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THE DEVELOPMENT AND ROLE OF SYMMETRY IN ANCIENT SCRIPTS

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Abstract: *This paper investigates various scripts regarding the occurrences of signs that have mirror symmetry along a central vertical line. The scripts belong to one of the following three script families: the Phoenician script family, the Minoan-Mycenaean script family, and the Indus Valley script family. It is shown that many scripts in these script families contain a high percentage of signs that have mirror symmetry. Moreover, the scripts within the Phoenician and the Minoan-Mycenaean script families show a tendency of increased percentage of mirror-symmetric signs over time. For example, while the Phoenician Alphabet contains 40.9 percent mirror-symmetric signs, one of its descendants, the Euclidean Greek Alphabet, contains 59.3 percent mirror-symmetric signs. The paper also identifies the boustrophedonic way of writing and religious writings with a deliberate mirroring as an afterlife symbolism as possible causes of the increased use of mirror-symmetric signs.*

Keywords: Boustrophedon; Mirror Symmetry; Palaeography; Reading Direction; Script

INTRODUCTION

Many scripts have an unexpectedly high number of signs that contain a type of symmetry where the left and right sides of the signs are mirrored along a central vertical line. For example, within the English alphabet, which is a late derivative of the Phoenician alphabet, the following letters have mirror symmetry: A, H, I, M, O, T, U, V, W, X and Y. That is, a total of 11/26 = 42.3 percent of the letters of the English alphabet has mirror symmetry.

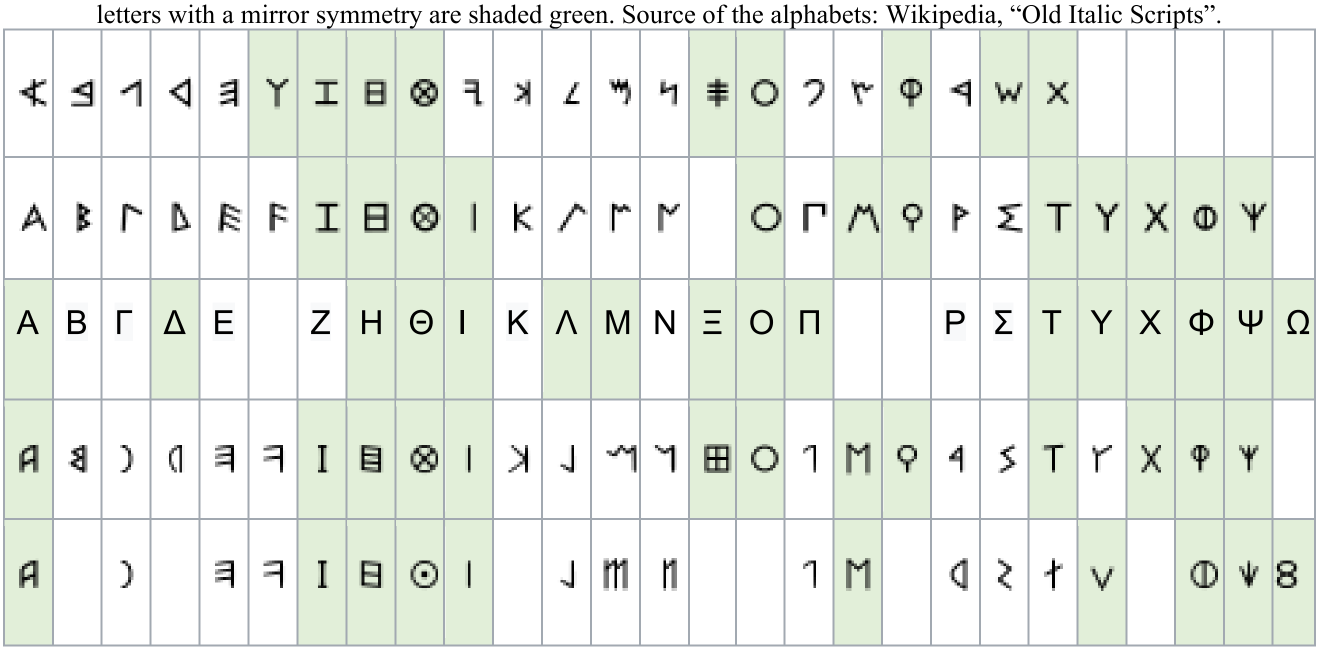
In this paper we try to answer the question of "Why is there such a high percent of mirrored signs in some scripts?" To answer the above question, we proceed as follows. In the next section, we collect statistical data regarding the presence of mirror symmetry in two different script families. Then in the following section, we give a theoretical explanation for the development of mirror symmetry. We argue that the use of *boustrophedonic* writing was a major reason for the development of mirror symmetry in various script families that used such writing. Finally, the last section gives some conclusions and directions for further research.

