Comparative rates of text reuse in classical Latin hexameter poetry

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Abstract

This paper presents a quantitative picture of the interactions between poets in the Latin hexameter tradition. The freely available *Tesserae* website (tesserae.caset.buffalo.edu) automatically searches pairs of texts in a corpus of over 300 works of Latin literature in order to identify instances where short passages share two or more repeated lexemes. We use *Tesserae* to survey relative rates of text reuse in 24 Latin hexameter works written from the 1st century BCE to the 6th century CE. We compare the quantitative information about text reuse provided by *Tesserae* to the scholarly tradition of qualitative discussion of allusion by Latinists.

The detection and interpretation of allusion currently represent the dominant mode of study of Latin poetry.[1] The typical goal of intertextual study is to describe how links between texts affect the meaning of both the specific passages that contain them and the poems as a whole. Although intertextual associations may be signalled in many different ways (including similarity of action, character, or theme), verbal repetition, or text reuse, is the best studied and often the strongest type of signal. Philogical commentaries, copiously detailed collections of information on individual books of Latin epic poems, have been the traditional means for Latin poetry scholars to collect and present interpretations based on studies of text reuse. An example from Parkes' recent commentary on the fourth book of Statius' *Thebaid* demonstrates the practice of translating the evidence of verbal repetition into interpretation:

> [Statius, *Thebaid* 4.260] **audaci Martis percussus amore** ["struck by a bold desire for warfare"[2]]: … The collocation *percussus amore* ["struck by a desire"] is not uncommon (compare e.g. Verg. *G.* 2.476, Hor. *Epod.* 11.2 *amore percussum*, and Nem. *Cyn.* 99) but Statius may be specifically recalling the ephebe Euryalus' reaction to Nisus' planned expedition at Verg. *A.* 9.197: *magno laudum percussus amore* ["struck by a great desire for glory"]…. Like Parthenopaeus, Euryalus is eager to brave danger for the chance of glory (*A.* 9.205–6), with similarly fatal results. [Parkes 2012, 164]

This exemplary note builds its interpretation on the evidence of the repetition of two key lexemes, the verb *percutio* ("I strike") and the noun *amor* ("desire").[3] The cooccurence of these lexemes in the Statian passage signifies for most readers a link to the passage from Vergil. The discovery of such verbal links has been facilitated in recent years by digital tools such as the freely available *Tesserae* web interface (tesserae.caset.buffalo.edu), a search program developed by Neil Coffee and a team at the University at Buffalo. *Tesserae* allows users to search pairs of texts (an earlier "source" text paired with a later "target" text) in a corpus of over 300 poetic and prose works, in order to discover every instance where short passages (either lines of verse or grammatical periods) share two or more repeated lexemes. Thus, a *Tesserae* search that pairs the *Thebaid* with the *Aeneid* permits the user to discover the allusion discussed by Parkes by identifying the repetition of the lexemes *percutio* and *amor*. The *Tesserae* scoring system signals the potential interpretive significance of the match by assigning it a high score, 8 out of approximately 11.[4]

In addition, *Tesserae* identifies a second potential match (score = 7) between *Thebaid* 4.260 and another passage from the *Aeneid*:

> Statius, *Thebaid* 4.260 *prosilit audaci **Martis** percussus **amore*** ("Parthenopaeus leapt up, struck by a

bold desire for warfare").

> Vergil, *Aeneid* 7.550 *accendamque animos insani **Martis amore*** ("I'll inflame their minds with a desire for mad warfare").

The words in the *Aeneid* are spoken by Allecto, a demon of the underworld, and we may thus once more translate this evidence of verbal repetition provided by *Tesserae* into literary interpretation.[5] Parthenopaeus' desire to fight in the Theban war in Statius is not only fatal, like the desire of Vergil's Euryalus to participate in Nisus' expedition; it is also infernal, like the war provoked by Vergil's Allecto. This is consistent with Statius' characterization of the Theban war as destructive and impious throughout the *Thebaid*. Such new avenues for specific intertextual interpretation are the typical results of *Tesserae* searches. Previous examples of comparable results can be found in a study of verbal reuse of Vergil's *Aeneid* by the epic poet Lucan [Coffee et al. 2012]. Coffee *et al.* hand-ranked all *Tesserae* results from a comparison of Lucan *Bellum Civile* 1 (target) and Vergil's *Aeneid* (source) on a 5–point scale of interpretive significance. They concluded that the *Tesserae* search had identified 25% more interpretively significant instances of text reuse than the standard philological commentaries on *Bellum Civile* 1 [Roche 2009] [Viansino 1995].

[3]

The interpretation of specific allusions relies partly on the characterization of the overall intertextual relationship between texts, which is often hampered by a haphazard approach to gathering data. This paper presents a more consistent, quantitative picture of the interactions between poets in the Latin hexameter tradition. We use *Tesserae* to generate a statistical analysis of relative rates of text reuse in 24 Latin hexameter works written from the 1st century BCE to the 6th century CE. We then compare the quantitative information about text reuse provided by *Tesserae* to the scholarly tradition of qualitative discussion of allusion by Latinists. Statistical analyses of certain aspects of Latin poetry are not new. Drobisch's studies beginning the 1860s represented the birth of the modern statistical studies of metrical aspects of the epic hexameter, a tradition which has reached a high-water mark in the recent work of Ceccarelli [Ceccarelli 2008] [Drobisch 1866]. Counts of individual lexical items in Latin poetry, usually in an effort to determine whether particular words should be considered "poetic" or "unpoetic", are best represented by the tradition of Axelson's work [Watson 1985] [Axelson 1945]. Yet scholars have not typically evaluated instances of verbal reuse in quantitative terms, as it has simply not been possible for human readers to count such instances accurately. The speed, consistency, and comprehensiveness of *Tesserae* searches now enable the interpreter to quantify the reuse of phrases on a scale beyond the capacities of ordinary human reading.

[4]

Powerful and productive as the *Tesserae* interface is, the following limitations must be clearly understood. They bear on analysis of specific passages, and to a lesser extent on our large-scale study:

[5]

1. Text reuse does not give the full, complex picture of intertextuality in Latin hexameter, where allusions may be signalled by similarity of action, character, theme, and so on.
2. Not all text reuse features the repetition of two or more lexemes. At its current stage of development, *Tesserae* focuses on pairs of lexemes and so cannot reliably identify repetition of single significant words. It would accordingly be unable to flag, for example, the very common word *arma* ("warfare"). This word takes on a new intertextual significance in poems written after the *Aeneid*, a foundational epic poem that begins with the words *Arma uirumque cano…* ("I sing of arms and the man…") [Fowler 1997, 20]. There is accordingly need of a sensitive human interpreter to uncover the metapoetic significance, for example, of the opening word of Ovid's *Amores, Arma graui numero uiolentaque bella parabam / edere…* ("I was beginning to sing of arms and violent wars in a serious meter...")
3. The Latin poets wrote for an audience of Roman elites that were literate in Greek [Hutchinson 2013], and so created numerous translingual calques on Greek phrases. To remain with the example of Vergil, the *Aeneid* adapts numerous lines and phrases from Homer's *Iliad* and *Odyssey*. Some foundational studies have uncovered these calques using traditional philological methods [Knauer 1964] [Nelis 2001], but such studies have not been pursued systematically across the Latin corpus. A feature of *Tesserae* currently in development searches for such translingual allusions between Latin and Greek poetry, but is not yet a reliable tool.
4. Repetitions with verbal variations that seem slight to a human reader are determinative for *Tesserae*. For example, *Tesserae* will locate the following correspondence based on the repetition of the lexemes *Acheron* and *moueo*:

> Silius Italicus, *Punica* 2.536 *quis* **Acheronta moues**, *flammam immanesque chelydros…* ("[The weapons] with which you rouse the underword — flame and monstrous serpents…").

> Vergil, *Aeneid* 7.312 *flectere si nequeo superos,* **Acheronta mouebo** ("If I cannot sway the gods above, I will rouse the underworld").

But *Tesserae* cannot yet locate the equally significant allusion:

> Silius Italicus, *Punica* 2.367 *…aeternum famulam liberque* **Acheronta uidebo** ("…An eternal slave; I will see the underworld as a free man").

The change from the verb *moueo* ("I move") to *uideo* ("I see") means the phrase no longer contains two repeated lexemes. This means that *Tesserae* will inevitably miss some of the variations on a verbal motif that form a component of the Latin poets' creative art. That said, the majority of allusions identified via traditional reading are repeated phrases. So though *Tesserae* cannot uncover allusions of this type, the majority of such allusions are typically missed by human readers as well.

5. The *Tesserae* scoring system provides a measure of interpretive significance that correlates with human-generated measures [Forstall et al. 2014]. Numerous passages of Latin poetry that human readers have traditionally thought of as linked through allusion are also high-scoring lexeme matches, and these correspondences form the basis for scholarly confidence in the scoring system. Yet the score assigned to any given lexeme match does not generate by itself the kind of sensitive assessment of significance that a scholarly reader of Latin poetry brings to the identification of parallel passages. In order to be significant, the allusion must be placed in a larger scholarly narrative of the passage's compositional goals. A human reader must be able to make a plausible interpretation of the allusion before it can be recognized as an allusion rather a chance repetition [Farrell 2005]. *Tesserae*'s usefulness comes in discovering potential allusive connections through lexeme matching and ordering them by the rarity and proximity of the paired lexemes. Subjective interpretation of these connections is still required for any meaning-making exercise [Drucker 2009].

Within these acknowledged limitations, *Tesserae* can be an extraordinarily powerful tool for representing the large-scale reuse of text in a literary tradition. Focusing as it does on repetition of phrases, the most commonly studied marker of allusion, *Tesserae* can provide a large-scale view of intertextual relationships that models traditional scholarly practice. The program can generate provisional answers to questions of particular relevance to the study of the Latin hexameter genre. *Tesserae* enables us to undertake the first large-scale statistical study of intertextuality in classical literary studies. Classicists have used new digital tools since their inception, and several techniques of digital text analysis were pioneered on Latin literary corpora, from Fr. Busa's *Index Thomisticus* to the Packard concordance of Livy [Bodard and Mahony 2010] [McCarty 2005]. Studies of intertextuality, however, have generally been confined to pairs or very small sets of texts, and have traditionally relied on broad but subjective classification of intertextual data (synonyms, similar motifs, images, etc.), rather than objective parameters such as lexeme matches, lexeme frequency, and lexeme proximity. The *Tesserae* scoring system, however, represents the first opportunity to quantify the study of intertextuality using a large set of poems and objective parameters. Our object of study is the entire super-genre of Latin hexameter poetry, in which we privilege the system of relationships between texts rather than any integral text itself.

Latin poetry scholars have traditionally divided the "super-genre" of hexameter into several subgenres, including satire, epic, and didactic [Hutchinson 2013]. Is it possible to quantify the verbal cohesiveness and distinctiveness of these genres? What other general factors affect text reuse across the entire hexameter tradition? Can the well-known influence of Vergil and Ovid on their epic successors be quantified? In particular, can it be determined how frequently one predecessor's text is reused compared to another's? For example, is Statius' *Thebaid* more "Vergilian" in terms of text reuse than another contemporary epic poem, Silius Italicus' *Punica*? Most specialist readers of these Flavian epic poets would correctly guess that the answer is no, but would perhaps not be so confident in making assertions about the two poems' relative rates of reuse of other, earlier poets such as Ovid, Lucan, or Manilius. Which works in the classical hexameter tradition provide the most significant verbal resources for the hexameter epics of late antiquity? This study offers preliminary answers to such questions from a quantitative perspective by surveying the relative rates of text reuse in

24 Latin hexameter works written from the 1st century BCE to the 6th century CE.

2. METHODS

a. Text Selection

Our analysis included every possible source–target pair from a set of 24 Latin hexameter texts written from the 1st century BCE to the 6th century CE (Table 1[6]). This set included every hexameter text available on the *Tesserae* website,[7] excluding hexameter poems from polymetric collections (such as Catullus' poems or Statius' *Silvae*), hexameter works with non-hexameter prefaces (such as Claudian's *In Rufinum*[8]), and four very short minor texts.[9]

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b. Data collection and scoring

Using the *Tesserae* Batch Processing option (http://tess-dev.caset.buffalo.edu/html/batch.php), we recorded the number of "hits" (phrases sharing at least two matching lexemes) in each source–target pair (searches conducted on 2 May 2014). Hits may include exact matches of inflected forms, such as Vergil, *Georgics* 1.493 *exesa inueniet scabra **robigine pila*** ~ Statius, *Thebaid* 3.582 *tunc fessa putri **robigine pila*** (lemmata: *robigo*, *pilum*). Matches may also occur among differently inflected forms of the same lexeme, such as Vergil, *Georgics* 2.64 *solido **Paphiae** de robore **myrtus*** ~ Statius, *Thebaid* 4.300 *hi **Paphias myrtos** a stirpe recuruant* (lexemes: *Paphius*, *myrtus*).[10]

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We used a set of search parameters that capture the most instances of interpretively significant text reuse while excluding many instances of less significant reuse. These were:

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- phrases as the search unit
- lemma as the matching feature
- 20 stop words, determined by frequency in the *Tesserae* corpus
- scores calculated by stem
- a maximum distance of 10, calculated by frequency
- no score cutoff[11]

We then partitioned the results by score. *Tesserae* assigns each matched phrase a score (rounded to the nearest integer) according to the following formula, which reflects the observation that instances of text reuse featuring rare words in close proximity are often more interpretively significant than instances featuring common words spaced farther apart [Forstall et al. 2014] [Coffee et al. 2013].

$$\text{Score} = \ln\left(\frac{\sum\frac{1}{f(t)}+\sum\frac{1}{f(s)}}{d_t+d_s}\right)$$

$f(t)$ is the frequency of each matching term in the target text

$f(s)$ is the frequency of each matching term in the source text

d_t is the distance in the target text

d_s is the distance in the source text

Figure 1.

Examples of hits of different scores are listed in Table 2.

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c. Weighing of counts

We thus obtained for each pair a count of the number of hits at each score (from 2 to 11). Hits scoring 6 and lower were excluded from the analysis, since it has been shown that these are unlikely to be instances of interpretively significant text reuse [Forstall et al. 2014]. We were left with five data points for each pair, C_7, C_8, C_9, C_{10}, and C_{11} (counts of score 7, 8, 9, 10, and 11; Table 8 and 9). In order to convert these five counts into a single useful "composite count", C, we took advantage of the strongly linear relationships between counts of every score except for the rare C_{11} hits. Because the mean correlation was strongest between C_9 and the other counts (mean R^2 = 0.879; mean ρ = 0.931), the smallest amount of error was introduced by converting all counts into C_9, using a combination of linear regressions and principal component analysis.

