-0.30631
DCMS4Sp(1)	0.64173	-0.06856	IambProtr (7)	1.53282	-0.07345
NicEth (4)	1.22268	-0.30631	DCMS4Sp(1)	0.64173	-0.06856
NicEth (5)	1.47456	0.20852	NicEth (1)	1.82964	0.08521
IambProtr (7)	1.53282	-0.07345	Myst3 (8)	-3.96306	0.16451
NicEth (2)	1.62466	-0.97271	NicEth (5)	1.47456	0.20852
NicEth (1)	1.82964	0.08521	Myst3 (10)	-5.97981	0.28412
IambProtr (5)	2.33703	5.30251	Myst3 (7)	-5.4113	0.73833
DCMSh&j (4)	2.38031	-3.66618	Myst3 (9)	-3.19356	1.11623
ArPol7 (1)	2.54568	-3.41218	Myst3 (3)	-5.80063	1.15831
IambProtr (8)	2.80165	2.90563	NicEth (3)	3.13589	1.16505
ArPol7 (2)	2.81569	-4.21858	IambProtr (2)	3.69378	1.60777
IambProtr (1)	2.82469	-3.77796	Myst3 (1)	-5.53374	1.69887
IambProtr (4)	3.09441	3.33753	Myst3 (11)	-3.35905	2.74307
DCMSh&j (5)	3.12881	-6.30093	IambProtr (8)	2.80165	2.90563
NicEth (3)	3.13589	1.16505	IambProtr (4)	3.09441	3.33753
IambProtr (6)	3.66586	8.0052	Myst3 (4)	-3.01143	3.81801
IambProtr (2)	3.69378	1.60777	IambProtr (3)	6.07902	4.02462
ArPol7 (3)	4.5846	-1.64404	IambProtr (5)	2.33703	5.30251
IambProtr (3)	6.07902	4.02462	IambProtr (6)	3.66586	8.0052

Table One: Results for first and second principal components

On factor 1, the green of the *de Mysteriis* is totally separated from all the rest apart from the first block of DCMS material that Hutchinson and Johnson would prefer assign to the *Protrepticus*. But that block is not far separated from most of the rest of such DCMS material. That Iamblichus could be intermittently following a single source in DCMS XXI-XXVII, and a single Aristotelian source at that, is not something that can be ruled out on the basis of this data. More problematic is the way in which the material from the *Protrepticus* is comparatively extreme, given positive values between 1.5 and 6.1, comparable with *Politics* (2.5-4.6) rather than with *Nicomachean Ethics* (1.2-3.2). The range of *DSCM* (-2.3 to +3.2) is quite ambiguous compared with that of *Protrepticus*. Suspicions that they are not so compatible may be enhanced by a glance at the results for principal component 2. Here the most obvious separation is between *DCMS* (-6.30 to -0.91) and *Protrepticus* (-3.78 to + 8.01). Are there conclusions to be drawn from this?

If the material in *DCMS* is plausibly Aristotelian in its language (for the most part), but less plausibly from the *Protrepticus* as represented in Iamblichus' *Protrepticus*, then four possibilities need to be considered:

- 1. That the material in *DCMS* is (mostly) from different Aristotelian works; this may mean that Aristotle's own self-plagiarising is responsible for overlapping material in DCMS XXVI.
- 2. That the differences are actually due to the use of different characters within Aristotle's *Protrepticus*, with Aristotle's own voice probably being better represented in Iamblichus' *Protrepticus* than in *DCMS*.
- 3. That the differences are due less to the use of different characters and more to the use of different diction within the *Protrepticus*.
- 4. That Iamblichus is actually following largely Aristotelian material through an intermediate source in the *DCMS*, which would certainly complicate the results.

Whatever has happened, the comparison between overlapping passages at first suggests that much material, which had in the *Protrepticus* (presumably the original version) pertained to ethics or the natural sciences, has been replaced in the *DCMS* (whether by Iamblichus himself or an unknown source) by new, usually briefer material that pertains to mathematics. This seems similar to what has happened at the beginning of XXVII, if either (a) Iamblichus directly follows *De Partibus Animalium* or (b) Aristotle had reused the passage from the *Protrepticus* almost unchanged.¹⁶ If a similar level of modifications had been made throughout, then the rather weaker Aristotelian response in *DCMS* would be explicable. But I doubt that Iamblichus was entirely responsible for the mathematization of material from the *Protrepticus*, for it is scarcely credible that he would have thought of that work as a desirable source, unless the *Protrepticus* had, in parts, especially promoted the study of mathematics.¹⁷ It is by no means impossible that Aristotle had employed two sets of examples in his early work, one pertaining to mathematics and the other to general scientific inquiry,¹⁸ this allowing Iamblichus to offer whichever set suited his context.

