The Mathematics of Direction in Writing

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Abstract

This article explains historically the reason why the order in which characters are written in English is from left to right, but in Arabic it is from right to left. There were all patterns of direction in writing; horizontal or vertical, right to left, left to right, reversed character horizontally or vertically, 90 degree rotation. Ancient Hieroglyphs had all patterns, but English, Arabic and Kanji differed. Author expects those may deeply relate to right hand manner.

Keywords: Direction in Writing, Boustrophedon, Mongolian characters, Cuneiform script, Hieroglyphs, Rosetta stone, Bamboo strips

1. The international boomerang project

One of my life's works has been research into the boomerang. I have spent a period of 40 years clarifying its principles of flight, and as a byproduct of this research, have also devised a paper boomerang which correctly returns indoors (see Nishiyama, 2007) [3]. Also, from the wish that many people may come to know how fun boomerangs are, I have compiled a document explaining on two sides of B4 paper how to make a paper boomerang, how it flies, how it may be caught, and the reason that it comes back. This may be seen on the Boomerang Association's web page.

I first produced the document in Japanese, which is natural, but I realized that Japanese can only be understood by the Japanese people. There are 195 countries and 6.6 billion people in the world. Even counting only languages which are considered to be official, there are 75 different languages. In terms of relative population, no more than one-sixtieth of the world understands Japanese. So, I made an extravagant plan and began translation work in order to produce an explanation that could be read by people all over the world.

After spending 10 years, translations into as many as 69 languages were completed and uploaded onto my home page. This enabled 99.9% of the world's 6.6 billion people, no matter where they are, to download the explanation of the boomerang and its paper template. For those readers who have an interest please refer to the following home page (Boomerang Internationalization Project 2007).

http://www.kbn3.com/bip/index2.html

There is a simple theory of boomerangs printed on the reverse side of the explanation. Using the title of this explanation as an example, this time I have thought about the direction in which writing advances (called 'writing direction').

If the Japanese title is translated into each different language, how does turn out? See Figure

European 1

English	Why does a boomerang come back?
German	Warum kehrt ein Bumerang zurück?
French	Pourquoi le boomerang revient-il ?
Spanish	¿Por qué regresa el bumerán?
Russian	Почему бумеранг возвращается?

European 2

Portuguese	Por que um bumerangue retorna?
Italian	Perché un boomerang torna indietro?
Dutch	Waarom komt een Boemerang terug?
Danish	Hvorfor kommer en boomerang tilbage?
Swedish	Varför kommer en bumerang tillbaka?
Greek	Γιατί το μπούμερανγκ γυρίζει πίσω?
Hungarian	Miért tér vissza a bumeráng?

Asian 1

Chinese	回飞镖为什么会飞回来呢？
Japanese	ブーメランはなぜ戻ってくるのか？
Korean	부메랑은 왜 되돌아 오는가?
Hindi	बूमरैंग वापस क्यों आता है ।
Bengali	কেন বুমেরাংটি আবার পুর্বের অবস্থানে ফিরে আসে?
Nepali	बुमर्याङ्ग किन फर्कन्छ

Asian 2

Vietnamese	Tại sao bumơrang có thể quay ngược trở lại được?
Mongolian	Боомеринг яагаад буцаж ирдэг вэ
Tagalog	BAKIT BUMABALIK ANG BUMERANG?
Indonesian	Mengapa bumerang terbang kembali?

Asian 3

Thai	ทำไมบูมเมอแรงจึงบินกลับมาหาเรา
Khmer	ហេតុអ្វីបានជាប៊ូមុឺរ៉ង់ហោះត្រលប់មកវិញ ?
Myanmar	ဘူးမယ်လမ်သည် ဘာကြောင့်ပြန်လှည့်လာပါသလဲ?
Lao	ເປັນຫຍັງບູມເມະແລງຈຶ່ງບິນກັບມາຄືນ?
Sinhalese	බූමරැංගුව ආපසු එන්නේ ඇයි?

Figure 1. European languages and Asian languages

1. Translating it into English, German, French, Spanish, and Russian yields the following. Regarding the question mark '?', it is characteristic of Spanish that the whole question is enclosed between the question marks '¿' and '?'. Also, Russian uses Cyrillic characters.

Translating it into Portuguese, Italian, Dutch, Danish, Swedish, Greek and Hungarian yields the following. It is also interesting to look at the relationship of these languages with English, German, French and Spanish. Greek is written in Greek characters, and it can be seen that these have had an influence on Russian Cyrillic characters. While Hungarian belongs to Europe, it is a distinctive language because the word order differs from other European languages. Due to the attacks of the Mongol empire in the 13th century and so on, it has been influenced by Asian culture.