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First, we used a series of linear regressions to characterize the relationship between C_9 and the other four counts and obtain an initial composite count, C_{regr}.[12] Second, we applied principal component analysis (PCA) to the five counts, first correcting for their very different scales by dividing each count by its standard deviation, in order to obtain a second composite count, C_{pca}.[13] Noting the similar weights in the formulae for C_{regr} and C_{pca}, we chose the average weights for the final formula for composite counts, which we considered to be the "observed count", C_{obs}:

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$$C_{regr} = 0.057C_7 + 0.225C_8 + C_9 + 6.168C_{10} + 212.062C_{11}$$

$$C_{pca} = 0.057C_7 + 0.225C_8 + C_9 + 6.404C_{10} + 243.426C_{11}$$

$$C_{obs} = 0.057C_7 + 0.225C_8 + C_9 + 6.286C_{10} + 227.744C_{11}$$

Figure 7.

d. Relative intensity of reuse

The resulting observed counts could not be directly compared to one another, since the total lengths of the texts were different for each source–target pair. For instance, we expected to obtain a much higher C_{obs} value for the pair Ovid, *Metamorphoses* (78098 words) – Silius Italicus, *Punica* (76292 words) than for the pair Horace, *Ars Poetica* (3090 words) – Claudian, *De Bello Gildonico* (3165 words), simply because there is much more space for text reuse in the longer texts. Indeed, we found that C_{obs} was correlated with the lengths of both source and target texts, W_s and W_t; the correlations were strongly linear when the variables were converted to a logarithmic scale (c_{obs}, w_s, and w_t).

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Thus, we could use a multiple regression to determine (in logarithmic scale) an expected count, c_{exp}, for any given length of source and target text, w_s and w_t. We obtained the model ($R^2 = 0.979$):[14]

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$$c_{exp} = -19.591 + 1.311 w_s + 1.208 w_t$$

Figure 9.

We then subtracted the expected count for each source–target pair from the observed count to obtain a residual, which we considered to be a measure of the relative intensity of text reuse for each pair:

$$r = c_{obs} - c_{exp}$$

Figure 10.

A positive value of r for a given pair indicates that the observed intensity of text reuse was higher than would be expected for an "average" pair of texts with those particular word counts — that is, for a pair of texts with no particularly strong or weak intertexual relationship. A negative value of r indicates that the observed intensity of text reuse was lower than average. The further the value deviates from zero, the stronger the evidence for an intensity of reuse above or below average. Thus, we sorted all pairs by their r values, presented in both standardized and non-standardized forms (Table 3). [15] We also presented the (non-standardized) r values graphically, partitioning the pairs by source text (Figure 11) and target text (Figure 12), and presented various subsets of the data to aid discussion (Figures 13–15, Tables 5–7).

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It should be reiterated that r is not a measure of the number of phrases reused for each pair (for which C_{obs} is the most direct measure), but a measure of the *intensity* of text reuse that takes into account the lengths of the source and target texts in each pair. For instance, the very high C_{obs} value of 7407.3 for the pair of the longest texts in our data set, Ovid, *Metamorphoses* (78098 words) – Silius Italicus, *Punica* (76292 words), actually reflects only moderately intense text reuse ($r = 0.146$), whereas the very intense reuse ($r = 1.280$) of Vergil's *Georgics* (14154 words) by Vergil's later poem, the *Aeneid* (63719 words) corresponds to a lower C_{obs} value (1974.8) because the texts are shorter.

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e. Centrality

For each of our 24 chosen texts, we determined the mean value of r for all pairs involving that text (23 pairs each time), and sorted the texts by the results (Table 4). We considered this to be a measure of the "centrality" of each of our chosen texts within the 24–text set: that is, how often each text reuses earlier texts and is reused by later texts. A text strongly influenced by its predecessors and influential to its successors would have a higher mean r than a text more peripheral to the literary tradition of Latin hexameter poetry.

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3. RESULTS AND DISCUSSION

We have kept two objectives in mind in interpreting our data set. First, we attempt to test whether the results of the automated search and statistical analysis match the conclusions reached by traditional scholarship. Second, we endeavor to identify unexpected results that suggest avenues for future research. We achieve those two objectives when interpreting both general (sections 3.a-b) and specific trends (section 3.c).

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a. Statistical outliers and centrality

Three pairs with standardized residuals near or above |3| may be considered statistical outliers (*Georg – Aen*, standardized *r* = 4.571; *Met – Mos*, 3.830; *Ars – Gild*, –2.977). These results reflect several phenomena that we will discuss: the influence of author on text reuse (*Georg – Aen*, section 3.b), the influence of genre (*Ars – Gild*, 3.b), and the importance of Ovid (among others) to late antique hexameter (*Met – Mos*, 3.c.iv). For a further 11 pairs, standardized residuals near or above |2| indicate intensity of text reuse markedly above or below average; these results also reflect phenomena that we will discuss.[16] These standard statistical thresholds should not be relied upon naively, however: for instance, several pairs for which we would expect a strong intertextual engagement (such as texts written by the same authors) had standardized *r* values well below 2.

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The centrality scores conformed to expectations (Table 4). The high centrality of the *Aeneid* (0.133) reflects the importance of Vergil's works to the subsequent hexameter tradition, while the high centrality of the *Ilias Latina* (0.186) reflects multiple reuse facilitated by its intense reuse of the *Aeneid* (see section 3.c.i). The high centrality of the *Georgics* (0.279) stems from a combination of these factors. All four of Claudian's works had positive centrality. This reflects not only Claudian's extensive reuse of his predecessors, but also the influence of authorship on text reuse: each of Claudian's works had high *r* values when paired with the other three works, thus increasing their centrality. The low centrality of the works of Horace, Persius, Juvenal, and Lucretius reflects the influence of genre in our data set comprising mainly epic/panegyric texts. Perhaps the most unexpected result is the high centrality of the *Achilleid* (0.117), which reflects both intense reuse of earlier epic sources and intense reuse by later epic targets. Because the *Achilleid* is a very short text, certain considerations must be kept in mind (see section 3.c.i).

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b. General trends

Unsurprisingly, the most important influence on text reuse intensity was authorship. In all 13 cases where a pair of texts was written by the same author, the reuse intensity was higher than average (*r* > 0.000), markedly so in 5 of the cases (standardized *r* > 2.000); see Figure 13 and Table 5. Vergil showed the highest intensity of text reuse within his own poems, followed by Claudian, while Horace and Statius reused their own poems with less intensity. Though drawing on a very different data set (a relatively small corpus of Latin hexameter poems), the results are nevertheless broadly comparable to Jockers' study of the author signal in a corpus of 3500 nineteenth-century novels written in English. Jockers observes that of five "signals" (author, decade, genre, gender, and text), the author signal is the strongest.[17]

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A secondary influence on text reuse intensity was genre. Although categorizing Latin poetry by genre is difficult, we may obtain a rough idea of the influence of genre by partitioning the texts of our data set into three genres: didactic, epic/panegyric, and satiric (Figure 14).[18] Within the small didactic and satiric genres, reuse intensity was higher than average for 5 of 6 pairs (*r* > 0.000; the exception, H*Sat* – J*Sat*, was slight: *r* = −0.007). Within the much larger (and more diverse) epic/panegyric genre, reuse intensity was higher than average in 66 of 78 pairs; the 12 remaining pairs had only slightly lower than average reuse intensity (standardized *r* ≥ −0.446). In contrast, pairs comprising texts from different genres tended to display lower than average reuse intensity. The trend was clearest for pairs composed of one epic/panegyric and one satiric text: 37 of 39 pairs had lower than average reuse intensity.[19] The results conform to the expectations of traditional reading, as epic and satire are the most distant hexameter genres from one another in style and subject matter. Genre is also perhaps the best explanation for the trends seen in the "centrality" measure (Table 4). Since 13 of 24 texts in our data set belong to the epic/panegyric genre, we would expect each of them to be more central than texts belonging to smaller genres. This is true in most cases; the most notable exception is the *Georgics*, which had the highest centrality score by far, despite belonging to the didactic genre. We discuss this exceptional text in section 3.c.i.

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Time period appeared to have no influence on text reuse intensity. This is not surprising, since the technical and aesthetic constraints of hexameter poetry discouraged changes in diction or syntax over time. However, it is possible that a future study which controls for much more salient influences such as authorship and genre may discover a subtle influence of time period.

c. Specific observations

The 276 pairs in our data set represent a generically and chronologically diverse collection of texts. Different scholars will accordingly highlight various aspects of the data. We only offer a handful of specific observations here. As with the general trends we observed, these specific results both confirmed that our analysis falls in line with the results of traditional scholarship and identified several possible avenues for future inquiry. For instance, Virgil's *Aeneid* predictably emerged as a major influence on subsequent poetry of all periods. Lucretius' *De Natura Rerum* was not a prominent verbal resource for later authors. The four Flavian epics were closely related, and late antique poets reused material from previous works in expected ways. The congruence of these results with traditional scholarship supports our contention that several unexpected results are indicators of potential for fruitful further research. For instance, Virgil's *Georgics* and the anonymous *Ilias Latina* scored high in reuse intensity in almost every case. This is probably an indication of frequent multiple allusions to both these texts and the more prominent *Aeneid* and *Metamorphoses* (section 3.c.i). The relationship between the Flavian epics and the *Aeneid* appears to be more "creative" or "original" than often allowed, although these terms must be used carefully (see 3.c.ii). Horace's *Ars Poetica* seems to have an unexpected influence on Manilius' *Astronomicon,* suggesting that didactic sensibility may cut across genre (see 3.c.iii). Finally, Ausonius' *Mosella*, usually considered primarily "Vergilian" in nature, also shows close links with Ovid's *Metamorphoses* (3.c.iv).

i. Vergil's Georgics and the Ilias Latina

The influence of Vergil's *Aeneid* on the subsequent tradition of Latin hexameter is well established and reflected in our results. The work had a high centrality score (0.133) and higher than average reuse intensity ($r > 0.000$) when paired with 13 of 18 subsequent target texts (the exceptions are *BC* and the non-epic texts *Ars*, P*Sat*, J*Sat*, and *HE*); see Tables 4 and 6 and Figure 11. However, the results for Vergil's early work, the *Georgics*, are even more exceptional. Its centrality score was more than twice as high (0.279) and it had higher than average reuse intensity ($r > 0.000$) when paired with 16 of 20 subsequent target texts (the exceptions are the non-epic texts *Ep*, *Ars*, P*Sat*, and J*Sat*). These results may seem surprising at first. Although the *Georgics* is an important text, few would argue that its influence on subsequent Latin literature eclipses that of the *Aeneid*. But two factors must be kept in mind. First, recall that r is not a measure of the number of phrases reused for each pair (for which C_{obs} is the most direct measure), but a measure of the *intensity* of text reuse that takes into account the lengths of the texts in each pair. Because the *Aeneid* is much longer than the *Georgics* (63719 vs 14154 words), it requires values of C_{obs} over 7 times higher, and thus the reuse of many more phrases, in order to achieve the same residual when paired with any subsequent target text. Subsequent target texts use many more phrases from the *Aeneid* than from the *Georgics* in total,[20] and the influence of the *Aeneid* on subsequent literature is therefore more obvious to the reader. Yet the intensity of the reuse is greater for the shorter *Georgics*.

The second factor arises from Vergil's extensive reuse in the *Aeneid* of his own phrases from the *Georgics*, which resulted in the highest r value in our data set (1.280), one of three statistical outliers (standardized $r = 4.571$). Because Vergil's two texts share many phrases, subsequent target texts that reuse phrases from one Vergilian text will often automatically reuse the same phrase from the other Vergilian text. In practice, subsequent epic poems that reuse phrases from the epic *Aeneid* will often automatically reuse the same phrase from the *Georgics*. A similar phenomenon explains the unexpected results for the *Ilias Latina*. Although no scholar would argue that this minor poem, a rough compression and translation of the *Iliad*, exerted any discernable influence on Latin literature in antiquity,[21] it had a higher centrality score than the *Aeneid* (0.186) and higher than average reuse intensity ($r > 0.000$) when paired with every subsequent target text (Tables 4 and 6 and Figure 11). However, the *Ilias Latina* also had markedly higher than average reuse intensity (standardized $r > 2.000$) when paired with both the *Aeneid* and Ovid's *Metamorphoses*, two foundational texts for later Latin literature.[22] This suggests that when a subsequent target text reuses phrases from either the *Aeneid* or the *Metamorphoses*, it will often automatically reuse the same phrase from the *Ilias Latina* and thereby increase the r value when paired with that poem.

The high scores for both the *Georgics* and *Ilias Latina* demonstrate that allusion in Latin literature is not always a case of a target text reusing a phrase from a single, specific source text. On the contrary, an allusion to, say, the *Aeneid* often necessarily entails an allusion to the *Georgics*, the *Ilias Latina*, or some other text(s). While scholars routinely privilege one source text at the expense of the others for the sake of interpretation, the automatic searches of *Tesserae* do not. This egalitarian interpretive practice is not very suitable in the case of the *Ilias Latina*, a minor text rightly subordinated to the sources it reuses, but it is more suitable in the case of the *Georgics*, where readers will more often hit upon compelling interpretations by treating the *Georgics* as a source text on par with the *Aeneid*.[23] *Tesserae* encourages this kind of interpretation not only by presenting all texts as equal in value, but also by offering the option to perform multi-text searches (http://tesserae.caset.buffalo.edu/multi-text.php), where matches between a source–target pair are presented alongside every other instance of the matching phrase in a user-selected set of texts.

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ii. Post-Vergilian classical epic

Scholarly interest in post-Vergilian classical epic (the *Metamorphoses*, *Bellum Civile*, *Argonautica*, *Thebaid*, *Achilleid*, and *Punica*) has roughly tracked the chronology of the epics themselves, with attention paid first to the *Metamorphoses* and last to the *Punica*. Similarly, the assumption has often been made that the earlier epics (*Metamorphoses* and *Bellum Civile*) responded to Vergil's influence in more creative and original ways, while the four later epics of the Flavian period tended to imitate Vergilian epic less creatively.[24] To compare this assumption to the results of our study, we must bear in mind the nature of the text reuse that *Tesserae* can discover. At its current stage of development, *Tesserae* identifies only matching phrases with exact repetition of two or more lexemes. It cannot detect allusions signaled by similarity of action, character, or theme, or text reuse involving single significant words or verbal variations. That is, *Tesserae* preferentially detects exactly the sort of allusions that may be classified as less "creative". Thus a high residual indicates not only higher than expected text reuse, but also potentially a less "creative" allusive relationship.

29

Bearing this in mind, the results do not fully support the assumption of declining creativity over time (Figure 15 and Table 7). In contrast, although the intensity of text reuse of both the *Georgics* and *Aeneid* by the *Argonautica*, *Thebaid*, and *Achilleid* was higher than average ($0.160 \leq r \geq 0.299$), it was not as high as the intensity of reuse of any of Vergil's three works by the *Metamorphoses* ($0.323 \leq r \geq 0.560$). The intensity of reuse of Vergil by the *Bellum Civile* was even lower: in fact, the intensity of reuse of the *Aeneid* was slightly lower than average ($r = -0.026$).[25] Thus, it would seem that the intertextual engagement with Vergil's texts by Lucan, Valerius Flaccus, and Statius are either less intense or more "creative" (or both) than often assumed.

30

The notable exception is the *Punica* of Silius Italicus, which had much higher than average intensity of text reuse when paired with the *Georgics* ($r = 0.433$) and *Aeneid* ($r = 0.540$). This is consistent with the assumption of an uncreative intertextual relationship, and inconsistent with recent claims about the *Punica*'s originality.[26] It must be acknowledged, however, that "originality" and "creativity" are subjective concepts, which are not directly measured by r values. A high r value for a given pair indicates only that the number of matching phrases of two or more lexemes was greater than expected for an "average" pair of texts with the same word counts. It does not indicate, for instance, a paucity of other kinds of subtler intertextuality (text reuse with verbal variation, or similarities of action, theme, or character). Nor does it take into account the context into which the lexemes are redeployed: a poet may, for instance quote a predecessor's words exactly, but in a completely different and original context.

