Cohesive Harmony Analysis for Ancient Greek: SelPap I:112 and PMich VIII:491 as a Test Case

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Abstract: Ruqaiya Hasan's Cohesive Harmony Analysis (CHA) is a useful tool to quantifiably predict the degree of the reader's perception of the coherence of an English text. This work adopts and reconfigures her ideas to make them applicable to ancient Greek texts. This article then applies the modified version of Hasan's CHA to investigate and compare the degrees of the perceived coherence of two family letters written in the second century AD. Based on the textual analyses, the conclusion is drawn that CHA is a promising tool to quantifiably predict the degree of coherence of ancient Greek texts. (Article)

1. *Introduction*

In this work, I explore the application of Ruqaiya Hasan's Cohesive Harmony Analysis (CHA) to ancient Greek texts. Hasan proposed CHA in 1984 as a means of quantifiably predicting the perception of the coherence of texts by human readers. Being primarily geared toward modern languages and texts (e.g., English), CHA has not been actively applied to ancient languages such as Hellenistic Greek.[1] In this work, therefore, I seek to provide an answer to the following question:

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1. There do exist some works. See, for example, Reed, "1 Timothy," 131–47; Land, *Integrity of 2 Corinthians*, 48–81.

Can CHA be used to predict the perceived coherence of ancient Greek texts?

I argue, in the present work, that the notions of cohesive tie, cohesive chain, and cohesive harmony proposed within Systemic Functional Linguistics (SFL)[2] provide a powerful tool, both in modern English and in ancient Greek, to quantifiably explicate how much coherence a reader will perceive in a given text.

In what follows, I discuss the most fundamental tenets of CHA, although the presentation of the theory reflects my own modification of it to make it properly capture the unique features of ancient Greek. I then apply the methodology to two texts. Lastly, I conclude that CHA in its modified version is a promising interpretive tool for investigating and objectively predicting degrees of coherence for ancient Greek texts.

2. *Methodology*

2.1 *Cohesion and Coherence*

Halliday proposes that there are three universal components that make it possible for human language to perform its main functions: the ideational, the interpersonal, and the textual metafunctions.[3] A language's textual metafunction is used to realize the textual shape of the language used in a discourse. Simply put, the textual metafunction is "the resources the language has for creating text"[4] of which cohesion constitutes a part.[5]

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2.   Both M.A.K. Halliday and Ruqaiya Hasan have proposed these notions.

3.   For good discussions of metafunction, see Halliday and Hasan, *Cohesion*, 26–30; Thompson, *Functional Grammar*, 28–29; Halliday and Webster, *Essential Halliday*, 308; Halliday, *Functional Grammar*, 30–31. Due to the scope of the present study, I exclude the discussion of the ideational and the interpersonal metafunctions.

4.   Halliday and Hasan, *Cohesion*, 27.

5.   Halliday and Hasan, *Cohesion*, 27. It should be noted that cohesion alone cannot properly create a text. It is "not a sufficient condition for the creation of text" (Halliday and Hasan, *Cohesion*, 298–99). The entire textual metafunction is responsible for the generation of the text, including cohesion,

What then is cohesion? Halliday and Hasan define cohesion as "the set of semantic resources for linking a sentence with what has gone before."[6] Cohesion, therefore, mainly concerns sentence linking—its role is to "express the continuity that exists between one part of the text and another."[7] As for coherence, I employ Hasan's definition that it refers to the property of "hanging together";[8] that is, if a text is perceived as coherent, "the patterns of language manifests—or realizes—the existence of semantic bonds."[9] Hasan also confirms that, if we examine the patterns (i.e., wordings) of language, we can find the semantic bonds that exist "between parts of his [or her] utterance."[10] So, the reader arrives at the ascertainment of the coherence of a text by observing the lexico-grammatical realizations of the semantic resources of cohesion in the text. Simply put, therefore, the fundamental goal of CHA lies in predicting the perception of the degree of coherence by human readers.

2.2 *Formation of Cohesive Ties*

When cohesion occurs or is used, what we see at the semantic level is the occurrence of ties. For example, in *I saw John. He was chasing a squirrel*, the *He* in the second clause presupposes the preceding *John*. This semantic linking between *John* and *He* is a tie.[11]

There are two types of ties: componential tie and organic tie.[12] Componential ties concern composing message(s) whereas

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"information structure, thematic patterns and the like" (Halliday and Hasan, *Cohesion*, 299).

    6.   Halliday and Hasan, *Cohesion*, 10.

    7.   Halliday and Hasan, *Cohesion*, 299. The authors (Halliday and Hasan, *Cohesion*, 19–20) distinguish cohesion as a system and cohesion as a process.

    8.   Hasan, "Cohesive Harmony," 181.

    9.   Hasan, "Cohesive Harmony," 183.

    10.   Hasan, "Cohesive Harmony," 185.

    11.   Halliday and Hasan (*Cohesion*, 3) speak of a tie as "one occurrence of a pair of cohesively related items."

    12.   For a good treatment of these concepts, see Reed, *Philippians*, 89–101. See also Halliday and Hasan, "Text and Context," 49.

organic ties pertain to logically organizing the composed messages.[13] Since the terms of a componential tie constitute message(s),[14] the terms are normally one of the three types of semantic relations: co-reference, co-extension, and co-classification.[15]

Co-referential relations take place when two lexical items refer to the same entity. The most significant cohesive device by which co-referential relations are expressed is reference. Reference is "the relation between an element of the text and something else by reference to which it is interpreted in the given instance."[16] I propose the following as seven major reference devices in Greek: naming, equivalence, semblance, metaphoric expression, verbal morphology, pronouns, and the article. Naming is referring to a thing or person by a specific label or name (e.g., Ἀπίων "Apion"). Equivalence (i.e., *A is B*) in Greek is often expressed via εἰμί 'to be.' Semblance is like simile where the relationship between two lexical items is expressed via the use of, for example, ὡς 'as, like.' An example of metaphoric linking of two lexical items can be seen in Matt 5:13 Ὑμεῖς ἐστε τὸ ἅλας τῆς γῆς 'You are the salt of the earth.' The metaphoric linking of 'you' and 'the salt' is meaningful only in this context (instance), i.e., there is no guarantee that 'you' and 'the salt' are semantically related in the system of Greek. For this reason, Hasan treats it as instantial lexical cohesion. However, in the present work, all of Hasan's instantial lexical cohesive devices (i.e., naming, equivalence, semblance, metaphoric expressions) are handled under co-reference because they assume the identity of referents. Greek allows more than one morpheme to occur per

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13. Reed, *Philippians*, 89. Organic ties are normally related to conjunction. Due to the limited scope of the present paper, I do not discuss organic ties. For a systemic treatment of Greek conjunctions, see Porter and O'Donnell, "Conjunctions," 3–14.

