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An Application of Software Engineering for Investigating the Language of Phaistos Disk

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Abstract

The Disk of Phaistos is a thirty-seven centuries old artifact, made of clay, which was discovered in 1908 at the Minoan palace of Phaistos (Crete). On its two sides, it bears the oldest known imprinted text of unknown content. The decipherment of this text is over a century-old unsolvable riddle, despite the various attempts for this purpose. Many of these attempts claim that the underlying language is a dialect of early Greek, yet each interpretation is different from any other. The purpose of this article is to describe the results of a decipherment algorithm, based on pattern matching of linguistic motifs, that investigates the possible Greek origin of the text by focusing on the language of Linear-B, which is the closest contemporary Greek dialect of Bronze Age Aegean.

1. Introduction

The Phaistos Disk (henceforth Disk) was discovered by the Italian archaeologist Luigi Pernier at the Minoan palace of Phaistos (Crete), on July 3rd 1908. It has a diameter of approximately 17 cm, thickness about 2 cm and is made of clay [1]. Dating back to the 17th century BC, it has more than 45 different symbols impressed, organized on both sides of the Disk in spirals Figure 1. Interesting information on the possible ways and construction techniques of the Disk are provided by Rumpel [2, 3] and Faucounau and Rumpel [4]. A doubt about the authenticity of the Disk [5, 6] has not been accepted by the scientific community, since artifacts with similar signs have been discovered elsewhere in Crete [7, 8].