31

Other observations may be made about the results for the four Flavian epics. The high r values for the epics when paired with the *Georgics* ($0.160 \leq r \geq 0.433$) may be influenced by factors discussed in section 3.c.i, but scholars have begun to interpret the relationship between these texts more aggressively (Pagán 2015), and our results support this line of inquiry. The *Metamorphoses* and *Bellum Civile* have often been interpreted as important texts for the Flavian epics; however, although the intensity of text reuse for the eight relevant pairs was usually higher than average ($r \geq -0.075$), it was usually only moderately so, approximately on par with the intensity of reuse for the epics when paired with the *Eclogues*, a text rarely argued to be important to Flavian epic. Again, this does not argue against a strong intertextual engagement between the *Metamorphoses*, *Bellum Civile*, and Flavian epics; it may instead suggest that future investigations should focus on allusions not signalled by the obvious text reuse that *Tesserae* discovers.

32

The intertextual relationship between the four Flavian epics has been the subject of recent study, and this line of inquiry is

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supported by our results. The intensity of the *Thebaid*'s reuse of the *Argonautica* was slightly higher than average, on par with the *Thebaid*'s reuse of the *Metamorphoses* (*r* = 0.064, 0.037). The intensity of the *Achilleid*'s reuse of the *Argonautica* was much higher than average, on par with the *Achilleid*'s reuse of the *Aeneid* (*r* = 0.279, 0.289).While the intertextual relationship between the *Thebaid* and *Argonautica* has been well studied, the relationship between the *Achilleid* and *Argonautica* has not;[27] future work in this vein could be productive. Unsurprisingly, the intensity of reuse of Statius' *Thebaid* by Statius' later *Achilleid* was higher than average (*r* = 0.141), but it was lower than 11 of the 12 remaining intra-author pairs (Figure 13 and Table 5). This low reuse cannot be explained purely by the divergent subject matter and style of Statius' two epics: Vergil's *Eclogues* and *Aeneid* are at least as divergent, but had a higher *r* value (0.224). Finally, the *r* value for the pair *Achilleid – Punica* was very high (0.410).[28] This was unexpected. Research on the intertextual relationship between Statius' and Silius' works has focused on the pair *Thebaid – Punica*,[29] but these results suggest more attention should be paid to the *Achilleid*. In all discussion of the *Achilleid*, however, we should keep in mind that it is much shorter than the other three Flavian epics; therefore, the considerations that applied to the *Georgics* in section 3.c.i apply here.

iii. Didactic and satiric hexameter

Hardie's study of the reception of Lucretius makes a strong and well-received case for the fundamental contribution of the *De Rerum Natura* to succeeding poetry from the Augustan poets through Milton's *Paradise Lost* [Hardie 2009]. No reader would dispute the conceptual and formal importance of the *DRN* to the Latin hexameter tradition. Features of later hexameter poetry such as *sententiae*, multiple explanations, and similes from the natural world all bear the marks of the Epicurean poet's mode of argumentation. Yet the vocabulary of the *DRN* was not mined as extensively as the other foundational works of Republican and Augustan poetry, as can be seen from our results (centrality = −0.151, *r* < 0.000 when paired with 21 of 23 succeeding target texts; Figure 11). The only positive *r* values resulted from pairings with other didactic works: Vergil's *Georgics* (*r* = 0.230) and Manilius' *Astronomica* (*r* = 0.023). While these results are consistent with the observed influence of genre on text reuse (section 3.b), the low *r* values overall demonstrate the difference between the importance of Lucretius' poem as a conceptual resource and its importance as a verbal resource.

34

Volk's study of the *Astronomica* makes a series of valuable observations about Manilius' thematic adaptations of Lucretius, Vergil, and Ovid [Volk 2009]. Those thematic adaptations were accompanied by verbal reuse only for Vergil in our results. Vergil's *Georgics* yielded the highest reuse intensity (*r* = 0.342), followed by the *Eclogues* (*r* = 0.307). Unexpectedly, Horace's *Ars Poetica* had the next highest *r* value (0.213). As the *Ars* is one of the shortest poems in our data set, the considerations that applied to the *Georgics* in section 3.c.i apply here. Yet there may be hitherto unexplored verbal connections between the poem on composing poetry and the poem of the stars, likely in the addresses of the didactic narrator. The intensity of reuse of the *DRN* was higher than average, but only negligibly so (*r* = 0.023). The intensity of text reuse of the *Astronomica* by later texts was low, suggesting a limited influence on the language of subsequent classical hexameter tradition.

35

The inclusion of the *Satires* of Horace, Persius, and Juvenal (H*Sat*, P*Sat*, J*Sat*) in this study permits us to begin investigation of the influence of genre on text reuse in Latin hexameter. As mentioned above (section 3.b), the author signal is a stronger determinant than the genre signal for intensity of text reuse, as evidenced by higher *r* values for pairs of texts written by Horace than inter-author pairs within the satiric genre.[30] But the importance of genre was especially marked when pairing epic/panegyric with satiric texts, where 37 of 39 pairs had lower than average reuse intensity (*r* < 0.000), including the lowest *r* values in our data set (Figure 14).[31] These results indicate a strong separation between the genres, related to satire's pedestrian vocabulary and everyday concerns, which contrast with the more elevated style and subject matter of epic.

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iv. Late antiquity

The tremendous influence of Vergil and Ovid on the hexameter poems of late antiquity has been well recognized in prior scholarship, but has been typically studied from the perspective of theme, character, and subject. The present study permits some initial quantification of the intensity of text reuse between these poems and those occurring earlier in the hexameter tradition.

37

Prior scholarship has identified Ausonius' *Mosella* as primarily Vergilian in character, with several secondary influences, but has not heretofore been able to quantify the nature of Ausonius' reuse of his predecessors' texts.[32] In our study, the intensity of text reuse of Ovid's *Metamorphoses* by the *Mosella* was markedly higher than average (standardized $r >$ 2.000). This pairing had the highest r value of any two independently authored texts (r = 1.073), and second only to Vergil's reuse of the *Georgics* in the *Aeneid* (r = 1.280). The intensity of reuse of Vergil's works was decidedly lower (*Georgics*, r = 0.260; *Aeneid*, r = 0.115). The intensity of reuse of Statius' *Achilleid* and Silius Italicus' *Punica* was slightly above average (r = 0.104 and 0.028), but lower than that of Manilius' *Astronomica* and the *Ilias Latina* (r = 0.130 and 0.120; for the latter, see section 3.c.i). Intensity of reuse was lower than average ($r < 0.000$) for Lucretius' *De Rerum Natura*, Lucan's *Bellum Civile*, Valerius Flaccus' *Argonautica*, and Statius' *Thebaid*. The centos entirely composed of phrases adapted from Vergil's works that appear in this period represent a new level of engagement with the foundational texts of the genre [McGill 2005]. Ausonius' *Cento Nuptialis*, the best known of the centos, is available on *Tesserae*, but was excluded in this study, since its artificially high reuse rates of Vergil's works would have produced extreme outliers that would have distorted our results.

As observed above (section 3.b), the works of Claudian are evidence for the strength of the author signal. Four of the top fifteen r values in our data set were derived from pairing works of Claudian (*Hon – Stil*, *Hon – Gild*, *Gild – Stil*, and *Rapt – Hon*; $0.461 \le r \ge 0.716$). The lower position of the *De Raptu Proserpinae* among the pairings of Claudian's works (*Rapt – Hon*, *Rapt – Gild*, *Rapt – Stil*; $0.243 \le r \ge 0.461$) may suggest that Claudian's self-reuse is strongest among works in a similar genre (panegyric rather than mythological epic). We are hesitant to draw firm conclusions, however, about the relative importance of the author and genre signals with so few data. Claudian's rates of reuse of his Augustan predecessors present a similar story to that told in the scholarly literature [Ware 2012, 9–10]. For instance, Vergil's *Georgics* (r = 0.538) and *Aeneid* (r = 0.326) had high reuse intensity when paired with Claudian's mythological *De Raptu Proserpinae*. The intensity of reuse of Statius' *Achilleid* was also high (r = 0.426), which accords with the importance of Statius as an intermediary between the Augustans and the poets of late antiquity. As Kaufmann observes, "Claudian, possibly inspired by Ausonius, [was] the trendsetter for the increased interest in Statius' poetry by the later poets" [Kaufmann 2015]. An unexpected but plausible result is the importance of Lucan's *Bellum Civile* to Claudian's historical panegyrics, *Gild* (r = 0.351) and *Hon* (r = 0.278).

We also included Juvencus' *Historia Evangelica*, a fourth-century Christian epic, and Corippus' *Johannis*, a sixth-century historical epic, in the data set. Both the *Johannis*' high rates of reuse of Vergil and Claudian and the *HE*'s low rates of reuse of classical pagan poetry (with the exception of the *Georgics* and *Ilias Latina*) conform to the expectations set by the scholarly literature.[33]

4. CONCLUSIONS

We chose to begin by studying a selected corpus of Latin hexameter poems because relationships between works in this "super-genre" have been the most closely studied of all intertextual relationships in ancient literature. We are able to compare the information about the relative rates of reuse of texts in Table 3 to a long tradition of qualitative discussion of allusion by Latinists. We provisionally conclude that a majority of the results conform to the statements typically made by poetry scholars about the significance of various intertextual relationships in the Latin hexameter tradition. For instance, the author signal is one of the strongest determinants of intensity of text reuse, the works of Ovid and Vergil are the most important verbal resources for the later works of the tradition, and satiric hexameter is strongly separated from the other hexameter genres in terms of reuse. If it is accepted that the high level of correlation between our quantified results and the scholarly tradition's qualitative assessments provides a strong vote of confidence for our methodology, then we can begin to explore the significance of unexpected findings. These include (a) the importance of Vergil's *Georgics* to the later tradition, (b) the indications of multiple reuse visible in the *Ilias Latina*, (c) the relatively low reuse of Vergil by Lucan, Valerius, and Statius, and (d) the intense reuse of Ovid's *Metamorphoses* by Ausonius' *Mosella.*

This is a first step in algorithmic criticism of the hexameter super-genre [Ramsay 2011]. As observed in the Introduction, *Tesserae* has some limitations which reflect its current state of development, and others which reflect the nature of Latin poetry. In this initial study, we confirmed the value of the lexeme-matching approach by comparing it to the traditional critical narrative of relationships among Latin hexameter poems. Our goal is to model a system of relationships between texts that can frame critics' discussions of the role of individual poems within the tradition. As Drucker observes, "on the

surface, a model seems static. In reality it is, like any 'form,' a provocation for a reading, an intervention, an interpretive act" [Drucker 2009, 16]. In Drucker's terms, *Tesserae* modeling is a dynamic rather than static approach to textual analysis. New data sets can easily be constructed, whether by using different *Tesserae* parameters or changing the texts in the group under analysis. These future analyses will produce new and different perceptions of the system of relationships among Latin literary texts in other genres, or between other genres and the hexameter super-genre.

Tables and Figures

Text	Abbreviation (name of work)	Date (approximate)	Length (words)
Lucretius, *De Rerum Natura*	*DRN*	before 55 BCE	49099
Vergil, *Eclogues*	*Ecl*	42–39 BCE	5617
Horace, *Satires*	H*Sat*	40–30 BCE	14215
Vergil, *Georgics*	*Georg*	36–29 BCE	14154
Horace, *Epistles*	*Ep*	23–20 BCE	9906
Vergil, *Aeneid*	*Aen*	29–19 BCE	63719
Horace, *Ars Poetica*	*Ars*	14 BCE	3090
Ovid, *Metamorphoses*	*Met*	2–8 CE	78098
Manilius, *Astronomica*	*Astr*	after 9 CE	27353
Persius, *Satires*	P*Sat*	before 62 CE	4457
Lucan, *Bellum CivileM*	*BC*	64–65 CE	51065
[Italicus], *Ilias Latina*	*Ilias*	60–70 CE	6597
Valerius Flaccus, *Argonautica*	*Arg*	before early 90s CE	37250
Statius, *Thebaid*	*Theb*	92 CE	62504
Statius, *Achilleid*	*Ach*	95 CE	7204
Silius Italicus, *Punica*	*Pun*	before 96 CE	76292
Juvenal, *Satires*	J*Sat*	after 96 CE	24884
Juvencus, *Historia Evangelica*	*He*	330 CE	19854
Ausonius, *Mosella*	*Mos*	370 CE	2957
Claudian, *De Raptu Proserpinae*	*Rapt*	395–397 CE	6991
Claudian, *De Quarto Consulatu Honorii Augusti*	*Hon*	397 CE	3965
Claudian, *De Bello Gildonico*	*Gild*	398 CE	3165
Claudian, *De Consolatu Stilichonis*	*Stil*	399–400 CE	7583
Corippus, *Johannis*	*Joh*	6th c. CE	29046

Table 1.

Score 11	
Pun 13.752 miscuerint Italis **Piraeo litore** leges	
Met 6.444 Cecropios intrat **Piraeaque litora** tangit	
Ilias 401 instat et **exstructos morientum calcat aceruos**	
Met 5.85 sternit et **exstructos morientum calcat acervos**	
Score 10	
Theb 10.228 cum **fetura gregem** pecoroso vere novavit	
Ecl 7.35 si **fetura gregem** suppleverit, aureus esto	
Astr 2.807 per latera atque imum templi **summumque cacumen**	
Aen 6.678 dehinc **summa cacumina** linquunt	
Score 9	
Astr 1.753 nec mihi celanda est **famae vulgata** vetustas	
Aen 12.608 Hinc totam infelix **volgatur fama** per urbem	
J*Sat* 10.99 an **Fidenarum Gabiorumque** esse potestas	
H*Ep* 1.11.7 **Gabiis** desertior atque / **Fidenis** vicus	
Score 8	
Theb 7.262 arma patris pinuque iubas **imitatur** equinas, / terribilis **silvis**	
Ecl 2.31 Mecum una in **silvis imitabere** Pana canendo	
Astr 4.897 pars sua perspicimus **genitique** accedimus **astris**	
Aen 9.641 sic itur ad **astra**, / dis **genite** et **geniture** deos	
Score 7	
Theb 7.447 **ipsa loco** mirum natura favebat	
Ecl 3.68 **ipse locum**, aëriae quo congessere palumbes	
Astr 4.96 **quin etiam** infelix virtus et noxia felix	
Aen 9.799 **Quin etiam** bis tum medios invaserat hostis	

Table 2. Randomly selected examples of hits from *Tesserae* searches scoring 11, 10, 9, 8, and 7.