14. Halliday and Hasan, *Language, Context, and Text*, 81. See also Halliday and Hasan, "Text and Context," 49.

15. Halliday and Hasan, "Text and Context," 44–48. See also Reed, "1 Timothy," 135; Reed, *Philippians*, 93–101. Note that I do not discuss co-classification in the present work.

16. Halliday and Hasan, *Cohesion*, 309.

word, and, in Greek, one morpheme has more than one meaning attached to it.[17] For example, the suffix -ω in the verb λέγω indicates the tense, voice, mood, and person and number of the grammatical subject (i.e., 'I say'). This "morphological intensity"[18] of Greek necessitates that we make a small modification to Hasan's methodology for it to be adapted to Greek. Another reference device involves pronouns. I define a pronoun as a lexical item that is used as a reference device to create a co-referential tie with another exophoric or endophoric term. Lastly, the Greek article, too, is a significant device for expressing co-referential relations. The use of the Greek article, however, should not simplistically be equated with that of the English article for, as Porter rightly suggests, a Greek author can choose to use an article not because of the need to mark definiteness but for some other reasons. Porter claims in Greek an article means that "the substantive may refer to a particular item, or it may represent a category of items."[19]

When co-extension occurs, both fully-grammaticalized lexical items (A and B) refer to "different things," but the referents normally belong to "the same semantic field."[20] In the following example, *Amy drives a Ford, but I don't even have a car*, the tie between *a Ford* and *a car* is co-extensional because it is apparent that both terms do not refer to the identical thing but to different entities that belong to the same semantic field, i.e., motorized vehicle. However, co-extensional ties may occur in a referential environment. For example, in *Amy drove a Ford. But she wanted to sell the car*, we know *a Ford* and *the car* share the same referent, i.e., Amy's Ford. This tie may ostensibly seem to be a co-extensional tie because it has two fully-grammaticalized lexemes (i.e., *Ford* and *car*). The presence of the reference item (*the*), however, makes it a co-referential tie. In this work,

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17. Greek is normally classified as a synthetic and fusional language (see Payne, *Exploring Language Structure*, 190–91).

18. Porter, "Further Modeling," 10.

19. Porter, *Idioms*, 103–4. For a thorough treatment of the Greek article, see Porter, *Idioms*, 103–14.

20. Halliday and Hasan, "Text and Context," 48.

therefore, I view this kind of tie as co-referential mainly because of the accompaniment of a reference device, the article. The representative device to express co-extensional relations is lexical cohesion.[21] I define lexical cohesion as a cohesive device utilizing vocabulary and their sense relations in the linguistic system. Lexical cohesion subsumes the following sense relations: synonymy, antonymy, hyponymy, and meronymy. Synonyms are defined as phonologically different words that have "the same or very similar meanings," e.g., *car* and *vehicle*.[22] As for antonymy, Saeed points out that there are different types of opposition under antonymy: simple antonyms (e.g., *dead/alive*), gradable antonyms (e.g., *hot* [*warm tepid cool*] *cold*), reverses (e.g., *come/go*), converses (e.g., *employer/employee*), and taxonomic sisters (e.g., *red orange blue . . . brown*).[23] Hyponymy refers to "a relation that holds between a general class and its sub-classes."[24] The general class is the superordinate and the sub-class the hyponym(s). For example, the superordinate *animal* has *cat*, *dog*, *donkey*, etc. as its hyponyms. So, we can say that *donkey* is "semantically related" to *animal* as a hyponym.[25] Meronymy is "a part-whole relation."[26] For example, *head*, *torso*, *limbs* are meronyms of *body*.

Since I have discussed so far how cohesive ties are formed, I now turn, in the following section, to demonstrate how these cohesive ties form chains.

21.   For Halliday and Hasan's treatment of lexical cohesion, see Halliday and Hasan, *Cohesion*, 274–92.

22.   Saeed, *Semantics*, 65. A blunt definition of synonymy, however, will negatively affect the analysis because an unguided use of the notion of synonymy can be so over-extended that it may hinder objective assessment of synonymy of lexemes. To obviate this problem, I suggest that the analysis be based within a pre-established framework (e.g., the Louw-Nida lexicon), instead of depending on the analyst's subjective intuition.

23.   Saeed, *Semantics*, 66–69.

24.   Halliday and Hasan, *Language, Context, and Text*, 80.

25.   Halliday and Hasan, *Language, Context, and Text*, 80.

26.   Halliday and Hasan, *Language, Context, and Text*, 81.

2.3 *Formation of Cohesive Chains*

A cohesive chain refers to a cumulative occurrence of cohesive ties. In the following example, we can extract a cohesive chain that refers to *Mr. Mitchell Y. McDeere*, consisting of five co-referential ties: *himself* (8)~*he* (5) [tie 1], *he* (5)~*He* (4) [tie 2], *He* (4)~*His* (3) [tie 3], *His* (3)~*He* (2) [tie 4], and *He* (2)~*M. Mitchell Y. McDeere* (1) [tie 5].