This paper is organized as follows. The next two sections collect data regarding the evolution of two script families. First, the Phoenician script family, which is a set of alphabets that derive from the Phoenician alphabet. The second is the Minoan-Mycenaean script family that includes four Bronze Age scripts. The first three scripts are associated with the Minoan civilization. These three scripts are the following: the Cretan Hieroglyphs, the Linear A script, and the Phaistos Disk script. The fourth scripts is the Linear B script, which was used by the Mycenaeans. The Minoan-Mycenaean script family is only a part of the more extensive Cretan Script Family (Revesz, 2016b). The fourth section gives a statistical analysis of the scripts and shows that the percentage of mirror-symmetric signs tends to increase over time within script families. The fifth section discusses several possible reasons for this tendency. Finally, the last section gives some conclusions and directions for further research.

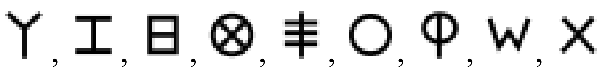
THE PHOENICIAN SCRIPT FAMILY

Table 1 shows five early alphabets that belong to the Phoenician script family. These developed as follows.

Table 1. Evolution of the alphabet: Phoenician (1st row), archaic Western Greek (2nd row), Euclidean Greek (3rd row), archaic Etruscan from Marsiliana (4th row), and Neo-Etruscan Alphabet (5th row). The letters with a mirror symmetry are shaded green. Source of the alphabets: Wikipedia, "Old Italic Scripts".



Phoenician to archaic Greek: The first data row of Table 1 shows the 22 letters of the Phoenician alphabet, which was already used around 1050 BC (Fisher, 2003). The following nine letter are shaded green, which indicates that they have mirror symmetry:



The Phoenician alphabet was adopted in Greece around 800 BC. The archaic Western Greek alphabet introduced mirror symmetry in the letters  > and  > , modified letter  >  while keeping its mirror symmetry, and introduced the letters ,  and , which have mirror symmetry. These developments show a preference for increased mirror symmetry. However, the preference for mirror symmetry was sometimes overridden by other preferences. The mirror symmetry was destroyed in letter  >  by a ninety-degree clockwise rotation. In this case the preference for mirror symmetry may have been overridden by an even higher preference to save space. The mirror symmetry was also destroyed in the letter > . In this case the preference for mirror symmetry may have been overridden by some other reason. This reason may be a desire for a better representation of a hook, which the  letter, called by the Phoenicians *wāw* 'hook,' was supposed to depict. This change freed the original Phoenician letter  to be used to denote the Greek phoneme /y/ in the notation of the International Phonetic Alphabet. This phoneme was not present in Phoenician. Table 2 shows that the percentage of mirror-symmetric letters increased from 40.9 to 48 percent from the original Phoenician alphabet to the archaic Western Greek alphabet.

Archaic Greek to Euclidean Greek: The Euclidean Greek alphabet introduced mirror symmetry in the letters  > A,  > Δ,  > Λ,  > M, > Π, and the new Ω letter around 400 BC. The mirror symmetry was destroyed in one letter, and two mirror-symmetric letters that represented unused phonemes were dropped. Nevertheless, Table 2 shows that the percentage of mirror-symmetric letters increased from 48 to 59.3 percent from the archaic Western Greek alphabet to the Euclidean Greek alphabet.

Archaic Greek to Archaic Etruscan: The archaic Western Greek alphabet spread to Italy. The archaic Etruscan alphabet introduced mirror symmetry in the letter  >  and the new letter. This archaic Etruscan alphabet is based on a single example from Marsiliana, which may contain some handwritten variations of ideal letter forms that had mirror symmetry. For example,  may have been a handwritten variation of a symmetric form of the letter A. Hence it is indicated in green. Table 2 shows that the percentage of mirror-symmetric letters increased from 48 to 50 percent from the archaic Western Greek alphabet to the archaic Etruscan alphabet.

