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The Pauline Canon Sung in a Linguistic Key: Visualizing New Testament Text Proximity by Linguistic Structure, System, and Strata

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Abstract: The pruning of the Pauline Canon is considered one of the signal achievements of contemporary New Testament studies. Quite intriguingly, however, *no consensus* on the Pauline Canon exists among researchers who have actually executed quantitative studies of style in the Greek New Testament (GNT). From the perspective of functional linguistics, *no study* in the GNT has been executed that uses a linguistically comprehensive set of measures for either the syntagmatic structures, paradigmatic systems, multiple strata or multiple metafunctions of the GNT. In this study we will pursue an approach that, for the first time, visually compares and contrasts these three dimensions in some depth. The advantages of such an approach are its (1) comprehensive selection of linguistic measures across six representative syntagmatic ranks in the GNT, (2) use of two data-driven (rather than *ad hoc*) feature-selection methods, (3) use of multiple extractive multivariate techniques (correspondence analysis and multiple correspondence analysis) which provide highly interpretable visualizations of the data, and (4) use of a formal experimental design methodology that explores each level of linguistic rank. This study proposes that such an approach provides a meaningful next step to the work of Neumann and Mealand in particular, and that the tighter integration of linguistics and multivariate visualization combines to provide new insights into the textual boundaries of the Pauline Canon. (Article)

Keywords: Pauline Canon, Authorship, Genre, Pseudepigraphy, Systemic Functional Linguistics, Style, Computational Stylistics.

1. *Introduction*

Said most generally, the goal of this study is to explore the stylistic boundary of the Pauline Canon within the larger canon of the GNT. We seek to explore this boundary, however, in a relatively nontraditional way, by applying modern methods of applied mathematics to modern dimensions of linguistics. Specifically, our core method involves visualizing New Testament text proximity in terms of linguistic structure, system, and strata,[1] and to explore whether that proximity is best explained by authorship or genre. Visualization of the relative proximities of the NT texts will be through the use of two related, advanced multivariate visualization techniques: Correspondence Analysis (CA) and Multiple Correspondence Analysis (MCA). Using these assets, we seek to answer four primary questions regarding the Pauline Canon:

1. Qualitatively, do the texts of the GNT seem to cluster more by authorship or by genre? Is there a way to quantify this?

2. Qualitatively, does that clustering differ when explored by linguistic rank?[2] Does it differ when explored by its paradigmatic systems?

1. In its briefest compass linguistic *structure* is that characteristic of language which functions within a given span or rank of linguistic units. Accordingly, morphemes, words, word groups, clauses, and clause complexes all reflect different ranks of linguistic structure. Linguistic *systems*, in contrast, reflect the network of available choices in language. While choice networks define the grammatically valid syntagmatic options (the lexical form of words that follow other words) they also govern the more familiar morphosyntagmatic paradigms within words themselves. *Strata*, finally, include those aspects of language that operate above lexico-grammar, and hence are to be properly considered as extra-linguistic. For our baseline purposes, here, we will limit our exploration of extra-linguistic strata to semantics. See especially Halliday and Matthiessen, *Introduction to Functional Grammar*, 9–25.

2. Rank, a term coined by Halliday, is central in Systemic Functional Linguistics (SFL) because all systems (choice networks) in language originate at a given rank in the language (clause, word group, etc.). See especially Halliday and Matthiessen, *Introduction to Functional Grammar*, 9–10. While most functional linguists, regardless of stripe, agree that language exhibits some sort of scale of rank, agreement on the *levels* of that scale are far from complete. In this study we will adopt, largely, the discrete components of Halliday's rank scale (word, word group, clauses, clause complexes) but will

What about when explored by linguistic strata (e.g. semantics)?

3. Quantitatively, how well do the individual historic authorship and genre theories perform in explaining the linguistic clustering of the texts?

4. Quantitatively, given the answers to 1–3 above, which single authorship or genre theory best fits the language data of the GNT?

To best address these questions requires a somewhat extended study of eight sections.[3] The first three sections review the *status quaestionis*, the second three sections propose the approach, and the last two sections present the baseline analysis and draw conclusions.

2. *A Review of the Current State of Diachronic and Synchronic Research Regarding the Pauline Canon*[4]

Five orienting statements should be sufficient to provide the diachronic and synchronic backdrop for our study. *First*, the consensus viewpoint of 21st century NT scholarship grants to Paul seven of the thirteen[5] texts originally attributed to him: the *Hauptbriefe* along with Philippians, Philemon, and 1 Thessalonians. *Second*, this *prima facia* reduction of the traditional breadth of the Pauline Canon constitutes one of the central lodestones of our discipline's current self-understanding.

omit morphemes. Cf. Halliday, *Linguistic Studies*, 24.

3. Special thanks are due to the *BAGL* editorial committee for even considering publishing an oddity such as this—one that fits in the nether regions, as one editor commented, "between an article and a monograph."

4. For modern treatments of the Pauline Canon especially in relation to authorship, style, and genre, see van Roon, *Authenticity of Ephesians*, 100–212; Knight, *Pastoral Epistles*, 21–22; Porter, "Pauline Authorship," 109–10; Towner, "Pauline Theology," 311–14; Harding, *What Are They Saying,* 9–28; Johnson, *Letters to Timothy*, 55–89; Fiore and Harrington, *Pastoral Epistles*, 15–19; Aageson, "Apostolic Authority," 7–11.

5. The canonical placement of Hebrews likely suggests a primitive view that Paul was its author. This study makes no attempt to arbitrate that possibility, and will instead use 13 texts as the traditional baseline for Pauline studies. For modern proposals regarding the authorship of Hebrews, see Harrington, *What Are They Saying*, 18–40; Allen, *Lukan Authorship of Hebrews*, 10–77.

This view on the Pauline Canon, after all, was forged in the energetic contests of the 19th century,[6] and the subsequent 20th century innovations in *Formgeschichte*, *Redaktionsgeschichte*, and social-scientific methods have done little to dislodge it. *Third*, this underscores our (perhaps by now obvious) point, that the current consensus regarding the Pauline Canon is, in fact, a largely *diachronic* consensus. Indeed, as little as 40 years ago a multipronged diachronic consensus was all that was needed to decide virtually any matter in NT studies, since mid-20th century scholarship parked itself very close to the "diachronic pole." Twenty-first century NT scholarship, in contrast, is in the midst of a broad-based disciplinary expansion in terms of method. This leads us to our fourth point, that the single most referenced contributing factor leading to the current *diachronic consensus* regarding the Pauline Canon is actually *synchronic* and linguistic in nature—the disparate literary *styles* of these texts. *Fifth*—and here we arrive at our point of departure for this study—when a synchronic approach to style is admitted as data, *no such consensus regarding the Pauline Canon exists* among those who have actually executed quantitative stylistic analyses upon it. Hence, Morton asserted that Paul wrote only four epistles (the *Hauptbriefe*), Grayston and Herdan concluded ten (all epistles but the Pastorals), Gerard Ledger assigned six to Paul (including, intriguingly, 2 Thessalonians), Barr concluded six or seven, and Kenny concluded that twelve were "the work of a single, unusually versatile author."[7] This jumble of results

6. While Erasmus doubted the authenticity of Ephesians as early as the 16th century, the pruning of the Pauline Canon and the scholars first responsible for it were as follows: 1 Timothy: J.E.C. Schmidt (1804) and Schleiermacher (1807); all three Pastorals: J.G. Eichhorn (1812); the entire Pauline Canon save the *Hauptbriefe*: F.C. Baur (1845); 2 Thessalonians and Colossians: J.E.C. Schmidt (1804), Hilgenfeld (1875), and H.J. Holtzmann (1885). (Erasmus, *Annotationes*; Schmidt, *Historisch-kritische Einleitung*; Eichhorn, *Einleitung in das Neue Testament*; Schleiermacher, *Ueber den sogenannten ersten Brief des Paulos an den Timotheos*; Baur, *Paulus, der Apostel*; Hilgenfeld, *Historisch-kritische Einleitung*; Holtzmann, *Lehrbuch der Historisch-Kritischen Einleitung*.)

7. See especially Grayston and Herdan, "Authorship of the Pastorals,"

could, of course, be used by diachrony-only scholars to dismiss the whole quantitative/synchronic enterprise. The thesis of this work, however, is that there are actually *two* motivations to revisit the storied issue of the Pauline Canon and indeed the larger issue of quantitative style in the GNT: (1) the compelling recent findings in computational stylistics and (2) the potentially profound theological implications that executing a modern, comprehensive synchronic study on the Pauline Canon may bring. In the next section we will explore the first of these motivations.

3. *A Review of the Current State of Computational Stylistics Regarding the Pauline Canon*[8]

Since the early 1980's, the occasional computational stylistics work of Radday, Neumann, and Greenspahn in relation to the OT,[9] and Morton, Smith, Merriam, Mealand, Ledger, and Greenwood in the NT[10] is likely familiar to most NT scholars. What is far lesser known, however, is that the combined stylometry/computational stylistics enterprise *outside of NT*

13–14; Morton, "Authorship of Greek Prose," 224–25; Barr, *Scalometry and the Pauline Epistles*, 125; Ledger, "Exploration of Differences," 95; Kenny, *Stylometric Study,* 100.

8. The content of this section, in a substantially expanded form, was part of the author's dissertation, Libby, "Disentangling Authorship," 3–7.

9. See especially Radday and Wickman, *The Unity of Isaiah*; Radday and Shore, *Genesis*; Greenspahn, *Hapax legomena*.

10. See Morton, "Authorship of Greek Prose," 169–233; Morton and Winspear, *It's Greek to the Computer*; Michaelson and Morton, "Positional Stylometry," 69–83; Morton, *Literary Detection*; Smith, "Hapax Legomena," 145–52; Binongo and Smith, "Stylometry," 448–52; Mealand, "Positional Stylometry Reassessed," 266–86; Mealand, "The Extent of the Pauline Corpus," 61–92; Mealand, "Measuring Genre Differences," 227–45; Linmans, "Correspondence Analysis," 1–13; Mealand, "Style, Genre, and Authorship," 479–505; Mealand, "Stylometric Evidence for Q," 483–507; Mealand, "Hellenistic Greek," 323–45; Ledger, "New Approach to Stylometry," 67–72; Ledger, "Exploration of Differences," 85–97; Greenwood, "Computational Result," 43–47; Greenwood, "Word Clusters," 211–19; Greenwood, "Common Word Frequencies," 183–87.

scholarship has expanded dramatically in the last several decades. As of 2012, by Rudman's count, the discipline now numbers over 1,500 peer-reviewed computational stylistics[11] articles, books, and monographs with the majority of that total being published within the last 20 years.[12] Two summary statements regarding this literature relate directly to our concern. *First*, earlier generations of scholars issued some vast oversimplifications regarding stylistic variation that are simply no longer tenable. In particular, earlier stylometric studies assigned, *de facto*, virtually any significant stylistic variation to authorship alone.[13] Now, however, close to 100 studies in traditional *textual stylistics*[14] and over 200 overall[15] demonstrate that not only do other sociolectic/sociocultural sources of stylistic variation *exist* (such as genre, gender, dating, audience and the like)[16] but subcategories within them can be empirically distinguished as well.[17]

11. Rudman's bibliography seems oriented toward stylometry and authorship attribution. The author's bibliography is more sociolectic in focus and currently numbers 1047 quantitative studies and 1541 overall.

12. Rudman, "Non-Traditional Authorship," 263.

13. Notable works in biblical studies that make this equivalence despite operating within a mixed-genre corpus include, without limitation: Harrison, *Problem,* 84–86; Morton, "Authorship of Greek Prose," 224; Morton, *Literary Detection*, 165–83; Bee, "Statistical Methods," 622; Bee, "Statistical Study," 421; Neumann, *Authenticity*, 206–22. Also included here is the earlier but generally not the latter Radday; Radday, "Isaiah and the Computer," 73; Radday et al., "The Book of Judges Examined," 494–99.

14. By traditional textual stylistics I mean stylistics operating upon formal written or spoken *language-in-use* texts.

15. This is arrived at by adding to that number studies from *extra-textual stylistics*. This includes idiolectic and sociolectic studies on nontraditional forms of language-in-use such as web content, computer source code, social media sources (e.g. Twitter) etc.

16. Per Wenham, "[What] . . . emerges from the study [is that] different genres of literature . . . have distinct styles" (Wenham, "Genesis," 6). For genre separations in particular, see Brainerd, "Distinction," 260–68; Brainerd, "Pronouns and Genre," 14–15.

17. Illustratively but not exhaustively, poetry is separated from prose and narrative from dialog in Herdan, *Advanced Theory of Language,* 206–13; Merriam, "Invalidation Reappraised," 419; Burrows, "Word-Patterns and

Second, not only is *generic stylistic variation* present in such texts, *mixed-genre* corpora very often demonstrate that *more of the total summed stylistic variation is due to genre rather than authorship*.[18] Moreover, in the last ten years in particular, researchers discovered that in some mixed-genre corpora an association or *covariance* exists between authorship and genre.[19] This means, quite simply, that if a given author tends to write disproportionately or uniquely in a given genre, it is quite easy to confound authorship with genre when that author's texts appear in a mixed genre corpus. If these same findings are also found to be true of the mixed-genre corpus of the GNT, the implications for the Pauline Canon would be vast. First, they would expand the accepted breadth and priority of the sociolectic causes of stylistic variation in the GNT. Second, if high author/genre covariance, in particular, is found to be true in the GNT, the relatively coarse univariate tools used by earlier scholars such as Morton may, ironically, have actually been confirming *plural genres* instead of *plural authors* within the Pauline Canon. These findings provide clear motivations to more deeply descriptively

Story-Shapes," 64; Biber, *Variation*, 101–69. Similarly, male is discriminated from female in Argamon et al., "Gender, Genre, and Writing Style," 326–42; Rustagi et al., "Learning Age and Gender," 207–11; Cheng et al., "Author Gender Identification," 80–86. Lastly, authorship is differentiated by date in Temple, "A Multivariate Synthesis," 69–74; Can and Patton, "Change of Writing Style," 66–77; HaCohen-Kerner et al., "Stylistic Feature," 852–59.

18. Typically, in extractive multivariate data analysis (EMVA) *within a mixed genre corpus*, the first component of variation (which accounts for the most variation) tends to be genre rather than authorship. See Burrows, "Word-Patterns and Story-Shapes," 64; Forsyth et al., "Authenticity of the Consolatio," 383; Juola and Baayen, "Authorship Identification by Cross-Entropy," 63. Cf. Burrows, "Interpretative Nexus," 92–102, Baayen et al., "Authorship Attribution," section 3. Even less sophisticated methods demonstrate that generic stylistic variation tends to be greater than authorial stylistic variation: O'Keefe, "Critical Remarks," 424. For more on EMVA, see section 7.

19. Factor analysis studies often demonstrate high covariance between authorship and genre. By my count 16 such computational linguistics studies have been performed. In many such cases genre and authorship constitute the first two extracted components, respectively, and are orthogonal (uncorrelated) to one another. In other studies, there is substantial covariance, and authorship and genre are extracted in the same component.

explore and "disentangle" idiolectic variation from sociolectic variation in the GNT.

4. *Identifying the Current "Gaps" in the Stylistic Analysis of the Greek New Testament*[20]

The first gap in the state of GNT computational stylistics is perhaps the most fundamental. Even using our somewhat less extensive bibliography than Rudman's, our meta-analysis reveals that 235 advanced multivariate computational stylistics studies have been executed to date upon principled sets of corpora,[21] but only 20 such studies have been performed upon the GNT itself. This relative paucity of research uncovers, moreover, three further gaps in the stylistic analysis of the GNT:

Linguistically, no studies have attempted to address a relevant problem in New Testament studies by using a *linguistically* comprehensive set of measures for either the syntagmatic structures, paradigmatic systems, multiple strata or multiple metafunctions[22] of the GNT. This is quite crucial because if we presume, for instance, that the systems of the Koine are at least as delicate (detailed) as they are in English, NT scholars have likely empirically studied somewhat less than one percent of the linguistic potential[23] in the GNT. Among NT linguists, Silva,

20. The content of this section, in a slightly more expanded form, was part of the author's dissertation, Libby, "Disentangling Authorship," 31–33.

21. Data as of November 2014. No bibliography can claim to be complete, but we view ours as reasonably comprehensive and directionally accurate.

22. SFL asserts that all languages do at least three things: they make sense of experience (the experiential metafunction), enact social relations (the interpersonal metafunction), and weave the two together using the assets of language (the textual metafunction). Halliday and Matthiessen, *Introduction to Functional Grammar*, 29.

23. By potential we mean the discrete linguistic measures and their combinations in the multiple strata, paradigmatic systems, syntagmatic structure, and multiple metafunctions of the Koine.

Nida, Pitts, O'Donnell, and Porter[24] are important conversation partners here.

Quantitatively, no studies of the covariance structure of the GNT across the systems and structure of the Koine have been performed. Moreover, while a small number of studies of GNT textual variation in terms of genre and authorship have been performed by Merriam, Mealand, and others,[25] that excavation has been largely limited to the rank of lexis (a span of only one "word"). Therefore, more unsupervised[26] decompositional work at all ranks (spans of linguistic structures) of the Koine is indicated. Lastly, given that we know virtually nothing about the structures of variation and covariation in the GNT, Structural Equation Modeling (SEM) and graphical models are clearly indicated. Long, Pearl, Burrows, Biber, and Jordan[27] are pioneers in this area outside of biblical studies.