> 1: At 10 A.M. on a Friday, limo stopped on Front Street and Mr. Mitchell Y. McDeere emerged. 2: He politely thanked the driver, and watched the vehicle as it drove away. 3: His first limo ride. 4: He stood on the sidewalk next to a streetlight and admired the quaint, picturesque, yet somehow imposing home of the quiet Bendini firm. 5: It was a far cry from the gargantuan steel-and-glass erections inhabited by New York's finest or the enormous cylinder he had visited in Chicago. 6: But he instantly knew he would like it. 7: It was less pretentious. 8: It was more like himself.[27]

There are two types of cohesive chain: identity chains (IC) and similarity chains (SC).[28] The identity chain members' semantic relation is that of "co-referentiality," and the members of a similarity chain are bound together either by co-classification or by co-extension.[29]

2.4 *Analysis of Cohesive Harmony*

Since a mere counting of IC's and SC's within a text does not shed much light on our understanding of its coherence, the notion of chain interaction has been proposed. Hasan writes, "Cohesive harmony consists not only in the formation of ICs and SCs but also in the creation of that additional source of unity which is provided by chain interaction."[30] We know there is chain interaction "when two or more members of a chain stand in an identical functional relation to two or more members of another chain."[31]

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27. Grisham, *The Firm*, 18.
28. Hasan, "Cohesive Harmony," 205. See also Halliday and Hasan, *Language, Context, and Text*, 70–96.
29. Hasan, "Cohesive Harmony," 205–6.
30. Hasan, "Cohesive Harmony," 216.
31. Hasan, "Cohesive Harmony," 212.

In order to discuss chain interaction, however, we first need to define the notion of token. A token refers to a lexical item (typically a word). There are, therefore, three tokens in the following clause: *Samuel*, *returned*, and *home*, and generally speaking, the total number of tokens refers to the total number of words. Unfortunately, when it comes to the cohesive harmony analysis of Greek texts, this rather simplistic notion of token needs to be refined due to the nature of Greek's verbal morphology. For example, in Ἀπίων . . . πρὸ μὲν πάντων εὔχομαί 'Apion . . . Most of all, I pray,' since Greek marks the grammatical subject on the verb, both Ἀπίων "Apion" and the verb εὔχομαι 'I pray' are tokens in the Apion chain.

Apion chain	Pray chain
Ἀπίων	
εὔχομαι	εὔχομαι
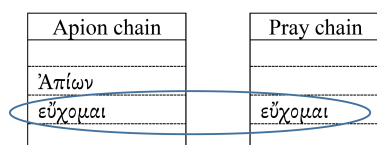
In my proposed framework, therefore, the lexeme εὔχομαι belongs simultaneously to Apion chain and to the Pray chain, and this is why the notion of a token as a single linguistic item does not guarantee a successful analysis in Greek. In order to capture that not the whole of the lexeme (εὔχομαι) is part of the Apion chain,[32] I propose the concept of token index (TI). Thus, in the case of εὔχομαι above, the token index of Ἀπίων is 1 while the TI of εὔχομαι in Apion chain is 0.5.

Some may object to the notion of TI for being ad hoc and arbitrary. As legitimate as the criticism is, however, one must somehow take into consideration the following points: first, Hasan's CHA—valuable as it is—is not ready to be applied to

Apion chain	Pray chain
Ἀπίων (TI=1)	
εὔχομαι (TI=0.5)	εὔχομαι (TI=0.5)
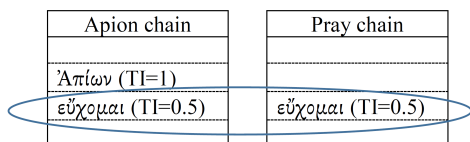
32. That is, only the grammatical subject (first person singular) marked on the verb (εὔχομαι) belongs to the Apion chain, not the whole verb.

Greek due to its peculiar verbal morphology; second, it may be necessary, therefore, to propose an alternative means which captures this peculiarity of Greek verbs and, at the same time, strives to avoid a large discrepancy between token number and actual lexical item number, because it makes it easier to compare the results if the two are calculated within the same number of total tokens.

As regards the arbitrariness of the suggested token index values, it is perhaps helpful to mention that, due to the complex nature of Greek verbal structure, the referential subject marked on a verb should be treated independently as a token value. This could be done as either εὔχομαι = 0.5 (verb) + 0.5 (subject) = 1.0, or εὔχομαι = 1.0 (verb) + 1.0 (subject) = 2.0. I am not arguing the former should always be preferred, but my contention is that the former will work better because it does not entail the discrepancy that I mentioned above. In my analysis, therefore, the latter notion of TI will be used, so that the TI of εὔχομαι in the Pray chain above is 0.5. In Hasan's framework, Ἀπίων εὔχομαι is counted as 2 tokens, which, I believe, is a reasonable way of counting according to her definition of token. In my framework, too, Ἀπίων εὔχομαι is viewed as 2 tokens (i.e., TI = 2). However, my framework identifies the TI as 2, not because it calculates Ἀπίων (Apion chain, TI = 1) + εὔχομαι (Pray chain, TI = 1), but because it calculates Ἀπίων (Apion chain, TI = 1) + εὔχομαι (Apion chain, TI = 0.5) + εὔχομαι (Pray chain, TI = 0.5).

Tokens are classified into significant sets. Total Tokens (TT) refers to the total number of words in a given text. Relevant Tokens (RT) are "the tokens subsumed in chains."[33] Central Tokens (CT) are a subgroup of RT, namely, "the subset of the RTs which actively participate in [chain] interaction."[34] Peripheral Tokens (PT) are "those tokens in a text which are not

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33. Hasan, "Cohesive Harmony," 211. RT refers to "all linguistic items in the text which are part of one or more chains" (see Reed, "Cohesiveness of Discourse," 44).

34. Hasan, "Cohesive Harmony," 214. "The CTs of a text are directly relevant to the coherent development of the topic in the text" (see Hasan, "Cohesive Harmony," 216).

subsumed in chains."[35] Although Hasan employs only these four types of token (TT, RT, CT, PT) in her cohesive harmony analysis, I suggest that the notion of Facilitating Tokens (FT) be included especially when examining lengthy texts. FT are lexical items that only occur once in the given text. For this reason, FTs do not form any chains. However, they function to connect two chains.[36]

Hasan proposes cohesive harmony as an indicator of how much coherence a reader will likely perceive in a text. She writes, "The degree of chain interaction is in direct correlation with the degree of coherence in a text, so that it can be claimed that the greater the cohesive harmony in a text, the greater the text's coherence." In Hasan's framework, this degree of cohesive harmony is expressed by "what percentage of total tokens acts as central token in the text."[37]

In Hasan's original proposal, therefore, the cohesive harmony rate is calculated by dividing the CT by the TT and multiplying by 100 (see Figure 1). Hasan demonstrates that the CT/TT rate is correlated to coherence. Her suggestion is that any text whose CT/TT ratio is at least 50 percent will be seen as coherent.[38]

$$\frac{CT}{TT} * 100$$

Figure 1. Cohesive Harmony Index Hasan (CHI Hasan)

Although Hasan's formula seems reasonable in general, it is too simplistic because the detailed dynamics of chain interaction in a given text are ignored. For example, if a text with 100 tokens has 70 instances of central tokens, Hasan's formula

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35.   Hasan, "Cohesive Harmony," 211.