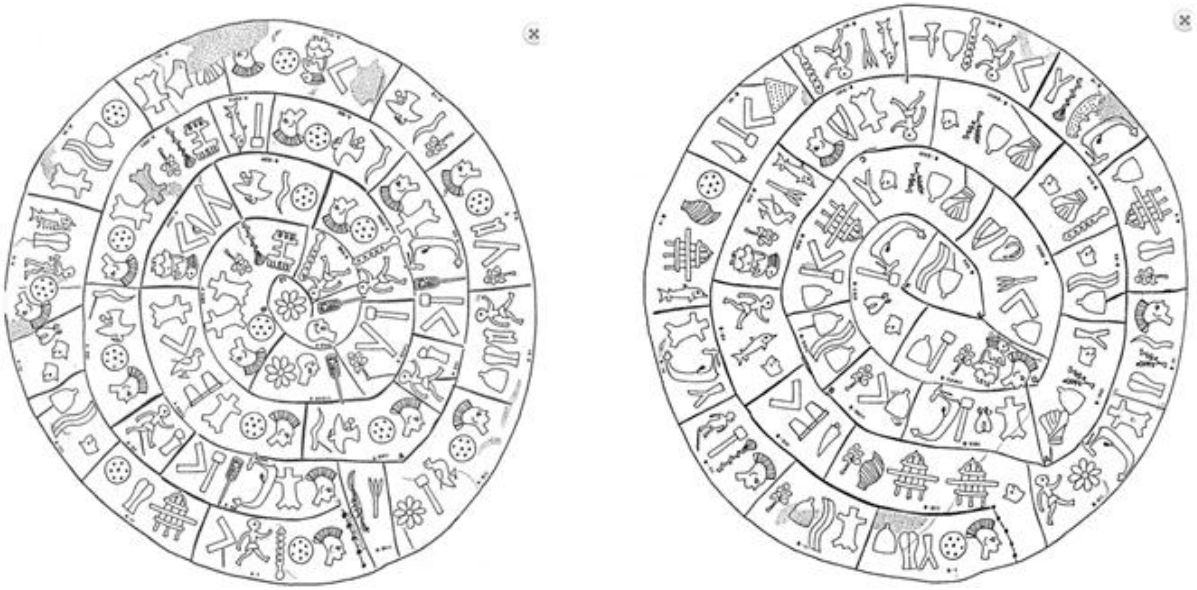


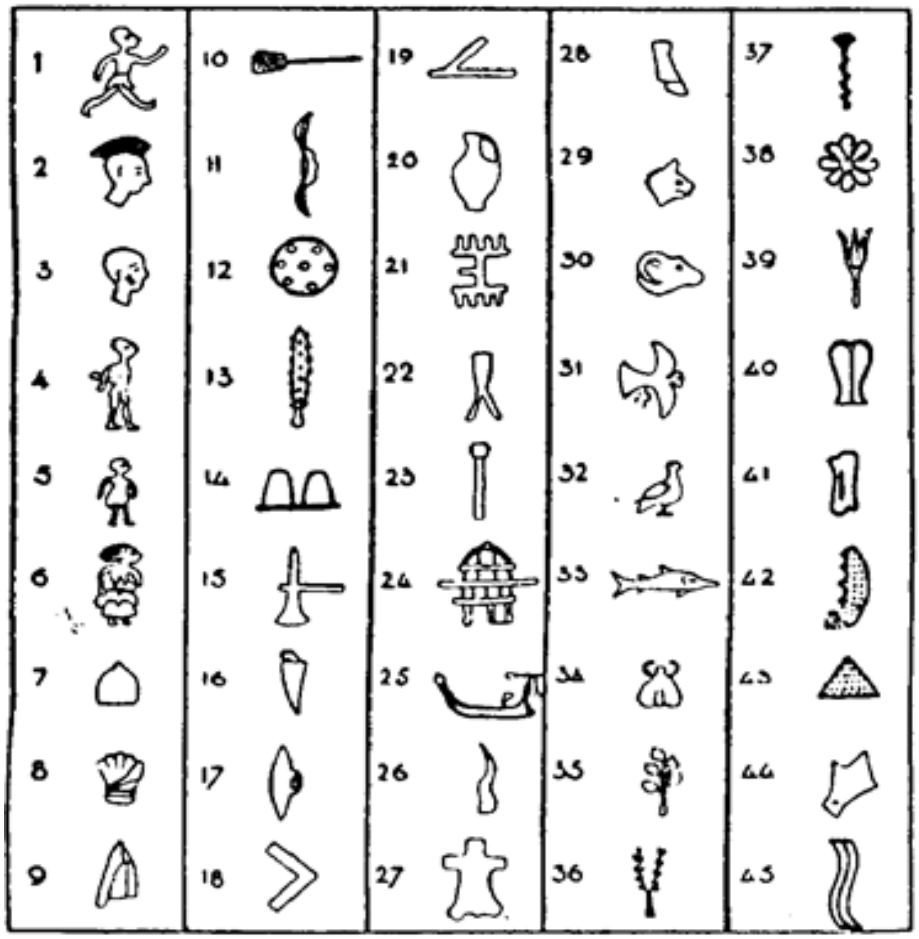
Figure-1. The two sides of Phaistos Disk.
(**Source:** TEI of Crete).

A specific enumeration coding has been established for the 45 discrete symbols of the Disk Table 1. These symbols make up 61 groups/"words", a total of 242 repeated symbols. Each word is conventionally designated by a capital letter indicating the side of the Disk (A/B) and a number indicating the order of a list from the periphery to the center (in total: A01-A31 and B01-B30). If a word is repeated, then it is denoted by another

designation as many times as the repetition, depending on its position. Besides these 45 symbols, there is one more symbol {\} at the end of 17 words. This is regarded as a punctuation mark; a dot in each sentence [1]. So according to this acceptation, the Disk consists of 17 clauses.

Over time, many attempts to decipher the Disk have been conducted. The first persons who attempted to decipher it were the man who discovered him, Luigi Pernier, and the excavator of Knossos: Sir Arthur Evans. Pernier considered that the Disk is of Cretan origin and is read from right to left, i.e., from the periphery to the center. On the other hand, Evans considered that the Disk is not of Cretan origin, that the script is syllabic and that is read from the center to the periphery [9]. Much later, Olivier [10] published a detailed study, documenting photographically the details of both sides of the Disk and submitting its concerns regarding how to read it. Another presentation of the Disk has been published by Duhoux [11] as well. Godart [12] considers that the Disk is a product of the Aegean and the text is directed from the periphery to the center. Furthermore, he believes that the 242 symbols of the Disk are too few and if a satisfactory number of new texts in the same script will not be found, then every effort of decipherment is doomed to fail. Once again on the other hand, Owens [13] disagrees with Godart regarding the failure of decipherment and argues that some comparisons with the other scripts of Bronze Age Crete (i.e., Linear-A, Linear-B and Cretan Hieroglyphic; for a brief introduction, see [14]: 332-334) allow to read but not to understand half of the symbols of the Disk. In particular, he considers that the reading of the Disk may be possible, at least to some extent, using the phonetic values of Linear B, Linear A and especially Cretan Hieroglyphic scripts [13]. Clearly, however, any symbolic similarity is relative and does not mean that symbols necessarily depict the same phonetic values [1]. Thus in the next section, the common decipherment aspects will be firstly mentioned (for a definition, see [15] before the presentation of the various attempts to decipher the Disk.