Experimentally, no studies in the GNT have compared and contrasted supervised and unsupervised classification tasks in

24. See, especially, Silva, *Biblical Words,* 101–78; Nida and Louw, *Lexical Semantics,* 107–32; Porter and Pitts, "Recent Research," 215–36; Porter and Pitts, eds., *Language of the New Testament*; O'Donnell, *Corpus Linguistics,* 273–485; Porter, *Verbal Aspect*; Porter and Carson, eds., *Biblical Greek Language and Linguistics*; Porter and Carson, eds., *Discourse Analysis and Other Topics*; Porter and Tombs, eds., *Approaches to New Testament Study*; Porter, *Studies in the Greek New Testament*; Porter and Reed, eds., *Discourse Analysis*; Porter and Carson, eds., *Linguistics and the New Testament*.

25. See especially Radday and Shore, *Genesis*; Neumann, *Authenticity*; Ledger, "Exploration of Differences," 85–97; Mealand, "Extent of the Pauline Corpus," 61–92; Mealand, "Style, Genre, and Authorship," 479–505; Putniņš et al., "Advanced Text Authorship," J1–J13; Ebrahimpour et al., "Automated Authorship Attribution," 1–12.

26. Unsupervised multivariate methods, in contrast to supervised multivariate methods, are not informed by prior classification data, nor is its goal generally classification at all, but rather understanding the variance and covariance structure of the system under question.

27. See especially the following: Long, *Confirmatory Factor Analysis*, 11–81; Long, *Covariance Structure Models*, 19–85; Pearl, *Probabilistic Reasoning in Intelligent Systems*, 1–19; 29–73; Burrows, "Interpretative Nexus," 91–103; Biber, "Linguistic Analyses," 332–44; Biber et al., *Corpus Linguistics*, 84–242; Jordan, "Graphical Models," 141–54.

relation to the GNT.[28] Nor have unsupervised quantitative methods of extracting authorship and genre factors "up from the text" (e.g. via eigen-system mathematics) been systematically compared to *a priori* quantitative methods "down from theory" (in which authorship and genre theories from the history of NT scholarship are tested via log-linear modeling, information-theoretic approaches, etc.). Lastly, no formal experimental design has been articulated that achieves these ends with the experiments necessary to reduce Type I and Type II error. Fisher, Spector, Brown and Melamed, Gray, Atkinson, and Meyers are helpful here.[29]

5. *Proposing and Justifying a Computational Stylistics-Based Approach*

Because of these gaps, we have elsewhere proposed a larger research program to execute abductive, post-positivist work in the GNT that is linguistically informed, experimentally controlled, causally disciplined, multiply validated, and hermeneutically responsible.[30] Quite critically, this larger research program is driven by an extensive experimental design.[31] Like most experimental designs, our design seeks first to be evaluative/descriptive, then inferential, and then causal. The present work is an initial, multivariate foray into the first of these tasks, multivariate description through the powerful metaphor of multivariate visualization. Three clarifying points

28. Supervised approaches provide the classification algorithm with *prior information*; specifically, correctly classified sets of known texts (e.g. authors or genres) in a training set. The algorithm then uses that information to solve for texts whose classification is unknown.

29. See especially the following sections of these important works: Fisher, *The Design of Experiments*, 91–134, 211–42; Spector, *Research Designs*, 39–76; Brown and Melamed, *Experimental Design and Analysis*, 20–44, 50–79; Gray, *Doing Research,* 15–62; Atkinson, *Optimum Experimental Designs*, 25–33, 58–71; Meyers et al., *Applied Multivariate Research*; Rasch et al., *Optimal Experimental Design*, 175–288.

30. Libby, "Disentangling Authorship," 21–76.

31. Libby, "Disentangling Authorship," 168–98.

should be underscored here. First, experimental designs in complex systems typically seek to initially collect, assemble, and *describe* what is currently known in order to establish a *baseline* body of information. By using the word *describe* we mean, "to summarize the data at the highest possible level of abstraction such that it does not confound the particulars." For this purpose, we have chosen to use a family of well-known multivariate data reduction approaches designed to achieve these ends. These techniques will be further explained in Section 7. Second, although the core data of this effort is necessarily *linguistic* in nature, the first step in our experimental design (evaluation/ description) is decidedly not to be confused with the failed early-to mid-20th century school of *linguistic descriptivism*.[32] Third, we have chosen the term "baseline" quite intentionally in characterizing the scope of this study. While this effort does, to my knowledge, constitute the largest single publication of multivariate data reduction visualizations of the GNT to date, and while it is the first effort to visually compare and contrast linguistic structure, system, and strata, when compared to the overall scope of the experimental design already referenced, this work is, indeed, an initial, *baseline* effort.

6. *Assembling the Required Materials to Perform Baseline Multivariate Visualizations of the GNT*[33]

Given that the core objective of this work is to visualize NT text proximity by linguistic structure, system, and strata, and to

32. Linguistic descriptivism was one of the last fulsome gasps of linguistic structuralism. Concerning the intriguing notion, however, that descriptivism failed because its aggressive agenda outstripped its pragmatics, see especially Well's postmortem on descriptivism written as early as 1963: "The levels-idea could have been—indeed, still can be—thought out much further than it was; for all that was done with it, it remains largely a neglected possibility in twentieth-century structuralism." Wells, "Some Neglected Opportunities," 44.

33. Much of the content in this section was originally presented in the author's dissertation. See Libby, "Disentangling Authorship," 199–231.

explore whether that proximity is best explained by authorship or genre, it is therefore necessary to:

1. Prepare a linguistically annotated version of the GNT that integrates, as far as is possible, the broadest set of current linguistic annotations available.
2. Collect and develop linguistic measures by linguistic structure, system and strata.
3. Collect, develop, and justify authorship theories.
4. Collect, develop, and justify genre theories.

In this section we will pursue these four aims in that order.

6.1 *Preparing the GNT for Linguistic Analysis*

Performing a computational stylistic/statistical linguistic analysis of the GNT requires both a well-designed database architecture and an appropriate suite of analytical software. To achieve these ends, in 2007 the author founded the Integrative Greek New Testament Project (IGNTP), a privately-funded research initiative.[34] The *mission* of the IGNTP is to meaningfully contribute to longstanding issues in NT scholarship (e.g. pseudepigraphy, authorship, the Synoptic problem and the like) using computational linguistics-related methods. Methodologically the IGNTP implements four intersecting research activities: (1) creating principled, theoretically-informed linguistic and extralinguistic[35] "probes" into the structures, systems, strata, and functions[36] of the Koine, (2) analyzing those texts descriptively, inferentially, structurally, systemically, and causally using both *a priori* and *a posteriori* methods, (3) interrogating the results using multiple validation methods and abductively modifying the working experimental design, and (4)

34. The author wishes to gratefully acknowledge the technical and programming support provided to the IGNTP by Decision Support Sciences, a marketing science consulting firm specializing in business analytics.

35. This refers to strata above or below the stratum of lexicogrammar. Halliday and Matthiessen, *Introduction to Functional Grammar*, 24–25.

36. We return to Halliday's original terminology ("functional" rather than "metafunctional") because our abductive experimental design will explore functional linguistic systems in addition to those of SFL.

publishing the results. The main product of the IGNTP is the Integrative Greek New Testament (IGNT) itself, a statistical database of the GNT where each row (record) of the database is one of the 138,019 words in the text of the GNT, and each column (field) is one of the probes discussed above. Currently, the IGNT has achieved the following milestones: (a) full integration of five annotated eclectic texts of the Greek NT into the IGNT (GramCordTM, AGNT, Logos, MorphGNT, and OpenText.org),[37] (b) the creation and verification of 4,086 fields[38] including approximately 2,800 linguistic probes derived largely from Systemic Functional Linguistics theory, (c) the creation of about 800 probes from traditional grammar to serve as controls, (d) the creation of close to 200 probes above the rank of the clause, (e) the creation of about 200 probes from language strata other than lexicogrammar including semantic domains, (f) the acquisition of an analytical software suite to analyze the IGNT, and (g) the development of a variety of custom IGNTP software tools.

6.2 *Collect and Develop Testable Language Measures*

To develop a theoretically grounded and representative set of linguistic measures we propose two simplifying assumptions. First, we propose that, at the very least, we seek to capture the types and depth[39] of *parole*: language as it is actually spoken or

37. Special thanks are due to Paul Miller, Executive Director of the GramCord Institute, for providing the GramCord GNT, Barbara and Timothy Friberg for their inaugural work on the Analytical Greek New Testament (a project now overseen by John Hughes of the AGNT project who provided us with the AGNT database), Logos Bible Software for access to the Logos GNT, Drs. Stanley E. Porter and Matthew Brook O'Donnell for access to the OpenText.org GNT, and James Tauber and Ulrik Sandborg-Petersen for creating online access to the MorphGNT.

38. The current working revision of the IGNT is revision 85.

39. In traditional grammar, *type* and *depth* are reflected via the parts of speech and their inflections. In the Prague school (Hajicová and Krouzek, *Travaux du cercle linguistique de Prague*) it is achieved via word/word groups and patterns. In Pike's tagmemics each mode of language (phonemic, morphemic, and tagmemic) has both slots and classes. Pike, *Unified Theory*, 82–84. In Halliday's later classification, this is reflected by rank and delicacy.

written. Second, we propose that principled down-selection of that data be executed; that is, we must select the most representative sets of categories that reflect the type and depth of that language. Given these simplifying assumptions, we have chosen Systemic Functional Linguistics (SFL)[40] as our linguistic schema of choice due the multistructural, multisystemic, and multifunctional richness of those categories.[41]

Within this framework we propose an initial exploratory set of eleven measures in three linguistic categories: structure (syntagmatics), system (paradigmatics), and strata (semantics). A caveat is to be registered here. Only the syntagmatic layer, as it is assayed here, is modestly representative of its "cline" (its linguistic dimension) within the Koine. The other layers are still relatively undeveloped in the Koine but certain completed fields developed within the IGNT will be used to provide our baseline forays into the Pauline Canon. A brief description of each of these categories of measures is below:

Paradigmatic Measures: Because no fully worked out paradigmatic system network of the Koine yet exists, as a proxy

Halliday and Matthiessen, *Introduction to Functional Grammar*, 19.

40. Halliday's Systemic Functional Linguistics (SFL) can be considered a principled extension of Firth's linguistics. Perhaps no better summary definition of SFL exists than Halliday's own description: "Systemic grammar is an analysis-synthesis grammar based on the paradigmatic notion of choice. It is built on the work of Saussure, Malinowski and Firth, Hjelmslev, the Prague school, and the American anthropological linguists Boas, Sapir, and Whorf; the main inspiration being J.R. Firth. It is a tristratal construct of semantics (meaning), lexicogrammar (wording), and phonology (sound). The organizing concept at each stratum is the paradigmatic system: A system is a set of options with an entry condition, such that exactly one option must be chosen if the entry condition is satisfied . . . the grammar as a whole is motivated with respect to the semantics. The only line of (relative) arbitrariness is that between content and expression (between the lexicogrammar and the phonology)." See Halliday, *On Grammar*, 262. Two particularly helpful introductions to SFL are Thompson, *Introducing Functional Grammar* and Teich, *Systemic Functional Grammar*, 7–50.

41. Because abduction requires that all relevant schemata be tested, Dik's functional grammar and Lamb's stratificational grammar will also be tested in subsequent loops through the abductive experimental design.

(with all its attendant limitations) we will test three separate traditional grammatical annotations of the GNT (GramCord, AGNT and Logos).

Semantic Measures: Two are from semantics, specifically nondisambiguated Louw-Nida major semantic domains obtained from OpenText.org and disambiguated Louw-Nida subdomains from Logos.[42]

Syntagmatic Measures: Seven will be collected from five distinct syntagmatic "lengths" in the GNT. The benefits of the syntagms selected are as follows:

1. They span from "small to large" GNT structures (from lemma to clause complexes).[43]
2. They recapitulate intuitive and well-understood categories familiar to traditional language pedagogy (lemmas, inflected lexemes ≈ words, word groups ≈ phrases, clauses, sequences of clauses/clause complexes ≈ sentences.)
3. They are all complete within a category (see Table 1). All analyses, unless otherwise noted, include *all* instances of those measures.
4. They bring critically needed visibility into the traditionally less investigated (and larger rank scale) "discourse end" of the syntagmatic spectrum.[44]

42. Semantics is considered to be a distinct stratum from lexicogrammar. See Halliday and Matthiessen, *Introduction to Functional Grammar*, 25.

43. The clause complex annotations we have developed are a simple extension to the systemic functional annotation of the clause defined in the OpenText.org GNT. The annotation starts from the first function slot in the first clause and proceeds sequentially to any clauses linked to the initial clause. An example annotation would be: 1A-2PA-3CcjSP-4cjP. In this example, the first clause constituent is comprised of a lone adjunct, the second clause in the complex is comprised of a predicator followed by an adjunct, the third by a complement, conjunction, subject, and predicator and so forth. Two types of clauses were developed. The first type used internal OpenText.org "pointers" to identify which clauses were "chained" to other clauses. These were termed Standard Attribution Clause Complexes (SACC). After executing initial analytics, however, we discovered that this chaining often omitted prior clause referents to which an existing clause referred. Accordingly, we developed a recursion program to "walk back up" the chain and fill in missing clauses; these we termed Proximity Attribution Clause Complexes (PACC).

44. Specifically, text linguistics (discourse analysis) focuses on structure

A summary of the definitional, developmental, and distributional information regarding these eleven measures can be inspected in Table 1.

Language Measure Used	*Linguistic Definition*	*What It Measures*	*How Was It Developed?*	*Categories/ Instances (NA27)*
Lemma	The canonical form of the lexeme[45]	The breadth of lemmas used (lemma vocabulary)	By arbitrating lemma disagreements between the five GNTs used	5,413 / 138,019 (all)
Unique Lexeme Forms: "Words"[46]	The distinct forms a lexeme can take in a language	The breadth of lexemes used (lexeme vocabulary)	By arbitrating spelling and diacritical differences among the five GNTs	17,736 / 138,019 (all)
Semantic Domain (Dis-ambiguated)	The sense given an arbitrary sign	Meaning (as defined by Louw and Nida's major semantic domains) [47]	By using the disambiguated semantic domains of the Logos Syntactic GNT	93 / 138,019 (all)
Semantic Sub-domain (Dis-ambiguated)	The sub-categories of sense given an arbitrary sign	Meaning (as defined by Louw and Nida's semantic subdomains)	By using the disambiguated semantic subdomains of the Logos GNT	666 possible, 663 actual / 138,019 (all)

above the rank of the clause. For applied discourse approaches executed upon the GNT, see Porter and Reed, eds., *Discourse Analysis*.

45. Lexemes are a basic unit of linguistics, a "family group" of words that share the same canonical form, or lemma.

46. The construct that traditional grammar labels as a "word," linguists view as an instance of a lexeme. It is a discrete unit of semantic content comprised of one or more morphemes which, in the GNT, may or may not be inflected.

47. For background theory on semantic domains, see Louw and Nida, eds., *Greek-English Lexicon*, 1.vi-xx.

Traditional Grammar: AGNT	None *per se*[48]	Parts of speech and their subcategories from the AGNT (Friberg)[49]	By mapping AGNT's TG categories into 1,635 common TG categories[50]	1,635 possible, 633 actual / 138,019 (all)
Traditional Grammar: GramCord	None *per se*	Parts of speech and their subcategories from GramCord (Boyer)[51]	By mapping GC's TG categories into 1,635 common TG categories	1,635 possible, 583 actual / 138,019 (all)
Traditional Grammar: Logos	None *per se*	Parts of speech and their subcategories from Logos's GNT.	By mapping Logos's TG categories into 1,635 common TG categories	1,635 possible, 617 actual / 138,019 (all)
Word Group	A nominal with optional modifiers (definers, etc.)	Natural groups of words with clauses (equal to a phrase)	Imported from the OpenText.org GNT[52]	886 actual / 89,679 (all)
Clause	The core syntax unit in language	Natural groups of clauses	Imported from the OpenText.org GNT	1,412 actual / 30,919 (all)

48. Traditional grammar predates linguistics proper, and therefore carries no particular linguistic definition.

49. For the annotation theory behind the AGNT, see Friberg et al., *Analytical Greek New Testament,* 797–854.

50. This mapping from the original categories of each GNT to 1,635 common categories was based on formal rather than functional linguistic principles.

51. GramCord is based on the annotation of the GNT originally developed by James Boyer; Boyer, "Project Gramcord," 97–99.

52. OpenText.org has applied a "functional and relational dependency model of syntax to the word group and clause structure of the GNT" per Porter and Pitts, "Recent Research," 234. The model has been in development since the mid 1990's. The OpenText.org GNT may be viewed broadly as an implementation of SFL principles applied to the Koine. Cf. Halliday and Matthiessen, *Introduction to Functional Grammar*, 121ff.

Clause Complex (Two types)	Via working back from any clause to its head clause	Structure above the clause	Derived from the SFL clause annotation model of the OpenText.org GNT	11,260 (PACC); 12,303 (SACC) / (all)

Table 1. Summary of Linguistic Measures

6.3 *Collect and Develop Testable Authorship Theories*

Now that we have decided what to measure *linguistically*, our next charge is to collect (or develop) authorship theories. Two principles animate this effort. First, our goal must be to test all reasonable relevant historic views of Paul, not just his current construals. Second, we must test all reasonable variants of those current construals.[53] Combining these criteria yields an initial set of six authorship theories to be tested:

1. The original critical authorship theory of F.C. Baur and the older Tübingen School (four Paulines and 21 total authors).
2. A milder, less restrictive version of the old Tübingen School construct (four Paulines and 19 total authors).
3. The current mainstream critical view (seven Paulines and 18 total authors).[54]
4. A modest refinement of the current mainstream view (seven Paulines and 17 total authors).
5. A still largely mainstream authorship view that grants Colossians to Paul, per Kümmel (eight Paulines and 15 total authors).
6. The traditional view of authorship (thirteen Paulines and nine total authors).