36.   For example, in ἐν δεξιᾷ αὐτοῦ "at his right hand" (Eph 1:20), the lexeme δεξιᾷ, which is only attested once in Ephesians, occurs between the token ἐν and αὐτοῦ. The lexeme δεξιᾷ thus connects the two chains (EN chain and God chain), but the lexeme itself (δεξιᾷ) does not have any standing as a chain. This kind of token is classified as FT in my proposal (see Lee, "Cohesive Harmony Analysis," 81).

37.   Hasan, "Cohesive Harmony," 216.

38.   Hasan, "Cohesive Harmony," 218.

calculates the coherence of the text as 70 percent and determines it to be coherent. But her formula, which I will call "CHI Hasan," cannot explain the relative difference in the significance of each chain that contributes to the coherence of the text.[39]

Furthermore, Hasan's formula does not involve non-interacting RTs—i.e., tokens that form a chain but that do not interact with other tokens in other chains. This is understandable because her target texts are short.[40] But in longer texts, ignoring non-interacting RTs will most likely drop the degree well below 50 percent. Therefore, it seems reasonable to suppose that we find a way to include non-interacting RTs and FTs as a meaningful factor.

According to Hasan, CTs are core elements that contribute to the reader's perception of the coherence of a text. Here I tentatively suggest that Hasan's formula may be used to indicate how many CTs are in each individual chain in the text in relation to the total number of tokens (TT); that is, I will use her formula (CHI Hasan) to quantifiably measure and estimate each chain's significance.[41] The resulting measure of CSI (Chain Significance Index) enables us to objectively determine which chains constitute "major" chains in the text. These major chains may shed light on our understanding of the prominent message of the text.

Ultimately, we need a more comprehensive formula that considers more factors than just CTs. So, I propose both the RTs and the FTs be included in the formula as follows:

$$\frac{CT + RT + FT}{2TT} * 100$$

Figure 2. CHI Modified

39. To be fair, it should be noted that this was not Hasan's intent. However, I am pushing her proposal further to be able to capture relative differences in significance among chains.

40. Hasan ("Cohesive Harmony," 189–90) analyzes three texts; each has only ten short clauses.

41. By "significance," I mean the number of CTs to TTs in the entire text. I will label it as CSI (Chain Significance Index) and use it in the analysis.

My CHI Modified formula intends to be comprehensive by including the RTs and FTs. What is being done via this formula is as follows. First, as Hasan originally proposed, the cohesive harmony rate concerning the CTs (α) is measured: CT/TT *100 = α. Next, I calculate the cohesive harmony rate concerning the RTs and FTs (β): (RT+FT)/TT *100 = β. Finally, the average of their cohesive harmony rate is calculated:

$$\frac{\alpha + \beta}{2} * 100 \quad = \quad \frac{CT + RT + FT}{2TT} * 100$$

Figure 3. CHI Modified Formula

One final thing to note is that CTs are calculated twice because RTs include CTs. This is because the CHI Modified formula intends to reflect the relative importance of CTs in cohesive harmony rate calculation.

I have so far briefly outlined the core tenets of the theory of cohesion and cohesive harmony analysis as suggested by Hasan. In doing so, I have suggested that, due to the unique character of Greek verbal morphology, the notion of a token index has been introduced. I have also suggested that there is need to include RTs and FTs in the measurement of the cohesive harmony rate. Finally, I suggested my own version of the cohesive harmony rate formula (CHI Modified).

3. *Text Analysis*

In this section, I conduct a modified cohesive harmony analysis of two ancient Greek letters from the second century AD. One is a family letter written by a young man named Apion (SelPap I 112).[42] Apion was a new Greco-Egyptian recruit to the Roman army. His letter was written to his father as soon as his regiment arrived in Italy. The other is also a family letter written by a young recruit Apolinarios to his mother (PMich VIII 491).[43] I have chosen these two primarily because they share the same

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42. This text is published in White, *Ancient Letters*, 159–60.
43. White, *Ancient Letters*, 164.

genre and era, i.e., family letters written in the second century AD. Their contexts of situation are very similar as well; both writers are Greco-Egyptian recruits who had to leave their families to serve in the Roman Legion. Both letters are written to their parents, Apion to his father and Apolinarios to his mother. The lengths of both letters are similar. In the sections below, I will apply the cohesive harmony analysis method I have proposed above first to measure the CHI (cohesive harmony index) of each text, second to account for chain interactions in each letter, and lastly to compare the perceived coherence of both letters.

3.1 *SelPap I 112 (II AD)*

Apion writes to his father, Epimachos, to inform him of his safe arrival in Italy after the dangerous challenge of the stormy sea. He speaks of the travel allowance that he has received from Caesar on his arrival in Misenum before he says that things are going very well for him. He then asks his father to write him a letter concerning the well-being of family members. Apion expresses his confidence in advancement because of the good training that he has received from his father. The rest of the letter is filled with farewell greetings to several people. It then concludes with his Roman soldier-name and the century that he belongs to. The Greek text is as follows.