In any case a further stage now seemed to be required in the investigation. One needed to be able to assign to chapters the DCMS material in the slimmed down files that only printed sentences assigned to the *Protrepticus* by Hutchinson and Johnson. Accordingly, the H&J material was now divided by

¹⁶ Both assumptions are probably wrong; only about 130 (50%) of the words in this part *DCMS* XXVII can be traced to *PA* as our analysis in n. 13 shows, and yet when its language appears *even more typically Aristotelian* than the rest of XXVII, when the two parts are analysed independently.

¹⁷ I note that common material of a mathematical nature in Proclus also makes this unlikely.

¹⁸ I believe that dialogue would have offered the best opportunity for presenting two parallel sets of examples of this kind.

chapters. The material in XXI and XXII was combined into one file, and the material in XXV (which at only 75 words was bound to yield odd results) was omitted and replaced by the full chapter. The first cluster analysis turned out as follows (fig. 8):



Figure 8: Dendrogram with H&J files considered by chapters (A)

At first sight this looked quite promising. All except one of the twelve *de Mysteriis* blocks were assigned to cluster 7 (red, right), which itself contained no blocks from either *Protrepticus* or *DSCM*, was closely related only to cluster 8 (green, far right), which contained the file of material from *DSCM* XXI & XXII with that from XXIV. This at least seemed to suggest that parts of these chapters were not neat Iamblichus even though the basic language-mix was not recognizably Aristotelian either. Chapter XXVI with its overlap with the beginning of the *Protrepticus* material was unsurprisingly placed with the first block of *Protrepticus* VI-XII in cluster 5 (magenta), and closely connected with cluster 4 (yellow). This cluster included one stray block of *de Mysteriis*, the material deemed relevant from *DCMS* XXIII and XXVII, and (more surprising), the whole of *DCMS* XXV. Since clusters 4-5 were then coupled with the Aristotelian material, this seemed to be a clear indicator that there was quite a bit of Aristotelian influence in the underlying Greek of all these files.

Unfortunately a little extra work identified one common word that I thought should have been excluded, the Greek *aei* ('always'), since there seemed to be a case that this was part of the technical material of any philosophy concerned with eternal truths. The following dendrogram (figure 9) was produced after this one variable was discarded:



Figure 8: Dendrogram with H&J files considered by chapters (B)

The individual clusters still consisted of exactly the same files with exactly the same cluster numbering and colour-allocation, but the weightings have now been recalibrated so that clusters 4-5 are linked with clusters 7 (Iamblichus) and 8 (material from DCMS XXI, XXII, and XXIV). It confirms that we are dealing with linguistically borderline material, even where one would be expecting Iamblichus to be consistently following an Aristotelian source. Principal component analysis on the same data offered the following results for three principal components:

Block	PC1	Block	PC2	Block	PC3
Myst3 (1)	-5.284	IambProtr (6)	-6.32085	dcmH&J23	-5.35973
Myst3 (7)	-5.20502	IambProtr (3)	-5.19988	IambProtr (3)	-4.53828
dcmH&J21&22	-4.53989	IambProtr (5)	-4.51756	dcmH&J26	-3.95387
Myst3 (3)	-3.69633	IambProtr (8)	-2.95156	IambProtr (1)	-3.9308
Myst3 (8)	-3.64209	Myst3 (7)	-2.52286	dcmH&J21&22	-3.13898
Myst3 (10)	-3.45365	Myst3 (1)	-2.10322	dcmH&J27	-2.21135
Myst3 (2)	-2.81881	Myst3 (4)	-1.24595	Myst2B (1)	-2.14026
Myst3 (5)	-2.73489	Myst3 (10)	-1.14558	DCMS25 (1)	-1.93732
Myst2B (2)	-2.71752	Myst2B (2)	-1.08615	ArPol7 (2)	-0.83902
dcmH&J24	-2.66701	Myst2B (1)	-0.90058	Myst3 (7)	-0.64789
Myst3 (4)	-2.65532	IambProtr (2)	-0.79228	IambProtr (8)	-0.58937
DCMS25 (1)	-2.57103	IambProtr (4)	-0.73211	IambProtr (6)	-0.58514
Myst2B (1)	-2.02778	dcmH&J23	-0.72344	dcmH&J24	-0.56371
Myst3 (6)	-1.56197	NicEth (1)	-0.60914	NicEth (2)	-0.52572
Myst3 (9)	-1.51974	Myst3 (8)	-0.59613	NicEth (1)	-0.27184