These six authorship theories group the 27 texts of the New Testament as follows in Table 2:

53. This second insight is quite relevant because contemporary New Testament scholars vary quite widely in their views of the authorship of the New Testament.

54. Pace Mealand ("Positional Stylometry Reassessed," 267) who, somewhat surprisingly, replaced Philemon with 2 Thessalonians yielding ("Mealand's Pauline Canon"): Romans, 1 and 2 Corinthians, Galatians, Philippians, and 1 and 2 Thessalonians.

<table>
<tr><th></th><th>Original Baur (21 authors)[55]</th><th>Reduced Baur (19 Authors)</th><th>Modern Critical (18 Authors)</th><th>Modern Critical (17 Authors)</th><th>Modern Critical (15 Authors)</th><th>Trad-itional (9 Authors)</th></tr>
<tr><td>Matt</td><td colspan="5">Mattean Writer</td><td>Matt</td></tr>
<tr><td>Mark</td><td colspan="6">Mark</td></tr>
<tr><td>Luke</td><td colspan="5">Lukan Writer</td><td>Luke</td></tr>
<tr><td>John</td><td colspan="2">2nd Century John</td><td colspan="3">John, Redactors[56]</td><td>John</td></tr>
<tr><td>Acts</td><td colspan="5">Lukan Writer</td><td>Luke</td></tr>
<tr><td>Rom</td><td colspan="6">Paul</td></tr>
<tr><td>1 Cor</td><td colspan="6">Paul</td></tr>
<tr><td>2 Cor</td><td colspan="6">Paul</td></tr>
<tr><td>Gal</td><td colspan="6">Paul</td></tr>
<tr><td>Eph</td><td colspan="5">Eph Writer[57]</td><td>Paul</td></tr>
<tr><td>Phil</td><td>Phil Writer[58]</td><td colspan="5">Paul</td></tr>
<tr><td>Col</td><td colspan="4">Col Writer[59]</td><td colspan="2">Paul[60]</td></tr>
<tr><td>1Thess</td><td colspan="2">1 Thess Writer[61]</td><td colspan="4">Paul</td></tr>
</table>

55. For Baur's evaluation of the nine Pauline letters he rejected, see Baur, *Paulus*, 417–99.

56. Some scholars see core source material in John (that has been subsequently redacted) connecting a certain eyewitness John to Jesus. Howard, "Gospel According to John," 460.

57. Baur (1845) followed Evanson (1792) and De Wette (1843) inveighed against the authenticity of Ephesians due to its perceived dependence on Colossians. Baur, *Paulus*, 417–18; Evanson, *Four Generally Received Evangelists*, 312–13; de Wette, *Kurze Erklärung der Briefe*, 79.

58. Though de Wette affirmed Philippians as Pauline beyond any dispute, Baur saw in it purported gnostic ideas. Baur, *Paulus*, 458–64; de Wette, *Lehrbuch der historisch-kritischen Einleitung*, 267–68.

59. Kümmel notes that the modern era of critical arguments against Pauline authenticity of Colossians began with Dibelius. Kümmel, *Introduction,* 140.

60. Kümmel supports authenticity based on its style. Kümmel, *Introduction*, 341–42.

61. Baur rejected 1 Thessalonians because it lacked originality. Baur, *Paulus*, 480–81.

2Thess	2 Thess Writer[62]					Paul
1 Tim	2 Tim Writer[63]	Pastoralist Paul[64]	1 Tim Writer	Pastoralist Paul[65]		Paul
2 Tim	2 Tim Writer	Testamental Paul[66]	2 Tim Writer	Testament Paul	Pastoralist Paul	Paul
Titus	Titus Writer	Pastoralist Paul	Titus Writer	Pastoralist Paul	Pastoralist Paul	Paul
Phlm	Phlm Writer[67]		Paul			
Heb	Heb Writer					
James	Jas Writer					Jas
1 Peter	1 Peter Writer					Peter
2 Peter	2 Peter Writer					Peter

62. J.E.C. Schmidt was the first to contest 1 Thessalonians due to perceived differences between the *parousia* of 1 and 2 Thessalonians. Schmidt, "Vermutungen," 380–86.

63. Schmidt doubted both epistles on the basis of aberrant vocabulary, and Schleiermacher because he viewed it as unknown to Polycarp as well as to the apostolic fathers. Schmidt, *Historisch-kritische Einleitung*, 257–67; Schleiermacher, *Ueber den sogenannten ersten Brief*, 16–19.

64. On the similarity of 1 Timothy and Titus, see Aageson, *Pastoral Epistles*, 87.

65. Kümmel viewed 1 Timothy as the work of a single pseudepigraphist. Kümmel, *Introduction*, 385.

66. This raises the notion of a pseudepigraphal Paul who wrote an endearing farewell discourse or testament for the man from Tarsus. Contemporaneous instances of Koine testaments (e.g. Testament of Abraham), of course, are well known, and testamental material in the papyri are mentioned as early as Deissmann (*Light from the Ancient East,* 90, 221). Whether the overall genre of 2 Timothy is testament (Collins, *Timothy,* 181–85; Fiore, *Pastoral Epistles*, 8–9), *paraenesis* (Johnson, *Letters to Timothy*, 320–24; Dibelius and Conzelmann, *Pastoral Epistles,* 7), or something else altogether (Miller, *Pastoral Letters,* 151–58; Donelson, *Ethical Argument,* 54–65), it is hard to deny that the text contains large swaths of testamental material (1 Tim 3:10–4:8). Here again is Aageson's (*Pastoral Epistles*, 70) conclusion that 2 Timothy is the most *unlike* the other two texts, "either 2 Timothy was written by a different author or the circumstances . . . had changed quite substantially."

67. Von Weizsäcker is one of the few to reject this epistle. von Weizsäcker, *Das apostilische Zeitalter*, 183–84.

1 John	Johannine School	John	John the Elder[68]	John
2 John	Johannine School	John the Elder		John
3 John	Johannine School	John the Elder		John
Jude	Jude Writer			Jude
Rev	1st Century John	Asia Minor John		John

Table 2. Authorship Theories by Books of the New Testament

6.4 *Collect and Develop Testable Genre Theories*

We have developed elsewhere an extensive justification for testing genre theories.[69] For our purposes here, we can summarize that justification under four heads. First, Aune's well-accepted literary categories will serve as our top level (hyperordinating) categories.[70] This we term literary *type*. Second, by interrogating the GNT linguistically, it becomes apparent that an important, repeated, binary choice in the system network of the Koine relies on *number*. The decision to promote number as our second organizing category has precedent given the longstanding observation made by Parry, Hitchcock, Simpson, and others that when Paul speaks to close associates, as opposed to the aggregate theological community, the *tenor* of his language changes.[71] Third, the *audience* addressed, whether it be Hebraic-Palestinian or Greco-Roman, doubtless shifts the lexicogrammatical as well as the semantic choices of the author/editor/redactor. This becomes our third and final organizing category.[72] While schemas other than this relatively simple *type/*

68. Kümmel views 1–3 John to be by one hand. Kümmel, *Introduction*, 450.

69. For more detail, see Libby, "Disentangling Authorship," 210–31.

70. Aune, *Literary Environment*, 17–252.

71. Our terminology here is not accidental. In SFL, shifts in the number of subjects addressed as well as the mood and manner (tenor) in which they are addressed fall within the interpersonal metafunction—the tenor of the language. See Halliday and Matthiessen, *Introduction to Functional Grammar*, 106–67.

72. Trobisch argues that 𝔓46 was organized by addressee, with the texts to theological communities preceding letters to individuals. If Trobisch is at all

number/audience taxonomy are of course possible,[73] at least this schema better reflects the *intrinsic* and *paratrinsic* features of the language of the New Testament than the purely *extrinsic* four-fold schema of Aune's literary theory alone.[74] Fourth, there remains one complication. Even with our type/number/audience schema, it is still unclear in some instances how to categorize certain GNT texts. Is Hebrews, for instance, a Jewish sermon, or an odd type of corporate didactic or simply a hortatory epistle? If the former, it becomes its own category; if the latter, it becomes possible to group it with Romans and other instances of the corporate didactic epistle form. To respect this uncertainty, we will test texts in various possible genre "slots," and then allow the mathematics to weigh in on which categorization performs best empirically. Following these principles, we have generated four distinct categorizations of genre.[75] The first is grouped by the richest combination of type, number, and audience elements. It yields thirteen groupings. We then successively simplified the

correct, not only is audience further confirmed as a natural organizing category for genre in general, it becomes uncontestably situated as a natural thought category in the early Christian era. Trobisch, *Paul's Letter Collection,* 52–54.

73. Reed suggests that genre can be identified via five aspects of discourse: (1) subject matter (semantic content), (2) situation type (context of situation), (3) participant roles, (4) mode (persuasive, explanatory, or imperatival), and (5) medium (spoken or written). The first four of these seem to be viable candidates for expanding or sharpening our view of genre. Reed, "Modern Linguistics in Historical Criticism," 40–41.

74. We borrow the terminology of intrinsic and extrinsic, but not the meaning, from Wellek and Warren. By *intrinsic* we mean the subcategories of genre (per Bakhtin); by *paratrinsic* we mean that certain subcategories of genre share common features. What we do directly borrow from Welleck and Warren is their notion that complex literary forms (genre) develop out of simpler units (literary forms). Wellek and Warren, *Theory of Literature*, 246; Bakhtin, *Speech Genres*, 61–67.

75. These three dimensions, in fact, create genre possibilities that are the product of their individual dimensions. For example, let's assume there are 20 types and subtypes of genre in the first century, by six audiences (the combinations of Jewish, Gentile, and Palestinian, by two numbers, corporate and individual). These three dimensions yield 120 possible type/audience/number combinations, most of which are not in evidence in the GNT.

type and audience dimensions to yield the remaining three genre categorizations as detailed in Table 3.

GNT Books by Genre (Following a Type / Audience / Number Typology)				
Closest Genre Category	*Genre (13)*	*Genre (12)*	*Genre (10)*	*Genre (8)*
Gospel: *Sui generis.* Closest to Greco-Roman biography w/traditional material (pronouncement stories, miracles)	Matt, Mark, Luke	Matt, Mark, Luke	Matt, Mark, Luke	Matt, Mark, Luke, John
Gospel: *Sui generis.* Closest to Greco-Roman biography w/traditional material and elements of φιλοσόφημα)	John	John	John	N/A
History/Historiography (with embedded form critical elements such as miracles)	Acts	Acts	Acts	Acts
Epistle Corporate: Didactic/Diatribe	Rom, 1–2 Cor, Gal, Phil	Rom, 1–2 Cor, Gal, Phil.	Rom, 1–2 Cor, Gal, Phil, Heb	Rom, 1–2 Cor, Gal, Phil, Heb
Epistle Corporate: Didactic/Paraenesis	Eph, Col	N/A	N/A	N/A
Epistle Corporate: General	1–2 Thess, 1–2 Peter,[76] Jude	Eph, Col, 1–2 Thess, 1–2 Peter, Jude	Eph, Col, 1–2 Thess, 1–2 Peter, Jude	Eph, Col 1–2 Thess, 1–2 Peter, Jude
Epistle Corporate: Hortatory (Sermon?)	Heb	Heb	N/A	N/A
Epistle Corporate: Jewish Paraenesis[77] (Ethical Paraenesis?)	Jas	Jas	Jas	Jas

76. Achtemeier's observation that 2 Peter has elements of testament is worthy of further investigation. In this case it would be grouped with 2 Timothy; Achtemeier et al., *Introducing the New Testament*, 528.

77. Given its address, "to the twelve tribes," and its tenor, a Jewish audience seems to be in view.

Letter[78] Individual: Paraenesis or *Mandata Principis*	1 Tim, Titus	1 Tim, Titus	1–2 Tim, Titus	1–2 Tim, Titus, Phlm
Letter Individual: Elements of *Mandata Principis*/Personal Appeal	Phlm	Phlm	Phlm	N/A
Letter Individual: Testament with Elements of Paraenesis	2 Tim	2 Tim	N/A	N/A
Letter Individual: Appeal/ Elements of φιλοσόφημα	1–3 John	1–3 John	1–3 John	1–3 John
Apocalyptic: Jewish	Rev	Rev	Rev	Rev

Table 3. GNT Books by Genre

7. *A Primer on Extractive Multivariate Analysis*[79]

To best underscore the need for EMVA in probing the boundaries of the Pauline Canon, and understanding its utility in the multivariate visualization of the GNT, a short summary of the author's prior research is clearly indicated.

7.1 *Prior Research*

In prior research the author presented findings that almost uniformly demonstrated that *genre* rather than *authorship* explains a larger proportion of the total variance observed across the rank scale of linguistic measures tested in the GNT (using the same measures mentioned in Table 1).[80] These finding hold regardless of whether that variation is assessed *in toto* by univariate measures (such as Cramér's V, Goodman and Kruskal's tau, or the Uncertainty Coefficient) or whether it is decomposed into its main effects and interactions via

78. For the essential difference between the epistle and letter is to be public and for posterity vs. private and personal; Deissmann, *Light from the Ancient East,* 228–30. Because discerning authorial intention is problematic, we have simplified the definition to *number*: audience plurality vs. singularity.

79. Following corpus linguistic convention, henceforth we will refer to the NT books as *texts*.

80. See Libby, "Disentangling Authorship," 232–324.

multivariate analyses such as hierarchical log-linear analysis (HLLA).[81] Given that genre displays: (a) a higher relative amount of association (Cramer's V), (b) a higher proportional reduction in error (Goodman and Kruskal's Tau), and (c) a larger amount of normed variation in its interactions controlled for other effects (HLLA), this makes the questions we raised in Section 2 even more pointed. Informed by even this brief review, we may now sharpen and extend the initial questions from Section 2 as follows:

> (1) Qualitatively, is this modestly higher "strength" of genre over authorship reflected in the relationship *between* the NT texts? That is, according to EMVA, how do the texts of the NT "cluster"? Do they cluster by genre, authorship or something in-between? Does this clustering admit more of an idiolectic or sociolectic explanation?
>
> (2) Qualitatively, does the clustering developed by EMVA differ when explored by linguistic rank (the "length" of the syntagmatic unit of language under study)? Does it differ when explored by its paradigmatic systems? What about when explored by other linguistic strata (e.g. semantics)?
>
> (3) Quantitatively, how do each of the relative authorship and genre theories compare? Based on EMVA, which displays the tightest clustering (i.e. the least spread)?
>
> (4) Quantitatively, can EMVA or other multivariate methods determine which single authorship or genre theory best fits the language data of the GNT?

7.2 *The Utility of Extractive Multivariate Analysis (EMVA)*

The broad field of EMVA exists, in fact, to answer these kinds of questions. EMVA approaches, in their many forms, simplify complex data relationships using *eigen-system mathematics*.[82] Eigen-system methods, in brief, reduce complex systems of variables into a set or sets of simpler components, and as such, constitute a form of multivariate data reduction (MDR). MDR

81. HLLA is a nonparametric method of multivariate analysis.

82. Eigen-systems are widely used in data mining, psychology, sociology, and marketing. For accessible introductions to eigen-systems in linear algebra see Lipschutz et al., *Linear Algebra*, 107–23; Golan, *The Linear Algebra*, 215–48.

methods, in turn, allow the original objects under study (in our case the 27 texts of the GNT) to be "compressed" into a two- or three-dimensional "map" while still maintaining most of the information of the original non-extracted data.[83] The indicated MDR techniques for contingency table (standard cross-tabulation) data are Correspondence Analysis (CA) and Multiple Correspondence Analysis (MCA), respectively.[84] More technically stated, both CA and MCA find the *characteristic roots* of complex multivariate systems. Said more colloquially, they are the mathematical analog of Ockham's razor.[85] That is, EMVA approaches reduce an original set of variables (in our case a large number of linguistic measures) into a much smaller set of components (sometimes called factors) which are typically themselves weighted combinations of the original set of variables. In so doing they yield two outcomes salutary for our purposes. First, they produce a quite Ockham-razor-like outcome—a parsimonious and interpretable summary of each component so extracted.[86] Second, these techniques calculate a

83. In MDR, the dimensions are necessarily defined by the smallest number of the multiple categories that are being analyzed minus 1.

84. For the inaugural work on CA, see Hirschfeld, "A Connection between Correlation," 520–24; and Benzecri, "Elaboration statistique," 7–30. For the now classic monograph on CA, see Greenacre, *Correspondence Analysis*. For two very accessible introductions to its application, see Clausen, *Applied Correspondence Analysis*, 2–26; Meulman and Heiser, "SPSS Categories 21.0," 46–66. Excellent separate monographs on MCA include those by Greenacre and Blasius, *Multiple Correspondence Analysis*, 4–29; and Le Roux and Rouanet, *Multiple Correspondence Analysis*, 1–67.

85. This analogy originates from a PowerPoint presentation authored by Michael Clark, now a statistical consultant for the Center for Social Research, University of Notre Dame. Clark, *Principle Components Analysis* (2009 [cited 9.28.2014 2014]); available from http://www.unt.edu/rss/class/mike/6810/Principal%20Components%20Analysis.pdf.