Source	Target	r	Standardized *r*
Georg	*Aen*	1.280	4.571
Met	*Mos*	1.073	3.830
Met	*Ilias*	0.719	2.565
Hon	*Stil*	0.716	2.555
Ilias	*Joh*	0.663	2.368
Hon	*Gild*	0.634	2.264
Ecl	*Georg*	0.603	2.153
Aen	*Ilias*	0.594	2.119
Gild	*Stil*	0.575	2.054
Georg	*Met*	0.560	1.999
Aen	*Pun*	0.540	1.928
Georg	*Rapt*	0.538	1.921
Rapt	*Hon*	0.461	1.644
Ilias	*Gild*	0.457	1.631
Georg	*Pun*	0.433	1.546
Ilias	*Pun*	0.433	1.545

Gild	Joh	0.427	1.525
Ach	Rapt	0.426	1.520
Ach	Pun	0.410	1.462
Rapt	Gild	0.404	1.442
Ilias	Ach	0.396	1.414
Mos	Hon	0.395	1.411
Ilias	Arg	0.389	1.387
Ach	Joh	0.375	1.337
Hon	Joh	0.372	1.327
Georg	Joh	0.355	1.266
Ep	Ars	0.354	1.262
Georg	BC	0.351	1.253
BC	Gild	0.351	1.252
Aen	Met	0.350	1.249
Georg	Astr	0.342	1.221
Ach	Stil	0.331	1.183
Aen	Rapt	0.326	1.162
Rapt	Stil	0.324	1.157
Ecl	Met	0.323	1.151
Georg	Ilias	0.310	1.107
Ecl	Astr	0.307	1.096
Rapt	Joh	0.302	1.079
Aen	Theb	0.299	1.067
Georg	Arg	0.297	1.061
Aen	Ach	0.289	1.033
Arg	Ach	0.279	0.996
BC	Hon	0.278	0.992
Aen	Joh	0.269	0.961
Georg	Gild	0.268	0.957
HE	Joh	0.267	0.951
Ach	Gild	0.263	0.939
Georg	Mos	0.260	0.928
HSat	Ep	0.259	0.925
Aen	Arg	0.255	0.910
BC	Stil	0.253	0.903
Ilias	Theb	0.252	0.899
BC	Rapt	0.250	0.893
Mos	Stil	0.247	0.883
Mos	Joh	0.243	0.866
Ach	Hon	0.238	0.851
Met	BC	0.238	0.850
Georg	Hon	0.232	0.829
DRN	Georg	0.230	0.823
Ars	Stil	0.228	0.813

Ecl	Aen	0.224	0.800
Ecl	Ilias	0.224	0.799
Ilias	HE	0.223	0.795
Ars	Astr	0.213	0.762
HSat	PSat	0.210	0.750
Stil	Joh	0.199	0.711
Georg	Theb	0.186	0.664
Georg	HE	0.172	0.614
Georg	Ach	0.160	0.570
Ilias	Stil	0.157	0.560
Mos	Rapt	0.153	0.546
Ilias	Rapt	0.152	0.543
Met	Pun	0.146	0.520
Theb	Ach	0.141	0.503
PSat	JSat	0.137	0.490
Georg	Stil	0.132	0.472
BC	Joh	0.132	0.471
Astr	Mos	0.130	0.465
Theb	Rapt	0.128	0.457
Pun	Rapt	0.128	0.457
BC	Pun	0.126	0.450
Astr	Ilias	0.125	0.446
Ilias	Mos	0.120	0.428
Aen	Mos	0.115	0.409
Ach	Mos	0.104	0.373
Astr	Joh	0.101	0.361
BC	Ach	0.097	0.348
Arg	Gild	0.097	0.346
Ecl	Stil	0.094	0.335
Ecl	Pun	0.093	0.332
Aen	Gild	0.092	0.328
Met	Rapt	0.089	0.319
Ars	JSat	0.078	0.278
Met	Ach	0.077	0.276
Arg	Pun	0.076	0.272
HE	Gild	0.075	0.267
Arg	Rapt	0.067	0.239
Aen	Hon	0.064	0.229
Arg	Theb	0.064	0.229
Pun	Hon	0.060	0.214
Theb	Pun	0.057	0.204
JSat	Hon	0.053	0.188
Theb	Hon	0.052	0.185
Pun	Joh	0.051	0.182

Astr	BC	0.048	0.171
Astr	Ach	0.047	0.168
Ecl	Ach	0.047	0.167
Ilias	JSat	0.045	0.160
Mos	Gild	0.042	0.150
HSat	Ars	0.041	0.146
HSat	Georg	0.037	0.133
Met	Theb	0.037	0.131
Ilias	Hon	0.036	0.130
Astr	Hon	0.036	0.130
BC	Arg	0.035	0.125
Aen	Stil	0.030	0.108
BC	Ilias	0.028	0.100
Pun	Mos	0.028	0.099
Arg	Hon	0.024	0.087
DRN	Astr	0.023	0.082
Pun	Gild	0.018	0.065
Met	Stil	0.017	0.060
Ars	HE	0.013	0.047
Aen	Astr	0.011	0.039
Ars	PSat	0.008	0.028
Ep	JSat	0.003	0.010
Ecl	Arg	-0.003	-0.012
Met	Arg	-0.006	-0.020
Theb	Stil	-0.006	-0.022
Astr	Stil	-0.007	-0.026
HSat	JSat	-0.007	-0.026
Ecl	Rapt	-0.009	-0.032
Georg	JSat	-0.009	-0.033
HE	Rapt	-0.010	-0.036
Astr	Pun	-0.013	-0.046
DRN	Aen	-0.015	-0.054
HE	Stil	-0.016	-0.058
Astr	Rapt	-0.016	-0.058
DRN	Ilias	-0.017	-0.062
Ecl	JSat	-0.021	-0.076
Met	Hon	-0.022	-0.077
Aen	BC	-0.026	-0.091
Arg	Joh	-0.030	-0.106
Arg	Stil	-0.039	-0.138
Ep	PSat	-0.040	-0.141
DRN	Hon	-0.042	-0.149
Georg	Ep	-0.045	-0.162
Aen	HE	-0.047	-0.169

DRN	Ars	-0.052	-0.184
Met	Gild	-0.055	-0.197
Ecl	Mos	-0.058	-0.206
Pun	Stil	-0.059	-0.212
Met	Astr	-0.064	-0.228
Ecl	HSat	-0.066	-0.237
Ach	JSat	-0.068	-0.242
BC	Theb	-0.075	-0.268
Ach	HE	-0.076	-0.273
Astr	Gild	-0.077	-0.276
HE	Mos	-0.079	-0.283
JSat	Gild	-0.081	-0.288
Theb	Gild	-0.081	-0.289
Met	Joh	-0.085	-0.302
Ecl	HE	-0.089	-0.318
Ecl	BC	-0.089	-0.319
Astr	HE	-0.090	-0.321
Ep	Stil	-0.090	-0.323
DRN	Ach	-0.091	-0.324
DRN	Pun	-0.092	-0.329
JSat	Mos	-0.094	-0.334
Ecl	Joh	-0.098	-0.351
Ars	BC	-0.100	-0.355
DRN	Joh	-0.101	-0.361
HSat	Ach	-0.102	-0.364
JSat	Joh	-0.104	-0.372
DRN	Rapt	-0.111	-0.394
DRN	Mos	-0.111	-0.397
HE	Hon	-0.112	-0.400
Ars	Met	-0.112	-0.401
JSat	Rapt	-0.113	-0.405
Ep	Astr	-0.114	-0.406
Georg	Ars	-0.114	-0.408
Astr	Arg	-0.114	-0.409
JSat	Stil	-0.117	-0.418
Ep	Hon	-0.117	-0.418
Ep	Mos	-0.121	-0.433
Theb	Joh	-0.125	-0.446
Theb	Mos	-0.128	-0.459
Ars	Mos	-0.131	-0.467
Ep	Rapt	-0.133	-0.476
DRN	Ecl	-0.134	-0.480
Arg	HE	-0.137	-0.490
Astr	JSat	-0.139	-0.496

DRN	Ep	-0.139	-0.497
PSat	Stil	-0.139	-0.498
BC	Mos	-0.142	-0.506
Ecl	Theb	-0.145	-0.518
Pun	HE	-0.154	-0.550
DRN	Met	-0.164	-0.585
Georg	PSat	-0.164	-0.587
DRN	Stil	-0.170	-0.606
Ars	Ilias	-0.171	-0.609
Ecl	Ep	-0.171	-0.610
DRN	HSat	-0.183	-0.654
PSat	Mos	-0.185	-0.661
Ars	Ach	-0.187	-0.668
Ep	Ach	-0.188	-0.670
Astr	Theb	-0.189	-0.673
HSat	Ilias	-0.195	-0.697
Ars	Pun	-0.195	-0.697
BC	JSat	-0.203	-0.724
HSat	Pun	-0.205	-0.731
PSat	Arg	-0.211	-0.754
BC	HE	-0.215	-0.768
Ep	Aen	-0.216	-0.772
DRN	HE	-0.221	-0.789
PSat	Pun	-0.230	-0.823
HSat	Astr	-0.236	-0.842
Met	JSat	-0.236	-0.843
HSat	HE	-0.242	-0.866
HSat	Gild	-0.243	-0.866
Aen	JSat	-0.243	-0.867
HSat	Aen	-0.243	-0.869
HSat	Stil	-0.244	-0.870
Ep	Ilias	-0.245	-0.873
Met	HE	-0.246	-0.877
HSat	Mos	-0.253	-0.903
Ep	Gild	-0.253	-0.903
Ep	Met	-0.261	-0.931
Ars	Rapt	-0.272	-0.971
JSat	HE	-0.273	-0.973
PSat	Ach	-0.273	-0.976
Ep	Arg	-0.279	-0.995
DRN	Arg	-0.283	-1.009
Ep	BC	-0.288	-1.028
Arg	Mos	-0.290	-1.035
Theb	HE	-0.293	-1.045

DRN	BC	-0.297	-1.059
Pun	JSat	-0.298	-1.062
PSat	BC	-0.300	-1.071
Ep	Joh	-0.301	-1.075
Arg	JSat	-0.303	-1.083
Ars	Arg	-0.304	-1.084
PSat	Hon	-0.315	-1.126
Ecl	PSat	-0.316	-1.127
DRN	PSat	-0.316	-1.128
HSat	Joh	-0.322	-1.148
HSat	Met	-0.326	-1.163
HSat	BC	-0.326	-1.165
DRN	JSat	-0.330	-1.179
Ep	HE	-0.336	-1.198
Ep	Pun	-0.338	-1.208
Ecl	Hon	-0.341	-1.219
Ars	Joh	-0.348	-1.242
Ars	Hon	-0.351	-1.254
PSat	Theb	-0.354	-1.264
Aen	Ars	-0.356	-1.269
DRN	Theb	-0.363	-1.296
Ecl	Ars	-0.370	-1.320
HSat	Hon	-0.376	-1.342
Met	PSat	-0.379	-1.353
HSat	Theb	-0.387	-1.381
Ars	Theb	-0.390	-1.393
HSat	Arg	-0.404	-1.442
PSat	Ilias	-0.406	-1.448
Ecl	Gild	-0.422	-1.507
Theb	JSat	-0.434	-1.548
PSat	Gild	-0.444	-1.584
Ep	Theb	-0.451	-1.609
PSat	Joh	-0.453	-1.617
PSat	HE	-0.454	-1.621
Astr	PSat	-0.468	-1.669
DRN	Gild	-0.484	-1.726
HSat	Rapt	-0.485	-1.731
Aen	PSat	-0.537	-1.917
PSat	Rapt	-0.579	-2.065
Ars	Gild	-0.834	-2.977

Table 3. Intensity of text reuse for 276 pairs of hexameter texts from the 1st century BCE to the 6th century CE, determined by comparing composite counts of high scoring results in *Tesserae* searches with expected counts based on text lengths. Reuse intensity is presented as both non-standardized and standardized residuals.

Text	Mean r
Georg	0.279
Ilias	0.186
Aen	0.133
Ach	0.117
Stil	0.105
Rapt	0.088
Hon	0.086
Joh	0.078
Met	0.073
Mos	0.057
Pun	0.044
Gild	0.032
BC	0.006
Astr	-0.006
Ecl	-0.018
Arg	-0.036
Theb	-0.096
HE	-0.102
JSat	-0.120
Ars	-0.146
DRN	-0.151
Ep	-0.153
HSat	-0.187
PSat	-0.270

Table 4. Centrality scores for 24 hexameter texts from the 1st century BCE to the 6th century CE, determined by calculating for each text the mean text reuse intensity for all 23 pairs involving that text.

Horace			Vergil			Statius			Claudian		
Source	Target	r	Source	Target	r	Source	Target	r	Source	Target	r
Ep	*Ars*	0.354	*Georg*	*Aen*	1.280	*Theb*	*Ach*	0.141	*Hon*	*Stil*	0.716
HSat	*Ep*	0.259	*Ecl*	*Georg*	0.603				*Hon*	*Gild*	0.634
HSat	*Ars*	0.041	*Ecl*	*Aen*	0.224				*Gild*	*Stil*	0.575
									Rapt	*Hon*	0.461
									Rapt	*Gild*	0.404
									Rapt	*Stil*	0.324

Table 5. Intensity of text reuse for pairs of hexameter texts written by the same author.

Georg		Aen		Ilias	
Target	r	Target	r	Target	r
Aen	1.280	Ilias	0.594	Joh	0.663
Met	0.560	Pun	0.540	Gild	0.457
Rapt	0.538	Met	0.350	Pun	0.433
Pun	0.433	Rapt	0.326	Ach	0.396
Joh	0.355	Theb	0.299	Arg	0.389
BC	0.351	Ach	0.289	Theb	0.252
Astr	0.342	Joh	0.269	HE	0.223
Ilias	0.310	Arg	0.255	Stil	0.157
Arg	0.297	Mos	0.115	Rapt	0.152
Gild	0.268	Gild	0.092	Mos	0.120
Mos	0.260	Hon	0.064	JSat	0.045
Hon	0.232	Stil	0.030	Hon	0.036
Theb	0.186	Astr	0.011		
HE	0.172	BC	-0.026		
Ach	0.160	HE	-0.047		
Stil	0.132	JSat	-0.243		
JSat	-0.009	Ars	-0.356		
Ep	-0.045	PSat	-0.537		
Ars	-0.114				
PSat	-0.164				

Table 6. Intensity of text reuse for pairs of hexameter texts with Vergil's *Georgics*, Vergil's *Aeneid*, or the *Ilias Latina* as source text.