Table-1. Enumeration of the symbols of Phaistos Disk [9].



2. Decipherment Aspects

The common practices of deciphering ancient scripts involve five aspects [16] [17]:

(i) The *underlying language*, including (besides the language per se) the language family (e.g., Indo-European, Semitic, Afro-Asiatic, etc.) and the typology (e.g., agglutinative, fusional, isolating, etc.). If the underlying language is known, then the decipherment becomes a typical case of decryption (cryptography).

(ii) The *script*, regarding the *phonetic value* (denoted sounds) of the symbols. In case of one symbol per sound, the script is alphabetic. In case of a combination of two to four sounds per symbol, the script is syllabic and the symbol is a syllabogram. In case of a symbol per word, the script is ideographic, the symbol being an ideogram (for a discussion, see [18]). A script may combine two types of symbols, like Linear-B that combines syllabograms and ideograms [19]. Knowing the phonetic value of symbols is not enough to decipher a script, as in the case of Etruscan (written in Greek alphabet) and Minoan Linear-A [20].

(iii) The *direction* of writing/reading, which can be horizontal uni-directional (right-to-left or left-to-right), vertical (top-down), spiral or *boustrophedon* ("like ox-turning") that is bi-directional with alternating lines (e.g., from right-to-left to left-to-right).

(iv) The *topic* that can be generally classified as administrative (lists of goods, products, materials or persons), religious (hymns, tributes, prayers), narrative (stories, voyages, descriptions), legal (laws, contracts, treaties), technical (craftsmanship guidelines), ethical and heraldic.

(v) The cultural *context* that refers to the overall conditions of the studied area and era for the civilization in focus.

According to the aspect in priority, the decipherment attempts of the Disk can be classified into two main categories:

- The linguistic attempts, based mainly on aspects 2.i-iii.
- The astronomical attempts, interpreting the Disk symbols as statement points of constellations and calendar concepts or maps [21, 22], thus mostly based on a non-textual narrative topic (2.iv).

The present study focuses on the linguistic attempts, mainly because the context of the Disk (2.v) indicates more sophisticated manufacturing techniques for such depictions [23, 24] than those proposed for the Disk. In addition, the potential astronomical values of the symbols cannot be verified in the same manner that linguistic values can, by comparison with other scripts.

3. Decipherment Attempts

The linguistic attempts to decipher the Disk generally comprise aspects 2.i-2.iv. Regarding the script (2.ii), all types of symbols: ideographic (3.i), alphabetic (3.ii) and syllabic have been suggested. The latter are classified herein as non-Greek (3.iii), indigenous pre-Greek (3.iv) and Greek (3.v), because the syllabic attempts are inextricably linked with the alleged underlying language of symbols (2.i).

(i) This category of ideographic attempts is actually interpretation efforts (2.iv), difficult to verify in relation to specific languages. Gordon [24] attempts to interpret the Disk by matching each symbol with a relative word, having Basque in mind, without any substantial result. Corresponding ideographic interpretations were also presented by Ballotta [25] and Haarmann [26]. Axiotis [27] interpreted the contents of the Disk as a description of the labors of Hercules and in particular a visit to the Labyrinth; an interpretation out of the contemporary context (2.v). Surnin [28] interprets the contents of Disk as instructions/orders of social behavior to a contemporary man of moral standards. Finally and similarly out of context (2.v), Denev [29] interprets the content of the Disk as a description of "Man Creation" and the "Great Flood", in Biblical terms.

(ii) An alphabetic attempt is attributed to Ohlenroth [30] who matched each symbol of the Disk with a letter of the alphabet. This correspondence led to the assertion that the text addresses two sanctuaries outside Crete. Since the alphabet had been developed many centuries after the construction time of the Disk, this attempt is out of contemporary context (2.v) because syllabic scripts prevailed. Similar was the attempt of Martin [31] who claims that the text of the Disk is bilingual, having the Greek version in side A and the Minoan one in side B, being read from the center to the periphery (2.iii).