86. The earliest modern form of eigen-systems mathematics was Principal Components Analysis. PCA was independently invented by Pearson in 1901 and Hotelling in 1933 and explicated in Thurstone's book length treatment in 1935; Pearson, "On Lines and Planes," 559–72; Hotelling, "Complex of Statistical Variables," 498–514; Thurstone, *The Vectors of Mind*. See especially the more modern and very accessible treatment by Dunteman; Dunteman, *Principal Components Analysis*, 7–54.

common space in which the data (in our case the linguistic measures themselves and the books of the GNT) can be parsimoniously projected and interpreted. Both CA and MCA are interpreted in the same way; categories (either texts or linguistic measures) that exhibit multivariate similarity are plotted closer to one another, and dissimilar categories are plotted farther from one another. Such a map places each row or column of the contingency table (e.g. the 27 NT texts and, say, the lemmas of the GNT) as a point on that "map."[87]

The Feature-Set Extraction Method: Feature Set Extraction (FSE) methods[88] are typically employed in supervised multivariate analytics to objectively discover a subset of features (in our case linguistic measures) that maximize a given desired outcome.[89] Although the EMVA techniques we propose (CA and MCA) are unsupervised approaches (they do not require pre-classification of categories), using FSE nonetheless achieves four important goals. First, it eliminates noncontributing linguistic measures (e.g. it finds the most discriminating lemmas among lemmas) and retains those that contribute maximally to the discrimination between texts. Second, by using standardized measures each text is considered as important as every other text.[90] Third, eliminating noncontributing measures produces "maps" with fewer dimensions and generally places more information in each dimension. Fourth, by using two methods of FSE, namely AAVASR and APASR,[91] two different perspectives on the language of the GNT can be secured. In the first

87. Points are actually the weighted geometric center (centroid) of all the objects that underlie it. Thus, the centroid αὐτός is the weighted geometric center of its 5,597 instances in the NT.

88. For a deeper overview of FSE techniques, see Blum and Langley, "Selection of Relevant Features," 245–71; and Kohavi and John, "Wrappers for Feature Subset Selection," 273–324.

89. Typically, this outcome would include correct classification, lift above chance or the like.

90. For the advantages of standardized residuals, see Haberman, "The Analysis of Residuals," 206–13.

91. This is analogous to the feature set extraction (FSE) step in supervised multivariate classification tasks.

perspective, the absolute value of the adjusted standardized residual (AAVASR) is calculated (as its acronym implies) for each linguistic measure by taking the average (the mean) of the absolute value of the adjusted standard residual across the 27 books of the GNT. By taking its absolute value, AAVASR considers negative ASR's (infrequent forms) just as "important" as frequent forms. The average positive adjusted standardized residual (APASR), on the other hand, is calculated by taking the mean of only the positive ASR's (i.e. high-frequency rather than low-frequency forms). In this way, APASR finds *characteristic* or *key measures* in a text; that is, it finds measures that are in high frequency in a given text or texts but in low frequency in the remaining texts. As a working example, we have produced Tables 4 and 5 below which list the top 20 APASR lexemes in the GNT that occur at least 10 times in the GNT:

Top Ten APASR Lexemes in the GNT				
Rank	Word	Text with the Highest Frequency	Frequency in the Highest Frequency Text	Frequency in GNT
1	ἀρνίον	Rev	29	30
2	χιλιάς	Rev	19	23
3	δράκων	Rev	13	13
4	φιάλη	Rev	12	12
5	καπνός	Rev	12	13
6	λευκός	Rev	16	25
7	κέρας	Rev	10	11
8	ἑπτά	Rev	55	88
9	σαῦλος	Acts	15	15
10	τάλαντον	Matt	14	14

Table 4. Top Ten APASR Lexemes in the GNT

Second Set of Ten APASR Lexemes in the GNT				
Rank	Word	Text with the Highest Frequency	Frequency in the Highest Frequency Text	Frequency in GNT
11	εὐθύς	Mark	42	59
12	φῆστος	Acts	13	13
13	καισάρεια	Acts	17	17
14	προσφέρω	Heb	20	47
15	νόμος	Rom	74	194
16	εὐσέβεια	1 Tim	8	15
17	σίλας	Acts	12	12
18	ἀγρίππας	Acts	11	11
19	Ἀνανίας	Acts	11	11
20	οὖν	John	200	499

Table 5. Second Ten APASR Lexemes in the GNT

For clarity, the data presented in Section 8 will be based on the 27 GNT texts, one for each book of the GNT, rather than multiple samples of equal size from each book (per, for instance, Mealand).[92] Both Mealand's sample approach and our "whole book" approach are legitimate but require different interpretive frameworks. In the former case texts with more words will have more mass,[93] just as they do in the corpus. In the latter case (per Mealand's work) the interpretation is different; it is as if every text was the same size in the NT. Lastly, to aid in interpreting the relationship between the texts of the NT, all CA and MCA biplots have been visually simplified by suppressing the display of the language measures.

Now that we have (finally!) retired all the requisite preliminaries, we are ready to present data from a main set of 270 visualizations (180 correspondence analyses and 90 MCA

92. See especially Mealand, "Pauline Corpus," 69.

93. For an understanding of mass in correspondence analysis, see Clausen, *Applied Correspondence Analysis*, 9–26.

analyses) in Section 8 and draw conclusions from those analyses in Section 9.

8. *Executing the Multivariate Visualizations and Associated Analyses*

In this section we will organize the results of our EMVA analyses into four sets of findings. This organization is directly influenced by the somewhat surprising initial finding; when the 90 MCA analyses were inspected, they revealed no novel insights that were not expressed more clearly in the CA analyses. Accordingly, our focus here will be upon the remaining 180 CA analyses.

8.1 *Correspondence Analyses Projections by Various Linguistic Categories (Structure, System and Strata)*

8.1.1 *The Initial Experimental Design for Correspondence Analysis.*[94] The initial experimental design cycle for Correspondence Analysis (CA) was as follows:

Language Measures: Ten of the original eleven language measures were selected for this exercise: five syntagmatic measures (lemmas, inflected lexemes or "words," clause groups and two types of clause complexes), two nonlexicogrammatical measures (semantic major domains and semantic subdomains) and three paradigmatic measures[95] (three traditional grammatical annotations of the GNT).

Experiments Executed: 180 initial correspondence analyses (CA) were executed. Specifically, each of the ten language measures above was varied by two methods of feature set

94. Some of this work was included in Libby, "Disentangling Authorship," 286–305, but this experimental design is a major expansion on that study.

95. From a functional linguistic standpoint traditional grammar is a quite limited and incomplete perspective on paradigmatics. In contrast to the paradigms of traditional grammar, systemic functional paradigmatics studies the language in terms of the various systems of choices made by speakers and writers. For one of the earliest and most clear introductions to systemic functional paradigmatics, see Halliday, *Functions of Language*, 22–71.

selection, AAVASR and APASR.[96] (Feature set selection[97] finds maximally different categories within a given linguistic measure, and AAVASR and AAPASR are two separate algorithms used to do so. By category we mean, for instance, a specific lemma within the set of all lemmas.) Three depths of AAVASR and APASR selected categories, in turn, were executed. That is, AAVASR and APASR were used to discover the top 26, 51, and 101 maximally different categories for each of the ten linguistic measures. These top categories in turn were drawn from a pool that required any single category to occur at least 10, 25, or 50 times in the GNT respectively. (Thus, 10 measures by 2 feature set extraction methods (FSE's) by 3 top measure cutoffs by 3 minimal frequency sizes = 180 runs.) Note that the "pool" size submitted to the CA analysis was always one category greater than the frequency (e.g. 26 rather than 25) because a "Rest" category was constructed to contain all the forms that do not fit that criterion. This additional category yielded two explicit benefits: (1) the entire GNT was thereby included in each correspondence analysis executed and (2) all analyses at a given cutoff yielded a contingency (crosstabulation) table that had the same degrees of freedom[98] for all 10 linguistic measures tested. This allowed the visual display of the data to be more directly interpretable across linguistic measures.

Layout of Results in This Subsection: With a set of results this large (180 CA analyses) we have elected to summarize the results in Section 8.1 into six exercises. *First*, we will provide principles for interpreting CA uniplots and biplots (Section 8.1.2). *Second*, we will present the highest level *general findings* by exploring a carefully selected CA run that will orient us to the interpretation of the remaining 180 CA runs in our design

96. Recall that AAVASR = average absolute value of the adjusted standardized residual. The higher the AAVASR the more variant that linguistic measure is across the texts of the GNT. APASR = average positive adjusted standardized residual. APASR is calculated essentially the same as AAVASR except it uses only texts with positive residuals.

97. Feature set selection is sometimes termed feature set extraction.

98. The degrees of freedom were as follows: 650 for the 26 by 27 table, 1,300 for the 51 by 27 table, and 2,600 for the 51 by 27 table.

(Section 8.1.3). This subsection will also serve as a pedagogical section on interpreting CA visualizations. *Third*, *specific findings* of the 180 runs will be summarized using the 10 representative CA runs (8.1.4). These runs are structured to allow interpretation of the CA data syntagmatically, paradigmatically, and semantically.

8.1.2 *Principles for Interpreting Correspondence Analysis (CA) Visual Projections*. Before we present the data, three principles should be clearly understood in order to properly interpret the output of the Correspondence Analyses.

Principle 1: Interpreting the Proximity of Points in Uniplots and Biplots: Uniplots are visual projections that present either the texts of the GNT or the categories of a given linguistic measure as a single set of points in a two-dimensional X-Y plot. A biplot, in contrast, projects both sets of points (e.g. the GNT texts and categories from a given linguistic measure) into the same space. Interpretively, texts that cluster closely together are similar to one another across the categories of that particular linguistic measure. Similarly, the categories of a given linguistic measure (e.g. the specific lemmas) that cluster closely together display a similar distribution across the texts of the GNT.[99] Lastly, texts close to a given linguistic category, *ceteris paribus*, tend to have a much higher frequency of that category than texts far from it.[100]

Principle 2: Interpreting the Dimensions in Uniplots and Biplots: Clearly, any two-dimensional (2-D) projection (one that lays flat on a page) necessarily omits the third dimension: depth. To mitigate this we have increased the size of the centroids (the spheres that we use to identify the location of the GNT texts) closer to the eyepoint of the reader and minimized those farther away. Yet, this does not fully solve the problem given that 3-D

99. For this work we have elected symmetric normalization, a method in which the total variance is spread equally across the row and columns (that is, across the linguistic measure and the texts of the GNT respectively).

100. Or, alternatively the texts have very low frequencies of the row points (the linguistic categories) far from them.

projections, in turn, omit information from all higher dimensions. This missing information is quite problematic interpretively, especially when visual projections display markedly different amounts of variance in two or three dimensions.[101] Accordingly, to assist our interpretation of CA projections with disparate amounts of variance[102] we have taken two steps. First, we will express the total inertia (a measure of variance) captured by the first three dimensions in the header of all visual CA exhibits. Second, we will express the fit between each CA run and each authorship or genre theory using a distance measure that calculates the average spread (the diffuseness) of that authorship or genre construct. Because this spread is expressed using a distance measure it can take into account all dimensions of the data, regardless of the number of dimesions. This data will be summarized in Section 8.3.

Principle 3: Interpreting CAs That Differ by Feature-Set Selection Methods: Feature set selection (FSS) is an objective method of picking a subset of categories (earlier researchers termed categories "markers") to represent the whole distribution of the linguistic population being explored (e.g. inflected lexemes, word groups, clauses etc.). FSS is necessary because both the calculations employed within multivariate techniques and the subsequent parsimonious analysis of the results becomes unduly complicated by the presence of too many categories. The first attempt at FSS was the most obvious possible: selecting the most frequent N categories (where N was typically < 200). This approach was pioneered by Burrows and explicated by Forsyth and Hoover,[103] and FSS (by frequency) was originally an attempt

101. To mitigate this effect one may quantitatively produce a table of distances between all texts, and test whether those distances are significant. This we do in section 8.3.

102. Inertia is a measure of variance in the cross tabulation table. Inertia = χ^2/n; where n = size of the sample. The first dimension necessarily explains more inertia than dimension two, dimension two more than three, etc. See Greenacre, *Correspondence Analysis in Practice*, 25–32.

103. For more on frequency priority as a method of feature set selection see the principles of the "Burrow's method" discussed by Forsyth and Hoover. For the rationale behind the selection of high-frequency forms, see Forsyth et

to find the most discriminating markers to address issues of authorship. The various FSS approaches used in this article—frequency, AAVASR, and APASR—have different advantages and disadvantages that should be clearly understood. First, FSS by frequency necessarily subsumes the largest number of instances of a given linguistic measure in a text or corpus in the fewest categories, but does not in any way guarantee that the most frequent categories yield the most discriminating categories. FSS by AAVASR, on the other hand, necessarily yields the most variant categories regardless of whether that variance is high or low. By the same token, however, it necessarily includes less total instances of that linguistic measure in its top number of categories compared to FSS by frequency. (Said another way it includes more instances in the combined REST category.) FSS by APASR, in turn, yields the most variant categories that are positively deviated (that is, they are significantly present rather than significantly absent in the text), but it tends to include the least total instances of that linguistic measure in its top number of categories compared to FSS by frequency.

8.1.3 *An Introductory Pedagogical Exercise in Interpreting Correspondence Analyses*.[104] To introduce the interpretation of CA we have elected to highlight a single CA obtained by crosstabulating the texts in the GNT against the Top 100 lexemes by AAVASR. (In terms more familiar to grammarians, a lexeme can be considered to be equivalent to a lemma.) To be included in the CA's individual categories, each lexeme had to occur at least 50 times in the GNT. Our decision to select this CA as our example was driven by four factors. First, lexemes (lemmas) have the fewest categories overall at the rank of lexis. Accordingly, they compress the highest amounts of inertia into

al., "Investigating the Authenticity," 379–80; Hoover, "Multivariate Analysis," 343–45.

104. The data in section 8.1.3 was previously incorporated in a substantially similar form in the author's dissertation. Libby, "Disentangling Authorship," 286–88.

the lowest three dimensions.[105] Second, empirically, lemmas repeatedly yield uniplots that maximally separate text clusters or individual texts in the lowest dimensions.[106] Third, as a method of FSS, AAVASR is best at finding characteristic lexeme categories regardless of whether those categories are significantly present or absent in the corpus. Fourth, because each lexeme was required to occur at least 50 times in the GNT, this increased the total percentage of the words in the CA that fell within their actual lexeme category, rather than being aggregated in the two combined categories.[107]

Three orienting pedagogical exercises will be executed: the display and interpretation of the dimensions of the uniplots, a demonstration of the relationship and distances between large texts in the GNT, and a calculation of the best fit between the CA data and theoretically and empirically derived theories of authorship and genre.

Inspection of both projections (Figure 1A and 1B) reveals that they both separate the NT into three complexes, and three texts that stand alone.[108] The three complexes include a diffuse complex of 1–3 John (seen best in Figure 1B), a tight complex including the Synoptic gospels (best seen in Figures 1A and 2), and another somewhat diffuse complex of epistles. In addition, Revelation, Acts, and the gospel of John in particular, stand distinctly apart from these complexes and from one another (best

105. That is, semantic domains reside at a different strata, and lexemes and inflected lexemes necessarily have more categories than sematic domains.

106. They share this distinction with semantic domains (both major domains and minor domains)

107. The first combined category includes lexemes that do not meet the frequency cutoff (50 times or more in the GNT). The second combined category includes lexemes that do not meet the AAVASR cutoff (its AAVASR score is too low to place it in the Top 100.) Fully 61% (84,124 out of 138,019) of the lexemes (lemmas) in the GNT are found in the Top 99 individual categories for this CA.

108. The CAs in this study were all initially developed using IBM's SPSS software package. Subsequently they were redeveloped (as a redundant check) using PositionSolve™, a proprietary eigen-systems-based data reduction and visualization application originally written by the author and subsequently enhanced by Decision Support Sciences.

seen in Figure 2). The difference between Figure 1A and Figure 1B is simply because Figure 1A was rotated "upwards" around the horizontal axis 90 degrees thus fully revealing the third "depth" dimension.[109]

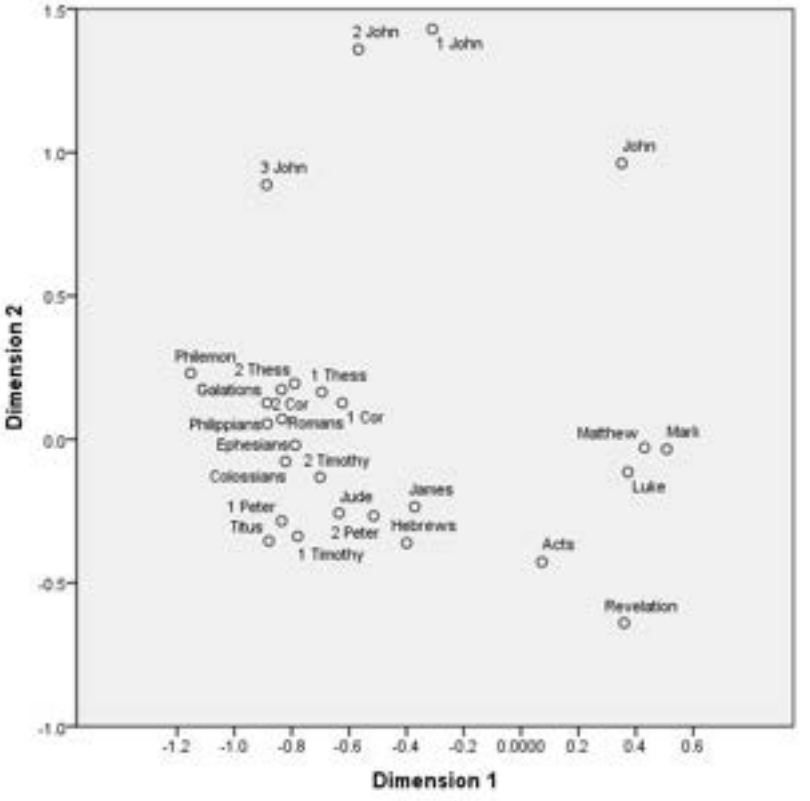


Figure 1A. High Level Finding 1:
The Display and Interpretation of the Dimensions of CA Uniplots[110]

109. Because the X (horizontal) axis in both projections is dimension one and we are rotating around that dimension, a vertical line can be drawn from Figure 1A down through Figure 1B and each of the 27 individual texts in the GNT will align vertically.