1	0 40 50 5		0.0(710		0 0000 7
dcmH&J23	-0.48585	Myst3 (9)	-0.26/12	Myst3 (5)	0.08097
dcmH&J26	0.89058	NicEth (3)	-0.19145	ArPol7 (1)	0.16227
NicEth (4)	1.10096	NicEth (2)	0.16192	Myst3 (2)	0.27905
NicEth (2)	1.4097	Myst3 (6)	0.17653	Myst3 (1)	0.29423
IambProtr (1)	1.55005	Myst3 (3)	0.22717	Myst3 (9)	0.31985
IambProtr (7)	1.68275	dcmH&J21&22	0.27329	IambProtr (2)	0.38952
NicEth (1)	1.72981	Myst3 (2)	0.39628	Myst3 (6)	0.90149
NicEth (5)	1.96198	dcmH&J24	1.50886	Myst2B (2)	0.93807
IambProtr (5)	2.32624	IambProtr (7)	1.73916	IambProtr (5)	0.97555
dcmH&J27	2.41474	NicEth (4)	1.89159	ArPol7 (3)	1.4247
ArPol7 (1)	2.47169	DCMS25 (1)	1.92014	Myst3 (10)	1.46777
IambProtr (4)	2.5509	ArPol7 (3)	2.06579	Myst3 (8)	1.57391
IambProtr (8)	2.75419	ArPol7 (1)	2.11373	Myst3 (3)	1.70656
ArPol7 (2)	3.30424	Myst3 (5)	2.21329	IambProtr (4)	2.83806
IambProtr (6)	3.56091	NicEth (5)	2.23045	NicEth (4)	3.00136
IambProtr (2)	3.62023	IambProtr (1)	3.36634	IambProtr (7)	3.13105
NicEth (3)	3.80692	ArPol7 (2)	3.46609	Myst3 (4)	3.43571
ArPol7 (3)	4.96449	dcmH&J26	3.95215	NicEth (3)	3.48384
IambProtr (3)	5.4805	dcmH&J27	4.20308	NicEth (5)	4.82933

Table 2: Results for three principal components

One can see from the allocation of colours (green for *de Mysteriis*, red for Aristotle, orange for Aristotelian chapters of *Protrepticus*, and yellows for *DCMS*), that it is the first principal component that best separates pure Iamblichus from Aristotle. If one inspects the figures themselves one finds a large gap between dcmH&J26 and dcmH&J23 (1.376), and another between dcmH&J23 and Myst3.9 (1.034), underscoring the extent to which dcmH&J23 falls midway between two stylistically different groups. There is no doubt also that dcmH&J21&22 and dcmH&J24 look like ordinary Iamblichus, whereas the entire chapter XXV is a little more marginal.

The second principal component is hard to interpret. *Iamblichan* files are scattered around the middle range, the *Politics* is placed at the positive end of the spectrum, the *Ethics* mostly in the middle, and the *Protrepticus* (remarkably) at the extremes—rather more of it at the negative extreme, away from later treatises. This evidence of stylistic diversity might indicate that the work is dialogic, and employs a diversity of styles or voices. Assuming a dependence on *Protrepticus* material, that diversity might also be weakly felt in the way that dcmH&J23 is placed well away from other blocks of *DCMS*. Also noteworthy is how dcmH&J26 and dcmH&J27 are united at the positive extreme.

On the third principal component both Aristotelian and Iamblichan material seems to be well scattered, but all six *DCMS* files are found well to the negative extreme, within the thirteen files furthest at this end of the spectrum, of which four are also from the *Protrepticus*. Again, assuming an on-going dependence of *DCMSXXI-XXVII* on *Protrepticus* material, one might be inclined to argue that some 'protreptic voice' was emerging here, and one would then have to consider why this voice was not also in evidence in *Protrepticus* blocks 2, 4-5, and 7.

The principal issues have now changed. We are no longer trying to determine whether the relevant chapters of *Protrepticus* were Iamblichan, as they clearly bore far more resemblance to Aristotle. Hence the primary thesis of Hutchinson and Johnson's article in *OSAP* 2005 is vindicated. Nor are we any longer trying to determine whether the *DCMS* chapters are wholly Iamblichan. The issues are now rather ones of coherence. How far do the various chapters of *Protrepticus* VI-XII cohere, how far

