Abstract

It has often been claimed that writing systems have formal grammars structurally analogous to those of spoken and signed phonology. This paper demonstrates one consequence of this analogy for Chinese script and the writing systems that it has influenced: as with phonology, areal script patterns include the borrowing of formal regularities, not just of formal elements or interpretive functions. Whether particular formal Chinese script regularities were borrowed, modified, or ignored also turns out not to depend on functional typology (in morphemic/syllabic Tangut script, moraic Japanese katakana, and featural/phonemic/syllabic Korean Hangul) but on the benefits of making the borrowing system visually distinct from Chinese, the relative productivity of the regularities within Chinese character grammar, and the representational level at which the borrowing takes place.

Keywords: Chinese characters, Tangut, katakana, Hangul, writing system grammar, areal patterns

1. Areal phonological patterns and areal script patterns

Tangut script, Japanese katakana, and Korean Hangul look a lot like Chinese characters, despite representing spoken language in quite different ways. Such observations have lead authors to speak of Sinoform writing systems, with Unseth (2005) explicitly drawing a parallel with the areal features that arise via spoken language contact. As with the writing system literature in general, studies of script borrowing have mainly looked at what Gelb (1963) called the inner structure or inner characteristics of writing systems. For example, in his study of the Chinese script area, Tranter (2001) is particularly interested in (p. 184) “the principles by which the forms represent the spoken language” and “the principles whereby the forms are created”, such as the arrangement of constituents within “ideal squares” (see also Tranter 2002). Other researchers who have studied these aspects of Sinoform scripts include Miyake (2017a) and especially Handel (2019). By contrast, little attention has been paid to the borrowing of what Gelb called the “outer form” of a script, which Tranter (2001, p. 185) describes as involving “simply the calligraphic style or ‘font’”. Yet this type of borrowing shares deep similarities with borrowing in areal sound patterns.

To appreciate these similarities, note first that “sound pattern” is a misnomer: what defines phonology, in contrast to morphology and syntax, is not physical sound but a system of linguistic form regularities that do not directly affect interpretation. After all, sign languages also have phonology (Brentari 2011), and more generally, phonology is at least as much mental as physical (Berent 2013). Since phonology is a system, the psychological processes that give rise to areal sound patterns are nontrivial. Even when they involve the borrowing of individual elements like phonemes, the rest of the system has to be adjusted to accommodate them, and still more radical changes are required when borrowing productive regularities like prosody (e.g. the influence of Bora syllable structure on the unrelated language Resigaro; Aikhenvald 2006) and phonological rules, like vowel harmony in Niger-Congo languages (Dimmendaal 2006) and possibly syllable-final devoicing in Europe (Blevins 2017). Thomason and Kaufman (1988) even argue that only words are literally
“borrowed”; contact-induced changes in phonology or morphosyntax instead involve "interference through language shift" (p. 37), as non-fluent speakers of a language retain parts of their native grammars. Blevins (2017) emphasizes that the borrowing occurs within the constraints of natural phonological processing and development, and as she also observes, naturalness (markedness, universals, or general tendencies) can also mimic borrowing, an alternative analysis of cross-language similarities that should always be kept in mind, alongside inheritance and chance.

That writing systems also have grammar-like elements and regularities is an old idea, as reflected in the long pedigree of the term 'grapheme' (Kohrt 1986). Formal grammatical analyses have also been offered for Roman letters (e.g. Watt 1975, Primus 2004), alphabetic spelling (e.g. Venezky 1967, Evertz 2018), abugida script (McCawley 1994), and Chinese characters (e.g. Wang 1983, Myers 2019). It is true that, in comparison to speaking and signing, writing is more an artificial tool than an intrinsic facet of human nature (Aronoff 1994), but the artificiality of writing should not be exaggerated. Readers and writers develop far more systematic knowledge than they are taught, as shown by numerous studies on children and adults, including in alphabetic scripts (e.g. Pacton et al. 2001; Seidenberg et al. 1994) and Chinese characters (e.g. Tsai & Nunes 2003; Lee et al. 2006; Myers 2019).