(iii) The notable non-Greek suggested languages of the Disk are Egyptian [32] a Semitic one [33, 34] and Luwian (/Hittite). The first work trying to connect the Disk's language with Luwian was that of Georgiev [35]. Two more attempts, referring to the relationship of the Disk with Luwian symbols, belong to Best and Woudhuizen [36] and a newer version of the previous [37]. Their estimate is that the content of the one side of the Disk concerns a letter of Tarhundaradus, the king of Arzawa, to Nestor, the king of Phaistos. The other side is the reply of Nestor to Tarhundaradus (2.iv). That assessment is inconsistent with the chronology of the Disk (2.v). Finally, Kenanidis [38] also relates the Disk to the Luwian language, explaining the reasons for the failure of the decipherment by Achterberg, et al. [37].

(iv) Most of the Minoan language advocates regard the language of the Disk as an indigenous pre-Greek language of the Aegean; a distinct Indo-European language akin of Greek and dialects of archaic Proto-Greek. MacDonald [39, 40] attempts a critical approach to another relevant research work [41] with quantitative linguistics methods, suggesting a Minoan pre-Hellenic script that has statistical affinity with Linear-B but not with Linear-A. Timm [42] concludes the opposite, considering that the language is the same as Linear-A, based on the distribution patterns of symbols Facchetti [43]. Owens [13] suggests the view of a Minoan script as an unknown local language with

several readable symbols (i.e., giving phonetic values). Rumpel [44, 45] interprets the contents of the Disk in Minoan language, along with the meaning of a particular symbol. His interpretation coincides with that of Sir Arthur Evans that the text is the glorification of a victorious naval campaign (2.iv).

(v) The attempts linking the underlying language with early or ancient dialects of Greek are numerous. Hempl [46] interprets the Disk in the Ionic dialect, but the resulting text is not coherent. Stawell [47] gives an original interpretation in "Homeric" Greek, reading the Disk from the periphery to the center (2.iii). Later on, she uses the acrophonic principle, according to which each symbol takes the first syllable of the word that represents [48] concluding that the script refers to the archaic Greek language. Schwartz [41] reads the script in Mycenaean (Achaean) Greek. Faucounau [49, 50] and Corsini [51] argue that the underlying language is Proto-Ionic. Duhoux [52] linguistically criticizes the views of Faucounau. Fischer [53, 54] also interprets the text in Mycenaean Greek. Massey and Massey [55] publish their study also attributing the text as archaic Greek. Both Polymeros Polymeros [56] and Balodima-Polygiannaki [57] relying upon the acrophonic principle, argue that the text is Greek, by reading it from opposite directions (from the periphery to the center and the reverse)! The topic in both works is religious (2.iv) but the above works exhibit a lot of linguistic arbitrariness. A recent attempt from ex-military cryptographer Cope-Williams [58] also assumes that the underlying language is Greek, producing a pattern with names of islands throughout the text.

Although most studies attribute some Greek dialect as the underlying language of the symbols, yet none of the interpretations coincides with another (3.v). This fact, by itself, is enough to make an objective reader suspicious that the Greek character of the language is highly questionable. Consequently, this research effort began with the intention to investigate the Greek character of the language of the Disc, without necessarily aiming at a specific decipherment outcome. The research assumptions adopted, regarding every other aspect except the underlying language (2.i), are presented in the following section.

4. Research Assumptions

The first assumption about the script (2.ii) is that each symbol of the Disk represents a syllable (syllabic type), such as the Minoan Linear-A and the Mycenaean Linear-B, because the 45 different symbols on both sides of the Disk Table 1 are too many to constitute an alphabet and too few to be a real ideographic script [13] [9] such as Chinese. Then, it is considered that the syllables at the beginning of words are stems and at the end of words are suffixes, according to standard Greek Morphology.