can those of *DMCS* XXI-XXVII be said to cohere, and, further, does the coherence of *Protrepticus* VI-XII and *DCMS* XXI-XXVII extend beyond the known area of overlap in chapters VI and XXVI respectively? At this stage it seemed best to exclude Iamblichus from the analysis, to leave the material from Aristotelian treatises, and to concentrate on the extent to which the *chapters* of *Protrepticus* and *DMCS* cohere, given that the chapter is conceived of as the normal unit of thought in the work of Hutchinson and Johnson. A tiny amount of linking material was now excluded from the *Protrepticus* chapter files, except for XII, where identifying where Iamblichus ends is harder, and which is not large enough to be a reliable sample in any case. The *DCMS* chapters were now considered in their entirety, since the overall impression had been that similar results were thus achieved to those for the reduced H&J files. Also added were the only pieces of plausibly Speusippan material that were available: the *DCMS* IV chapter, fragment 28 from *On Pythagorean Numbers*, and the *Letter to Philip*. Let us look first at a dendrogram (figure 9).



Fig. 9: Protrepticus and DCMS by chapter, 78 function-words

It will be observed that all material from *Politics* and most material from *Nicomachean Ethics* is placed in cluster 1 (red), all material from *Protrepticus* in cluster 1 or cluster 3 (blue), and one stray block from *Ethics* (the first, thus from chapter 6) is placed with all available Speusippus in cluster 2 (green). As for *DCMS* chapter XXI (being too short for serious testing) has cluster 4 (yellow) to itself, chapters XXII-XXV appear with Speusippus in cluster 2, and chapters XXVI-XXVII are placed with most of the Aristotelian material in cluster 1. The conclusion that *cannot legitimately* be drawn is that *DCMS* XXII-XXV actually comes from Speusippus. Nor indeed would I advocate the conclusion that 'Speusippus' was a speaker in the Aristotelian *Protrepticus*. Early Aristotelian style and Speusippan style were presumably both influenced by debate in the Academy in the last two decades of Plato's life, and could have been rather similar. Moreover, cluster 2 is more closely linked with cluster 1 than chapter 3, and it would be very strange to regard *Protr*. VII, IX, XI, and XII as from a different author (or work) than *Protr*. VI, VIII, and X. It seemed more sensible to suppose that a different type of

discourse was somehow involved in the two groups of chapters, whether involving a recognizably different speaker or a contrast between monologic and dialogic material. One needs to be able to see exactly how the discourse of the different clusters differed. For that we needed to look at Principal Component Analysis, and figure 10 charts the first two components extracted (after discarding the rather anomalous *Protrepticus* XII and *DCMS* XXI as being potentially liable to skew the analysis).



Fig. 10: MinitabTM chart of first and second principal components.

Close inspection will reveal that *Protr.* VII, IX, and XI are placed in the upper left corner (strong negative values on PC1 [X-axis], strong positive values on PC2 [Y-axis]). The remainder of the *Protrepticus* chapters have weakly negative values on PC1 and negative values also on PC2, with most of the other Aristotelian blocks.¹⁹ All of Speusippus and *DCMS* XXII-XXV warrants a positive score on both PC1 and PC2. It is now time to examine the vocabulary, and to determine whether or not the results for the excerpts from Iamblichus are compatible with there having been one single Aristotelian source for the bulk of the material in all chapters. These are the words having most weight in determining a block's being placed *in the negative range* according to the first three principal components, or, correspondingly, whose absence contributes to its being placed in the positive range:

¹⁹ Note here that blocks 1-2 of the *Nicomachean Ethics* sample are weakly positive on PC2, while two blocks of *Politics* VII are placed in the positive range on PC1, fairly close to *DCMS* XXVI.

No.	Word	PC1	Word	PC2	Word	PC3
1	γε	-0.244539	ὥσπερ	-0.228975	πᾶς	-0.306101
2	άρα	-0.241236	οὐδὲ	-0.217571	μὲν	-0.2135
3	εi	-0.231277	τίς	-0.198038	ἐκεῖνος	-0.206048
4	οὐκοῦν	-0.203662	oủ	-0.190172	μόνος	-0.176971
5	γὰρ	-0.197881	πῶς	-0.186679	ἐὰν	-0.154425
6	η	-0.197073	μὴ	-0.172151	őτι	-0.151822
7	μάλα	-0.195754	ἕκαστος	-0.16205	ώστε	-0.147943
8	ὄστις	-0.191821	o บ ้ง	-0.155196	οὐκοῦν	-0.145746
9	μὴ	-0.176982	őτι	-0.133504	οὕτως	-0.144548
10	őτι	-0.160909	μηδεὶς	-0.129938	τοίνυν	-0.125278
11	τις	-0.146414	καθάπερ	-0.125763	μηδεὶς	-0.111041
12	οἶος	-0.145197	ầν	-0.124265	οὔτε	-0.096542
13	κατὰ	-0.143566	δεῖν1	-0.123791	ὄστις	-0.095562
14	οὐδὲ	-0.127839	περί	-0.121416	μάλα	-0.094756
15	ὃς	-0.123571	οὕτως	-0.121097	μὴ	-0.089599
16	μόνος	-0.118492	οὔτε	-0.116161	όμοῖος	-0.087972
17	τοίνυν	-0.116277	γὰρ	-0.116034	ώς	-0.085815
18	μὴν	-0.108605	η	-0.11189	οἶος	-0.082504
19	ἐὰν	-0.100972	ἐὰν	-0.110748	ἐĸ	-0.075847
20	πᾶς	-0.09649	άλλὰ	-0.10691	οὗτος	-0.073831
21	oủ	-0.08936	εἴτε	-0.101267	ò	-0.069731