110. For Figures 1A and 1B: CA of the 27 GNT texts by the top 100 lexemes (by AAVASR). Lexemes must occur at least 50 times. Figure 1A has dimension 1 vs. dimension 2 and Figure 1B has dimension 1 vs. dimension 3.

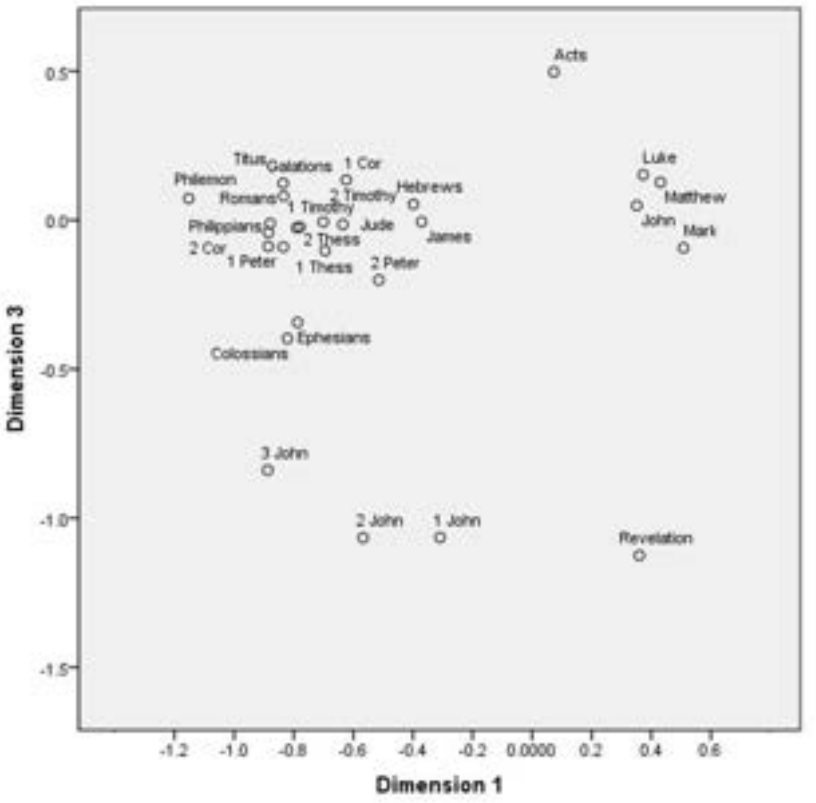


Figure 1B. High Level Finding 1:
The Display and Interpretation of the Dimensions of CA Uniplots

Recall that per our prior discussion, any two-dimensional projection necessarily fails to represent information in the third dimension. Accordingly, we used a proprietary data reduction tool, PositionSolveTM to rotate the CA so that the six texts with positive component loadings seen in Figures 1A and 1B lay (as closely as possible) upon the plane of the page.[111] This yields a truer perspective of the relative distances between these NT texts. The rotated perspective demonstrated that Acts, John, and Revelation lie relatively far apart from each other while the

111. The distances are between texts adjusted by inertia of the first three dimensions.

Synoptic gospels lie relatively close to one another. We will use PositionSolveTM repeatedly in this study to rotate the texts so that they lie as closely as possible upon the plane of the page.[112] The Euclidean distances between the texts pairs are as follows:

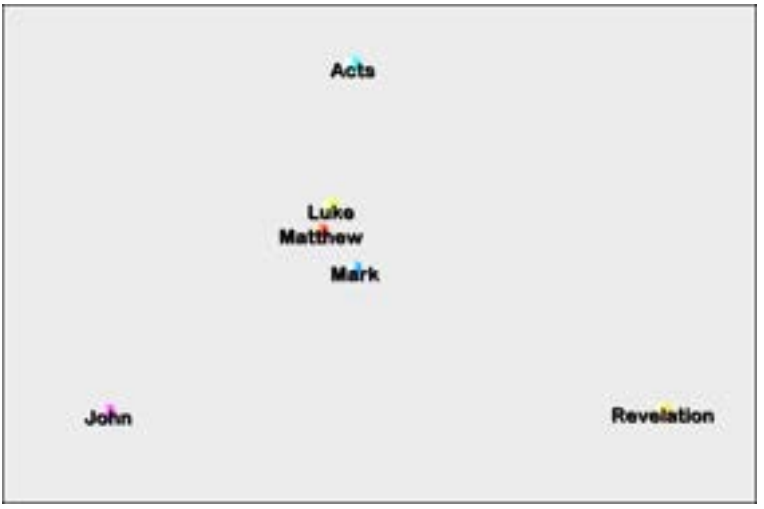


Figure 2. High Level Finding 2: Demonstration of the Relationship and Distances between the Largest Texts in the GNT[113]

	Book Pairs		*Generalized Euclidean Distance*[114]
1	Luke	Matt	2.29
2	Matt	Mark	3.17
3	Luke	Mark	4.84
4	Luke	Acts	10.87
5	Synoptics	Acts	13.14
6	Synoptics	John	18.97
7	Luke	Rev	16.42

112. Ideally this should be performed using ordinary least squares (OLS) but we will do so qualitatively.

113. CA of the 27 GNT texts by the top 100 lemmas by AAVASR. The output is rotated so that texts lie as closely as possible upon the plane of the page.

114. While, technically, a chi-squared distance is indicated here, given the modestly similar mass of these books and the pedagogical nature of our effort, Euclidean distance serves as a close approximation.

8	Luke	John	19.87
9	Synoptics	Rev	16.46
10	Acts	Rev	19.09
11	Acts	John	27.19
12	John	Rev	31.93

Table 6: Generalized Euclidean Distance between Selected Pairs of NT Texts[115]

Given these distances, it is appropriate here to introduce a finding that appears repeatedly in this study. Both Figure 2 and Table 6 problematize the *de facto* historic view that NT texts cluster primarily by authorship. Two consistent observations are important in this regard.

Using lemmas (and in fact across all measures at the rank of lexis—lemmas, inflected lexemes, and semantic domains) the Synoptic gospels are quite tightly grouped. If the primary component of this data reflects authorship, this is *not* what one would expect given that the Matthean/Markan/Lukan authors (or editors or redactors) are universally assumed to be separate individuals. If one should object that the close proximity of the Synoptics is due to common source material (such as Q), then one would expect Mark to be closer to Matthew and Luke, and that unique Matthean material (M) and unique Lukan material (L) would place these two gospels at some relief from one another. Actually the opposite is the case, per Table 6. A more perspicuous explanation for the observed text clusters at the rank of lexis is that the Synoptic gospels group together because they constitute a Synoptic *genre* (i.e. Greco-Roman biography or the like).[116]

115. This distance was developed from the column scores of a CA in which the columns were the texts of the NT and the rows were the top 100 most variant lemmas (via AAVASR, the average absolute value of the adjusted standardized residual). To obtain Table 1, Euclidean distance was multiplied by the inertia of each dimension to adjust for the information content in each dimension, and then by 100 for easier visual comparison.

116. We propose that the greater similarity between Luke and Matthew reflects the greater similarity in lexical stock between M and L. That is, Mark stands apart because his non-common Markan material (or his redaction of Q)

Moreover, as was observed in Figure 2, the texts of Luke and Acts lie relatively far from one another. Given that NT scholarship almost without exception confirms that Luke-Acts was written entirely or substantially by the same author, this is also not what one would expect if the primary component of the variance structure of the GNT reflects authorship. If, on the other hand, genre were the primary driving factor in the conformation of these texts, and authorship a more secondary factor, then one would expect Luke-Acts to be located at some distance from one another, and that Luke would be closer to Acts than the other two synoptics. This indeed is the case.

In Figure 3 we report the *average* and *normed* Euclidean distances (the spread within groups) for six theories of authorship and the four theories of genre previously defined. In addition, we have added two new genre theories, Genre 9A and Genre 9B.[117] Genre 9A and 9B were empirically developed by rigidly rotating many CAs in the first three dimensions to see which text pairings seem most reproducible syntagmatically, paradigmatically, and semantically. Intriguingly these pairings were quite similar to existing genre theories, and hence properly the 9A and 9B groupings are to be understood as genre conformations. Correct interpretation of Figure 3 is best facilitated by providing a numerical example of how the two distances plotted in the columns and the line series were developed. These exercises follow immediately below.

has less in common lexically with M and L than M and L have with each other.

117. For a justification of this, see Figure 5 below.

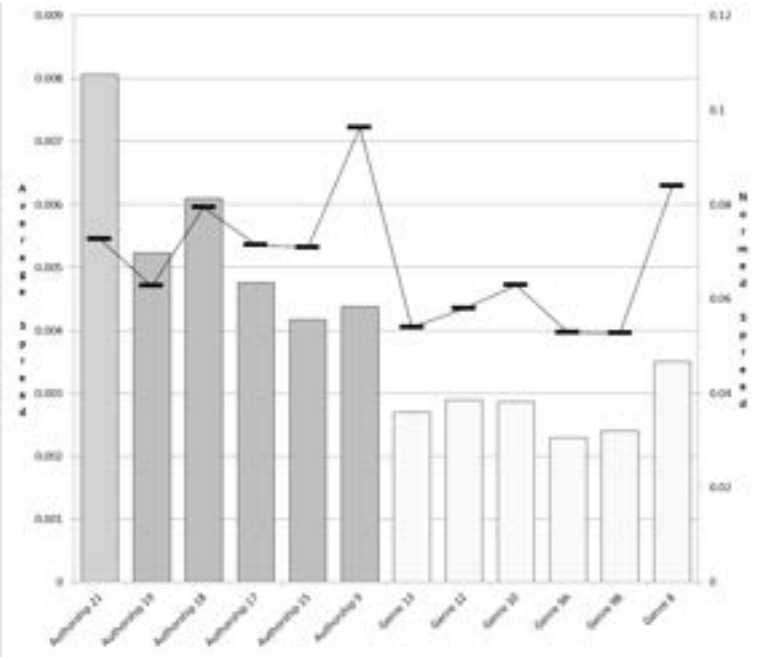


Figure 3. High Level Finding 3: Calculation of the Best Fit between CA Data and the Authorship and Genre Theories[118]

Calculating Average and Normed Euclidean Distance: To best explain average and normed Euclidean distances, we will focus on Authorship 17, one of the mainstream theories of authorship. Authorship 17 is comprised of five groupings of two or more texts (for a total of 15 texts) as well as 12 individual texts.[119] The average spread for Authorship 17 is achieved by calculating the Euclidean distances between each of the 15 texts in a group and

118. Average and normed spread: Euclidean distance and normed Euclidean distance between the texts and their respective centroids by theory.

119. The five groupings of texts defined by Authorship 17 are as follows: In the first grouping are seven texts that the theory hypothesizes were written by Paul. The second grouping contains two texts hypothesized to be written by the Lukan writer (Luke and Acts). Grouping three contains two texts (1 Tim and Titus) putatively authored by an hypothesized pastoralist Paul who is a different author/redactor than the Paul of grouping one. Grouping four is an hypothesized author we might call John the Elder (2 and 3 John) and grouping five is hypothesized to be written by John and his redactors (John and 1 John).

the overall centroid for that group, and then simply averaging those distances. The average spread is represented on the left vertical axis and by its associated line series in Figure 3. The normed Euclidean distance is calculated by dividing the average Euclidean distance by the number of texts that are members of groups (in our case 15). The 12 individual texts in Authorship 17 do not enter into the calculation of spread.

Interpreting Average and Normed Euclidean Spreads: The average Euclidean distance (the line series of horizontal bars) is a commonly recognized distance measure used to compare raw measure of spread between sets of objects.[120] Assuming that the number of texts that contribute to the average are approximately the same, the spreads can be directly compared. Interpretively, the higher the spread for a given theory, the more poorly that theory explains or "fits" the actual position of the NT texts. When the number of texts that underlie the average differ even slightly, however, a normed Euclidean measure is needed. The reason for this is straightforward—it is topologically unfair to compare a theory such as Genre 8, which must fit 24 of 27 texts within its groupings, to, say, an hypothesis like the Baur 21 hypothesis that must fit only nine of 27 texts.[121] Our chosen norming measure above, however, is only a rough estimator, since it assumes a linear increase in difficulty in clustering larger numbers of subtexts.[122] Even this rough estimator, however, is

120. Alternative distance measures, especially chi-squared distances and Mahalanobis distances, are indicated and will be performed in subsequent abductive cycles upon both chi-squared and Euclidean CA spaces.

121. The simple method of norming presented here must be considered as only a rough estimate since it assumes a linear increase in difficulty in clustering larger numbers of subtexts.

122. The problem of fitting more total texts (or points) from a finite set of texts is little discussed in the literature. More commonly the discussion concerns how to develop the most optimal number of clusters in a given N dimensional space. (See Yan, "Number of Clusters," 30–56.) In any event, fitting more total points within a finite set or fitting a higher number of points per cluster is, *ceteris paribus*, likely to yield more diffuse clusters, so the task must be normed in some way.

more than sufficient to clarify the interpretive point made by the average Euclidean distance.

Given the discussion above, the interpretation of Figure 3 is similarly straightforward. Even when using non-normed data, the top four theories that best fit the empirical data are genre theories (Genre 13, Genre 12, and Genre 9A, and Genre 9B). When using normed distances all six theories of genre fit the data better than all six theories of authorship. Moreover, the abductively inspired genre theories, Genre 9A and Genre 9B, fit the data better than all ten *a priori* theories, with Genre 9A fitting the data best overall. Lastly, the coherence of the genre classification seems to begin to break down at Genre 8. This likely indicates that past this point, combining together existing coherent categories of genre creates more diffuse and more incoherent categories. With our highest level findings thus discharged, we are now free to examine the main body of the data in our study.

8.1.4 *The 180 Initial Correspondence Analyses.*

I. Specific Findings: Syntagmatic Measures.

The CA from Figure 4 displays the same general conformation as in our high level findings; six texts (the gospels, Acts, and Revelation) populate one hemisphere with all other texts located in the other hemisphere. Linguistically the pairings seen in this specific CA seem very suggestive of coherent context of situation frameworks that, in turn, call forth coherent register/genre responses from the author/editor/redactors of these texts. The coherence of these pairings and their subsequent register/genre characterizations are explored next.

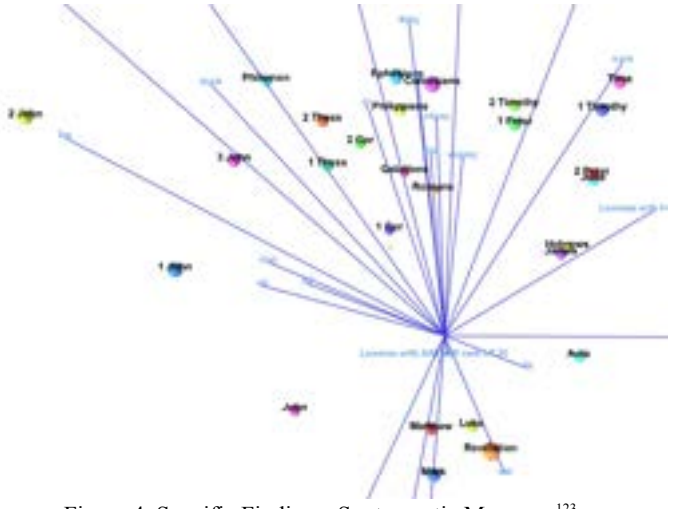


Figure 4. Specific Findings: Syntagmatic Measures[123]

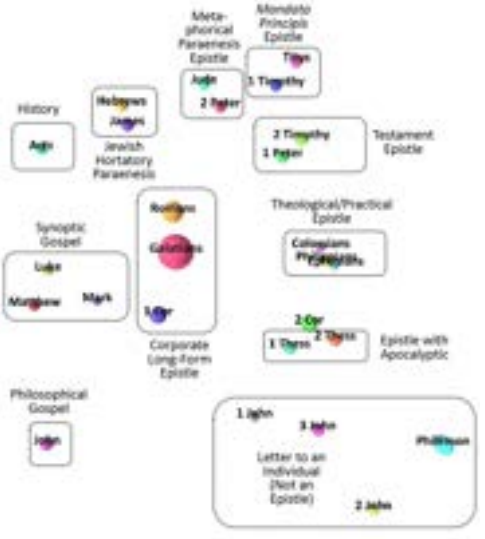


Figure 5. Specific Findings: Syntagmatic Measures

123. For Figure 4 and Figure 5, the linguistic measure is the top 25 lemmas by AAVASR with minimum frequency greater than 10. The rank is the uninflected lexis. The 3-D variance is 68.7%.