It is also assumed that the direction of reading the Disk is from the center to the periphery on both sides (2.iii). Although the numbering of both sides starts from their periphery, Evans had been the first to believe that the reading is from the center to the periphery [9] contrary to most scholars that advocate the reverse [10]. Nevertheless, the poor results of the reading and interpretation from the periphery to the center allow for eliminating this assumption and study the Disk from the center to the periphery, at least initially. The correlation of its script with Greek must take account of two elements:

- The closest contemporary to Disk Greek script is Linear-B, which was written as nowadays with the direction from left to right. Regarding the Disk, this reading direction is from the center to the periphery (clockwise).
- If we accept, as most scholars, that the syllabograms confined between two vertical lines comprise a word, then in counterclockwise reading (from the periphery to the center) 19 out of 61 words of the text start with the same syllable. Especially in side A, this happens in 14 out of 31 words! This is not so likely in Greek, unless we assume something not so unlikely: that articles are attached in a few words as prefixes or that this script includes simultaneously syllabograms and ideograms or even supersyllabograms (abbreviations of whole words), as in Linear-B [59]. The latter case though is very unlikely because of the administrative type of Linear-B documents, which is not what expected for the topic of the Disk (see below).

In any case, Linear-B is the nearest contemporary reference point for the investigation of the Greek character of the Disk. Thus, this research approach started with the assumption that the reader of the text of the Disk reads the symbols from the center to the periphery on both sides.

The topic of the Disk (2.iv) is assumed to be religious, or at least non-administrative, because there are indications of a hymn due to a metric structure of the text of side A [9]. The administrative documents had a strict format, composed of lines, columns and abbreviations, that facilitate fast writing. The spiral writing of the Disk is way too cumbersome for such a purpose. This assumption is also augmented by the contemporary context (2.v) of documents, which are either administrative, religious/ceremonial [60] or heraldic on seals [69]. Consequently, the research methodology was based on these assumptions.

5. Research Methodology

The methods of decipherment are heavily based on language statistics [61]. These concern the frequencies of letters, syllables, whole words or parts of them (affixes), as found in corpora of languages [17]. The statistical decipherment is nowadays computerized [62, 63]. Accordingly, the present research method is

based on computerized statistics, yet without initially assuming any pre-assigned phonetic value to the symbols, according to their pictorial similarity with Linear-A or Linear-B syllabograms, as discussed by other scholars [9, 13, 64]. The similarity of some symbols of the Disk with Linear-B syllabograms does not guarantee or even marks the equivalence of phonetic values. Therefore, the conclusions drawn are based more on the statistical study of the symbols and less on estimates that cannot be proved. Moreover, the purpose of this method is to free the process of decipherment from a-priori giving phonetic values to symbols that may potentially be proved wrong, later on. Thus, the phonetic values of the syllabograms will occur afterwards, where if the pictorial similarity is also supported by a phonetic similarity, then the results will be most credible.

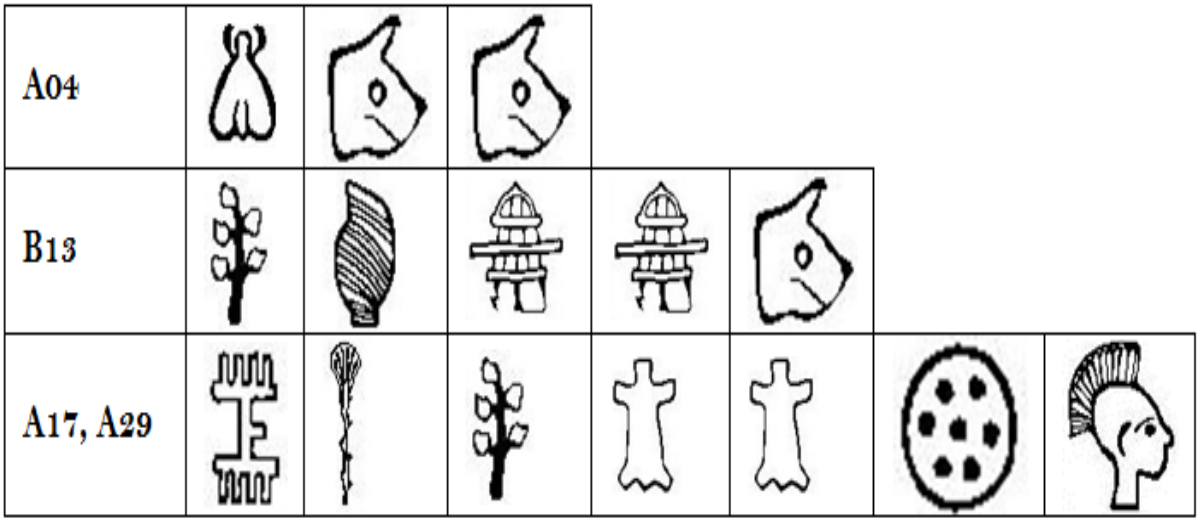
For realizing the proposed method, the notion of *linguistic motifs* has been applied, which is defined as: "*the longest continuous sequence of equal or increasing values representing a quantitative property of a linguistic unit*" [65]. In this case, the linguistic unit is the words of the Disk and their crucial property is an identical repeated syllable of a word longer than two syllables. From words with two syllables, it is not possible to draw any meaningful conclusion, because the first syllable is the stem and the second is the suffix. For this reason, words with more than two syllables were primarily investigated. Namely, at the example of Table 2 there are three words (A04, B13 and A17/A29) with more than two syllables (enumerated in curly brackets):
A04={34-29-29}, B13={35-20-24-24-29} and A17/A29={21-37-35-27-27-12-02}
that have an identical consecutive syllable twice:
[A04: 29]; [B13: 24]; [A17/A29: 27].