Even if writing systems have visual grammars, however, the function of writing means that those for alphabetic systems are still closely linked to pronunciation, not just in spelling but even in letter shape, where correlations have been observed with the sonority of the associated phonemes (Fuhrhop et al. 2011). Grammatical analyses of alphabetic writing systems therefore tend to incorporate script/pronunciation interactions within a larger modality-independent phonological system that also covers purely visual regularities (e.g. Wiese 2004, Evertz 2018).

In less transparent scripts, however, the systematic nature of uninterpreted outer form takes up more of the script grammar, as demonstrated particularly clearly by Chinese characters. As wholes, characters are virtually always interpreted as the monosyllabic morphemes of the spoken Sinitic languages that use them. The vast majority of characters are made up of a component roughly indicating the semantic class and a component representing the syllable’s (original) pronunciation, with most of the remaining characters being semantic compounds. While experiments confirm that these components are actively interpreted by readers (see review in Myers 2019), there are a great many other regularities in character-internal structure without any link to speech. Some involve the semantic and phonetic components, not their interpretation but formal regularities like their arrangement and constraints on reduplication. Other regularities do not depend on identifying constituent type at all, such as those involving the stroke inventory, the direction and order in which strokes are written, how strokes may be combined to make well-formed constituents, and how strokes and stroke groups vary in size and shape in different contexts. Adapting the modality-neutral definitions necessary for sign languages, Myers (2019) uses the term “character morphology” for the first type of formal regularity and “character phonology” for the latter type, where constituent interpretations are irrelevant, noting that they show other properties traditionally associated with their namesakes in spoken and signed languages, for example that semantic components act like morphological affixes and (following Wang 1983) that strokes and stroke changes can be analyzed, respectively, with something like features and phonological rules.

These considerations suggest that we can say something more specific and theoretically interesting about the shared “look” of Sinoform scripts than Tranter’s (2001, p. 199) speculation that it is “due more than anything to the media used and the aesthetic tradition of the region.” If Chinese characters truly have a script phonology, borrowing would instead involve formal regularities (rules and constraints) like those borrowed in areal sound
patterns. Unseth (2005, p. 33) is close to drawing a similar conclusion when he compares cross-script borrowing to speakers using a “second language imperfectly, still maintaining habits from their first language,” except that here “habits” must be understood as much more cognitively rich and abstract.

To explore these ideas, this paper starts by reviewing the evidence for a number of patterns in Chinese character phonology (Section 2). It then looks for these patterns in a small but typologically varied sample of Sinoform scripts: Tangut script (Section 3.1), Japanese katakana (Section 3.2), and Korean Hangul (Section 3.3). The conclusions in Section 4 attempt to explain why particular regularities were borrowed, modified, or ignored.

2. Chinese character phonology

Gelb (1963, p. 85) is not far wrong about Chinese script when he writes: “To be sure, in its outer form the writing has changed greatly in the course of its long history, but from the point of inner characteristics the oldest inscriptions hardly differ from those of recent times.” Admittedly, there have also been changes in character morphology during the long development of characters (Qiu 2000), from their origins in oracle bones (before 1200 BCE) up to modern standard script (matured by 600 CE), as seen today in the traditional system retained in Hong Kong, Macau, and Taiwan and in the simplified system developed in the People’s Republic of China (Wiedenhof 2017). However, these morphological changes have been far less dramatic than changes in character phonology, most obviously the replacement of the curves of older systems with the familiar straight stroke (see Myers 2019 for analyses). Such changes in outer form cannot really be explained solely by the writing media as Tranter (2001) implies, given that the traditional ink brush was also used to produce nonlinear calligraphic styles (influencing the cursive look of Japanese hiragana) and the circles of Korean Hangul. Nor is it helpful to ascribe character outer form to some amorphous aesthetic tradition, since like a phonological system, it has a productive internal logic of its own. Indeed, while the patterns discussed in this section will be illustrated with a single traditional Chinese character typeface, they also appear in most other modern typefaces and in simplified characters as well (see Myers 2019 for thorough analyses).