> 1 Ἀπίων Ἐπιμάχῳ τῶι πατρὶ καὶ κυρίῳ πλεῖστα χαίρειν 2 πρὸ μὲν πάντων εὔχομαί σε ὑγιαίνειν 3 καὶ διὰ παντὸς ἐρωμένον εὐτυχεῖν μετὰ τῆς ἀδελφῆς μου καὶ τῆς θυγατρὸς αὐτῆς καὶ τοῦ ἀδελφοῦ μου 4 εὐχαριστῶ τῷ κυρίῳ Σεράπιδι 5 ὅτι μου κινδυνεύσαντος εἰς θάλασσαν ἔσωσε εὐθέως 6 ὅτε εἰσῆλθον εἰς Μησήνους, ἔλαβα βιάτικον παρὰ Καίσαρος χρυσοῦς τρεῖς 7 καὶ καλῶς μοί ἐστιν 8 ἐρωτῶ σε οὖν, κύριέ μου πάτηρ, 9 γράψον μοι ἐπιστόλιον πρῶτον μὲν περὶ τῆς σωτηρίας σου, δεύτερον περὶ τῆς τῶν ἀδελφῶν μου, 10 τρ[ί]τον, ἵνα σου προσκυνήσω τὴν χεραν, ὅτι με ἐπαίδευσας καλῶς, 11 καὶ ἐκ τούτου ἐλπίζω ταχὺ προκόσαι τῶν θε[ῶ]ν θελόντων 12 ἄσπασαι Καπίτων[α] πολλὰ καὶ τοὺς ἀδελφούς [μ]ου καὶ Σε[ρηνί]λλαν καὶ το[ὺς] φίλους μο[υ] 13 ἔπεμψά σο[ι εἰ]κόνιν μ[ου] διὰ Εὐκτήμονος 14 ἔσ[τ]ι[ν] μου ὄνομα Ἀντῶνις Μάξιμος 15 ἐρρῶσθαί σε εὔχομαι 16 κεντυρί(α) Ἀθηνονίκη

> 1 Apion to my father and lord, very many greetings. 2 Most of all, I pray that you are healthy, 3 and continually prosperous with my sister and her daughter and my brother. 4 I thank Lord Serapis 5 because, when I was in

danger at sea, he rescued me immediately. 6 When I entered in Misenum, I received travel money from Caesar; it was three gold pieces. 7 And things are going well for me. 8 So, I ask you, my lord and father, 9 to write me a letter, firstly, concerning your well-being, secondly, concerning that of my brothers, 10 thirdly, so that I [give obeisance] to your writing because you trained me well. 11 And I hope, by this means, to advance quickly, the gods willing. 12 Greet Kapiton very much and my brothers and Serenilla and my friends. 13 I sent you a picture of me through Euktemonos. 14 My name is Antonius Maximus. 15 I pray you are well. 16 Century Athenonike.

The token index (TI) of the total tokens (TT) of the letter is 114. The TI of all the relevant tokens (RT) is 80. As has been discussed above, CTs are the subset of the RTs. The TI of the CTs of the text is 16.5 while that of the other RTs (i.e., non-CT) is 63.5. There is only one Facilitating Token. Lastly, the TI of the peripheral tokens (PT) is 33.5. The table below summarizes the tokens observed in the letter.

| | TT | RT | | FT | PT |
		CT	Non-CT		
T1	114	16.5	63.5	0.5	33.5

Table 1. Tokens in SelPap I 112

If the CHI of this text is measured by Hasan's formula, it is 14.5 percent (16.5/114 * 100). This CHI (14.5 percent) is surprisingly low considering that the lowest of Hasan's sample texts is 30.43 percent.[44] The limitation of Hasan's formula seems to be that it does not do justice to SelPap I 112 by deeming it as unduly low in its CHI; according to Hasan's formula, the reader should find this text very incoherent. However, using my formula (CHI Modified), the cohesive harmony index is as follows:

$$\frac{16.5 + 80 + 0.5}{2 * 114} * 100 = 42.5 \text{ percent}$$

Figure 4. Application of the CHI Modified formula

44.   Hasan, "Cohesive Harmony," 217.

As the calculation above evinces, the CHI of SelPap I 112 is 42.5 percent. The CHI of SelPap I 112 is not yet fully meaningful for there are no other values for it to be compared with. The CHI of SelPap I 112 (42.5 percent), however, may be able to say more about the degree of the perceived coherence of the text by readers once it will have been compared to that of the other text (PMich VIII 491) in the next section.

As for cohesive chains, I have found a total of 23 chains in the text. There are five ICs (Brother, Epimachos, Serapis, Sister, Apion) and 18 SCs (Wish, All, Coordinate KAI, Conjunctive KAI, DIA, EIMI, EIS, Gods, Good, Greet, Healthy, Immediately, MEN, Much, Name, Orderly Number, OTI, PERI). Based on the notion of CSI (chain significance index), I have identified the following major chains of the letter.

Chains	CSI
Apion chain	3.9 percent
Brother chain	2.6 percent
Epimachos chain	1.8 percent
Healthy chain	1.8 percent
Much chain	1.8 percent
Greet chain	1.3 percent
Wish chain	1.3 percent

Table 2. Major Chains of SelPap I 112

It can also be argued that, if the CSI of each segment is calculated, the linear flow of CSI of a text may shed light on where salient parts are observed in the text because we can assume that high density of chain interaction in a certain place (or portion) of the text may indicate the author's intent—either conscious or unconscious—to orient the reader's attention. The following chart shows, in that sense, the flow of the CSI throughout SelPap I 112. According to this chart, roughly speaking, 12 and 15 seem to deserve our attention for they are the segments that have the highest concentration of chain

interactions.[45] In 12, chain interaction is first observed between Greet and Much chains (ἄσπασαι Καπίτων[α] πολλὰ 'Greet Kapiton very much'). Another chain interaction occurs between the Apion chain and the Brother chain (τοὺς ἀδελφούς [μ]ου 'my brothers'). 15 ἐρρῶσθαί σε εὔχομαι 'I pray you are well' is a prototypical way of ending Greco-Roman letters of that era, where two interactions are observable: first, the Apion and Wish chains interact with each other ('I [Apion] pray'); second, the Epimachos and Healthy chains are seen in interaction ('you are (be) well'). The chart below outlines the flow of CSI in SelPap I 112.
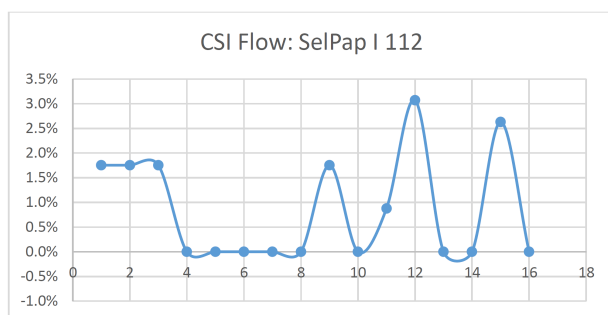