Two identical consecutive syllables is the longest continuous sequence of equal phonetic values that can be found on the Disk. By looking up these words in a proper dictionary, equivalent Greek words can be found and the corresponding phonetic values will be assigned to the matching symbols. Then, the phonetic value of each symbol (e.g., of 29) will be assigned to all occurrences of it (e.g., in A04 and B13) in every word of the Disk and the search will continue with other words, until all of them will be determined. Other similar cases that were considered are:

- A word with three symbols with identical first and last.
- Some symbols in words of the same size appear in different positions.

The first two cases (i.e., consecutive syllables and identical first & last) can be applied directly and some results arise.

Table-2. Form of words with consecutive syllables on the Disk.



The proper dictionary utilized is a database of Ancient Greek that has been transcribed in syllabic writing-form, according to the rules of Linear-B script [16, 66]. For this purpose, a pattern matching algorithm has been created (in C# programming language), capable of searching the dictionary, in order to record any syllabic patterns of Linear B identical to those of the Disk. Syllabic pattern matching between Achaean and Classical Greek is credible, because the phonotactics of Greek language had hardly changed from Mycenaean to classical times (even to present). The identification of such words by replacing repetitive syllables could lead, with some degree of certainty, in statistically measurable results for the phonetic value of a syllabogram. Moreover, the detection of phonetic values could contribute to the assignment of meaning even for whole words. With this algorithm, the research process was faster and the search effective; a task that if done without the help of a computer would require much more time and would not be so reliable. Furthermore, it was easiest to identify some recurring patterns of syllables on the Disk, showing similarities with the patterns of the Linear-B dictionary.

6. Implementation & Outcomes

After having done a statistical study of the repeatability of the Disk's symbols, the first outcomes emerged. Several words were extracted that had identical consecutive syllables, but only five (5) words or groups of them met the criteria as shown in Table 2. These words/groups that formed the reference point to make substitutions of syllables and assignment of phonetic values are the following:

A. o-pi-te-te-re, pe-re-re (for B13, A04);
B. no-u-te-te-o, e-o-o (for B13, A04);
C. e-tu-ka-ka-no, a-no-no (for B13, A04);
D. su-tu-ka-ka-no, a-no-no (for B13, A04);
E. de-ki-si-o-o-ma-i (for A17/A29).

For each one of these five cases (A-E), the known phonetic values had to be replaced around the Disk and then investigate in the dictionary other words that match with those emerged. Because there is no safe determination for phonetic values, that led to several possible solutions to the search conducted. Thus, Table 3 includes the results for all cases combining the phonetic values tested.

Table-3. Aggregate results of specific cases.

			Complete Matching	Non Matching	Partial Matching or Non Result
A	o-pi-te-te-re, pe-re-re	1	16 (26,23%)	37 (60,66%)	8 (13,11%)
		2	17 (**27,86%**)	37 (60,66%)	7 (11,48%)
B	no-u-te-te-o, e-o-o	1	9 (14,76%)	35 (57,38%)	17 (27,86%)
		2	9 (14,76%)	41 (67,21%)	11 (18,03%)
		3	17 (27,86%)	38 (62,30%)	6 (9,84%)
C	e-tu-ka-ka-no, a-no-no	1	17 (27,86%)	37 (60,66%)	7 (11,48%)
		2	15 (24,59%)	40 (65,57%)	6 (9,84%)
		3	9 (14,76%)	37 (60,65%)	15 (24,59%)
		4	9 (14,76%)	42 (68,85%)	10 (16,39%)
D	su-tu-ka-ka-no, a-no-no	1	17 (27,86%)	38 (62,30%)	6 (9,84%)
		2	17 (27,86%)	38 (62,30%)	6 (9,84%)
		3	17 (27,86%)	38 (62,30%)	6 (9,84%)
E	de-ki-si-o-o-ma-i	1	14 (22,95%)	43 (70,49%)	4 (6,56%)
		2	13 (21,31%)	41 (67,21%)	7 (11,48%)
		3	11 (18,03%)	36 (59,02%)	14 (22,95%)