Met		BC		Arg		Theb		Ach		Pun	
Source	r	Source	r	Source	r	Source	r	Source	r	Source	r
Georg	0.560	Georg	0.351	Georg	0.297	Aen	0.299	Aen	0.289	Aen	0.540
Aen	0.350	Met	0.238	Aen	0.255	Georg	0.186	Arg	0.279	Georg	0.433
Ecl	0.323	Aen	-0.026	BC	0.035	Arg	0.064	Georg	0.160	Ach	0.410
Ars	-0.112	Ecl	-0.089	Ecl	-0.003	Met	0.037	Theb	0.141	Met	0.146
DRN	-0.164	Ars	-0.100	Met	-0.006	BC	-0.075	BC	0.097	BC	0.126
Ep	-0.261	Ep	-0.288	Ep	-0.279	Ecl	-0.145	Met	0.077	Ecl	0.093
HSat	-0.326	DRN	-0.297	DRN	-0.283	DRN	-0.363	Ecl	0.047	Arg	0.076
		HSat	-0.326	Ars	-0.304	HSat	-0.387	DRN	-0.091	Theb	0.057
				HSat	-0.404	Ars	-0.390	HSat	-0.102	DRN	-0.092
						Ep	-0.451	Ars	-0.187	Ars	-0.195
								Ep	-0.188	HSat	-0.205
										Ep	-0.338

Table 7. Intensity of text reuse for select pairs of hexameter texts with post-Vergilian epics as target text (Ovid's *Metamorphoses*, Lucan's *Bellum Civile*, Valerius Flaccus' *Argonautica*, Statius' *Thebaid* and *Achilleid*, and Silius Italicus' *Punica*).
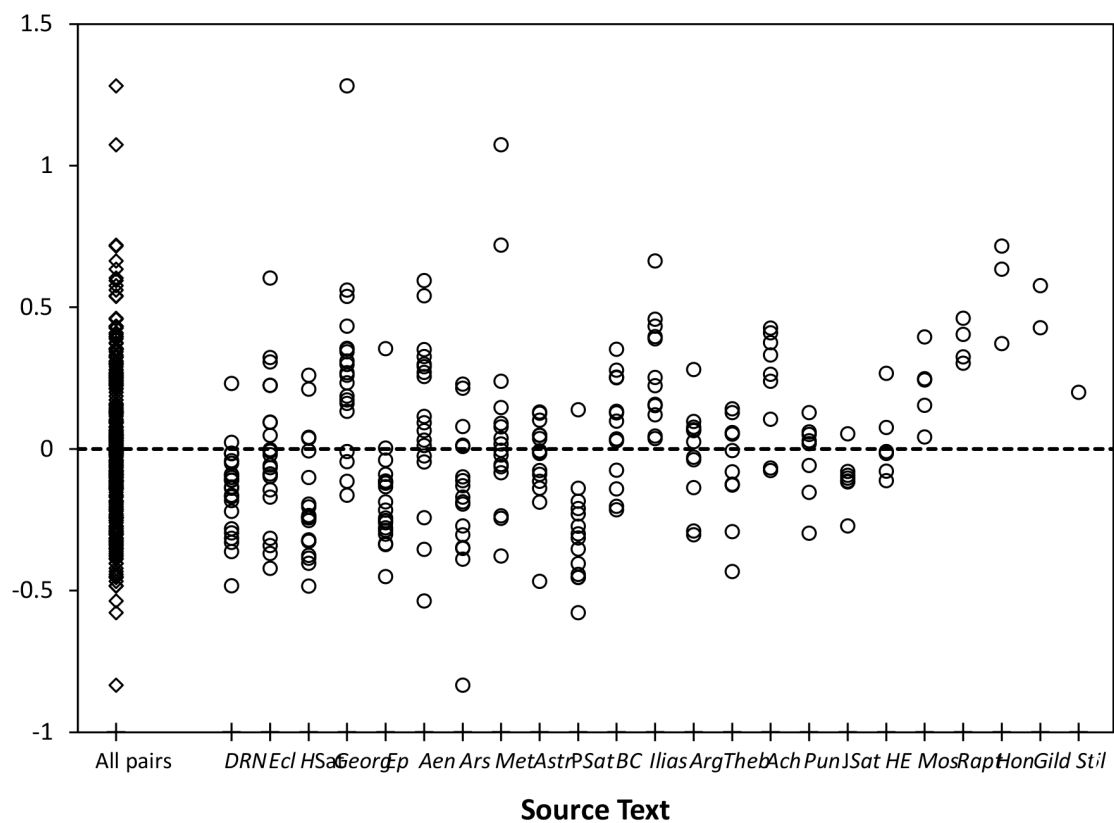
Figure 11. Intensity of text reuse for 276 pairs of hexameter texts from the 1st century BCE to the 6th century CE, determined by comparing composite counts of high scoring results in Tesserae searches with expected counts based on a text lengths. Reuse intensity is sorted chronologically by source text (with the set of all pairs for comparison).
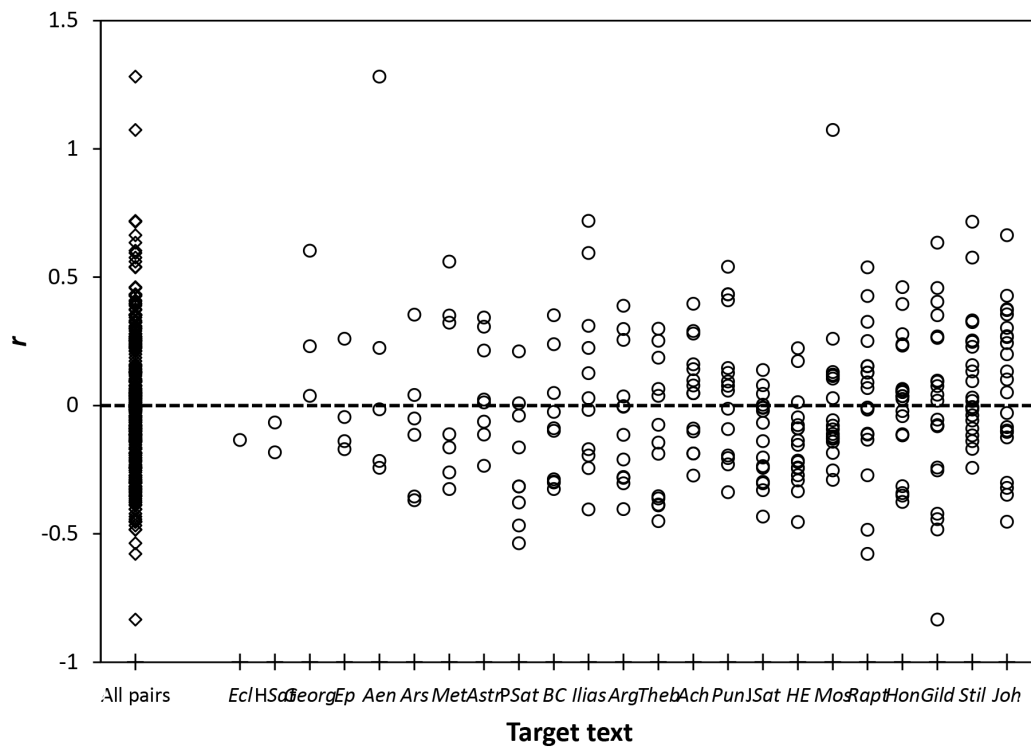
Figure 12. Intensity of text reuse for 276 pairs of hexameter texts from the 1st century BCE to the 6th century CE, determined by comparing composite counts of high scoring results in *Tesserae* searches with expected counts based on a text lengths. Reuse intensity is sorted chronologically by target text (with the set of all pairs for comparison).
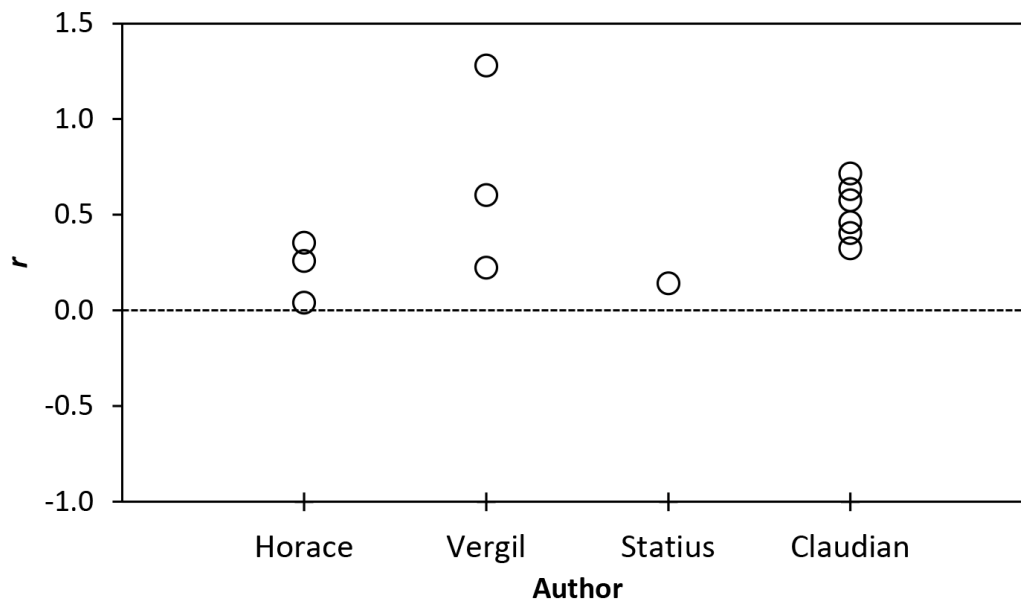
Figure 13. Intensity of text reuse for pairs of hexameter texts written by the same author.
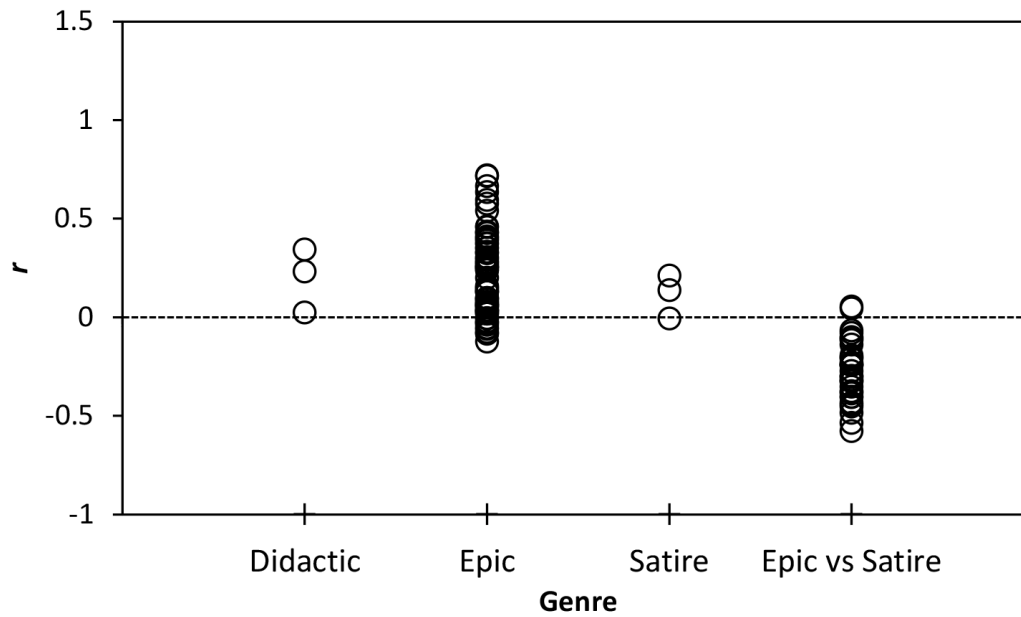
Figure 14. Intensity of text reuse for pairs of hexameter texts within the same genre (didactic, epic/panegyric, and satire), or pairs comprising one epic/panegyric and one satiric text. The didactic genre comprises: *DNR*, *Georg*, and, *Astr*. The epic/panegyric genre comprises: *Aen*, *Met*, *BC*, *Ilias*, *Arg*, *Theb*, *Ach*, *Pun*, *Rapt*, *Hon*, *Gild*, *Stil*, and *Joh*. The satiric genre comprises: H*Sat*, P*Sat*, and J*Sat*.
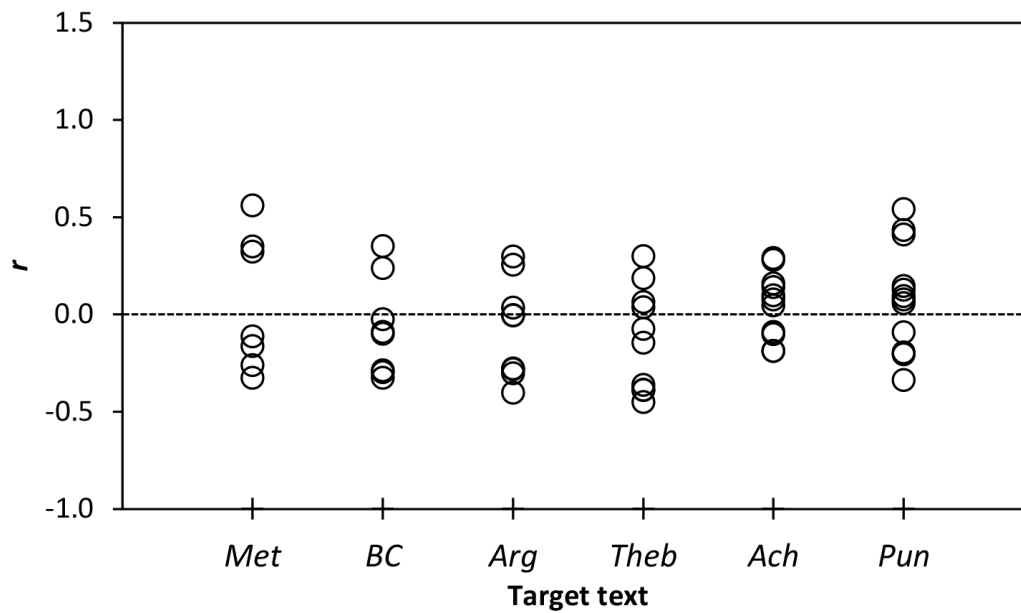
Figure 15. Intensity of text reuse for select pairs of hexameter texts with post-Vergilian epics as target text (Ovid's *Metamorphoses*, Lucan's *Bellum Civile*, Valerius Flaccus' *Argonautica*, Statius' *Thebaid and Achilleid*, and Silius Italicus' *Punica*).

Source	Target	C_7	C_8	C_9	C_{10}	C_{11}	C_{obs}	r
DRN	Ecl	911	193	28	1	0	129.9	-0.134
DRN	HSat	2171	552	100	5	0	380.0	-0.183
DRN	Georg	2643	894	169	8	0	571.8	0.230
DRN	Ep	1414	358	70	4	0	256.7	-0.139

DRN	Aen	11060	3350	790	92	0	2755.7	-0.015
DRN	Ars	407	74	16	2	0	68.6	-0.052
DRN	Met	12958	3726	827	100	0	3036.4	-0.164
DRN	Astr	5380	1458	331	10	0	1030.2	0.023
DRN	PSat	601	84	16	2	0	81.9	-0.316
DRN	BC	8160	2318	464	22	0	1591.4	-0.297
DRN	Ilias	1089	254	39	3	0	177.4	-0.017
DRN	Arg	5904	1416	351	15	0	1102.3	-0.283
DRN	Theb	9682	2443	520	44	0	1901.1	-0.363
DRN	Ach	1117	260	42	3	0	183.4	-0.091
DRN	Pun	12722	3892	907	105	0	3171.5	-0.092
DRN	JSat	3685	955	188	5	0	645.5	-0.330
DRN	HE	3353	883	132	4	0	548.0	-0.221
DRN	Mos	377	86	14	1	0	61.2	-0.111
DRN	Rapt	1028	235	49	2	0	173.4	-0.111
DRN	Hon	565	124	27	1	0	93.6	-0.042
DRN	Gild	387	65	9	0	0	45.8	-0.484
DRN	Stil	1074	282	49	1	0	180.3	-0.170
DRN	Joh	4842	1393	306	13	0	978.6	-0.101
Ecl	HSat	201	33	6	0	0	25.0	-0.066
Ecl	Georg	374	98	5	0	0	48.5	0.603
Ecl	Ep	130	27	1	0	0	14.5	-0.171
Ecl	Aen	1222	250	53	4	0	204.4	0.224
Ecl	Ars	39	3	0	0	0	2.9	-0.370
Ecl	Met	1482	325	55	12	0	288.5	0.323
Ecl	Astr	501	93	24	1	0	79.9	0.307
Ecl	PSat	56	7	0	0	0	4.8	-0.316
Ecl	BC	801	146	23	2	0	114.3	-0.089
Ecl	Ilias	138	19	1	0	0	13.2	0.224
Ecl	Arg	693	116	13	1	0	85.1	-0.003
Ecl	Theb	1106	175	29	1	0	138.1	-0.145
Ecl	Ach	128	22	0	0	0	12.3	0.047
Ecl	Pun	1312	261	45	7	0	222.9	0.093
Ecl	JSat	413	83	9	0	0	51.4	-0.021
Ecl	HE	330	56	5	0	0	36.5	-0.089
Ecl	Mos	54	3	0	0	0	3.8	-0.058
Ecl	Rapt	117	20	0	0	0	11.2	-0.009
Ecl	Hon	51	5	0	0	0	4.1	-0.341
Ecl	Gild	30	5	0	0	0	2.8	-0.422
Ecl	Stil	137	26	0	0	0	13.7	0.094
Ecl	Joh	524	99	5	0	0	57.3	-0.098
HSat	Georg	583	176	20	0	0	93.0	0.037
HSat	Ep	490	126	19	0	0	75.4	0.259
HSat	Aen	2638	674	111	3	0	432.7	-0.243