Figure 5. CSI Flow in SelPap I 112

Below is the overview of the chain interaction among the seven major chains in the text. Each rectangular box indicates a chain. The name of the chain is written in each box. The relative difference in the vertical length of the box depicts each chain's significance (i.e., CSI); the longer the vertical length of the rectangle, the more significant the chain is (e.g., Apion CSI = 3.9 percent; Wish CSI = 1.3 percent). The arrow indicates that there is chain interaction (e.g., see *a* in Figure 6 below). If the interaction takes place at clause level, the arrow is a solid-line. But if the interaction is found at word-group level, the arrow is a dashed line (e.g., see *d* in Figure 6 below).[46]

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45. Note that, for convenience's sake, I have divided the sentences into manageable units and have given them verse numbers. For a precise analysis, however, it is advised that the division be made according to clause boundaries.
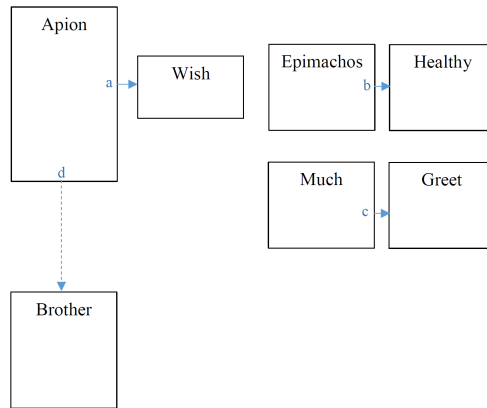46. This idea of distinguishing clause-level and word-group level

Figure 6. Chain Interaction in SelPap I 112

It looks clear that the Apion chain is the most significant chain in the text. This chain is an identity chain that refers to the author of the letter. It actively interacts with the Wish chain (see *a* in Figure 6). The primary reason that Apion writes this letter is to wish his father well-being and this is well captured by this interaction. Also, this interaction not only opens the letter (2) but also (15) closes it. This interaction is diagrammed as below.

Apion chain		Wish chain
εὔχομαι (#2)	~	εὔχομαι (#2)
ἐλπίζω (#11)	~	ἐλπίζω (#11)
εὔχομαι (#15)	~	εὔχομαι (#15)

There is also interaction between the Epimachos chain and the Healthy chain (see *b* in Figure 6). What Apion wishes or prays in the letter is the well-being of his father, Epimachos. His wish is reflected in this interaction where Epimachos functions as the Senser of the Phenomenon of being healthy and prosperous.

interactions is credited to Dr. Stanley E. Porter. I agree with him that word-group level interactions may not contribute to cohesion as much as clause-level interactions do for their span is too localized.

Epimachos chain		Healthy chain
σε (#2)	~	ὑγιαίνειν (#2)
σε (#11)	~	ἐρρῶσθαι (#11)

Greeting, too, is an important topic in Apion's letter, which is indicated in the chain interaction between the Much and Greet chains (see *c* in Figure 6). The tokens in the Much chain function as the Circumstance in which the act of greeting takes place; that is, this interaction evinces that Apion is trying to express that his

Greet chain		Much chain
χαίρειν (#1)	~	πλεῖστα (#1)
ἄσπασαι (#12)	~	πολλὰ (#12)

greeting is sincere and wholehearted.

I have so far identified three clause-level interactions (see *a*, *b*, *c* above). There are word-group level chain interactions in the text as well, e.g. τοῦ ἀδελφοῦ μου 'my brother' (3); τῶν ἀδελφῶν μου 'my brothers' (9);[47] τοὺς ἀδελφούς [μ]ου 'my brothers' (12). This word-group level interaction, however, does not carry much

Brother		Apion chain
τοῦ ἀδελφοῦ (#3)	~	μου (#3)
τῶν ἀδελφῶν (#9)	~	μου (#9)
τοὺς ἀδελφούς (#12)	~	[μ]ου (#12)

cohesive force because it is confined within a clause.

Apion tries to write about many things in this short letter (e.g., well-being of his father and his siblings; the stormy sea disaster; arrival in Misenum; travel allowance; his own well-being; his yearning for letters from his father; greetings to his family and friends). My cohesive harmony analysis shows,

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47. This may also mean 'my sisters.'

however, that his letter is not really active in terms of chain interaction; it yields only three clause-level interactions and the CHI of the entire text is below 50 percent. Although my analysis shows that Apion emphasizes the elements of wishing for good health and greeting in his letter, I tentatively conclude that, in general, the clauses in SelPap I 112 do not hang together.[48]

3.2 *PMich VIII 491 (II AD)*

This family letter was written by a young man named Apolinarios. Like Apion above, Apolinarios, too, was a Greco-Egyptian recruit to the Roman military. He wrote two letters to his mother, Taesis, and the letter that I discuss in the present work is the second of the two.[49] In his second letter to his mother, Apolinarios, after the conventional greetings, informs her of his safe arrival in Rome and assignment in Misenum. He does not know yet to which century he will be assigned, but he promises he will notify her as soon as he does. Not forgetting to comfort his mother by saying he is doing well, he asks her to write him about the well-being of herself and his siblings. He concludes his letter by greeting several people. The Greek text is as follows.