The first fair and notable observation from the study of Table 3 is that the maximum rate of complete matching for all cases (27.86%) was relatively small, while the average was 22.62%. Pursuing a different approach, double words were removed, partial and complete matching categories were joined and a new category was created by those words which had not been attributed a phonetic value to any syllable. By adopting this option, Table 4 was created, in which the maximum rate is 35.85%, while the average is 31.45%.

Studying the entire course of this process, in relation with the existing on this matter bibliography, the research results and their commentary are summarized in the next section.

Table-4. Aggregate results without duplicate words and categories' differentiation.

			Complete or Partial Matching	Non Matching	No Phonetic Value
A	o-pi-te-te-re, pe-re-re	1	19 (35,85%)	33 (62,26%)	1 (1,89%)
		2	19 (35,85%)	33 (62,26%)	1 (1,89%)
B	no-u-te-te-o, e-o-o	1	13 (24,53%)	31 (58,49%)	9 (16,98%)
		2	15 (28,30%)	36 (67,92%)	2 (3,78%)
		3	14 (26,42%)	35 (66,03%)	4 (7,55%)
C	e-tu-ka-ka-no,a-no-no	1	17 (32,08%)	34 (64,15%)	2 (3,78%)
		2	18 (33,96%)	34 (64,15%)	1 (1,89%)
		3	17 (32,08%)	33 (62,26%)	3 (5,66%)
		4	13 (24,53%)	36 (67,92%)	4 (7,55%)
D	su-tu-ka-ka-no,a-no-no	1	18 (33,96%)	33 (62,26%)	2 (3,78%)
		2	18 (33,96%)	33 (62,26%)	2 (3,78%)
		3	18 (33,96%)	33 (62,26%)	2 (3,78%)
E	de-ki-si-o-o-ma-i	1	15 (28,30%)	38 (71,70%)	0
		2	16 (30,19%)	37 (69,81%)	0
		3	18 (33,96%)	34 (64,15%)	1 (1,89%)

7. Results

Regarding the aspect of the underlying language (2.i), the emergence of the Disk words with full identification, compared to the words of Linear-B dictionary, does not allow the assignment of meaning or the determining of grammatical terms with certainty.

Therefore, either the particular word combinations may not be relevant or there is not any relationship of the text with Linear-B, thus any other statistical results, presented so far by other scholars, are merely random. Observing the tables with the aggregated results of matching Table 3 & 4, the overall mapping of words with complete identification to the dictionary reinforces the assessment that the Disk may not be related at all with Linear-B.

The small percentage of words that are identical with the words of the dictionary shows that, although some syllabic patterns of the Disk resemble some patterns of Linear-B, the text of the Disk is written in a language that is not an earlier stage of the one that later became Achaean Greek (Linear-B). Consequently, the hypothesis of this research study that the Disk can be deciphered with the assistance of Linear-B is not verified, since the statistical results reveal that a relation of the Disk with Linear-B does not exist.

Concerning the features of the script (2.ii), the application of the algorithm in the symbols, by additionally assigning phonetic values commonly accepted in accordance with the international bibliography, helped to highlight the major problem of arbitrary (or even non-documented) assignment of phonetic values to the Disk syllables. In our case, the consistent and continuous commitment, throughout the course of this investigation, to the statistical results obtained led to few results and in failure to fully read and interpret the Disk. Nevertheless, none of the findings is arbitrary or without a basis on the results of the research process.

Regarding the reading direction (2.iii), a reasonable, and uncomfortable for any researcher of the Disk, reality is that the Disk itself does not reveal the starting point of the text or the reading direction. This is very important in any decipherment effort, because every researcher is forced to assume the text starting point and based on this assumption to support an entire research process.