HSat	Ars	151	23	1	0	0	14.8	0.041
HSat	Met	3107	780	112	7	0	509.6	-0.326
HSat	Astr	1090	282	31	0	0	156.9	-0.236
HSat	PSat	196	45	6	0	0	27.4	0.210
HSat	BC	1983	424	58	6	0	304.8	-0.326
HSat	Ilias	239	56	3	0	0	29.3	-0.195
HSat	Arg	1419	329	31	1	0	192.6	-0.404
HSat	Theb	2400	551	67	6	0	366.3	-0.387
HSat	Ach	254	81	3	0	0	35.8	-0.102
HSat	Pun	3151	839	108	13	0	559.1	-0.205
HSat	JSat	1167	292	37	1	0	175.9	-0.007
HSat	HE	769	190	19	0	0	105.8	-0.242
HSat	Mos	87	20	1	0	0	10.5	-0.253
HSat	Rapt	218	49	0	0	0	23.5	-0.485
HSat	Hon	125	18	2	0	0	13.2	-0.376
HSat	Gild	126	19	0	0	0	11.5	-0.243
HSat	Stil	257	68	3	0	0	33.0	-0.244
HSat	Joh	1052	287	30	0	0	154.9	-0.322
Georg	Ep	413	114	6	0	0	55.3	-0.045
Georg	Aen	4150	1276	275	42	4	1974.8	1.280
Georg	Ars	140	16	1	0	0	12.6	-0.114
Georg	Met	4460	1415	251	28	1	1228.6	0.560
Georg	Astr	1578	473	75	1	0	278.1	0.342
Georg	PSat	158	34	2	0	0	18.7	-0.164
Georg	BC	2876	794	140	18	0	596.6	0.351
Georg	Ilias	372	111	2	0	0	48.3	0.310
Georg	Arg	2341	584	108	2	0	386.1	0.297
Georg	Theb	3433	965	144	14	0	645.8	0.186
Georg	Ach	428	83	3	0	0	46.2	0.160
Georg	Pun	4728	1489	245	32	0	1052.0	0.433
Georg	JSat	1104	329	31	1	0	174.6	-0.009
Georg	HE	975	313	33	0	0	159.3	0.172
Georg	Mos	159	28	2	0	0	17.4	0.260
Georg	Rapt	379	126	15	0	0	65.1	0.538
Georg	Hon	204	42	3	0	0	24.1	0.232
Georg	Gild	162	39	1	0	0	19.1	0.268
Georg	Stil	353	96	6	0	0	47.8	0.132
Georg	Joh	1677	473	94	1	0	302.8	0.355
Ep	Aen	1658	420	56	5	0	276.9	-0.216
Ep	Ars	134	22	0	0	0	12.6	0.354
Ep	Met	2052	545	67	5	0	338.6	-0.261
Ep	Astr	860	205	15	0	0	110.4	-0.114
Ep	PSat	116	25	1	0	0	13.3	-0.040
Ep	BC	1437	278	46	1	0	197.2	-0.288

Ep	Ilias	150	39	0	0	0	17.4	-0.245
Ep	Arg	951	211	34	0	0	136.0	-0.279
Ep	Theb	1496	372	32	2	0	214.0	-0.451
Ep	Ach	188	43	0	0	0	20.5	-0.188
Ep	Pun	1803	460	79	3	0	304.7	-0.338
Ep	JSat	705	219	21	0	0	110.7	0.003
Ep	HE	513	114	5	0	0	60.1	-0.336
Ep	Mos	75	14	0	0	0	7.5	-0.121
Ep	Rapt	150	41	3	0	0	20.8	-0.133
Ep	Hon	94	19	1	0	0	10.7	-0.117
Ep	Gild	57	17	0	0	0	7.1	-0.253
Ep	Stil	199	47	2	0	0	24.0	-0.090
Ep	Joh	742	164	19	0	0	98.4	-0.301
Aen	Ars	539	85	15	1	0	71.3	-0.356
Aen	Met	21610	6172	1364	250	7	7156.5	0.350
Aen	Astr	6658	1763	437	35	0	1435.2	0.011
Aen	PSat	735	131	21	0	0	92.6	-0.537
Aen	BC	13863	3157	815	99	0	2942.2	-0.026
Aen	Ilias	2361	670	112	10	0	460.9	0.594
Aen	Arg	12214	3071	647	99	0	2660.2	0.255
Aen	Theb	18667	4816	1166	190	3	5196.9	0.299
Aen	Ach	2196	511	87	8	0	378.1	0.289
Aen	Pun	26063	7011	1720	323	7	8415.5	0.540
Aen	JSat	5113	1252	299	19	0	993.2	-0.243
Aen	HE	4656	1236	255	19	0	919.3	-0.047
Aen	Mos	623	114	28	3	0	108.2	0.115
Aen	Rapt	1674	494	83	14	0	378.1	0.326
Aen	Hon	910	182	41	2	0	146.7	0.064
Aen	Gild	773	151	24	2	0	114.9	0.092
Aen	Stil	1761	411	73	7	0	310.4	0.030
Aen	Joh	9050	2482	550	59	0	1997.9	0.269
Ars	Met	681	83	15	2	0	85.3	-0.112
Ars	Astr	213	58	8	0	0	33.3	0.213
Ars	PSat	37	4	0	0	0	3.0	0.008
Ars	BC	398	56	10	1	0	51.7	-0.100
Ars	Ilias	59	3	0	0	0	4.1	-0.171
Ars	Arg	268	33	6	0	0	28.8	-0.304
Ars	Theb	515	57	7	0	0	49.4	-0.390
Ars	Ach	50	7	0	0	0	4.4	-0.187
Ars	Pun	642	109	15	0	0	76.3	-0.195
Ars	JSat	229	39	4	0	0	25.9	0.078
Ars	HE	164	27	3	0	0	18.5	0.013
Ars	Mos	24	1	0	0	0	1.6	-0.131
Ars	Rapt	49	5	0	0	0	3.9	-0.272

Ars	Hon	28	1	0	0	0	1.8	-0.351
Ars	Gild	15	0	0	0	0	0.9	-0.834
Ars	Stil	66	15	0	0	0	7.2	0.228
Ars	Joh	207	29	2	0	0	20.4	-0.348
Met	Astr	8646	2366	466	39	0	1738.9	-0.064
Met	PSat	797	161	22	6	0	141.6	-0.379
Met	BC	16737	3936	966	131	6	5000.8	0.238
Met	Ilias	2497	662	74	14	1	681.8	0.719
Met	Arg	12279	2899	622	75	1	2677.2	-0.006
Met	Theb	19745	5002	1015	165	4	5220.1	0.037
Met	Ach	2330	639	78	7	0	399.3	0.077
Met	Pun	24950	6621	1564	284	5	7407.3	0.146
Met	JSat	6383	1685	328	37	0	1305.5	-0.236
Met	HE	5307	1420	235	20	0	984.3	-0.246
Met	Mos	814	135	26	6	1	368.5	1.073
Met	Rapt	1971	548	97	9	0	389.8	0.089
Met	Hon	992	260	29	5	0	175.8	-0.022
Met	Gild	775	192	23	3	0	129.5	-0.055
Met	Stil	2073	597	84	10	0	400.0	0.017
Met	Joh	9569	2604	515	29	0	1831.5	-0.085
Astr	PSat	305	59	2	0	0	32.8	-0.468
Astr	BC	6009	1465	239	21	0	1045.0	0.048
Astr	Ilias	732	161	17	0	0	95.2	0.125
Astr	Arg	3871	867	171	3	0	606.8	-0.114
Astr	Theb	6224	1506	257	16	0	1053.1	-0.189
Astr	Ach	760	166	17	0	0	97.9	0.047
Astr	Pun	8545	2134	439	30	0	1597.4	-0.013
Astr	JSat	2253	554	91	3	0	363.6	-0.139
Astr	HE	1916	533	61	0	0	290.7	-0.090
Astr	Mos	314	59	5	0	0	36.3	0.130
Astr	Rapt	657	151	17	0	0	88.6	-0.016
Astr	Hon	407	70	8	0	0	47.1	0.036
Astr	Gild	304	47	4	0	0	32.0	-0.077
Astr	Stil	731	159	21	0	0	98.7	-0.007
Astr	Joh	3184	870	154	4	0	557.3	0.101
PSat	BC	564	79	12	1	0	68.4	-0.300
PSat	Ilias	63	7	0	0	0	5.2	-0.406
PSat	Arg	434	63	12	0	0	51.1	-0.211
PSat	Theb	698	113	11	1	0	82.7	-0.354
PSat	Ach	60	14	0	0	0	6.6	-0.273
PSat	Pun	891	150	28	1	0	119.1	-0.230
PSat	JSat	343	79	7	0	0	44.4	0.137
PSat	HE	197	33	0	0	0	18.7	-0.454
PSat	Mos	31	3	0	0	0	2.5	-0.185

PSat	Rapt	62	5	0	0	0	4.7	-0.579
PSat	Hon	30	6	0	0	0	3.1	-0.315
PSat	Gild	28	2	0	0	0	2.1	-0.444
PSat	Stil	77	16	0	0	0	8.0	-0.139
PSat	Joh	250	46	5	0	0	29.7	-0.453
BC	Ilias	1387	294	25	4	0	195.8	0.028
BC	Arg	8571	1837	391	48	0	1597.4	0.035
BC	Theb	14282	3067	631	85	0	2674.1	-0.075
BC	Ach	1607	303	48	4	0	233.5	0.097
BC	Pun	18677	4366	957	147	1	4161.6	0.126
BC	JSat	4549	1061	211	10	0	773.3	-0.203
BC	HE	3518	851	138	8	0	581.4	-0.215
BC	Mos	463	76	19	0	0	62.7	-0.142
BC	Rapt	1458	334	47	9	0	262.3	0.250
BC	Hon	920	160	22	4	0	135.9	0.278
BC	Gild	580	133	23	4	0	111.3	0.351
BC	Stil	1645	357	59	9	0	290.2	0.253
BC	Joh	7466	1754	336	23	0	1303.1	0.132
Ilias	Arg	1150	237	30	1	0	155.5	0.389
Ilias	Theb	1818	380	45	3	0	253.6	0.252
Ilias	Ach	234	36	0	0	0	21.5	0.064
Ilias	Pun	2581	582	70	6	0	386.6	0.396
Ilias	JSat	465	107	17	0	0	67.7	0.279
Ilias	HE	484	106	10	0	0	61.6	0.433
Ilias	Mos	50	12	0	0	0	5.6	0.076
Ilias	Rapt	158	32	0	0	0	16.3	0.045
Ilias	Hon	88	10	0	0	0	7.3	-0.303
Ilias	Gild	77	18	0	0	0	8.5	0.223
Ilias	Stil	177	35	0	0	0	18.0	-0.137
Ilias	Joh	977	212	29	3	0	151.6	0.120
Arg	Theb	11371	2503	535	45	0	2032.8	-0.290
Arg	Ach	1304	297	31	2	0	185.1	0.152
Arg	Pun	14178	3236	650	68	0	2618.2	0.067
Arg	JSat	2895	682	118	4	0	462.5	0.036
Arg	HE	2731	614	121	0	0	415.7	0.024
Arg	Mos	357	50	4	0	0	35.7	0.457
Arg	Rapt	1099	224	31	0	0	144.4	0.097
Arg	Hon	538	96	11	1	0	69.7	0.157
Arg	Gild	430	82	14	0	0	57.1	-0.039
Arg	Stil	1120	226	22	1	0	143.3	0.663
Arg	Joh	4622	1069	171	9	0	733.0	-0.030
Theb	Ach	2283	517	58	2	0	317.8	0.141
Theb	Pun	22806	5275	1076	165	2	5062.7	0.057
Theb	JSat	4733	1232	170	13	0	800.1	-0.434

Theb	*HE*	4047	989	184	10	0	701.3	-0.293
Theb	*Mos*	612	95	20	1	0	82.8	-0.128
Theb	*Rapt*	1844	500	53	5	0	302.6	0.128
Theb	*Hon*	972	200	28	2	0	141.3	0.052
Theb	*Gild*	727	130	17	1	0	94.2	-0.081
Theb	*Stil*	1836	395	60	6	0	291.8	-0.006
Theb	*Joh*	7759	1900	303	22	0	1313.5	-0.125
Ach	*Pun*	2631	614	91	7	0	423.9	0.410
Ach	*JSat*	559	115	10	0	0	67.9	-0.068
Ach	*HE*	448	87	6	0	0	51.3	-0.076
Ach	*Mos*	68	10	0	0	0	6.1	0.104
Ach	*Rapt*	207	45	2	0	0	24.0	0.426
Ach	*Hon*	112	16	0	0	0	10.0	0.238
Ach	*Gild*	68	13	1	0	0	7.8	0.263
Ach	*Stil*	226	45	1	0	0	24.1	0.331
Ach	*Joh*	881	194	27	1	0	127.4	0.375
Pun	*JSat*	6378	1625	296	26	0	1190.6	-0.298
Pun	*HE*	5321	1403	262	26	0	1046.0	-0.154
Pun	*Mos*	755	133	21	5	0	125.6	0.028
Pun	*Rapt*	2074	573	76	11	0	392.9	0.128
Pun	*Hon*	1168	247	31	5	0	185.0	0.060
Pun	*Gild*	957	163	31	2	0	135.1	0.018
Pun	*Stil*	2204	544	73	6	0	359.4	-0.059
Pun	*Joh*	11414	2598	525	43	0	2034.1	0.051
JSat	*HE*	1386	361	47	1	0	213.9	-0.273
JSat	*Mos*	191	43	5	0	0	25.6	-0.094
JSat	*Rapt*	464	131	15	0	0	71.1	-0.113
JSat	*Hon*	300	67	10	0	0	42.3	0.053
JSat	*Gild*	222	42	6	0	0	28.2	-0.081
JSat	*Stil*	592	143	12	0	0	78.1	-0.117
JSat	*Joh*	2486	594	106	3	0	401.0	-0.104
HE	*Mos*	165	35	2	0	0	19.3	-0.079
HE	*Rapt*	430	102	11	0	0	58.6	-0.010
HE	*Hon*	244	43	3	0	0	26.7	-0.112
HE	*Gild*	202	44	3	0	0	24.5	0.075
HE	*Stil*	470	117	11	0	0	64.3	-0.016
HE	*Joh*	2321	639	105	8	0	432.1	0.267
Mos	*Rapt*	62	5	1	0	0	5.7	0.153
Mos	*Hon*	44	5	0	0	0	3.6	0.395
Mos	*Gild*	34	0	0	0	0	2.0	0.042
Mos	*Stil*	77	11	0	0	0	6.9	0.247
Mos	*Joh*	263	43	10	0	0	34.8	0.324
Rapt	*Hon*	104	27	0	0	0	12.0	0.243
Rapt	*Gild*	100	13	0	0	0	8.7	0.461

Rapt	Stil	193	53	0	0	0	23.0	0.404
Rapt	Joh	845	198	21	0	0	114.0	0.302
Hon	Gild	59	8	0	0	0	5.2	0.634
Hon	Stil	133	38	0	0	0	16.2	0.716
Hon	Joh	472	89	11	0	0	58.1	0.372
Gild	Stil	100	21	0	0	0	10.5	0.575
Gild	Joh	402	74	6	0	0	45.7	0.427
Stil	Joh	862	182	24	0	0	114.4	0.199

Table 8. Results of *Tesserae* searches of 276 pairs of hexameter texts from the 1st century BCE to the 6th century CE, sorted chronologically by source text. Results include: raw counts of score 7, 8, 9, 10, and 11; composite counts calculated from the raw counts using a combination of linear regressions and principal component analysis; and text reuse intensity, determined by comparing the composite counts with expected counts based on a text lengths.