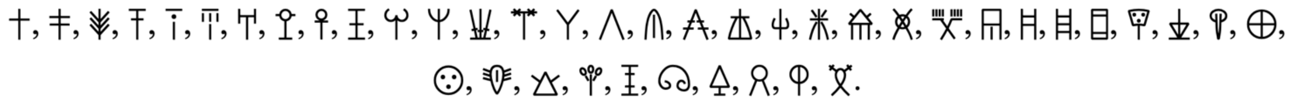
Archaic Etruscan to Neo-Etruscan: The Neo-Etruscan alphabet introduced mirror symmetry in the letter  >  and the new  letter. The Neo-Etruscan alphabet also omitted some letters that denoted unused phonemes. These letters included both mirror symmetric and non-mirror symmetric letters. Table 2 shows that the percentage of mirror-symmetric letters remained 50 percent from the archaic Etruscan alphabet to the Neo-Etruscan alphabet.

THE MINOAN-MYCENAEAN SCRIPT FAMILY

Phaistos Disk script to Linear A script: The Phaistos Disk is one of the oldest Minoan inscriptions that is commonly dated to around 1800 BC (Evans, 1909; Pernier, 1909). Although the Phaistos Disk is considered undeciphered, there are several recent computer-aided attempts that started to decipher the text of the Phaistos Disk (Revesz, 2016) and those of several Linear A inscriptions (Revesz, 2017), with the AIDA database providing a growing library of Minoan inscriptions and their proposed translations (Revesz *et al*., 2019). Only the following signs of the Phaistos Disk contain mirror symmetry:

That is, only 13/45 = 28.9% of the Phaistos Disk signs have mirror symmetry.

The Minoan Linear A script is a later script which existed from about 1800 to 1450 BC (Godart and Olivier, 1996). The Linear A script contains the following mirrored signs:



These 42 signs are about half of the most frequent signs in the Linear A script, which are estimated to be about 88 signs. That is, about 47.7% of the Linear A signs contain mirror symmetry.

In the case of this script family, it is harder to identify exactly which signs of the Phaistos Disk may have developed further into which Linear A sign, but the overall trend of the evolution of the script in the Minoan-Mycenaean script family is also clearly toward an increased use of mirror symmetry.

THE PERCENTAGE OF MIRROR-SYMMETRIC SIGNS INCREASES OVER TIME IN SCRIPT FAMILIES

We calculated some statistics regarding the mirror-symmetric signs for the various scripts as shown in Table 2. Within the Phoenician script family, we find a steady growth in the percent of mirrored signs on the early branches of the Phoenician script family as shown in Figure 1. There are two main branches of the Phoenician script family. On the left, there is an increase from the Phoenician Alphabet with 40.9 percent mirror-symmetric signs to the Neo-Etruscan Alphabet with 50.0 percent mirror-symmetric signs. On the right, there is an increase from the Phoenician Alphabet with 40.9 percent mirror-symmetric signs to the Euclidean Greek Alphabet with 59.3 percent mirror-symmetric signs. The percent of mirror-symmetric signs either increases or remains constant in the Phoenician script family tree as we go from the root to either of the leaves.

Table 2. Statistics regarding mirror symmetry in ancient scripts. Three script families are considered. The first is the Phoenician script family, which includes the five alphabets that are listed in the first five data rows. The second is the Minoan-Mycenaean script family, which includes the Phaistos Disk and the Linear

A scripts. The third is the Indus Valley script that has no other known members. The name of a script is indented under another script's name if the former is a descendant of the later.