In the bibliography, it appears that the scientific community has not yet come up with any certainty neither for the point of the Disk that is the start of the text, nor for the direction of reading. In this case, it was considered appropriate to adopt the view of Evans, who was the first to believe that the reading is from the center of the Disk to the periphery of each side, which is the direction that the signs "show" [9]. Namely, the depicted persons, faces and most animals "look" towards this direction, which, when reading, is from left-to-right, as in Linear-A and Linear-B scripts. This choice led to some results and at highlighting existing words with meaning in Linear-B. However, the number of statistical findings does not warrant that this option is appropriate. Practically this means that if the creator of the Disk had taken the opposite direction, all the findings and results of this research are misguided.

At this point it should be also noted that the different views regarding the direction at which the symbols were imprinted, does not necessarily indicate that the reading direction is the same. The undeniable conclusion is that none has proven, with a scientifically documented way, which is the Disk reading direction. In this research question, this investigation failed to reach a safe conclusion.

The final consideration concerns the topic of the Disk (2.iv). As words emerged through the implementation of this algorithm, it is possible to assume that the first side of the Disk has a topic related to products or offerings devoted to a female deity.

This case is not novel in interpreting the Disk. However, the topic of the second side cannot be determined, as the highlighted words have heterogeneous meaning and it is not possible to synthesize a single context, in which to be able to extract some, even approximate, meaning. This fact objectively reinforces the suspicion that the text of the Disk is written in a language that bears no relation to the language of Linear-B, because it is unlikely that the same syllables give apt results on one side of the Disk and completely heterogeneous on the other side. Consequently, unlike other decipherment attempts, this one doesn't propose any irrefutable arguments, concerning the correctness of the interpretation of the text.

8. Commentary

Unlike several studies identified in the bibliography, this research has not led to a decipherment of the Disk, except from some estimation about the phonetic value of some signs. This is mainly due to the decision of the researchers herein not to be lured by attractive though unsubstantiated assessments, but rather to limit the results to the computational analysis confirmed as true. The processing algorithm in C# has been created exclusively for the needs of this research, to detect the connection of the Disk's words with the words of the Linear-B dictionary. Thus, the distinct feature of the present approach lies in that the decipherment process is not based on assigning predefined phonetic values to the signs. It requires a dictionary of the hypothesized underlying language, transliterated in a syllabic form. This approach may also cope with the limited number of signs and size of the text that prevents a classical statistical decipherment, based on frequencies in large corpora, from arriving to conclusions.

Finally, the marking of certain limitations is necessary, concerning the results and conclusions of this study. The first and major limitation is that the conclusions drawn were extracted under the specific hypothesis that the reading of the text is from the center to the periphery of the Disk.

This objective means that if the starting point was the exact opposite, then the results and therefore the conclusions would be quite different. The second, equally important, limitation is that the words of the Disk are in the form that is known from the time of Linear-B, so far. But it is not unlikely, especially in the case of poetic text or religious hymn, that the words of Disk may contain articles or enclitics. In this case, the dictionary of Linear-B must be enriched with all the necessary combinations of article-word-enclitic entries, to facilitate the search and assignment of possible common syllabic patterns.

9. Conclusions

To sum up, the attempt to read the Disk from the center to the periphery did not lead with certainty in a new discovery, either regarding some area/word or in relation to a specific syllabic value of a sign.

The conclusion resulting from the usage of the Linear-B dictionary is that the syllabic patterns contained in the Disk have nothing to do with those of Linear-B, since the effort of combining and matching some signs did not lead eventually to any safe results. It is therefore necessary to continue the research process towards the study of the reverse reading direction, which will eventually cover every case of consideration on the Greek character of the Disk, before the relevant investigation proceeds to other contemporary languages.

Regarding the decipherment methodology, the proposed and presented approach is based on the notion of *linguistic motifs*, as a selected linguistic unit, which in this case is the syllable. The crucial convenient property is an identical repeated syllable of a word longer than two syllables. Having such words, a syllabic pattern matching is conducted in a dictionary of the hypothesized underlying language, with its words transliterated in a syllabic form.

This concept accordingly relies upon the significant diachronic stability of the phonotactics of languages. Consequently, the limited size of a text that may prevent a classical statistical decipherment, based on frequencies in large corpora, cannot affect the present deciphering process. If it fails, it means that the hypothesized language is not the underlying one.

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