Per the prior discussion, the CA was rigidly rotated to best separate the clusters in the top hemisphere of Figure 4. The resulting rotation yielded a remarkably clear clustering of GNT texts by genre (Figure 5).[124] This rotation inspired a new set of experiments in which we rotated the other 179 CAs to discover reproducible pairings. That work clarified the following widely reproducible pairings *at the rank of lexis*: Jude and 2 Peter, 1 Peter and 2 Timothy, Hebrews and James, Titus and 1 Timothy. The ubiquity of these pairings abductively inspired the creation of two new genre categories: Genre 9A and 9B. Genre 9A is identical to the groupings in Figure 5 except the Theological and Practical Epistle triad is reduced to include only Colossians and Ephesians. We next explore inflected lexemes (words).

Two projections of the single CA from Figures 4 and 5 were rotated to yield Figures 6A and 6B. In Figure 6A we focus on the hemisphere that best separates the epistles. In Figure 6B, in contrast, we focus on the hemisphere that best separates the remaining texts. Both hemispheres were rotated to best separate the clusters within them. Four findings are evident:[125]

1. First and Second Thessalonians are the most lexically discriminated epistles (farthest from the origin),[126] as well as the texts that are most closely paired.
2. As with the lemma CAs, John, Revelation, and Acts are far from the Synoptics.
3. Romans, 1 Corinthians, and Galatians form a diffuse complex, but 2 Corinthians' collocation with these three is questionable.

124. This association exists for all other measures at the rank of lexis (i.e. for inflected words, and semantic domains).

125. For clarity, the display of retrograde lexemes (those that point away from the texts) have been suppressed. We also suppressed 2 Corinthians because we could find no rotation where it did not obscure either the Philippians–Philemon pairing or the Colossians–Ephesians pairing. The location of 2 Corinthians as the most "smaller-epistle-like-text" among the *Hauptbriefe* is important and will be discussed in forthcoming research.

126. The proximity of the Thessalonian epistles was first discovered by Mealand who noted that 2 Thessalonians often lay closer to Philippians than 1 Thessalonians. Mealand, "Pauline Corpus," 86.

4. The proximity of the GNT words and texts is intuitive.

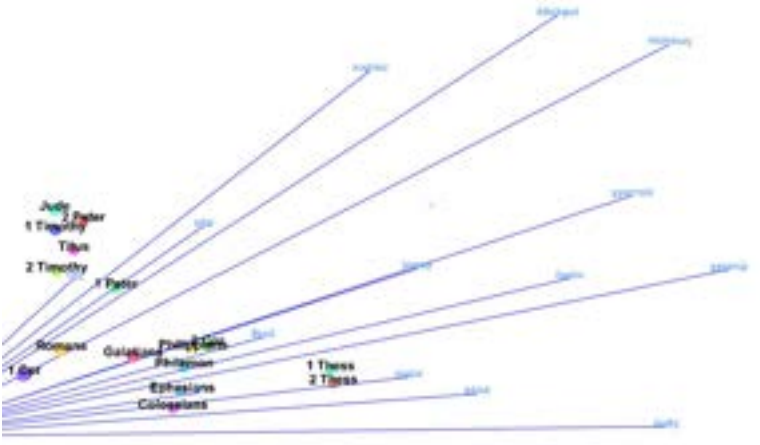


Figure 6A. Syntagmatic Measures: Infected Lexemes (Epistles)

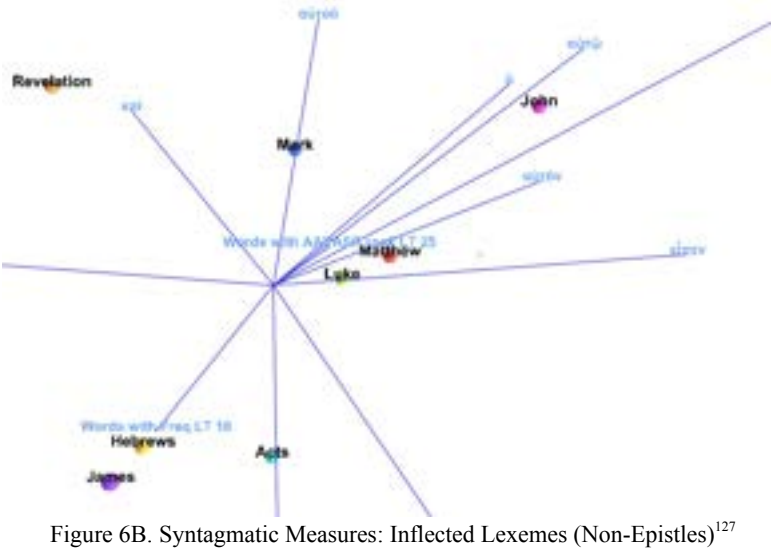


Figure 6B. Syntagmatic Measures: Inflected Lexemes (Non-Epistles)[127]

To clarify the effect of adding more linguistic measures we next explored two biplots using the Top 50 inflected lexemes in

127. For Figures 6A and 6B, the linguistic measure is the top 25 lemmas by AAVASR with minimum frequency greater than 10. The rank is the inflected lexis (unique words). The 3-D variance is 69.7%.

Figures 7A and 7B. Both projections from this single CA were rotated so as to be most comparable to Figures 6A and 6B. Three further findings stand out:

1. The two CAs (the Top 25 and Top 50 inflected lexemes) are quite similar.[128]
2. The distance from Mark to the pairing of Matthew and Luke narrows (cf. Figures 6B and 7B).
3. The distinction between the two Thessalonians epistles and the rest of the epistles *decrease*s when more linguistic measures are included.

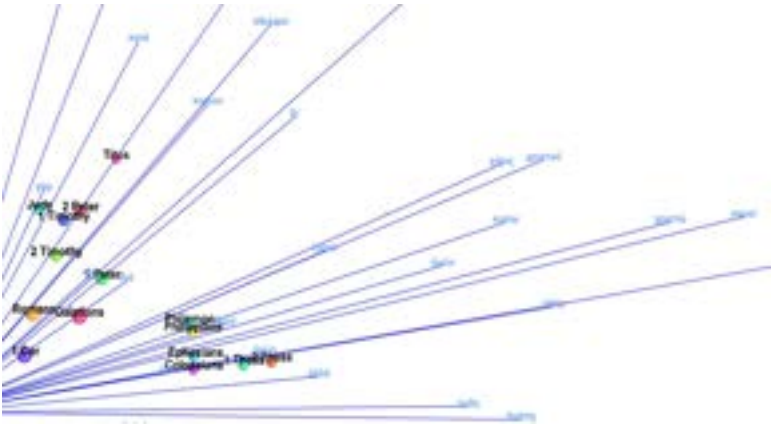


Figure 7A. Syntagmatic Measures: Inflected Lexemes (Epistles)

128. This is to be expected given that the vast majority of the variance found in the top 50 linguistic categories of a CA is already contained in the top 25.

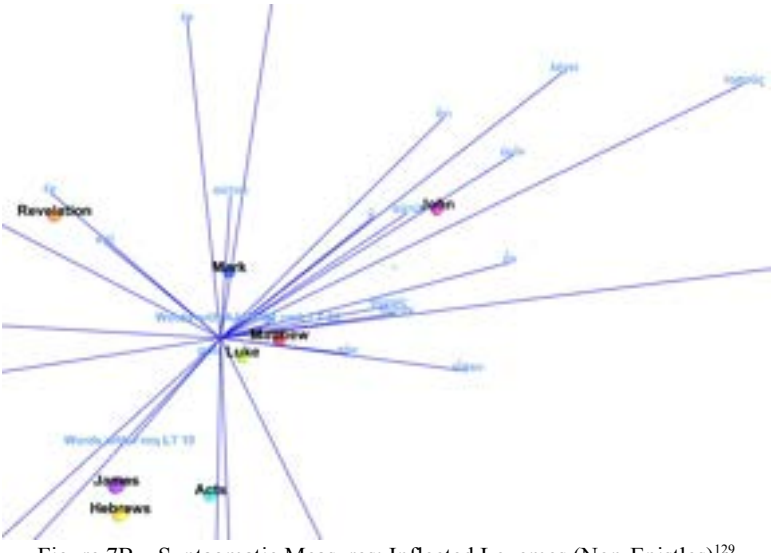


Figure 7B. Syntagmatic Measures: Inflected Lexemes (Non-Epistles)[129]

We next explore structures of higher linguistic rank in the GNT.

Figure 8A. Syntagmatic Measures: Clause Level (AAVASR)

129. For Figures 7A and 7B, the linguistic measure is the top 50 inflected lemmas by AAVASR with minimum frequency greater than 10. The rank is the lexis (unique words). The 3-D variance is 58.3%.

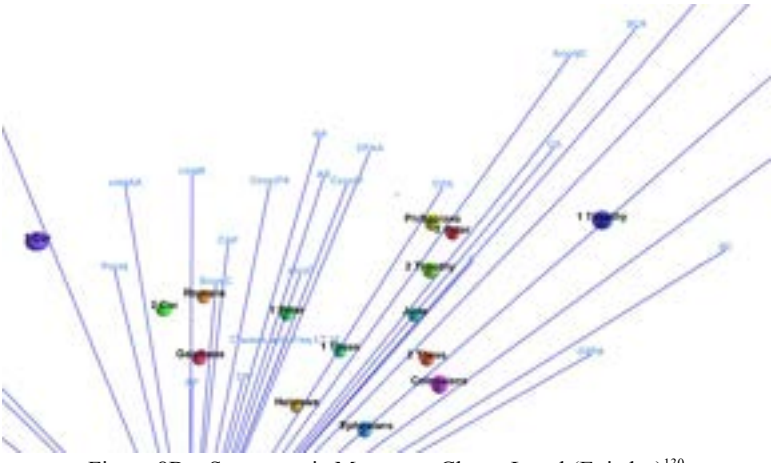


Figure 8B. Syntagmatic Measures: Clause Level (Epistles)[130]

Figure 8A demonstrates that the Top 50 AAVASR clauses produce the same broadly hemispherical (bifurcated) text clusters as did the Correspondence Analyses at the rank of lexis. On the left hemisphere of Figure 8A are found the now traditional complex of the gospels, Acts, and Revelation. With clauses, however, James now moves intermediate between the two, now quite familiar hemispheres. In Figure 8B the aforementioned texts are removed and only nonretrograde clauses (clauses that "point" in the direction of the "epistle" hemisphere) are retained. At the most general level, Figure 8B demonstrates familiar characteristics seen at the rank of lexis *but in a more diffuse form*. The most marked characteristic of 8B is the strong deviation of the pastorals and 2 Peter from the other epistles due to their high frequecy of adjunct-fronted clauses (or multiple adjunct clauses) and S-fronted clauses with adjuncts.

Figures 9A and 9B are identical to 8A and 8B except they were generated using APASR rather than AAVASR.[131] Figure 9A

130. For Figures 8A and 8B, the linguistic measure is the top 50 proximity clauses by AAVASR with minimum frequency greater than 10. The rank is at the clause level. The 3-D variance is 47.8%.

131. For Figures 9A and 9B, the linguistic measure is the top 50 proximity clauses by APASR with minimum frequency greater than 10. The rank is at the clause level. The 3-D variance is 44.2%.

(similar to 8A) yields a bifurcated map with one hemisphere (the bottom in this case) containing the Synoptics, the Johannines, Acts, and Revelation and, again, James. Figure 9B demonstrates the diffuse pairing of the Thessalonian epistles again, but *no pairing* of Hebrews and James. Consistant with the clausal AAVASR results in Figure 8B, in 9B the Pastoral Epistles and 2 Peter are clearly differentiated from the complex of the rest of the epistles due to their high frequency of adjunct-fronted clauses, or multiple adjunct clauses.

Figure 9A. Syntagmatic Measures: Clause Level (APASR)

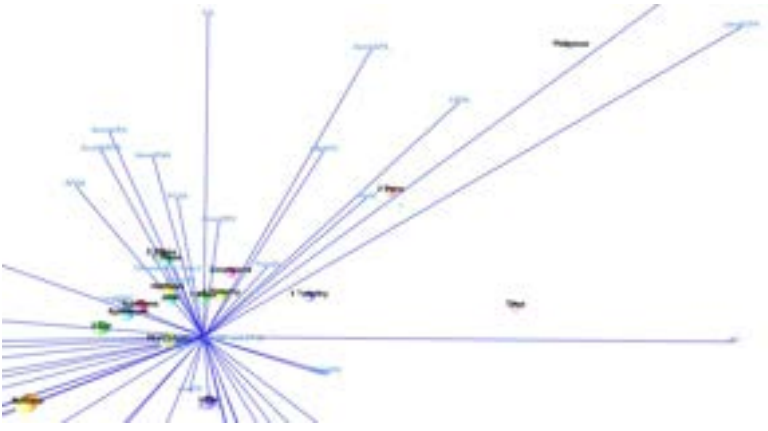


Figure 9B. Syntagmatic Measures: Clause Level (Epistles)

A CA of the top 50 proximity clause complexes (by AAVASR) by all GNT books can be inspected in Appendix I. That CA reveals that most epistles reside in a void region in terms of clause complexes. Interpretively, this void region means that the location of these epistles is indeterminate because these texts are being largely defined by the forms they *lack*. To improve the certainty of their location we execute below AAVASR *only on the clauses in these epistles* rather than upon the entire GNT.

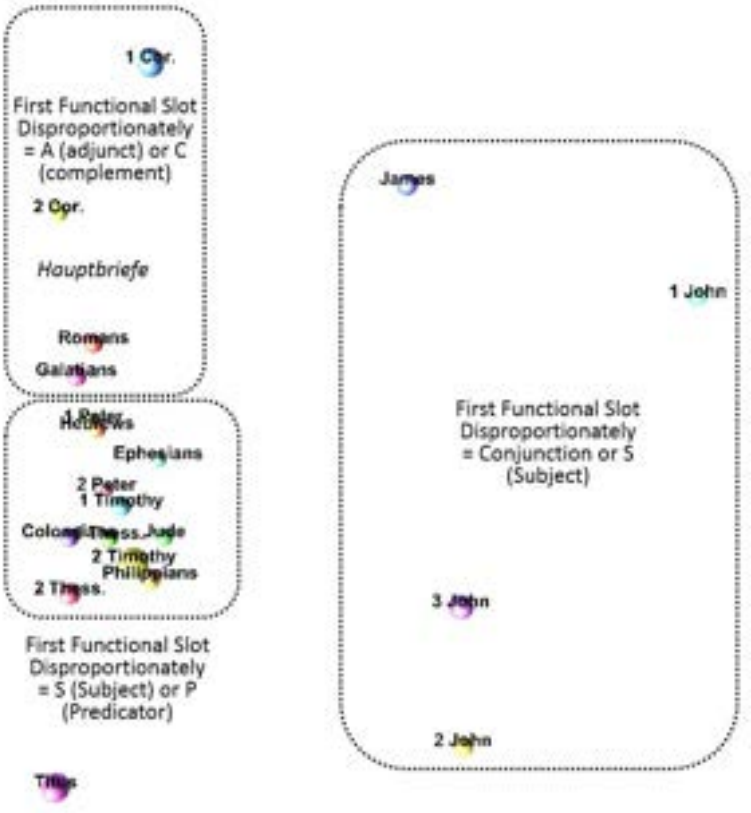


Figure 10A. Syntagmatic Measures: Clause Complexes

The resulting CA (Figure 10A) yields three findings:

1. The smaller Johannine texts still stand quite separate from the rest of the epistles, as in Figures 1A and 1B. Their clauses disproportionately

begin with a conjunction (conj).

2. The *Hauptbriefe* are separated (but rather poorly) separated from the rest of the epistles. It is more accurate to say that in terms of clause complexes, Romans and Galatians are intermediate between the Corinthian texts and the rest of the epistles. Note that the clause complexes of the Corinthian epistles disproportionately begin with adjuncts (A) or complements (C).

3. In contrast to the *Hauptbriefe*, the remainder of the epistles display clauses that disproportionately begin with a subject (S) or predicate (P).

Rotating the general and Pastoral Epistles to lie as closely as possible to the plane of the page yields Figure 10B, which reveals that clauses in 1 Timothy, 2 Thessalonians, and Philippians disproportionately begin with subject or subject-complement (SA or SC). Clauses in Titus tend to be adjunct fronted (AC) while clauses in 2 Timothy tend to disproportionately begins with a predicate-complement or simple predicate (PC or conjP).

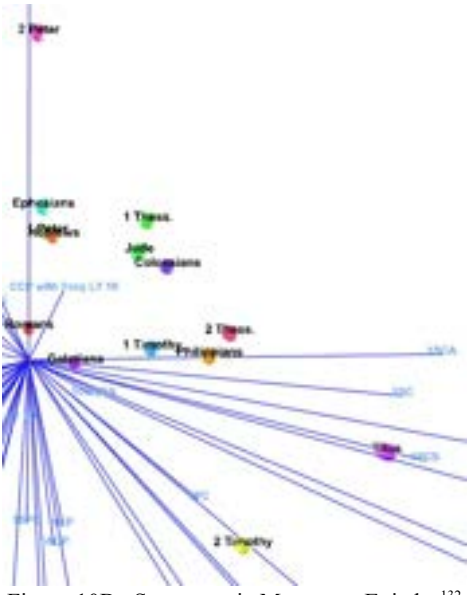


Figure 10B. Syntagmatic Measures: Epistles[132]

132. For Figures 10A and 10B, the linguistic measure is the top 50

II. Specific Findings: Paradigmatic Measures.

As mentioned earlier, no complete paradigmatic system network of the Koine yet exists. Accordingly, we must use as a proxy, paradigmatic data from five distinct traditional grammatical (TG) annotations in the IGNT database. Extensive analysis revealed that these TG-based annotations produced essentially identical CA maps. We therefore report here only the CA produced by the AGNT of Barbara and Timothy Friberg[133] since it contains a slightly larger number of paradigmatic categories.