Script Family	Script	Mirrored Signs	Total Signs	Percentage	Time (BC)
Phoenician	Phoenician Alphabet	9	22	40.9	1050 - 150
	Greek, Archaic Alphabet	12	25	48.0	800 - 400
	Greek, Euclidean Alphabet	16	27	59.3	400 - present
	Etruscan, Archaic Alphabet	13	26	50.0	700 - 400
	Neo-Etruscan Alphabet	10	20	50.0	400 - 100
Minoan-Mycenaean	Phaistos Disk Script	13	45	28.9	1800
	Linear A Script	42	88	47.7	1800 - 1450
Indus Valley	Indus Valley Script	353	694	50.9	2400 - 1900

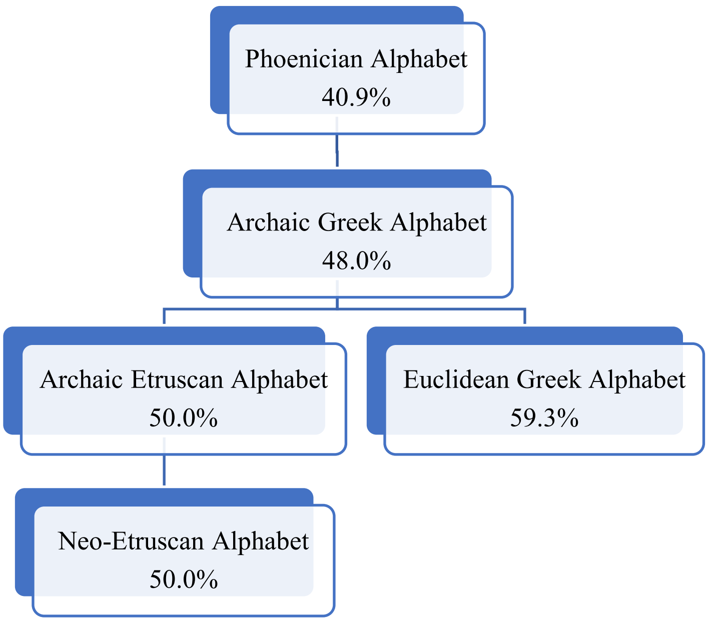


Figure 1 The evolution of the Phoenician script family.
The percent of signs with mirror symmetry are shown below each script.

POSSIBLE CAUSES OF INCREASED PERCENTAGE OF MIRROR-SYMMETRIC SIGNS

We believe that the unexpectedly high number of symmetric signs is due to a development of writing that is called *boustrophedonic*, or literally as 'the ox goes' meaning that at the end of a line the next line continues right below the end and goes in the opposite direction. Hence a left-to-right line is followed by a right-to-left line, which is again followed by a left-to-right line and so on. This is reminiscent of how oxen plow a plot of land. Figure 2 shows two examples of boustrophedonic writings. On the left side a Euclidean Greek text from Gortyn and on the right side a Linear A inscription (Godart and Olivier, 1976, vol. 4, p.14). Boustrophedonic writing is clearly associated with the increased use of mirror-symmetric signs because in both the Phoenician and the Minoan-Mycenaean script families the earlier scripts do not use boustrophedonic writing, while the latter scripts use it. For example, there are no boustrophedonic writing samples using the Phaistos Disk script, which is only attested on the Phaistos Disk, the Archalochori Axe, and a seal from the palace of Phaistos (Revesz, 2022). However, boustrophedonic writing was used in the latter Cretan Hieroglyphic and Linear A scripts. Hence, the introduction of boustrophedonic writing is clearly associated with the growth of mirror-symmetric signs from 28.9 percent among the Phaistos Disk signs to 47.7 percent among the Linear A signs.