Translating it into the Asian languages, Chinese (with simplified characters), Korean (Hangul characters), Hindi (Indian, Devanāgarī characters), Bengali (Bangladesh) and Nepalese yields the following. Chinese uses a simplified version of the *kanji* characters used in Japanese, so ignoring the pronunciation, it is possible for the Japanese people to guess the meaning.

Translating it into Vietnamese, Mongolian, Tagalog (the Philippines) and Indonesian yields the following. It can be seen that many of the countries in Asian have lost their original characters as a result of European colonial policies. The fact that Vietnam was under the control of France, and Mongolia under the control of the former Soviet Union is also conveyed by their characters. However, Thai, Khmer (Cambodia), Myanmar (Burma), Lao (Laos), Sinhalese (Sri Lanka), etc., continue to use their native characters.

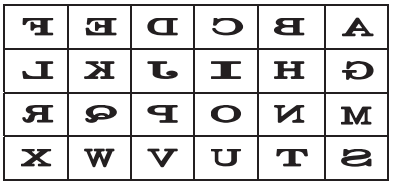
2. Arabic is written from right to left

The characters are written from right to left in the Islamic region of the Middle-Eastern countries. See figure 2. The characters are reversed from left to right in all of the countries using Arabic, Hebrew (Israel), Persian (Iran), Urdu (Pakistan), Pashto (Afghanistan) and so on, and it is characteristic that the question mark '؟' is also reversed horizontally. Hebrew however, uses the same question mark as English, '?'.

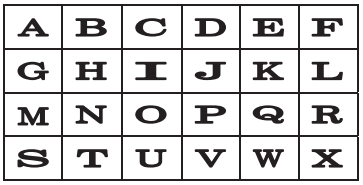
Arabic	لمـــاذا تعـود البومـــرنغ؟
Hebrew	מדוע בו מרנג חוזר?
Persian	چرا بوم رنگ برمي گردد؟
Urdu	بومرينك واپس كيسے آتا ہے ؟
Pashto	ولي لیندی بیرته راګرځي ؟

Figure 2. Middle Eastern languages

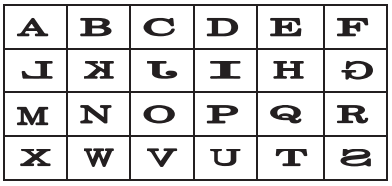
It has been explained that the order in which characters are written in English, Japanese and so on is from left to right, but in Arabic, Persian and so on it is from right to left, but Japanese and Chinese were originally written vertically. There is a book called 'Characters of the



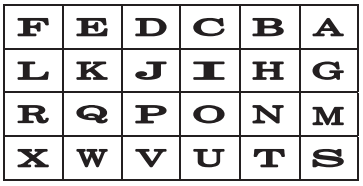
(1) Right-horizontal (reversed)



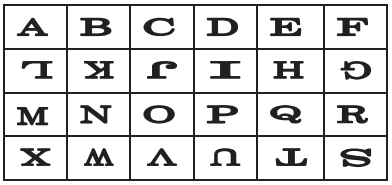
(2) Left-horizontal



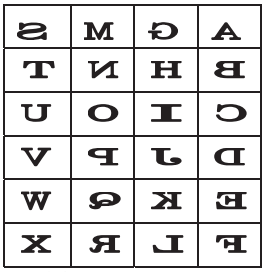
(3) Boustrophedon



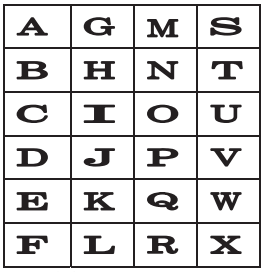
(4) Right-horizontal



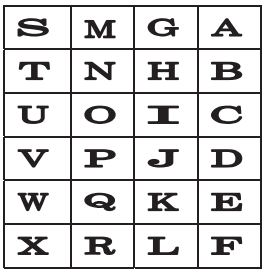
(5) Special form



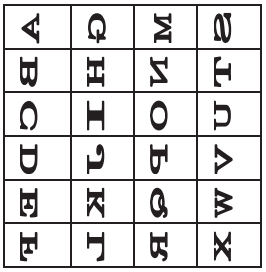
(6) Right-vertical (reversed)



(7) Left-vertical



(8) Right-vertical



(9) Left-vertical (90 degree rotation)

Figure 3. The various directions of writing (reproduced from reference of Nakanishi, 1990 [2])

World' by Ryo Nakanishi, which contains a column on page 73 entitled 'The direction in which characters are written'. Figure 3 shows various directions of writing compiled by referring to this column (see Nakanishi, 1990) [2].