1 Ἀπολινάριος Ταήσει τῇ μητρὶ καὶ κυρίᾳ πολλὰ χαίρειν 2 πρὸ μὲν πάντων εὔχομαί σε ὑγιαίνειν 3 κἀγὼ αὐτὸς ὑγιαίνω καὶ τὸ προσκύνημά σου ποιῶ παρὰ τοῖς ἐνθάδε θεοῖς 4 γεινώσκειν σε θέλω, μήτηρ, ὅτι ἐρρωμένος εἰς Ῥώμην Παχὼν μηνὶ κὲ ἐκληρώθην εἰς Μισηνοὺς 5 οὔπω δὲ τὴν κετυρίαν μου ἔγνων οὐ γὰρ ἀπεληλύτειν[50] εἰς Μισηνοὺς ὅτε σοι τὴν ἐπιστολὴν ταύτην ἔγραφον 6 ἐρωτῶ σε οὖν, μήτηρ, σεαυτῇ πρόσεχε, 7 μηδὲν δίσταζε περὶ ἐμοῦ 8 ἐγὼ γὰρ εἰς καλὸν τόπον ἦλθον 9 καλῶς δὲ ποιήσεις γράψασά μοι ἐπιστολὴν περὶ τῆς σωτηρίας σου καὶ τῶν ἀδελφῶν μου καὶ τῶν σῶν πάντων 10 καὶ ἐγὼ εἴ τινα ἐὰν εὕρω γράφω σοι οὐ μὴ ὀκνήσω σοι γράφειν 11 ἀσπάζομαι τοὺς ἀδελφούς μου πολλὰ καὶ Ἀπολινᾶριν καὶ τὰ τέκνα αὐτοῦ καὶ Καραλᾶν καὶ τὰ τέκνα αὐτοῦ 12 ἀσπάζομαι Πτολεμαῖν καὶ

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48. Note that this is only a tentative conclusion at this moment. It will be clearer when compared to the analytical results of the other text in the next section.

49. This text is published in White, *Ancient Letters*, 164. White (*Ancient Letters*, 161) notes that the marked difference in handwriting in these two letters indicates that Apolinarios "probably used professional scribes in both cases."

50. Read ἀπεληλύθειν.

Πτολεμαείδα καὶ τὰ τέκνα αὐτῆς καὶ Ἡρακλοῦν καὶ τὰ τέκνα αὐτῆς 13 ἀσπάζομαι τοὺς φιλοῦντάς σε πάντας κατ᾽ ὄνομα 14 ἐρρῶσθαί σε εὔχομαι

1 Apolinarios to Taesis, my mother and lady, many greetings. 2 Most of all, I pray that you are healthy, 3 and I am in good health myself, and I intercede for you to the gods here. 4 Mother, I want you to know that I have safely arrived in Rome on the twenty-fifth of the month of Pachon and that I have been assigned to Misenum. 5 But I do not know yet my century because I had not gone to Misenum when I was writing this letter to you. 6 So, mother, I ask you that you take care of yourself. 7 Worry about nothing about me 8 because I have come to a good place. 9 But it will be great if you will write me a letter about your well-being and my brothers and all of your people. 10 And if I know something, I will write you. I will not delay writing to you. 11 I greet my brothers much, and Apolinarios and his children, and Karalas and his children. 12 I greet Ptolemy, and Ptolemais and her children, and Heraclous and her children. 13 I greet all your friends, each by name. 14 I pray you are well.

The number of total tokens (TT) for the letter is 131. The TI of all the relevant tokens (RT) is 106.5. The TI of the CTs is 32 while that of the other RTs (i.e., non-CT) is 74.5. There is only one FT. Lastly, the TI of the peripheral tokens (PT) is 23.5. It is readily recognizable that PMich VIII 491 has fewer PTs than SelPap I 112; in PMich VIII 491, the PTs account for 17.9 percent of the TT while in SelPap I 112, the PTs account for 29.4 percent of the total tokens. The table below summarizes the statistic of the tokens in the letter.

	TT	RT		FT	PT
		CT	Non-CT		
T1	131	32	74.5	1	23.5

Table 3. Tokens in PMich VIII 491

While Hasan's formula yields a CHI value of 24.4 percent, the CHI Modified formula calculates the cohesive harmony index (CHI) of this second letter PMich VIII 491 to be 53.2 percent. This is perhaps a good place to compare the two texts in terms of CHI. The following table shows the two different sets of the CHI of each text: CHI based on "CHI Modified" and CHI based on "CHI Hasan."

	TT	CT	CHI Modified formula	CHI Hasan formula
SelPap I 112	114	16.5	42.5 percent	14.5 percent
PMich VIII 491	131	32	53.2 percent	24.4 percent

Table 4. CHI Comparison

The data in the table above show that the CHI of PMich VIII 491, both by the modified formula and by Hasan's formula, is slightly higher than that of SelPap I 112. This does not directly indicate that PMich VIII 491 is more coherent than SelPap I 112; rather, we could say, with caution, that the data likely correlates with the degree of coherence perceived by readers. However, if both formulas (i.e., CHI Modified and CHI Hasan) equally show the higher CHI of PMich VIII 491, what would then be an advantage of the CHI Modified formula? Most of all, because the CHI Hasan formula disregards RTs and FTs, the resulting CHI is too low to do justice to the actual coherence of the text (14.5 percent and 24.4 percent).[51]

There are 28 chains in PMich VIII 491. I have identified 19 SCs (All, Conjunctive KAI, Coordinate KAI, DE, EIS, GAR, Go, Good, Greet, Healthy, If, Know, Letter, Make, Much, Negation, PERI, Wish, Write) and 9 ICs (Apolinarios, Taesis, Brother, Children, Misenum, Apolinarios,[52] Karalas, Ptolemais, Heraclous). Among these 28 chains, in terms of CSI (chain significance index), I have identified the following major chains of the letter.

Chains	CSI
Apolonarios	5.3 percent
Taesis	3.8 percent
Greet	1.9 percent
Brother	1.5 percent
EIS	1.5 percent
Go	1.5 percent

51. It is well below the 50 percent baseline that Hasan herself has established.
52. This Apolinarios is the author's namesake.