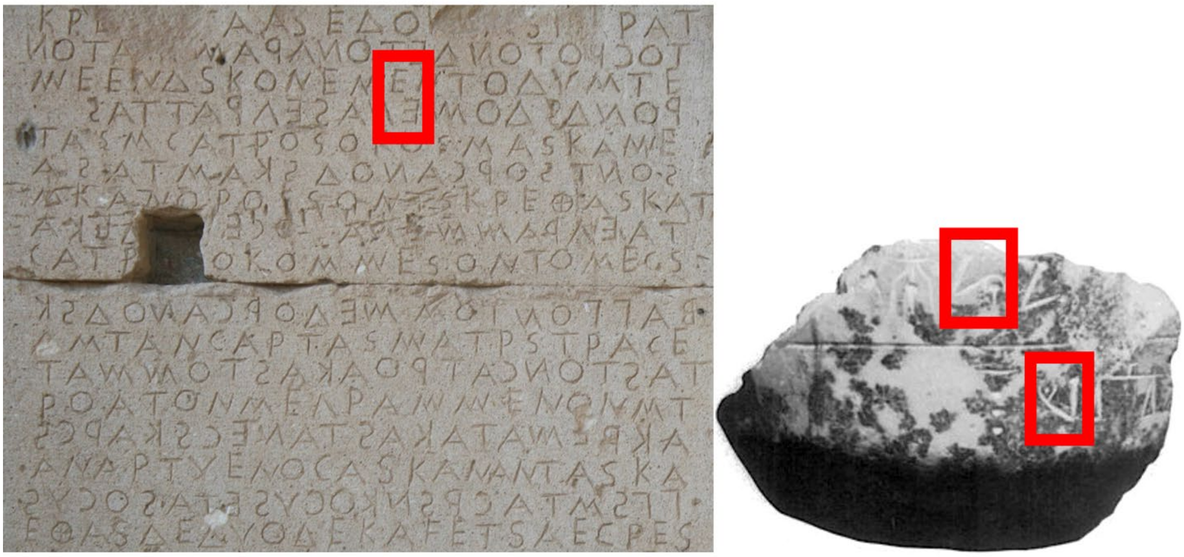


Figure 2 Examples of boustrophedonic writing from Gortyn (left), showing part of the famous Gortyn law code, and Knossos (right).[1] The red boxes, which we added to the photos, indicate the two mirror images of the letter E in the third and fourth row (on the left), and the mirrored images of a Linear A sign in the first and second rows (on the right).

The main problem with boustrophedonic writing is that when we look at a particular line, we do not automatically know which way it should be read, unlike in modern English texts, where every line is read from left-to-right. As a modern example, suppose we would like to write ‘GOD’ in a row that is to be read from right-to-left. This looks like an easy task that can be done by simply writing: ‘DOG’. The problem is that the reader may not recognize that the row needs to be read from right-to-left, hence ‘God’ becomes ‘dog’ for the reader. Ancient scribes compensated for this problem by vertically mirroring any non-symmetric letter so that the orientation of the words would indicate the direction. Using this concept, instead of ‘DOG’, they would have written ‘ᗡOӘ’.

While boustrophedonic writing with mirroring of asymmetric signs is an attractive solution, and it occurs also in the Mycenaean Linear A script and the Indus Valley Script, it causes the problem of having to know and correctly write the mirrored versions of the asymmetric signs. Many people make mistakes when writing mirrored letters and can read mirrored letters much slower than ordinary texts. We believe that these factors combined with the observation that only a few frequently occurring asymmetric signs are enough to indicate the writing direction led to the development of symmetric forms for most signs. Another possible reason for using mirror-symmetric signs is that the reading direction is reversed because the mirroring recalled how objects are reflected in a mirror or a lake. In particular, the ancient Bronze Age Europeans may have taught that spirits of the dead persons live on at the bottom of the lakes. The spirit world always seemed mirrored. This afterlife connection with water reflection (see Figure 3) may explain why in druid graves, the dead person's weapons were placed at his left side. The apparent mirroring of all things in the afterlife may have led to the use of mirrored signs on religious inscriptions. This may have been thought to facilitate communication with the dead who wrote using reversed signs. Then similarly to the boustrophedon writings, this constant mirroring may have become cumbersome and led to the increase in the number and percentage of mirror-symmetric signs to save time in writing using mirrored signs.

Figure 3 Illustration of the connection between afterlife beliefs and water reflections.

Mirrored signs can also occur in non-boustrophedonic and non-religious writings. These other cases are investigated and listed by Daggumati and Revesz (2021). They focus on the Indus Valley Script, but their observations are applicable to other scripts too. The following are some of the cases that were included in their investigation:

When the writer used a mirrored sign to save space.

Copying errors.

Location anomalies.

CONCLUSIONS AND FUTURE WORK

This paper started an exploration of the reasons for the apparent gradual development of mirror symmetry of signs in various script families. It was pointed out that the increase seems to be present in those script families where boustrophedonic writings was practiced. In the future, we plan to expand this investigation by studying a larger set of scripts within the Phoenician script family and other script families.

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[1] Photos were retrieved from Wikimedia. PRA, CC BY 4.0, https://en.wikipedia.org/wiki/Boustrophedon and Godart and Olivier (1976).

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