Figure 11. A Proxy for Paradigmatics: The Grammatical Categories of the AGNT[134]

Two findings in Figure 11 command our attention:

1. As was observed with lemmas and inflected lexemes, both Thessalonian texts are significantly displaced from the other epistles. This appears to be the first CA data not at the level of lexis to support Mealand's pairing of 1 Thessalonians with 2 Thessalonians. While this CA finding alone is insufficient to argue that these epistles are

proximity clauses by APASR and APASR with minimum frequency greater than 10. The rank is at the level of clause complexes (clauses that range in rank from 1 to 45 functional slots). The 3-D variance is 57.0%.

133. See Friberg et al., *Analytical Greek New Testament*, xiii–xv.

134. The linguistic measure of the top 50 traditional grammar categories of the AGNT by AAVASR. The rank is the lexis with frequency greater than 10. The 3-D variance is 63.5%.

Pauline,[135] it either (a) increases the case for the Pauline authorship of 2 Thessalonians because of its persistent pairing with 1 Thessalonians, (b) argues for pastiche, or (c) argues that the common genre of both books swamps any extant authorial effects.

2. The distance of the Pastoral Epistles from the rest of the epistles is due to the high frequency of feminine plural accusative adjectives and present active imperatives (2nd singular). Rotation demonstrates that the displacement of the Pastoral Epistles is slightly less than that of the Thessalonian pairing.

III. Specific Findings: Semantics: Disambiguated Major Semantic Domains.[136]

We now move beyond lexico-grammar to explore a different linguistic strata in the data, the strata of semantics. We will limit our exploration here to semantic major and minor domains.

Two steps were taken in order to facilitate understanding the semantic domain data. First, we focused on the espistles and second, we decluttered the biplots by displaying only 15 of the 50 major domains This yielded the visualizations in Figures 12A and 12B. Last (per the pedagogical exercise), we rotated the horizontal axis in Figure 12A upwards by 90 degrees to yield the projection in Figure 12B.

Several findings regarding Figures 12A and 12B are noteworthy:

1. Similar to the lemmas findings, disambiguated major semantic domains seem to map remarkably closely to notional constructs of genre. (Compare 12A and 12B to Figure 5.)

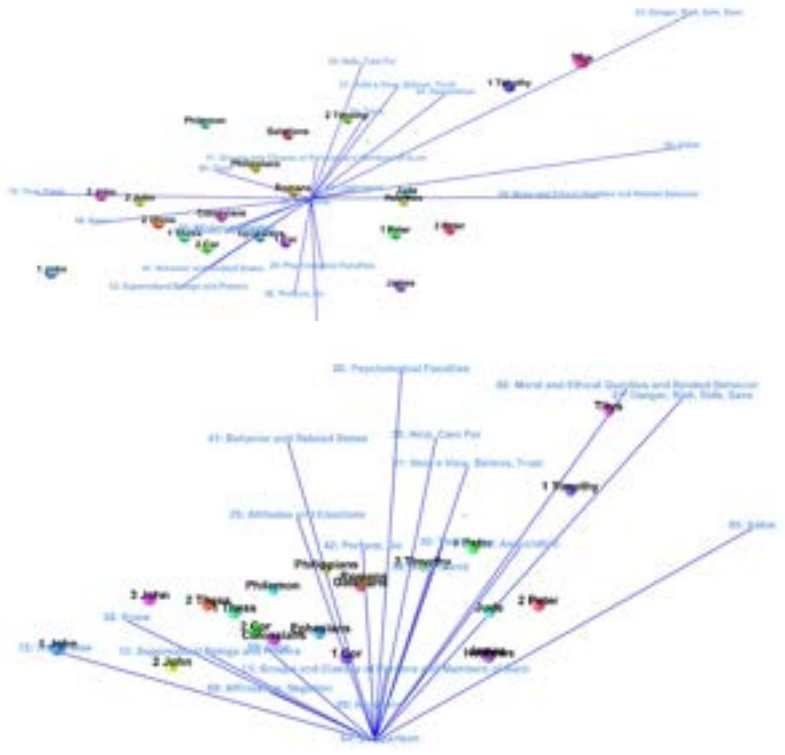
2. There is a marked similarity between the clusters seen here (Figures

135. See Mealand, "Pauline Corpus," 86. In our view Mealand's judgment may prove right even though it was premature because (a) Mealand did not recognize the extent to which the overall clustering of the GNT texts is by genre rather than authorship, (b) he used only 19 measures rather than the 50 we use here, and (c) his measures were developed apart from any formal feature set selection approach.

136. Nondisambiguated semantic major and minor domains have been directly imported from Louw and Nida's Greek-English Lexicon (courtesy of the OpenText.org database). By "nondisambiguated" we mean that for polysemous words, all possible meanings have been imported from the lexicon (e.g. λόγος has 13 semantic domains/subdomain combinations according to Louw and Nida).

12A and 12B) and those produced by lemmas (Figures 1, 2, 4, and 5) and inflected lexemes (Figures 6A, 6B, 7A, and 7B).

3. Semantically, per Figures 12A and 12B, the Pastoral Epistles are deviated from the main body of the rest of the epistles by their distinct semantic content (major domains 21, 65, and 88).



Figures 12A and 12B. Disambiguated Major Semantics Domains[137]

8.2 *Correspondence Analyses Projections by Inertia*

Inertia in CA is proportional to the amount of variance explained by a given extracted component.[138] In Figure 13 below, we compare the top 50 linguistic measures by frequency. The data

137. The linguistic measure for Figure 12A and 12B is the top 50 disambiguated major semantic domains by AAVASR. The rank is the lexis with frequency greater than 10. The 3-D Variance is 69.8%.

138. Technically inertia is the square of the eigenvalue.

demonstrates that major semantic domains explained the most inertia in the lowest three dimensions when crossed against the NT texts (69.8% of the total inertia). While this does not argue that major semantic domains are the most important language measure (given that inertia is strongly influenced by the initial number of categories) it does argue that a multistratal view of language is necessary to further decode the linguistic structure of the NT. Notice, as well, the relatively lower amount of inertia explained by the data at the rank of clause and above. A number of explanations for this are possible including (a) multicausal interactions that are unable to be disentangled by eigen-system mathematics, (b) a more skewed initial distribution, and (c) poorer annotational consistency. These and other possibilities are being actively pursued.

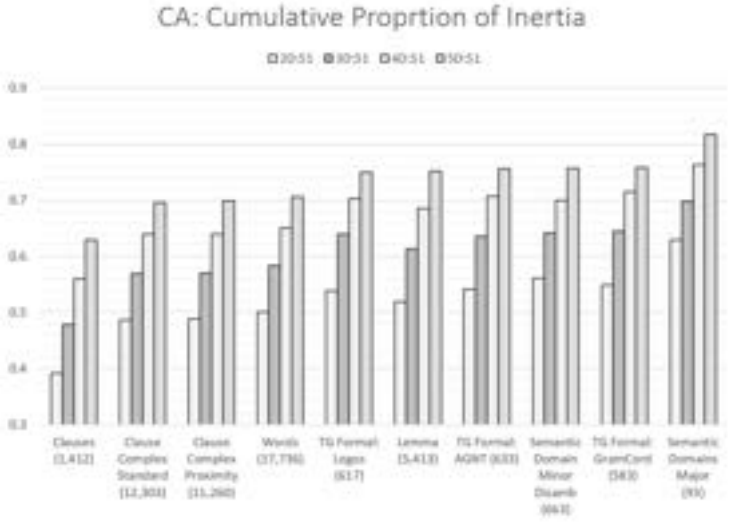


Figure 13. CA: Cumulative Proportion of Inertia

8.3 *Correspondence Analyses by Fit (Testing the Relative Fit of Genre/Authorship)*

In addition to the rotations performed in Figures 2 through 12B, we rotated the remaining 168 CAs to inspect each for a genre-like or authorship-like text clustering. We also rotated these same CAs in the fourth, fifth, and sixth dimensions to discover whether an obvious authorship conformation emerged in

subsequent components (dimensions). The sheer drudgery of that work made it clear that we needed a better way to identify "author-like" or "genre-like" conformations. Accordingly, we generalized the notion of fit by Euclidean distance spread (Figure 3) to all linguistic measures. This yielded the normed spread data presented in Figures 14 and 15 below:

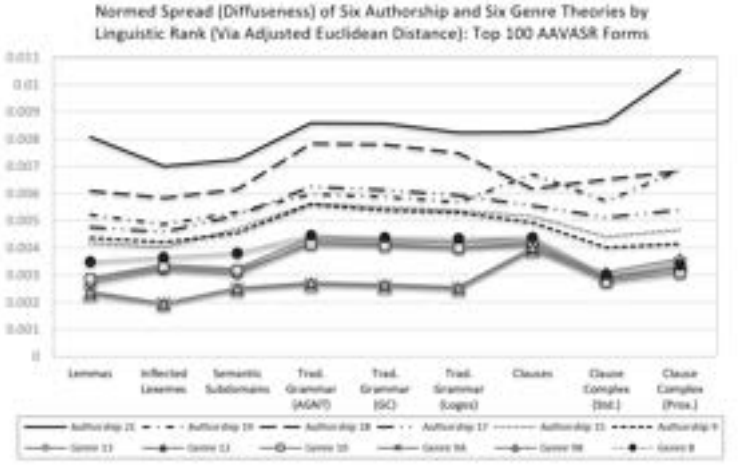


Figure 14. Normed Spread of Authorship and Genre Theories (AAVASR)

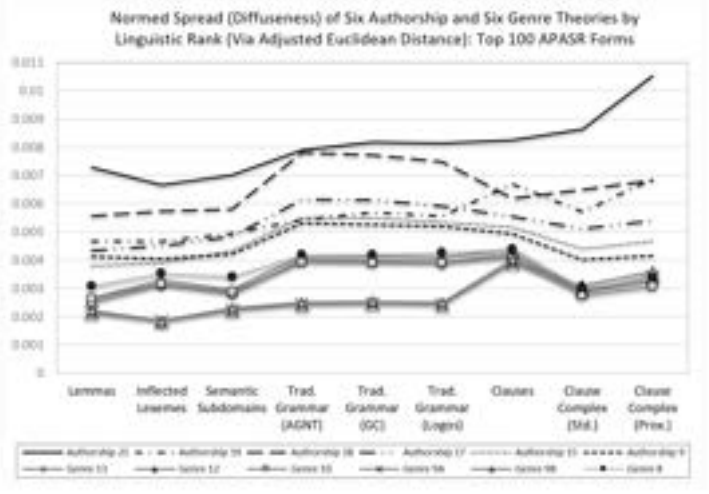


Figure 15. Normed Spread of Authorship and Genre Theories (APASR)

The interpretation of this data is the same as the normed spread presented in Figure 3. Both figures (whether AAVASR or APASR) demonstrate four findings. First, all theories of genre display less spread (higher fit across all nine linguistic measures tested) than all theories of authorship. Second, the empirically-derived genre theories (9A and 9B) outperform all other genre theories. Third, above the rank of the clause all genre theories still outperform the authorship theories, but become indistinguishable from one another.[139] Fourth, even when the data is non-normed, per the line series in Figure 3, genre fits the data better for all linguistic measures except at the rank of the clause (data not shown). In conclusion, then, across all linguistic measures tested, as measured by AAVASR, APASR, and frequency, the variation seen in the GNT is disproportionately associated with genre (generic) rather than authorship.

8.4 *Correspondence Analyses: An Abductive Finding of a Diffuse Group of Eight Texts?*

In the process of visually rotating the 180 CAs for this article, we noticed that a diffuse complex of eight texts appeared under certain conditions, especially when the CAs were performed with more than 100 categories extracted by APASR. While this complex was indeed not present under many other conditions, what this text grouping may lack in ubiquity it more than makes up for in terms of potential relevance to current NT scholarship, and so we include it here. Compellingly, this diffuse cluster of texts includes the seven texts modern mainstream NT scholarship have ascribed to Paul, plus 2 Thessalonians. Rotations of this complex (the linguistic measure here is lexemes) can be inspected in Figures 16 and 17.

The obvious question this raises is whether this complex might constitute our long sought-after authorship signal, especially since these texts are modestly well separated from the Colossians–Ephesians and the Titus–1 Timothy pairings. If

139. This indistinguishability may relate to the fact that measures at or above the rank of the clause are much more highly skewed—they contain a higher number of low-frequency forms.

authorship *is* being extracted here, however, it is an authorship signal that is problematized in at least three ways. First, the signal itself is not a very clean one.

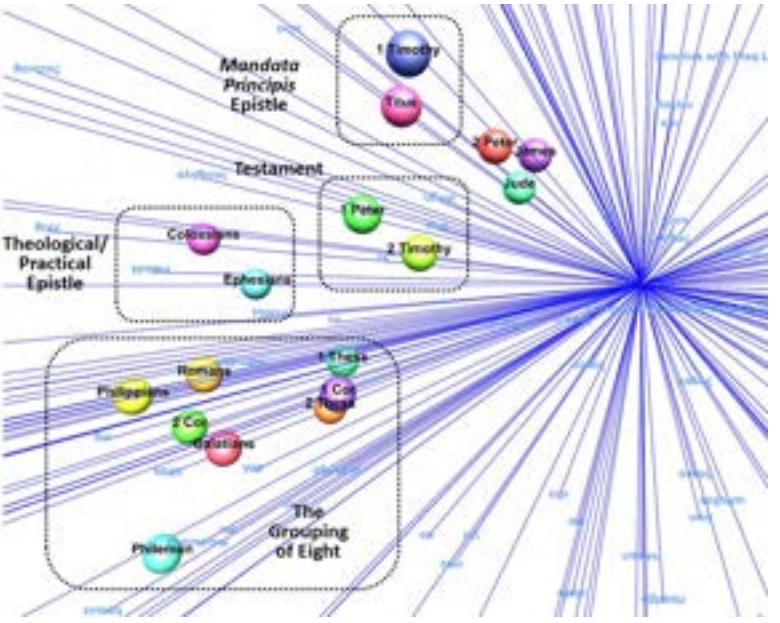


Figure 16. The Grouping of Eight Texts

For example, per Figure 17, 2 Thessalonians lies closer to the center of this cluster than does 1 Corinthians. Moreover, Philemon is actually quite distant (Figure 16) from the other texts. Second, while certain text pairs within this conformation are consistently seen across all linguistic measures (e.g. the Thessalonian pairing), other pairings (the proximity of 2 Corinthians to the rest of the *Hauptbriefe*) are not at all consistent.[140] Third, interpretively, the data throughout this article (especially Figures 2–8B and 11–12B as well as the spread data in Section 7.3) demonstrates consistently that the first three dimensions of lexis (the data here are lexemes) are clearly associated with genre rather than authorship. These three factors

140. This is true even in the texts of the *Hauptbriefe*. Most CAs inspected placed 2 Corinthians farther from the rest of the *Hauptbriefe*. See especially Figure 10A.

as well as the diffuse nature of the eight texts themselves combine to significantly problematize authorship as the primary explanation for this specific conformation. *Lastly, this example clearly underscores the interpretive difficulties of attempting to adjudicate the various sources of causation from the spatial conformation of texts alone.*

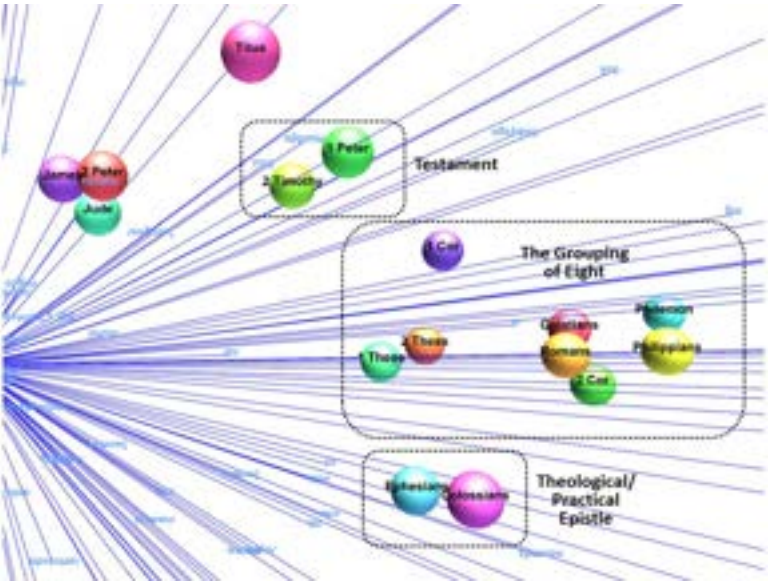


Figure 17. The Grouping of Eight Texts (Another Rotation)

To further disentangle these intertwined effects requires designed experiments that subtract or control for main and interaction effects between genre, authorship, and other potential sociolectic, idiolectic, dialectic, or diatypic sources. The critical genre vs. authorship experiments were, in fact, performed and have been summarized in the subsection "Prior Research" found in Section 5 of this study. Those findings demonstrated, most centrally, that by (a) exhaustively building hierarchical log-linear analysis (HLLA) models that express stylistic variation and the various genre and authorship theories as main effects and (b) analyzing the resulting interaction effects, *genre* rather than *authorship* explains a larger proportion of the total variance observed across the rank scale of linguistic measures tested in

the GNT. This finding, per the fourth point made above, underscores the interpretive difficulties of attempting to interpret authorship conclusions from the spatial conformation of texts in which the predominant genre signal has not been first mathematically subtracted or nulled.