Table 3: Words contributing to negative placement, with weightings less than -0.1

And here again are those words that contribute to a block's belonging to the positive range:

No.	οὕτως	0.08028	εἰς	0.101084	έv	0.113796
12	ċк	0.08268	μὴν	0.103082	εἰ	0.126833
11	παρὰ	0.097415	αὐτὸς	0.113422	μετὰ	0.128118
10	μὲν	0.101036	κατὰ	0.119813	εἰπεῖν	0.128485
9	περὶ	0.121703	διὰ	0.128281	καθάπερ	0.146817
8	δὲ	0.129945	τε	0.134323	ΟŮ	0.162609
7	τε	0.146553	έαυτὸν	0.154663	ἅπας	0.165004
6	αὐτὸς	0.160862	ἄρα	0.172246	έαυτὸν	0.18367
5	οὔτε	0.162976	οὐκοῦν	0.192148	κατὰ	0.203464
4	έv	0.179088	ὃς	0.198659	ἐρεῖν	0.21514
3	πρῶτος	0.179982	ἀπὸ	0.205289	τοιοῦτος	0.225548
2	ύπὸ	0.192807	τοίνυν	0.221482	α̈ν	0.229788
1	εἰς	0.212302	ἀεὶ	0.245917	δὴ	0.306927

Table 4: Words contributing to positive placement, with weightings more than +0.1

The next step is to see whether any pattern is present here. What, if anything, is being separated? In the middle column of table 3 to(vuy, oùkoũy, and ǎpa may all draw inferences, while $\delta_{i\lambda}$ too can be concerned with logical connections and $\dot{\alpha}\pi\dot{\alpha}$ can be concerned with what derives from what. I suspect that such terminology is most at home with *continuous constructive discourse*, devoted to the explanation of a theory or the presentation of a sequence. But in the middle column of table 3 the third and fifth words introduce questions, whether face-to-face, rhetorical, or indirect. This seems to imply engagement with an interlocutor (imaginary or real), something reinforced by the presence of five negatives, including the second, fourth, and sixth most influential words. The first, eleventh and fifteenth words suggest material rich in comparisons, and while ov might be thought to involve the same kind of inference as toivov, it is perhaps the most direct word for 'therefore', and likely to be used in *more combative discourse*, along with such connectives as $\dot{\alpha}\lambda\lambda\dot{\alpha}$ and $\gamma\dot{\alpha}\rho$, and perhaps $\ddot{\eta}$. The presence of $\delta \tilde{\epsilon} v$ (must) also indicates strength of argument. There can surely be no surprise that a single philosophic work should include passages that develop a thesis in a more relaxed manner, and those that engage with opponents more forcefully, particularly (but not exclusively) if that work were written as a dialogue. After all, $EN \times 6-9$ exhibits a range of values between -4.91 and +1.73 on PC2. The difference of 6.64 is not far short of the figure of 7.08 that separates chapters X and XI of the Protrepticus, nor even that separating DCMS XXVII from Protr. XI (7.28).