Source	Target	C_7	C_8	C_9	C_{10}	C_{11}	C_{obs}	r
DRN	Ecl	911	193	28	1	0	129.9	-0.134
DRN	HSat	2171	552	100	5	0	380.0	-0.183
Ecl	HSat	201	33	6	0	0	25.0	-0.066
DRN	Georg	2643	894	169	8	0	571.8	0.230
Ecl	Georg	374	98	5	0	0	48.5	0.603
HSat	Georg	583	176	20	0	0	93.0	0.037
DRN	Ep	1414	358	70	4	0	256.7	-0.139
Ecl	Ep	130	27	1	0	0	14.5	-0.171
HSat	Ep	490	126	19	0	0	75.4	0.259
Georg	Ep	413	114	6	0	0	55.3	-0.045
DRN	Aen	11060	3350	790	92	0	2755.7	-0.015
Ecl	Aen	1222	250	53	4	0	204.4	0.224
HSat	Aen	2638	674	111	3	0	432.7	-0.243
Georg	Aen	4150	1276	275	42	4	1974.8	1.280
Ep	Aen	1658	420	56	5	0	276.9	-0.216
DRN	Ars	407	74	16	2	0	68.6	-0.052
Ecl	Ars	39	3	0	0	0	2.9	-0.370
HSat	Ars	151	23	1	0	0	14.8	0.041
Georg	Ars	140	16	1	0	0	12.6	-0.114
Ep	Ars	134	22	0	0	0	12.6	0.354
Aen	Ars	539	85	15	1	0	71.3	-0.356
DRN	Met	12958	3726	827	100	0	3036.4	-0.164
Ecl	Met	1482	325	55	12	0	288.5	0.323
HSat	Met	3107	780	112	7	0	509.6	-0.326
Georg	Met	4460	1415	251	28	1	1228.6	0.560
Ep	Met	2052	545	67	5	0	338.6	-0.261
Aen	Met	21610	6172	1364	250	7	7156.5	0.350
Ars	Met	681	83	15	2	0	85.3	-0.112
DRN	Astr	5380	1458	331	10	0	1030.2	0.023
Ecl	Astr	501	93	24	1	0	79.9	0.307

HSat	Astr	1090	282	31	0	0	156.9	-0.236
Georg	Astr	1578	473	75	1	0	278.1	0.342
Ep	Astr	860	205	15	0	0	110.4	-0.114
Aen	Astr	6658	1763	437	35	0	1435.2	0.011
Ars	Astr	213	58	8	0	0	33.3	0.213
Met	Astr	8646	2366	466	39	0	1738.9	-0.064
DRN	PSat	601	84	16	2	0	81.9	-0.316
Ecl	PSat	56	7	0	0	0	4.8	-0.316
HSat	PSat	196	45	6	0	0	27.4	0.210
Georg	PSat	158	34	2	0	0	18.7	-0.164
Ep	PSat	116	25	1	0	0	13.3	-0.040
Aen	PSat	735	131	21	0	0	92.6	-0.537
Ars	PSat	37	4	0	0	0	3.0	0.008
Met	PSat	797	161	22	6	0	141.6	-0.379
Astr	PSat	305	59	2	0	0	32.8	-0.468
DRN	BC	8160	2318	464	22	0	1591.4	-0.297
Ecl	BC	801	146	23	2	0	114.3	-0.089
HSat	BC	1983	424	58	6	0	304.8	-0.326
Georg	BC	2876	794	140	18	0	596.6	0.351
Ep	BC	1437	278	46	1	0	197.2	-0.288
Aen	BC	13863	3157	815	99	0	2942.2	-0.026
Ars	BC	398	56	10	1	0	51.7	-0.100
Met	BC	16737	3936	966	131	6	5000.8	0.238
Astr	BC	6009	1465	239	21	0	1045.0	0.048
PSat	BC	564	79	12	1	0	68.4	-0.300
DRN	Ilias	1089	254	39	3	0	177.4	-0.017
Ecl	Ilias	138	19	1	0	0	13.2	0.224
HSat	Ilias	239	56	3	0	0	29.3	-0.195
Georg	Ilias	372	111	2	0	0	48.3	0.310
Ep	Ilias	150	39	0	0	0	17.4	-0.245
Aen	Ilias	2361	670	112	10	0	460.9	0.594
Ars	Ilias	59	3	0	0	0	4.1	-0.171
Met	Ilias	2497	662	74	14	1	681.8	0.719
Astr	Ilias	732	161	17	0	0	95.2	0.125
PSat	Ilias	63	7	0	0	0	5.2	-0.406
BC	Ilias	1387	294	25	4	0	195.8	0.028
DRN	Arg	5904	1416	351	15	0	1102.3	-0.283
Ecl	Arg	693	116	13	1	0	85.1	-0.003
HSat	Arg	1419	329	31	1	0	192.6	-0.404
Georg	Arg	2341	584	108	2	0	386.1	0.297
Ep	Arg	951	211	34	0	0	136.0	-0.279
Aen	Arg	12214	3071	647	99	0	2660.2	0.255
Ars	Arg	268	33	6	0	0	28.8	-0.304
Met	Arg	12279	2899	622	75	1	2677.2	-0.006

Astr	Arg	3871	867	171	3	0	606.8	-0.114
PSat	Arg	434	63	12	0	0	51.1	-0.211
BC	Arg	8571	1837	391	48	0	1597.4	0.035
Ilias	Arg	1150	237	30	1	0	155.5	0.389
DRN	Theb	9682	2443	520	44	0	1901.1	-0.363
Ecl	Theb	1106	175	29	1	0	138.1	-0.145
HSat	Theb	2400	551	67	6	0	366.3	-0.387
Georg	Theb	3433	965	144	14	0	645.8	0.186
Ep	Theb	1496	372	32	2	0	214.0	-0.451
Aen	Theb	18667	4816	1166	190	3	5196.9	0.299
Ars	Theb	515	57	7	0	0	49.4	-0.390
Met	Theb	19745	5002	1015	165	4	5220.1	0.037
Astr	Theb	6224	1506	257	16	0	1053.1	-0.189
PSat	Theb	698	113	11	1	0	82.7	-0.354
BC	Theb	14282	3067	631	85	0	2674.1	-0.075
Ilias	Theb	1818	380	45	3	0	253.6	0.252
Arg	Theb	11371	2503	535	45	0	2032.8	0.064
DRN	Ach	1117	260	42	3	0	183.4	-0.091
Ecl	Ach	128	22	0	0	0	12.3	0.047
HSat	Ach	254	81	3	0	0	35.8	-0.102
Georg	Ach	428	83	3	0	0	46.2	0.160
Ep	Ach	188	43	0	0	0	20.5	-0.188
Aen	Ach	2196	511	87	8	0	378.1	0.289
Ars	Ach	50	7	0	0	0	4.4	-0.187
Met	Ach	2330	639	78	7	0	399.3	0.077
Astr	Ach	760	166	17	0	0	97.9	0.047
PSat	Ach	60	14	0	0	0	6.6	-0.273
BC	Ach	1607	303	48	4	0	233.5	0.097
Ilias	Ach	234	36	0	0	0	21.5	0.396
Arg	Ach	1304	297	31	2	0	185.1	0.279
Theb	Ach	2283	517	58	2	0	317.8	0.141
DRN	Pun	12722	3892	907	105	0	3171.5	-0.092
Ecl	Pun	1312	261	45	7	0	222.9	0.093
HSat	Pun	3151	839	108	13	0	559.1	-0.205
Georg	Pun	4728	1489	245	32	0	1052.0	0.433
Ep	Pun	1803	460	79	3	0	304.7	-0.338
Aen	Pun	26063	7011	1720	323	7	8415.5	0.540
Ars	Pun	642	109	15	0	0	76.3	-0.195
Met	Pun	24950	6621	1564	284	5	7407.3	0.146
Astr	Pun	8545	2134	439	30	0	1597.4	-0.013
PSat	Pun	891	150	28	1	0	119.1	-0.230
BC	Pun	18677	4366	957	147	1	4161.6	0.126
Ilias	Pun	2581	582	70	6	0	386.6	0.433
Arg	Pun	14178	3236	650	68	0	2618.2	0.076

Theb	Pun	22806	5275	1076	165	2	5062.7	0.057
Ach	Pun	2631	614	91	7	0	423.9	0.410
DRN	JSat	3685	955	188	5	0	645.5	-0.330
Ecl	JSat	413	83	9	0	0	51.4	-0.021
HSat	JSat	1167	292	37	1	0	175.9	-0.007
Georg	JSat	1104	329	31	1	0	174.6	-0.009
Ep	JSat	705	219	21	0	0	110.7	0.003
Aen	JSat	5113	1252	299	19	0	993.2	-0.243
Ars	JSat	229	39	4	0	0	25.9	0.078
Met	JSat	6383	1685	328	37	0	1305.5	-0.236
Astr	JSat	2253	554	91	3	0	363.6	-0.139
PSat	JSat	343	79	7	0	0	44.4	0.137
BC	JSat	4549	1061	211	10	0	773.3	-0.203
Ilias	JSat	465	107	17	0	0	67.7	0.045
Arg	JSat	2895	682	118	4	0	462.5	-0.303
Theb	JSat	4733	1232	170	13	0	800.1	-0.434
Ach	JSat	559	115	10	0	0	67.9	-0.068
Pun	JSat	6378	1625	296	26	0	1190.6	-0.298
DRN	HE	3353	883	132	4	0	548.0	-0.221
Ecl	HE	330	56	5	0	0	36.5	-0.089
HSat	HE	769	190	19	0	0	105.8	-0.242
Georg	HE	975	313	33	0	0	159.3	0.172
Ep	HE	513	114	5	0	0	60.1	-0.336
Aen	HE	4656	1236	255	19	0	919.3	-0.047
Ars	HE	164	27	3	0	0	18.5	0.013
Met	HE	5307	1420	235	20	0	984.3	-0.246
Astr	HE	1916	533	61	0	0	290.7	-0.090
PSat	HE	197	33	0	0	0	18.7	-0.454
BC	HE	3518	851	138	8	0	581.4	-0.215
Ilias	HE	484	106	10	0	0	61.6	0.223
Arg	HE	2731	614	121	0	0	415.7	-0.137
Theb	HE	4047	989	184	10	0	701.3	-0.293
Ach	HE	448	87	6	0	0	51.3	-0.076
Pun	HE	5321	1403	262	26	0	1046.0	-0.154
JSat	HE	1386	361	47	1	0	213.9	-0.273
DRN	Mos	377	86	14	1	0	61.2	-0.111
Ecl	Mos	54	3	0	0	0	3.8	-0.058
HSat	Mos	87	20	1	0	0	10.5	-0.253
Georg	Mos	159	28	2	0	0	17.4	0.260
Ep	Mos	75	14	0	0	0	7.5	-0.121
Aen	Mos	623	114	28	3	0	108.2	0.115
Ars	Mos	24	1	0	0	0	1.6	-0.131
Met	Mos	814	135	26	6	1	368.5	1.073
Astr	Mos	314	59	5	0	0	36.3	0.130

PSat	Mos	31	3	0	0	0	2.5	-0.185
BC	Mos	463	76	19	0	0	62.7	-0.142
Ilias	Mos	50	12	0	0	0	5.6	0.120
Arg	Mos	357	50	4	0	0	35.7	-0.290
Theb	Mos	612	95	20	1	0	82.8	-0.128
Ach	Mos	68	10	0	0	0	6.1	0.104
Pun	Mos	755	133	21	5	0	125.6	0.028
JSat	Mos	191	43	5	0	0	25.6	-0.094
HE	Mos	165	35	2	0	0	19.3	-0.079
DRN	Rapt	1028	235	49	2	0	173.4	-0.111
Ecl	Rapt	117	20	0	0	0	11.2	-0.009
HSat	Rapt	218	49	0	0	0	23.5	-0.485
Georg	Rapt	379	126	15	0	0	65.1	0.538
Ep	Rapt	150	41	3	0	0	20.8	-0.133
Aen	Rapt	1674	494	83	14	0	378.1	0.326
Ars	Rapt	49	5	0	0	0	3.9	-0.272
Met	Rapt	1971	548	97	9	0	389.8	0.089
Astr	Rapt	657	151	17	0	0	88.6	-0.016
PSat	Rapt	62	5	0	0	0	4.7	-0.579
BC	Rapt	1458	334	47	9	0	262.3	0.250
Ilias	Rapt	158	32	0	0	0	16.3	0.152
Arg	Rapt	1099	224	31	0	0	144.4	0.067
Theb	Rapt	1844	500	53	5	0	302.6	0.128
Ach	Rapt	207	45	2	0	0	24.0	0.426
Pun	Rapt	2074	573	76	11	0	392.9	0.128
JSat	Rapt	464	131	15	0	0	71.1	-0.113
HE	Rapt	430	102	11	0	0	58.6	-0.010
Mos	Rapt	62	5	1	0	0	5.7	0.153
DRN	Hon	565	124	27	1	0	93.6	-0.042
Ecl	Hon	51	5	0	0	0	4.1	-0.341
HSat	Hon	125	18	2	0	0	13.2	-0.376
Georg	Hon	204	42	3	0	0	24.1	0.232
Ep	Hon	94	19	1	0	0	10.7	-0.117
Aen	Hon	910	182	41	2	0	146.7	0.064
Ars	Hon	28	1	0	0	0	1.8	-0.351
Met	Hon	992	260	29	5	0	175.8	-0.022
Astr	Hon	407	70	8	0	0	47.1	0.036
PSat	Hon	30	6	0	0	0	3.1	-0.315
BC	Hon	920	160	22	4	0	135.9	0.278
Ilias	Hon	88	10	0	0	0	7.3	0.036
Arg	Hon	538	96	11	1	0	69.7	0.024
Theb	Hon	972	200	28	2	0	141.3	0.052
Ach	Hon	112	16	0	0	0	10.0	0.238
Pun	Hon	1168	247	31	5	0	185.0	0.060