Writing direction is broadly separated into horizontal and vertical directions. Horizontal writing is described as (1) right-horizontal writing, when it is written from right to left, and (2) left-horizontal writing, when it is written from left to the right. Current European languages, beginning with English, are (2) left-horizontal. The Middle-Eastern Islamic languages, beginning with Arabic, are (1) right-horizontal. It should be noted that the characters are reversed horizontally in the right-horizontal case. Phoenician characters were exclusively (1) right-horizontal, but Greek combined (1) right-horizontal and (2) left-horizontal characters, and sometimes the direction of writing reversed itself in every row, which folded back forming what is known as (3) a boustrophedon. Phoenician characters are Aramaic and Arabic characters, and form type (1) right-horizontal writing.

There is a pattern of right-horizontal writing under which, in contrast to (1), the characters are not flipped horizontally (4). This was seen in pre-World War II Japan. However, according to Makoto Yanaike's 'The Appearance of Horizontal Writing', this should not be regarded as right-horizontal writing, but rather as vertical writing in which each column contains only a single character (see Yanaike, 2003) [6]. There is also a special rare form of horizontal writing (5). In the Rongorongo characters of Easter Island alone, the fragments of wood inscribed with these characters are swiveled around head-to-tail so that there is a mixture of vertically inverted characters.

There is also a right-vertical pattern which advances from right to left (6), and a left-vertical pattern which advances from left to right (7). The characters are flipped horizontally in the case of (6). Japanese *kanji* are a right-vertical pattern which advances from right to left, but the characters are not reversed (8). Mongolian characters have a special left-vertical pattern (9), and tracing back historically, Uyghur characters which have a 90 degree rotation (anticlockwise) were influenced by Islam. Figure 4(1) is written in Mongolian characters, but it can be seen that the result of rotating these by 90 degrees (clockwise) is similar to Arabic characters (Figure 4(2)). It can be said that Mongolian characters are a product of combining Middle-Eastern Islamic culture with the Chinese culture of writing characters vertically.

(1) (2)

Figure 4. Mongolian characters (from reference of Wikipedia, 2009 [5])

3. Hieroglyphics, which include all formats

We have discussed various types of vertical and horizontal writing above, but the question of why English is left-horizontal, Arabic is right-horizontal, and Japanese *kanji* are right-vertical

remains.

In the history of writing, it is said that the Sumerian characters of the Mesopotamian culture (around 3500BC) are the oldest. These are cuneiform characters recorded by pressing a reed stylus into a clay tablet to form indentations, and it seems that both vertical and horizontal writings exist. The hieroglyphics of ancient Egypt (around 3000BC) include horizontal writing patterns (1) and (2), as well as vertical patterns (6) and (7) from Figure 1, and the direction of text is determined by the direction in which the nose of a person or animal points. If a person or an animal is facing left, then the writing is read by advancing from left to right, and if a person or animal is facing right, then it is read from right to left.

Figure 5 was produced by reference to Andrew Robinson's *The Story of Writing,* and shows 'Aleksandros' (Alexander the Great) drawn in hieroglyphics (see Robinson, 2006) [4]. This demonstrates right-horizontal and left-horizontal writing in the upper level, and right-vertical and left-vertical writing in the lower level. The direction of writing may be seen from the direction in which the bird is facing.

The hieroglyphic alphabet has 24 categories, and each corresponds to a picture character. Removing all the vowels of 'Aleksandros' apart from 'a' leaves 'Alksandrs', which looks like Figure 3 when written in hieroglyphics. The first character is an Egyptian bald eagle, representing 'a', and the last is a bolt, representing 's'. English characters and hieroglyphics do not necessarily correspond 1-to-1, but hieroglyphics are written according to these kinds of rule.

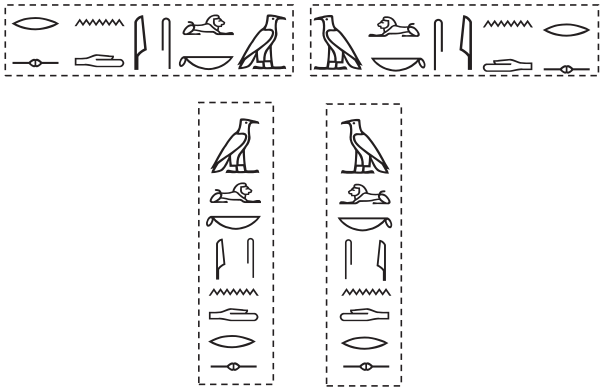


Figure 5. Horizontally and vertically written hieroglyphics (Aleksandros)

All of the patterns exist in hieroglyphics, and it seems like they were a basis for differentiation, so why did right-horizontal writing from right to left develop first, and left-horizontal writing from left to right appear later?