Hence our conclusion should be that PC2 differentiates between chapters allegedly from Aristotelian chapters in a manner that is entirely compatible with their being different parts of a single work. What then of PC1? It is easiest to look in table 4 at the positive part of the range first. Here we find five prepositions in the eleven most influential words: $\epsilon i \zeta$, $\dot{\nu} \pi \dot{\rho}$, $\dot{\epsilon} v$, $\pi \epsilon \rho \dot{i}$, and $\pi \alpha \rho \dot{\alpha}$. Also present are both $\mu \dot{\epsilon} v$ and $\delta \dot{\epsilon}$ that so often combine in more oratorical styles, especially in Isocratean style, and $\pi \rho \tilde{\omega} \tau c \zeta$, that may also be related in the phrase $\pi \rho \tilde{\omega} \tau o \mu \dot{\epsilon} v$ Otherwise the frequency of fairly colourless conjunctions like $\tau \epsilon$, $\delta \dot{\epsilon}$, and $o \check{\upsilon} \tau \epsilon$ is all that need be noted. This suggests some stylistic consciousness coupled with a relatively *low level of argumentative engagement* in the blocks that are placed in the positive range (to the right of figure 10). Opposed to these features are some that belong to a more engaged, perhaps even dialogic style shown in chart 2. Topping the list is the limiting $\gamma \epsilon$ and the inferential $\check{\alpha} \rho \alpha$ (along with its associates $o \grave{\upsilon} \kappa o \check{\upsilon} v$ and $\tau o \acute{\upsilon} v \upsilon v$), followed by the conditional conjunctions ϵi and $\dot{\epsilon} \alpha v$, the explanatory $\gamma \dot{\alpha} \rho$ and disjunctive $\mathring{\eta}$, $\mu \dot{\alpha} \lambda \alpha$ (including its comparative and superlative), three relatives and three negatives. The single preposition, $\kappa \alpha \tau \dot{\alpha}$, is one noted for its specifically philosophic uses. This is mostly a balanced collection of little words typical of philosophic texts from Plato on.

The scores of text-blocks on all three principal components is as follows (table 5):