JSat	Hon	300	67	10	0	0	42.3	0.053
HE	Hon	244	43	3	0	0	26.7	-0.112
Mos	Hon	44	5	0	0	0	3.6	0.395
Rapt	Hon	104	27	0	0	0	12.0	0.461
DRN	Gild	387	65	9	0	0	45.8	-0.484
Ecl	Gild	30	5	0	0	0	2.8	-0.422
HSat	Gild	126	19	0	0	0	11.5	-0.243
Georg	Gild	162	39	1	0	0	19.1	0.268
Ep	Gild	57	17	0	0	0	7.1	-0.253
Aen	Gild	773	151	24	2	0	114.9	0.092
Ars	Gild	15	0	0	0	0	0.9	-0.834
Met	Gild	775	192	23	3	0	129.5	-0.055
Astr	Gild	304	47	4	0	0	32.0	-0.077
PSat	Gild	28	2	0	0	0	2.1	-0.444
BC	Gild	580	133	23	4	0	111.3	0.351
Ilias	Gild	77	18	0	0	0	8.5	0.457
Arg	Gild	430	82	14	0	0	57.1	0.097
Theb	Gild	727	130	17	1	0	94.2	-0.081
Ach	Gild	68	13	1	0	0	7.8	0.263
Pun	Gild	957	163	31	2	0	135.1	0.018
JSat	Gild	222	42	6	0	0	28.2	-0.081
HE	Gild	202	44	3	0	0	24.5	0.075
Mos	Gild	34	0	0	0	0	2.0	0.042
Rapt	Gild	100	13	0	0	0	8.7	0.404
Hon	Gild	59	8	0	0	0	5.2	0.634
DRN	Stil	1074	282	49	1	0	180.3	-0.170
Ecl	Stil	137	26	0	0	0	13.7	0.094
HSat	Stil	257	68	3	0	0	33.0	-0.244
Georg	Stil	353	96	6	0	0	47.8	0.132
Ep	Stil	199	47	2	0	0	24.0	-0.090
Aen	Stil	1761	411	73	7	0	310.4	0.030
Ars	Stil	66	15	0	0	0	7.2	0.228
Met	Stil	2073	597	84	10	0	400.0	0.017
Astr	Stil	731	159	21	0	0	98.7	-0.007
PSat	Stil	77	16	0	0	0	8.0	-0.139
BC	Stil	1645	357	59	9	0	290.2	0.253
Ilias	Stil	177	35	0	0	0	18.0	0.157
Arg	Stil	1120	226	22	1	0	143.3	-0.039
Theb	Stil	1836	395	60	6	0	291.8	-0.006
Ach	Stil	226	45	1	0	0	24.1	0.331
Pun	Stil	2204	544	73	6	0	359.4	-0.059
JSat	Stil	592	143	12	0	0	78.1	-0.117
HE	Stil	470	117	11	0	0	64.3	-0.016
Mos	Stil	77	11	0	0	0	6.9	0.247

Rapt	*Stil*	193	53	0	0	0	23.0	0.324
Hon	*Stil*	133	38	0	0	0	16.2	0.716
Gild	*Stil*	100	21	0	0	0	10.5	0.575
DRN	*Joh*	4842	1393	306	13	0	978.6	-0.101
Ecl	*Joh*	524	99	5	0	0	57.3	-0.098
HSat	*Joh*	1052	287	30	0	0	154.9	-0.322
Georg	*Joh*	1677	473	94	1	0	302.8	0.355
Ep	*Joh*	742	164	19	0	0	98.4	-0.301
Aen	*Joh*	9050	2482	550	59	0	1997.9	0.269
Ars	*Joh*	207	29	2	0	0	20.4	-0.348
Met	*Joh*	9569	2604	515	29	0	1831.5	-0.085
Astr	*Joh*	3184	870	154	4	0	557.3	0.101
PSat	*Joh*	250	46	5	0	0	29.7	-0.453
BC	*Joh*	7466	1754	336	23	0	1303.1	0.132
Ilias	*Joh*	977	212	29	3	0	151.6	0.663
Arg	*Joh*	4622	1069	171	9	0	733.0	-0.030
Theb	*Joh*	7759	1900	303	22	0	1313.5	-0.125
Ach	*Joh*	881	194	27	1	0	127.4	0.375
Pun	*Joh*	11414	2598	525	43	0	2034.1	0.051
JSat	*Joh*	2486	594	106	3	0	401.0	-0.104
HE	*Joh*	2321	639	105	8	0	432.1	0.267
Mos	*Joh*	263	43	10	0	0	34.8	0.243
Rapt	*Joh*	845	198	21	0	0	114.0	0.302
Hon	*Joh*	472	89	11	0	0	58.1	0.372
Gild	*Joh*	402	74	6	0	0	45.7	0.427
Stil	*Joh*	862	182	24	0	0	114.4	0.199

Table 9. Results of *Tesserae* searches of 276 pairs of hexameter texts from the 1st century BCE to the 6th century CE, sorted chronologically by target text. Results include: raw counts of score 7, 8, 9, 10, and 11; composite counts calculated from the raw counts using a combination of linear regressions and principal component analysis; and text reuse intensity, determined by comparing the composite counts with expected counts based on a text lengths.

Notes

[1] See, for example, [Hutchinson 2013], [Farrell 2005], and [Hinds 1998] for points of entry to the study of intertextuality in Latin literature.

[2] All translations are by the authors.

[3] Because Latin is a highly inflected language, the same lexeme may occur in many different inflected forms. For example, *percutio* may appear as *percussus* ("struck"), *percutimus* ("we strike"), *percusserant* ("they had struck"), etc. Traditional literary interpretation may privilege specific morphological forms, such as the opening words of Vergil's *Aeneid* (*arma uirumque*), which are frequently adapted by later poets, but more often the various inflected forms of a lexeme may be considered to be the same. *Tesserae* converts all inflected forms to a single lemma (e.g., *percussus* and *percussum* are treated as *percutio*) and so does not permit analysis of individual inflected forms.

[4] See section 2.b for discussion of the scoring system.

[5] Recent commentaries (such as [Steiniger 2005], [Micozzi 2007], and [Parkes 2012]) note the verbal parallel with *Aeneid* 7.550, but do not offer a literary interpretation of the link. Their reticence is symptomatic of the scholarly tendency to privilege certain allusions (here, *Aeneid* 9.197) over others in interpretation. The impartial automatic searches of *Tesserae* encourage an interpretive style that is both less hierarchical and less committed to authorial intention.

[6] The dates of texts mostly follow those found in *Brill's New Pauly*, and depart in some cases from the dates used by the *Tesserae* to assign source and target text status for each pair (http://tesserae.caset.buffalo.edu/blog/authors−and−text−dates/). Where necessary, we manually corrected for the switched source and target. Some dates are uncertain; see, e.g., [Zissos 2008, xiv–xvii] on Valerius Flaccus' *Argonautica*, or [Gruzelier 1993, xviii–xix] on Claudian's *De Raptu Proserpinae*. Alternative datings would affect our results in some cases, since the calculation of the variable c_{exp} depends on which text in a pair is considered the source and which the target. But the overall effect of any plausible change in dating would be small.

[7] The *Tesserae* repository is extensive but not complete. Relevant hexameter texts unavailable for the study at this writing include, for example, Ennius' *Annales*, the *Appendix Vergiliana*, the *Eclogues* of Calpurnius Siculus, and the various Latin versions of Aratus' *Phaenomena*.

[8] We included Claudian's *De Raptu Proserpinae* because it is an important text and because its pentameter preface is short compared to the text as a whole (69 out of 6991 words), and therefore unlikely to noticeably affect our results.

[9] Ausonius' *Precationes*, *Ordo Urbium Nobilium*, and *Cento Nuptialis* (see section 3.c.iv), and Claudian's *In Consulatum Olybrii et Probini*.

[10] False lemma matches also sometimes occur, such as Vergil, *Georgics* 4.308 **ossibus umor** ~ Statius, *Thebaid* 4.698 **ora** … **umor**. Here *ossibus* ("bones") and *ora* ("faces") are inflected forms of two different lexemes, both of which share the lemma *os*. Since such false matches occur infrequently, we did not expect them to affect the results significantly.

[11] These parameters are explained at http://tess−dev.caset.buffalo.edu/html/help_advanced.php.

[12] The regressions yielded the following formulae:

$$C_9 = -21.191 + 0.057 C_7$$

$$C_9 = -17.943 + 0.225 C_8$$

$$C_9 = 36.958 + 6.168 C_{10}$$

$$C_9 = 84.259 + 212.062 C_{11}$$

Figure 2.

We omitted the intercepts, which provide no useful information, and thus obtained a formula for a composite count:

$$C_{regr} = 0.057 C_7 + 0.225 C_8 + C_9 + 6.168 C_{10} + 212.062 C_{11}$$

Figure 3.

[13] The first principal component had weights

$$0.458\tilde{C}_7 + 0.462\tilde{C}_8 + 0.465\tilde{C}_9 + 0.463\tilde{C}_{10} + 0.383\tilde{C}_{11}$$

Figure 4.

This led to, in original scale, the composite count (which accounts for 90.1% of the total variability):

$$C_{pca} = 0.458\frac{C_7}{4341} + 0.462\frac{C_8}{1118} + 0.465\frac{C_9}{253} + 0.463\frac{C_{10}}{39} + 0.383\frac{C_{11}}{1}$$

$$= 10^{-3}(0.106C_7 + 0.413C_8 + 1.839C_9 + 11.775C_{10} + 447.617C_{11})$$

Figure 5.

Further rescaling it such that the weight for C9 became 1, we obtained:

$$C_{pca} = 0.057C_7 + 0.225C_8 + C_9 + 6.404C_{10} + 243.426C_{11}$$

Figure 6.

[14] This model was the best of several considered, namely:

$$c_{exp} \; w_s + w_t$$

$$c_{exp} \; w_s + w_t + w_s \times w_t$$

$$c_{exp} \; w_s + w_t + w_s{}^2 + w_t{}^2 + w_s \times w_t$$

$$c_{exp} \; w_{st}, \text{ where } w_{st} = w_s + w_t \text{ (treated as a single variable)}$$

the above in original scale

Figure 8.

[15] The r values are also sorted chronologically by source and target in Table 8 and 9. Standardized residuals have been adjusted by the standard deviation of the entire set in order to detect statistical outliers. Standardized residuals greater than |2| are normally considered unusual; standardized residual greater than |3| are normally considered statistical outliers.

[16] Author (*Hon–Stil*, *Hon – Gild*, *Ecl – Georg*,*Gild – Stil*, section 3.b), genre (P*Sat - Rapt*, 3.b), multiple reuse (*Met – Ilias*, *Ilias – Joh*, *Aen – Ilias*, *Georg – Met*, *Georg – Rapt*, 3.c.i), and the influence of Vergil (*Aen – Pun*, 3.c.ii).

[17] Jockers observes, "the strength of the author signals in this experiment in fact trumps the signals of individual texts — something intuition does not prepare us for. The classifier [program] is more likely to identify the author of a given text segment than it is to correctly assign that same text segment to its novel of origin." [Jockers 2013, 93]

[18] The didactic genre comprised: *DRN*, *Georg*, and *Astr*. The epic/panegyric genre comprised: *Aen*, *Met*, *BC*, *Ilias*, *Arg*, *Theb*, *Ach*, *Pun*, *Rapt*, *Hon*, *Gild*, *Stil*, and *Joh*. The satiric genre comprised: H*Sat*, P*Sat*, and J*Sat*. This partitioning excludes five texts (*Ecl*, *Ep*, *Ars*, *HE*, *Mos*) that do not fit into any of the three genres. Including Horace's *Epistles* and *Ars Poetica* in the satiric genre would not alter our conclusions: in fact, the lowest *r* value in our data set would then comprise an epic/panegyric–satric pair, *Ars – Gild* (*r* = −0.834).

[19] The exceptions were slight: *Ilias – JSat* (*r* = 0.053) and J*Sat – Hon* (*r* = 0.045).

[20] The average C_{obs} value for the *Aeneid* paired with all subsequent target texts is 1876.6, compared to 284.6 for the *Georgics*.

[21] Its influence grew later on: the text is quoted in the late antique commentary on the *Thebaid* ascribed to Lactantius Placidus, and became popular in the Middle Ages [Curtius 1953, 49–51].

[22] This is consistent with scholarly observation; see *New Pauly* s.v. *Ilias Latina* [Courtney 2016].

[23] For example, see the discussion of the "many mouths" topos [Gowers 2005].

[24] For discussion of the Flavian poets' gradual return to scholarly favor, see [Dominik 2010].

[25] Given the low residual, it is remarkable that *Tesserae* searches reported in [Coffee et al. 2012] identified 25% more interpretively significant instances of verbal reuse in the pair *Aeneid – Bellum Civile* 1 than the standard philological commentaries. Similar studies for pairs with more intense text reuse (e.g., *Aeneid – Metamorphoses*) would presumably be even more successful.

[26] E.g.,

> Compared with other writers of Latin epic, [Silius] tends to eschew signposting his intertexts by the technique of "quotation", that is, by repeating complete phrases or other word collocations from earlier poems. He prefers to signal the intertextual connection by alternative means, in particular, by coincidence of situation and detail rather than wording and, occasionally, by more explicit hints. [Wilson 2004, 225]

[27] Parkes on the *Achilleid* and *Argonautica* is an exception [Parkes 2009]. For the *Thebaid* and *Argonautica*, see [Lovatt 2015], with bibliography.

[28] The relative dating of these two epics is uncertain. This study has treated the *Achilleid* as the source, but the two epics may well have been composed concurrently and influenced one another [Ripoll 2015].

[29] Marks argues for "bi-directional influence" between the two works [Marks 2014].

[30] *Ep – Ars* ($r = 0.354$), H*Sat* – *Ep* (0.259), H*Sat* – *Ars* (0.041) vs. H*Sat* – P*Sat* (0.210), H*Sat* – J*Sat* (−0.007), P*Sat* – J*Sat* (0.137).

[31] H*Sat* – *Rapt* ($r = −0.485$), *Aen* – P*Sat* ($r = −0.537$), P*Sat* – *Rapt* ($r = −0.579$). The lowest pair, *Ars* – *Gild* (−0.834), was one of three statistical outliers (section 3.a); although we did not class Horace's *Ars Poetica* as a satire, it shares has stylistic features of the genre.

[32] Gruber's comments are representative of a long tradition of Ausonius commentary: "Sprachlich und thematisch ist Vergil stets gegenwärtig. In jahrzehntelanger Lehrtätigkeit, in deren Mitte der Vergilerklärung stand, hat Ausonius diesen Dichter so verinnerlicht, daß ihm nicht nur seine Worte, sondern die gesamte Thematik seiner Werke zur Verfügung stehen. Aber auch Lukrez, Horaz und Ovid gehören zum sprachlichen Fundus. Von den Autoren der frühen Kaiserzeit ist vor allem Statius sprachliches und thematisches Vorbild. Dazu kommen Lukan, Silius Italicus, Valerius Flaccus, und Martial" [Gruber 2013, 27–28]. One of the goals of the present study is to place on an objective footing such statements of the relative importance of a given text as an overall verbal resource for its successors.

[33] Hofmann (*New Pauly* s.v. *Corippus, Flavius Cresconius*) calls Corippus "the last great practitioner of the Roman epic… in his use of language and his narrative skill," and cites Vergil and Claudian as the poet's primary classical influences. Juvencus' *Historia Evangelica* differs from all other texts in the data set due to its Biblical subject matter, and it should accordingly come as no surprise that exhibits both low rates of reuse and low centrality. Schmidt (*New Pauly* s.v. *Iuvencus, C. Vettius Aquilinus*) lists only Vergil as a relevant source for Juvencus. See [Green 2006, 11–14], who observes "roughly speaking, allusions to Vergil outnumber allusions to all other writers combined by at least five to one" (11 n. 63).

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