Page 85 of Jiro Kondo's 'Enjoying Hieroglyphics' contains the following (see Kondo, 2004) [1]: 'In general, when hieratic and so on was inscribed on papyrus using a rush pen, the characters were written from right to left, but in the case of hieroglyphics, they were drawn towards both the left and the right because decorative elements were incorporated. However, for epitaphs on gravestones and so on, writing from right to left was overwhelmingly common.' This explains that both right-horizontal and left-horizontal writing exists but that right-

horizontal writing was dominant.

Regarding the dominance of right-horizontal writing, there is the following hypothesis. The Egyptian hieroglyphs characters were engraved into stone tablets by holding a chisel in the left hand and a mallet in the right hand, so in order to avoid the characters which had already been written being hidden by the left hand, writing advanced from the right to the left. The reason that the characters are flipped horizontally in the right-horizontal case can also be understood to some extent. It is a serious mistake to think that left-handedness is common among the Arabian people, while right-handedness is common among Europeans. Right-handedness is more common among people everywhere. Right-handed stone masons hold the chisel in their left hand and mallet in their right, so writing became right-horizontal. There is an explanation according to which the reason why right-handed people are more common is because the heart is located on the left side, but if I begin this explanation it will take a long time so I'll save it for another time.

In order to unify a nation it makes sense to unify the language and direction of writing. The dominance of the right-horizontal direction in hieroglyphics is inherited from Phoenician characters (around 1500BC). Languages like Arabic and Middle-Eastern Islamic societies also maintain this tradition today. After Phoenicia, the characters in ancient Greece (around 800BC) were written from both right to left, and left to right. There was a boustrophedon with a mixture of right-horizontal and left-horizontal writing, and eventually left-horizontal writing became dominant. By Roman times, under the establishment of new countries, language, standards of weight and measurement, religion, and culture were all changed from those of Egypt, so perhaps as a part of this process the left-horizontal writing from left to right was settled.

4. Why are Japanese *kanji* written right-vertical?

The plot (trajectory) of horizontal writing has thus been connected, but the question of why vertical writing is used in the cultural sphere of Chinese characters still remains (Japanese *kanji* derive from Chinese characters). The first ancient writing from China is the oracle bone script (around 1400BC), and this was already written vertically. In ancient China, just as with hieroglyphics in ancient Egypt, it ought to have been possible for right-horizontal, left-horizontal, right-vertical and left-vertical writing all to exist. The history of the oracle bone script is recent by comparison to Sumerian characters (around 3500BC) and hieroglyphics (around 3000BC). Perhaps if archeological excavation advances in China, new facts might emerge.

Let's think about why, as a form of vertical writing, Japanese *kanji* are written right-vertically from right to left. In ancient China, strips of bamboo or wood were used (around 1300BC). Bamboo was carved to produce a single stick, and a single column of characters was written upon it, then the top and bottom were stitched together, and the strips rolled up and stored. When it was read, the roll of bamboo strips was held in the left hand, and the bamboo strips were pulled out in order using the right hand. It should be possible to understand that for right-handed people, holding the heavy roll of bamboo strips in the right hand, and pulling them out using the left would make it difficult to manage the rolled up bamboo.

When switching from bamboo to paper, if a scroll format is retained, it is also easier to see

if the vertical columns of writing come out from the right and move to the left. When writing on a roll of paper using a brush, if the paper roll is held in the left hand and the writing is advanced using a brush held in the right, it is natural for the paper roll to be managed with the left hand to expose new blank paper, and for the written part to droop to the right or be placed on the floor while waiting for the ink to dry. It can thus be inferred through the development from bamboo to paper that right-vertical writing which advances from right to left was the dominant form. In the same way as hieroglyphics, right-handedness is also an important key with regard to *kanji*.

In the past, the tools used for writing in Japan were brush and ink, and brushes, by nature, are held vertically so the hand holding the brush does not touch the paper. So there is no worry that if right-vertical writing is used the hand may become dirty. On the other hand, the tools used for writing in the West were pen and ink, so the hand holding the pen touches the paper, so left-horizontal writing from left to right may be considered appropriate. However, in the Middle-Eastern countries right-horizontal writing from right to left remains in use, so the question of what technique is used when writing with a pen remains. I hope to continue investigating writing direction in future.

References

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