Block	PC1	Block	PC2	Block	PC3
Protr11 (1)	-5.78761	NicEth (5)	-4.91474	Protr11 (1)	-4.4328
Protr7 (1)	-4.63182	DCMS27 (1)	-3.05565	ArPol7 (1)	-3.0791
Protr9 (1)	-3.59202	ArPol7 (3)	-2.92974	Protr6 (1)	-2.8751
NicEth (3)	-2.98537	ArPol7 (1)	-2.88372	DCMS26 (1)	-2.5476
ArPol7 (3)	-2.35504	Protr10 (1)	-2.85307	DCMS25 (1)	-2.3788
Protr8 (1)	-1.75893	NicEth (4)	-2.34055	Protr8 (1)	-1.9322
Protr10 (1)	-1.74192	Protr8 (1)	-2.20044	Protr10 (1)	-1.7429
NicEth (1)	-1.25139	NicEth (3)	-1.90005	Speus F28 (1)	-1.5146
NicEth (5)	-1.19788	ArPol7 (2)	-1.68413	Protr7 (1)	-1.4364
NicEth (2)	-0.98752	DCMS26 (1)	-1.15181	ArPol7 (3)	-1.2925
Protr6 (1)	-0.91696	Protr6 (1)	-0.7918	EpPhilip (1)	-1.0935
DCMS27 (1)	-0.71657	DCMS25 (1)	0.07591	ArPol7 (2)	0.1780
DCMS27 (1) NicEth (4)	-0.71657 0.03961	DCMS25 (1) EpPhilip (1)	0.07591 0.19746	ArPol7 (2) Protr9 (1)	0.1780 0.3041
DCMS27 (1) NicEth (4) ArPol7 (1)	-0.71657 0.03961 0.57552	DCMS25 (1) EpPhilip (1) NicEth (1)	0.07591 0.19746 0.84483	ArPol7 (2) Protr9 (1) DCMS27 (1)	0.1780 0.3041 0.5767
DCMS27 (1) NicEth (4) ArPol7 (1) ArPol7 (2)	-0.71657 0.03961 0.57552 0.67242	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1)	0.07591 0.19746 0.84483 1.0601	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1)	0.1780 0.3041 0.5767 1.0435
DCMS27 (1) NicEth (4) ArPol7 (1) ArPol7 (2) DCMS23 (1)	-0.71657 0.03961 0.57552 0.67242 1.35169	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1)	0.07591 0.19746 0.84483 1.0601 1.10229	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1)	0.1780 0.3041 0.5767 1.0435 1.1275
DCMS27 (1) NicEth (4) ArPol7 (1) ArPol7 (2) DCMS23 (1) DCMS4Sp (1)	-0.71657 0.03961 0.57552 0.67242 1.35169 1.4526	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1) NicEth (2)	0.07591 0.19746 0.84483 1.0601 1.10229 1.73392	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1) DCMS23 (1)	0.1780 0.3041 0.5767 1.0435 1.1275 1.9434
DCMS27 (1) NicEth (4) ArPol7 (1) ArPol7 (2) DCMS23 (1) DCMS25 (1)	-0.71657 0.03961 0.57552 0.67242 1.35169 1.4526 1.75529	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1) NicEth (2) Speus F28 (1)	0.07591 0.19746 0.84483 1.0601 1.10229 1.73392 2.52065	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1) DCMS23 (1) NicEth (4)	0.1780 0.3041 0.5767 1.0435 1.1275 1.9434 2.0073
DCMS27 (1) NicEth (4) ArPol7 (1) ArPol7 (2) DCMS23 (1) DCMS25 (1) DCMS26 (1)	-0.71657 0.03961 0.57552 0.67242 1.35169 1.4526 1.75529 2.82885	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1) NicEth (2) Speus F28 (1) DCMS23 (1)	0.07591 0.19746 0.84483 1.0601 1.10229 1.73392 2.52065 3.12012	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1) DCMS23 (1) NicEth (4) NicEth (5)	0.1780 0.3041 0.5767 1.0435 1.1275 1.9434 2.0073 2.2526
DCMS27 (1) NicEth (4) ArPol7 (1) DCMS23 (1) DCMS23 (1) DCMS26 (1) DCMS22 (1) DCMS24 (1)	-0.71657 0.03961 0.57552 0.67242 1.35169 1.4526 1.75529 2.82885 3.59113	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1) NicEth (2) Speus F28 (1) DCMS23 (1) Protr9 (1)	0.07591 0.19746 0.84483 1.0601 1.10229 1.73392 2.52065 3.12012 3.77916	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1) DCMS23 (1) NicEth (4) NicEth (5) DCMS4Sp (1)	0.1780 0.3041 0.5767 1.0435 1.1275 1.9434 2.0073 2.2526 2.3070
DCMS27 (1) NicEth (4) ArPol7 (1) ArPol7 (2) DCMS23 (1) DCMS25 (1) DCMS26 (1) DCMS22 (1) DCMS24 (1)	-0.71657 0.03961 0.57552 0.67242 1.35169 1.4526 1.75529 2.82885 3.59113 4.8942	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1) NicEth (2) Speus F28 (1) DCMS23 (1) Protr9 (1) DCMS22 (1)	0.07591 0.19746 0.84483 1.0601 1.10229 1.73392 2.52065 3.12012 3.77916 3.93711	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1) DCMS23 (1) NicEth (4) NicEth (5) DCMS4Sp (1) NicEth (2)	0.1780 0.3041 0.5767 1.0435 1.1275 1.9434 2.0073 2.2526 2.3070 2.5822
DCMS27 (1) NicEth (4) ArPol7 (1) DCMS23 (1) DCMS23 (1) DCMS26 (1) DCMS22 (1) DCMS22 (1) DCMS24 (1) Speus F28 (1) EpPhilip (1)	-0.71657 0.03961 0.57552 0.67242 1.35169 1.4526 1.75529 2.82885 3.59113 4.8942 5.01811	DCMS25 (1) EpPhilip (1) NicEth (1) DCMS24 (1) DCMS4Sp (1) NicEth (2) Speus F28 (1) DCMS23 (1) Protr9 (1) DCMS22 (1) Protr7 (1)	0.07591 0.19746 0.84483 1.0601 1.10229 1.73392 2.52065 3.12012 3.77916 3.93711 4.1046	ArPol7 (2) Protr9 (1) DCMS27 (1) DCMS24 (1) DCMS22 (1) DCMS23 (1) NicEth (4) NicEth (5) DCMS4Sp (1) NicEth (2) NicEth (3)	0.1780 0.3041 0.5767 1.0435 1.1275 1.9434 2.0073 2.2526 2.3070 2.5822 3.1481

Table 5: Scores of each text-block according to three principal components

Is it the case that the blocks appearing highest in value on PC2 ought to involve a more relaxed and constructive discourse, and those that are highest in value on PC1 have a low level of argumentative engagement? Given the amount of historical and descriptive material in *DCMS* XXII-XXV and the overall nature of the Speusippan material examined, I believe that there is a degree of truth in both descriptions; however, one would surely want to ponder further whether the *Protr.* VII, IX, and XI display a more relaxed and constructive discourse than blocks VI, VIII, and X. It is natural, however, to think of the Aristotelian blocks given the lowest scores on PC1, including the *Protrepticus*, as having a high level of argumentative engagement. That would perhaps apply particularly to the *Protrepticus* if it were a dialogue.