Healthy	1.5 percent
Letter	1.5 percent
Misenum	1.5 percent
Much	1.5 percent
Write	1.5 percent
Wish	1.1 percent
Know	0.8 percent

Table 5. Major Chains of PMich VIII 491

The CSI flow chart below indicates that segments 5 and 10 show the highest density of chain interaction. The interactions in these two segments are found among the following chains: Apolonarios~Know (οὔπω . . . ἔγνων 'I do not yet know'; εὕρω 'if I know'); Apolonarios~Go (ἀπεληλύτειν 'I arrived'); Apolonarios~Write~Taesis (σοι τὴν ἐπιστολὴν ταύτην ἔγραφον 'when I was writing this letter to you'; γράφω σοι 'I will write you'; σοι γράφειν '(my) writing you'). This shows that the foremost intent of Apolonarios in this letter is to notify his mother of his military assignment.
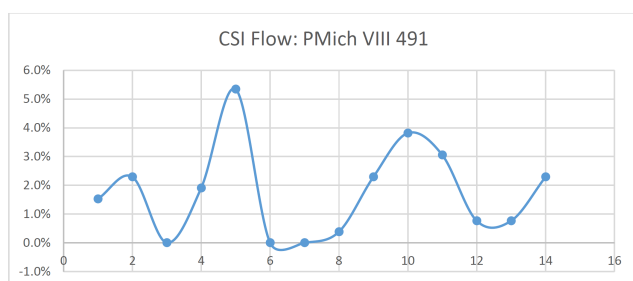

Figure 7. CSI Flow of PMich VIII 491

Below is the overview of the chain interaction among the major chains of PMich VIII 491. Unlike the Apion chain in SelPap I 112, the Apolinarios chain here actively interacts with several other chains, e.g., Greet, Wish, Go, Know, Write, and Brother. The interaction between the Apolinarios and Greet chains is concentrated in the closing of the letter where he greets several people (see *a* in Figure 8).

Apolinarios chain		Greet chain
χαίρειν (#1)	~	χαίρειν (#1)
ἀσπάζομαι (#11)	~	ἀσπάζομαι (#11)
ἀσπάζομαι (#12)	~	ἀσπάζομαι (#12)
ἀσπάζομαι (#13)	~	ἀσπάζομαι (#13)

It is also notable that, as in SelPap I 112, the Greet chain here, too, is in interaction with the Much chain (see *f* in Figure 8). Apolinarios also expresses his wishes, which is reflected in the interaction between the Apolinarios and Wish chains. He shares the same wish with Apion in that he wishes his mother well-being (see, especially, 2 and 14) (see *b* in Figure 8).

Apolinarios chain		Wish chain
εὔχομαι (#2)	~	εὔχομαι (#2)
θέλω (#4)	~	θέλω (#4)
εὔχομαι (#14)	~	εὔχομαι (#14)

The Taesis chain is an identity chain that refers to Apolinarios's mother. It interacts with the Healthy chain (see *h* in Figure 8) and the Write chain (see *g* in Figure 8). The interaction pattern of the Taesis and Healthy chains is the same as that of the Epimachos and Healthy chains.

Taesis chain		Healthy chain
σε (#2)	~	ὑγιαίνειν (#2)
σε (#14)	~	ἐρρῶσθαι (#14)

In the interaction between the Taesis and Write chain, however, the tokens in the Taesis chain are functioning as the Beneficiary of the Process of writing; Apolinarios is always the Actor of the Process of letter writing, and Taesis is the recipient (Beneficiary) of the letter (see *e* and *g* in Figure 8).

Apolinarios chain		Write chain
ἔγραφον (#5)	~	ἔγραφον (#5)
γράφω (#10)	~	γράφω (#10)

Also, the Apolinarios chain interacts with the Go chain (see *c* in Figure 8). This interaction is multiple in that it includes more than two chains. The functional structure depicted in this multiple interaction is Actor (i.e., Apolinarios chain) → Process (i.e., Go chain) → Circumstance (i.e., the EIS and Misenum chains). The multiplicity of chain interaction (see [*g*, *h*] and [*c*] above) deserves the reader's attention primarily because of its higher density of interaction. In PMich VIII 491, multiple chain interactions are observed around the Apolinarios, Write, and Taesis chains as well as the Apolinarios, Go, EIS, and Misenum chains, which helps us to understand that Apolinarios sees it as important to notify his mother of his whereabouts.

Apolinarios chain		Go chain
ἀπεληλύτειν (#5)	~	ἀπεληλύτειν (#5)
ἦλθον (#8)	~	ἦλθον (#8)

The Apolinarios chain also interacts with the Know chain (see *d* in Figure 8).

Apolinarios chain		Know chain
ἔγνων (#5)	~	ἔγνων (#5)
εὔρω (#10)	~	εὔρω (#10)

Lastly, I have identified two word-group level interactions involving the Apolinarios and Brother chains (see *i* in Figure 8) as well as the EIS and Misenum chains (see *j* in Figure 8).

PMich VIII 491 is as short as SelPap I 112, but it is richer in terms of chain interaction. Apolinarios not only utilizes (albeit unconsciously) active chain interaction but also succeeds in clearly presenting the two-fold goal of his letter: to wish his mother well-being and to notify her of his current situation (whereabouts). As a result, the CHI of PMich VIII 491 (53.2 percent) is higher than that of SelPap I 112.
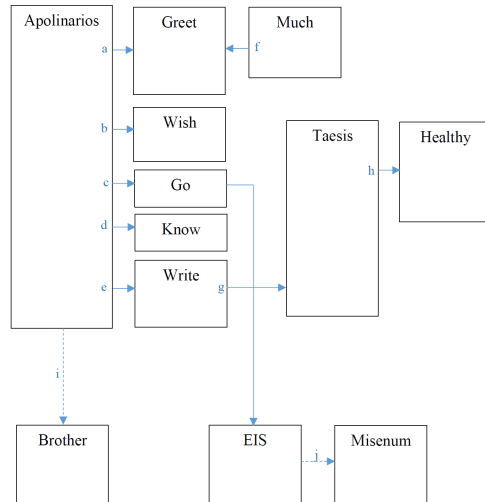
Figure 8. Chain Interaction in PMich VIII 491

4. *Conclusion*

I have argued and shown in this article that Hasan's Cohesive Harmony Analysis, as long as it is modified to heed the uniqueness of the morphologically rich Greek language, is a useful model to predict the coherence of ancient texts. Outlining the core components of the theory of CHA, I have adjusted several aspects of CHA so that it can properly function in the context of Greek studies. My application of a modified version of CHA to two second-century AD letters has clearly shown that CHA works well with both modern languages and ancient languages in quantifiably predicting the coherence of a text. Thus, to return to the original research question: Can CHA be used to successfully measure the degree of perceived coherence of ancient Greek texts? The answer is "yes."

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