9. *Results and Conclusions*

A review of the data findings from section 8 allows us to issue preliminary conclusions regarding three of our original four research questions. We list those questions and their conclusions below.

9.1 *How Do the Texts of the NT "Cluster"?*

Based on a visual inspection of text clusters developed from the various CA here as well as more extensive MCA plots (data forthcoming), all syntagmatic ranks tested (lemmas, inflected lexemes, clauses, and to a lesser extent clause complexes) demonstrate a clear separation between biography/gospel, history/historiography (Acts), apocalyptic, and epistle/letter (see Figures 1, 2, 3, 4, 5B, 6B, 7A, 8A, 13, and 14). Quite importantly, these major genre findings empirically recapitulate Aune's categories.[141] When we turn to the Pauline Canon, subgenres within the epistle genre tend to be less distinct than the differences between genres, as one would expect. Despite the more diffuse nature of subgenres, however, several consistent conformation pairings or complexes within the epistles are repeatedly observed across linguistic categories. Specifically, lemmas, inflected lexemes, semantic domains, and to a lesser extent traditional grammar demonstrate consistent pairings of subgenres that might be characterized as *mandata principis* (Titus and 1 Timothy; Figures 4, 5, 6A, 7A, 12A, 12B), metaphorical paraenesis (Jude and 2 Peter; Figures 4, 5, 6A, 7A, 12B), theological/practical epistles (Colossians and Ephesians; Figures 4, 5, 6A, 7A, 12B), Jewish hortatory paraenesis (Hebrews and James; Figures 4, 5, 6B, 7B), testament or some

141. Aune, *Literary Environment*, 13.

hybrid of it (2 Timothy and 1 Peter; Figures 4, 5, 6A, 7A), and epistle with apocalyptic (1 and 2 Thessalonians; Figures 4, 5, 6A, 7A, 11,12B).

When comparing and contrasting the text clusters syntagmatically, paradigmatically, and semantically, the most notable finding relates to the differences seen between our proxy for paradigmatics (traditional grammar) and the other categories. Specifically, text clusters from TG retain the pairing of the Thessalonian epistles and perhaps the Jude and 2 Peter pairing, but not much else in terms of the epistles. Moreover, unlike the other, TG places the Pastoral Epistles at a substantial remove from the other epistles.[142] Despite the fact that traditional grammar (TG) is a limited proxy for the paradigmatic breadth of the Koine, the marked differences seen between TG and other syntagmatic measures (lemmas, inflected lexemes, clauses, and clause complexes) is to be expected. From a modern linguistics perspective, the paradigmatic cline of language and the syntagmatic cline of language encode two different *kinds* of data: language system vs. language structure respectively. Further research into the continuities as well as the discontinuities between these two clines will likely constitute a fruitful area of research going forward.

9.2 *Do the Texts Cluster Differently by Linguistic Rank?*

Prior to answering this question, it should be noted that texts explored using two different linguistic measures (lemmas and inflected lexemes) at the same level of rank cluster very similarly. This provides us at least some warrant, *ceteris paribus*, to conclude that text cluster differences at different levels of rank are attributable to rank.[143] Two observations and two discussion

142. It is incontestably true that traditional NT interpretation has been perspectivally paradigmatic through the dominant influence of traditional grammar. Based on the closer syntagmatic proximity of the Pastorals to the *Hauptbriefe* one cannot but wonder if the accidents of history had been ordered so that NT interpretation had been dominantly syntagmatic rather than paradigmatic, then would the adjudication of the non-Pauline authorship of the Pastorals have been so early or so vigorous?

143. The operative phrase here is *ceteris paribus*. One potentially

points can now be provisionally registered in this regard. First, across the levels of rank measured (lemmas, inflected lexemes, clauses, and clause complexes) Aune's original categories of gospel, apocalyptic, epistle, and history are clearly and repeatedly retained. Yet, as we move up the scale of rank, the picture becomes less clear because the clusters themselves become more diffuse. Second, by moving up the scale of rank, James seems to move toward the longer length text complexes (gospel, apocalyptic, epistle, and history). Third, the more diffuse, less genre-like character of linguistic structure at the rank of the clause or above raises the very central question of whether other factors (e.g. sociolectic, idiolectic, dialectic, or diglossic) begin to disproportionately emerge above the rank of lexis. Fourth, the markedly lower number of instances per category especially in terms of clause complex may be substantially confounding the interpretation of the data—and yielding the much smaller percentages of inertia accounted for in those visualizations. In sum, the research presented here seems to confirms that texts do indeed cluster differently by rank. Further experimental design work, however, is required to tease out whether these effects are due to rank differences alone or whether binning, inertial inhomogeneity, or other effects are contributing disproportionately to these differences.

9.3 *Does Genre or Authorship Better Explain the Observed Stylistic Differences in the GNT?*

Another insight from EMVA mathematics is helpful in order to properly frame our findings here. It will be recalled from our primer in Section 7 that EMVA mathematics extracts the largest proportion of the data in cardinal order of the extracted

confounding effect is immediately apparent: different ranks are not drawn from similarly sized populations. For example, in our current annotation scheme, inflected lexemes, clauses, and clause complexes exist in 17,736, 1,412, and 11,260 categories in the GNT. This necessarily yields maps that display disparate proportions of total inertia in the first three dimensions. Intriguingly, those proportions are inverted from expectations of 58.3%, 47.8, and 57% respectively.

components. That is, the first dimension explains more of the total variation than the second, the second dimension explains more of the total variation than the third, and so on. Given that the general morphological conformation of the CA data by almost any qualitative assessment is generic (due to genre) rather than authorial, this necessitates that more of extracted variation is explained by genre rather than authorship. This conclusion is strongly supported by the very clear results of the smaller spread seen within the genre theories compared to the authorship theories (Section 8.3.)

9.4 *Implications in Terms of the Pauline Canon*

Assuming that further confirmation of genre-priority (a larger proportion of variation due to genre or other sociolectic sources of variation compared to authorship) is demonstrated, a single question immediately follows: If these text groupings are indeed generic, what does this mean in terms of the authorship of the Pauline Canon? Four implications seem to follow in terms of the text pairings repeatedly seen in the CA data.

The Thessalonian Epistle Pairing: The most ubiquitous finding in this research is that the Thessalonian epistles are *always* paired—paired lexically, paired semantically, paired clausally, and paired paradigmatically. While we may speculate that higher dimensions of the eigen-system solution (or perhaps a different annotation schema such as we propose in Section 8.5) may separate these two epistles, the fact of the matter is that, stylistically, these epistles are not capable of being separated by any of the seven categories of linguistic measures used to date. The tight pairing of these epistles, apart from the hypothesis that the writer of 2 Thessalonians was an excellent copyist of Pauline style, leaves little room to suggest that the Thessalonian correspondences are a product of multiple authors.

The Colossians and Ephesians Pairing: The same arguments made concerning the Thessalonian epistles apply here. Colossians and Ephesians are repeatedly paired lexically, semantically, and clausally. The only linguistic level at which this pair seems to slightly separate is at the level of traditional grammar.

The Pairing of 1 Timothy and Titus: Four such findings seem most salient in terms of 1 Timothy and Titus. First, *lexically* (via both lemmas and inflected lexemes and per Figures 6A and 7B) this pairing is actually *less* deviated from the main body of the epistles than are the Thessalonian epistles. Second, *semantically* (per Figures 12A and 12B) this pair is distinct from the rest of the epistles, especially regarding major domains 21, 65, and 88. When the top 50 domains (Figure 12A) and all major domains are fully rotated, however, the deviation of 1 Timothy and Titus from the main body of the rest of the epistles is found to be no greater than any other epistle complex (data not shown).[144] *Third*, when we move to paradigmatics (or more properly our proxy for it), however, the story changes. Specifically, at least as assayed by traditional grammar (Figure 10), these two epistles become *far* more deviated from the main body of the rest of the epistles. (This finding is not especially clear in Figure 11 but can be clearly seen by rotation.) The biplot makes it clear that the two most profound factors that drive this deviation are the high proportion of second person imperatives and the catalogs of adjectives. In conclusion, it is in the realm of paradigmatics where the Pastoral Epistles, especially Titus and 1 Timothy, differ most from the rest of the epistles.

Given the lexical, semantic, and paradigmatic data above, what theory best accounts for it? First, it is clear that 1 Timothy and Titus semantically, and especially paradigmatically, are modestly clear examples of the Greco-Roman category of paranaesis, or perhaps even *mandata principis*, a letter form from a superior to an inferior. What might have called forth the need for such a letter form? Viewed in terms of systemic functional linguistic theory, this state of affairs can be explained

144. James, Jude, Philemon, and Titus are further deviated from the epistle complex than 2 Timothy or 1 Timothy. James, Jude, and Titus are most significantly deviated on domain 88: moral and ethical qualities (an ASR of 10.0, 5.4, and 13.1 respectively). Philemon is most significantly deviated on domains 93 and 25: names of persons and attitudes and emotions (both with an ASR of 4.8). 2 Timothy is most significantly deviated on domain 50: contests and play (an ASR of 11.0).

by (a) an author/editor/redactor reacting to a *context of situation* that asked for a response from the theological community or (b) a theological community responding to a context of situation (*Sitz im Leben*) that caused them to formulate a text. In either case, this response was met by adopting a culturally shared *social semiotic* well understood by both the author/editor/redactor and his audience—in our case, via the *mandata principis* letter form. This communication subsumed a register that, by definition, deselects the normal breadth of the paradigmatic choices available to the author/editor/redactor. This in turn yielded the semantic, lexical, and especially the paradigmatic profile seen in the data. Given this reconstruction, per our second question, what historical setting could have called forth such a letter form? While any number of social or ecclesiastical crises suggest themselves, the text itself hints at such a context—either an incipient Gnosticism emerging during the last half of the first century or a more mature (possibly Valentinian) Gnosticism in the second century. If such a reconstruction recapitulates the historic situation as coherently as it weaves together the semantic, paradigmatic, and syntagmatic data, this *still* leaves us with two options either (1) an aged Paul reemerges again as a viable candidate for the authorship of these diminutive epistles or (2) some configuration of pseudepigraphal Pauls still remains a viable option.[145] Lastly, the data also leaves us with the need to explain the very close pairing of the Thessalonian epistles on the one hand, and the Colossians–Ephesians pair on the other. The Thessalonian pairing, in particular, is close enough to make it problematic to propose that these texts were not written by the same author . . . or were written by an excellent linguistic doppelganger! To more fully discriminate between these two options requires us to pursue more thorough research which we propose immediately below.

145. One more point is necessary to close out our observations. The closest that we seem to be able to arrive at in terms of authorship being an explanation of the conformation of the GNT texts is the consistently diffuse conformation of the Johannine complex. But is this authorship or pastiche? More research is called for here as well.

9.5 *Next Steps*

Based on the data presented here, nine follow-on research steps are indicated. First, the distinct differences seen in this study within and between the various linguistically developed categories (paradigmatic, syntagmatic, and semantic) support what over 200 prior studies in GNT linguistics have confirmed[146]—it must no longer be considered adequate to understand the Koine only through the limited lens of traditional grammar. Second, the older, *ad hoc*, univariate "pick-any-marker" approach to computational stylistics has had its day. Not only must modern computational stylistics approaches operate across the entire linguistic landscape, they must do so *inclusively*. That is, at a given "way-station" of analysis, we must either embrace the entire population of linguistic measures or utilize appropriate methods of feature-set selection (linguistic measure down-selection) such as those propounded by Thisted and Efron,[147] Burrows,[148] or those we have developed here (AAVASR and APASR). Only then will our conclusions be either representative or characteristic of the underlying linguistic population under study. Third, a new complex of tools is needed to probe into the simultaneous, intertwined, multifunctional, multisystemic social semiotic that we recognize as "language." To be specific, our analytical toolbox, at the very least, should be stocked with extractive/decompositional (eigen-systems-based), latent structural, causal, and information-theoretical methods of multivariate analysis. Fourth, even if Campbell exaggerates a bit by asserting that NT computational stylistics is dominated locally by a tiny cadre of scholars that "can be counted on the fingers of the proverbial single hand,"[149] his point is well taken.

146. Porter and Pitts, "Recent Research," 241–55.

147. Thisted and Efron, "Did Shakespeare Write," 446–48; Valenza, "Thisted-Efron Authorship," 28–46.

148. Burrows developed two methods: high frequency function words (Burrows, "An Ocean Where Each Kind," 309–10; Burrows, "Interpretative Nexus," 90–6; Forsyth et al., "Investigating the Authenticity," 379–82) and Burrows' Delta (Burrows, "Stylistic Difference," 267–87; Hoover, "Testing Burrows's Delta," 456–71).

149. See Campbell, *Framing Paul*, 213. According to our review, ten

Of the over 1,000 books, articles, monographs, and reviews of computational stylistics since the late 19th century, only about 20 multivariate studies have been executed upon the GNT.[150] Despite our discipline's rather dismal participation in modern multivariate stylistics to date, NT studies must not worry about "catching up." Rather, we must concern ourselves with developing far more adequate experimentally designed approaches, approaches that are informed linguistically, quantitatively, and verificationally. Fifth, this study is to be understood as a first, baseline cycle of visualization. All we have done so far is to make a modest attempt at understanding linguistic structure, system, and strata at some commonly accepted visual "way stations" along the complexity scale of the GNT. This means that we still know virtually nothing about the strata and systems of the Koine, nor their causal relationship to idiolect, sociolect, dialect, diglossia, and the like. Both the GNT and the larger Koine must be more thoroughly linguistically annotated in these ways to draw out these missing insights.[151]

major figures populate the modern (non-"pick-a-marker") history of NT stylometry; Kenny, Ledger, Mealand, Neumann, Barr, Linmans, Greenwood, Erwin et al., Putniņš et al., and Ebrahimpour et al. (See, especially, Kenny, *Stylometric Study*; Ledger, "Exploration of Differences," 85–97; Mealand, "Pauline Corpus"; Mealand, "Measuring Genre Differences," 227–45; Mealand, "Style, Genre, and Authorship in Acts," 479–505; Mealand, "Computers in New Testament Research," 97–115; Mealand, "Stylometric Evidence," 323–45; Neumann, *The Authenticity of the Pauline Epistles*; Barr, "Literary Dependence in the New Testament Epistles"; Barr, "New Testament Epistles," 71–90; Barr, "Computer Model," 233–50; Barr, "Interpolations," 439–55; Barr, *Scalometry and the Pauline Epistles*; Linmans, "Correspondence Analysis of the Synoptic Gospels," 1–13; Greenwood, "Computational Result," 43–47; Greenwood, "Word Clusters," 211–19; Greenwood, "Common Word Frequencies," 183–87; Putniņš et al., "Advanced Text Authorship Detection Methods," J1–J13; Erwin and Oakes, "Correspondence Analysis"; Ebrahimpour et al., "Automated Authorship Attribution," 1–12.) Of these, Kenny, Ledger, Neumann, Greenwood, Mealand, Erwin, and Putniņš are the dominant figures.

150. In our database, 1,048 quantitative studies in stylistics only 20 multivariate studies have centered on the GNT.

151. A modestly complete system network of the Koine would be an excellent place to start.

Sixth, we do not pretend to have anywhere nearly adequately measured the syntagmatic potential of the GNT, especially at or above the level of the clause. In fact, we have only used a single slot and filler notion of the clause, one that annotates it in a fairly coarse way (subjects, complements, adjuncts, predicators, direct address, and conjunctions). In the future, clauses should also be annotated *textually* (including theme and rheme, given and new), *interpersonally* (mood), and *experientially* (transitivity).[152] Clause complexes, moreover, should be annotated with discourse features and other functional annotations (e.g. cohesion, participant chaining, patterning of collocations and colligations, etc.). Seventh, binning should be used at the level of texts, not merely at the level of linguistic categories. How might this data have differed, for instance, if we had performed parallel analytics upon the epistles alone?[153] (Figures 10A and 10B are our sole examples of this strategy in this study.) Eighth, the story of "the complex of eight" texts needs, at the very least, to be further explored by the binning just described and by log linear methods, respectively. Ninth, and perhaps most importantly in terms of drawing or redrawing the boundaries of the Pauline Canon, the types of visualization employed must be presented not in terms of the *total variation* seen here, but in terms of *partial variation.* That is, genre and other sociolectic effects must be mathematically subtracted or nulled to produce authorship maps, and authorship effects must be mathematically subtracted or nulled to produce sociolectic maps. Moving forward on these nine fronts should not only deepen our stylistic understanding of the boundaries of the Pauline Canon but also illuminate other related issues of occasion and introduction in the GNT.

152. See especially Halliday and Matthiessen, *Introduction to Functional Grammar*, 63.

153. Experimentally, the Pauline Canon must first be explored in the context of the corpus of the GNT. It should be recalled, however, that Figures 10A and B were run upon the epistles alone because they initially resided in a region devoid of clause complexes.

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