As is often the case, one cannot dismiss the idea that some real differences underlie PC3 (for the high scores of all *Ethics* blocks and the low scores of most *Protrepticus* blocks cannot be a coincidence), but explaining those differences in terms of the list of influential words (unless, perhaps, it is a matter of Aristotelian chronology) is very hard. It is also beyond the scope of this inquiry. For what was

required was to demonstrate that some apparent internal differences within *DMCS* XXII-XXVII and within *Protrepticus* VI-XI are not such that they cannot be ultimately attributed to the same Aristotelian work. If that work contained both historical and rigorously philosophic material, and if, moreover, it employed both longer speeches and dialogic exchanges, then it would seem that this is quite enough to explain the principal differences observed. It is obvious that this does not prove that they *must* be attributed to the same work, but given that we are not dealing with the natural language of lamblichus, and that he draws regularly on classic fourth-century sources, we are virtually forced to consider Aristotle's *Protrepticus* as a possible source for much if not all of this material.

The mention of classic fourth-century sources may remind one that other figures were active in the Academy at the time when *Protrepticus* was written, including Plato and Philip of Opus. One might usefully compare the material with which we have been dealing with a little late Plato and with the *Epinomis* (which I choose to regard as the work of Philip). For this purpose *Protrepticus* and *DMCS* files were left undivided. I begin by including *Critias* and *Philebus* (figure 11):



Fig. 11: Cluster analysis with Critias and Philebus: 1500 word blocks

The *Philebus* is kept completely separate from all this material (cluster 5, magenta), but all blocks of *Critias* come to be placed (cluster 3, blue) with two of three blocks of *DCMS* and with some Speusippus. The stylistic differences of the *Critias* from the rest of late Plato, other than the *Timaeus*,

not least because of the myth-like language of the Atlantis-story, had been previously observed.²⁰ All blocks of *Epinomis* were kept together (cluster 4, yellow), loosely related to the alleged Speusippus in cluster 2 (green). Aristotelian material, including *Protrepticus* but only the final block of *DCMS*, was kept separate in cluster 1 (red). One could repeat similar charts with other Platonic material in them, but it would be best to conclude (figure 12) with one that includes *Phaedrus*.



Fig. 12: Cluster analysis with Critias and Philebus: 1500 word blocks

Apart from block 5 which involves palinode material (beginning 246a2), the *Phaedrus* too was kept quite separate, but here it is noticeable that all blocks of the *DCMS* XXI-XXVII now appear in cluster 1 (red) with the Aristotelian *Politics* and *Nicomachean Ethics*, with the intrusion of just one block of *Critias*,²¹ while all blocks of *Protrepticus* VI-XII are kept together in the closely related cluster 3 (blue). This result is one that offers excellent support for the supposition that the great majority of *DCMS* XXI-XXVII is from an Aristotelian work. Naturally it raises further questions, but that is in the nature of our work.

Harold Tarrant, April 2013

²⁰ H. Tarrant, E.E. Benitez, and T. Roberts, 'The Mythical Voice in the *Timaeus-Critias*: Stylometric Indicators', *Ancient Philosophy* 31 (2011), 95-120.

²¹ Critias 1, two thirds of which is the introductory conversation, is perhaps clearly, though perhaps quite fortuitously, very close in its basic linguistic mix to the second block of the *DCMS* extract; this means that, in the absence of any block that is closer to either of them, they will move clusters together.

Addendum (28th April):

The above has been only slightly revised since I performed two more analyses of relevance to these questions. First I have looked at the second part of *Protrepticus* V in a bid to determine whether it is Aristotelian or (as Jaeger had claimed) Porphyrian. A wide range of Porphyrian texts was utilized. Results were quite ambiguous, and it seemed to me (both on the basis of my own reading and on the basis of the computational results) most probable that Iamblichus had here begun following a Porphyrian passage indebted to Aristotel. From VI on Iamblichus must have switched rather to the original Aristotelian text, as no further signs of Porphyrian influence were detected.

Second I examined *DCMS* XXVII in two files, one involving the overlap with *PA* and the other incorporating the rest of the chapter. Since the file involving overlap consisted of fewer than 300 words one could not affirm that the results would be conclusive, but the analysis was nevertheless helpful. It showed that the file that involved overlap had to be regarded as Aristotelian in spite of having only 130 or so words that could be attributed directly to *PA* if that was the text being followed. Cluster analyses based on both standardized and non-standardized data placed the file with the bulk of Aristotelian material, and though it was somewhat aberrant Aristotle, PCA proved it to be hyper-Aristotelian, to the extent that it was placed further away from the Iamblichan texts on PC1 than (e.g.) the remainder of XXVII, *which still gave good Aristotelian results*. Porphyrian texts were included in this analysis, but neither part of *DCMS* XXVII appeared any more Porphyrian than Iamblichan. This has led me to the conclusion that Iamblichus is not following *PA* directly in XXVII, modifying it to suit mathematics, but rather has a more mathematically inclined Aristotelian text that he does not greatly modify himself.

ΗT