The stroke inventory, for example, is not arbitrary but derivable from a few simple principles (see also Wang 1983, Peng 2017): strokes are straight by default, fall primarily along the two cardinal axes (horizontal and vertical) and otherwise along the two major oblique axes (diagonals), with each stroke written from left to right and/or from top to bottom. These principles correctly predict that for three of the four axes (|, –, \) there is only one stroke type, but for the anti-diagonal (/), there are two: one drawn left to right but bottom to top and the other drawn top to bottom but right to left. This featural system also predicts a stroke without a pre-specified axis, the dot, by default drawn as a very short falling diagonal (\) to conform with both directional principles. These basic strokes may then be linked (endpoint to starting point) to produce a variety of complex strokes. A sampling of basic strokes, complex strokes, and stroke features is shown in Figure 1, with traditional names in Pinyin and simplified characters.
Figure 1. Basic and complex strokes and stroke features in the character 永 [grayscale version of public domain image at https://commons.wikimedia.org/wiki/File:8_strokes_of_%E6%B0%B8-zh.png]

The principles themselves are motivated by perception and motor control: perhaps inspired by natural scenes, writing systems favor the two cardinal axes (Changizi et al. 2006), and the left-to-right and top-to-bottom directions allow a right-handed writer to pull the writing instrument instead of having to push it (Watt 2015).

Variations in dot axis also have clear external motivations, particularly symmetry (another orthographic universal; Morin 2018), as illustrated in (1).

(1) 冰首當受只黑

Universal principles help explain how strokes are combined to form Chinese character constituents: across scripts, cardinal and oblique axes tend not to mix (Morin 2018), resulting in Chinese strokes frequently being parallel, as in (2a), or else contacting or crossing each other orthogonally, as in (2b). Moreover, when one stroke touches another without crossing it, it is generally at the initial point of the second-written stroke, which, combined with the directional principles, means that stroke combinations like ┬ and ├ are more frequent than those like ┴ and ├. The same preferences were observed by Ninio and Lieblich (1976) when non-Chinese-speaking children copied simple geometrical figures.

(2) a. 三 川 么 宸 豸
    b. 十 子 丑 卦 豸
However, character constituents show several other stroke regularities that are more uniquely Chinese (see also Wang 1983). As illustrated by the examples in (3), the lowest and rightmost of a set of identical elements within a constituent is almost always enlarged (prominent, in Myers’s 2019 terms, by analogy with the prosody of spoken and signed languages). This is true whether the affected component is a single stroke as in (3a) or a stroke group as in (3b). Both patterns can apply together, as in (3c), and lexical exceptions, like those in (3d), are rare. Since the enlarged element is always written last, the external motivation is the same motor-control bias that lengthens final syllables in both spoken languages (Beckman & Edwards 1990) and signed languages (Sandler 1993). In other scripts, however, this effect is barely visible, as in the optional and slight size increase in the lower portions of the uppercase Roman letters <B> and <E>; in Chinese characters this effect has been fully “phonologized”. The enlargement of entire constituents clearly goes beyond a merely motoric explanation, and even when it affects individual strokes, enlargement occurs in positions defined not by the entire character, but by the boundaries of interpretable internal constituents (i.e. it is sensitive to character morphology), as illustrated in (3e). Myers (2019) provides experimental evidence that Chinese readers judge nonce stroke combinations as more character-like if the longest of a set of parallel strokes appears at the bottom or right.

(3) a. 二三土大王手 川 州
b. 昌多炎哥呂串官飛 林 比
c. 井
d. 士末壬
e. 圭（cf. 土）刑（cf. 开，忄）

Another uniquely Chinese (but possibly motorically motivated) constituent-level pattern is the curving of the leftmost vertical stroke, already seen in some of the above examples. Further examples are given in (4a); the last two show how the rule overrides mirror reversal. Vertical strokes are never curved when not at the left edge, as illustrated by the straight strokes in the center and at the right in (4b). However, curving has many more exceptions than enlargement, as suggested by the straight left-edge strokes in (4c). As first observed by Wang (1983) and confirmed quantitatively by Myers (2019), curving is more likely in tall thin constituents (like <丷>) than in wide ones (like <冊>); Myers (2019) incorporates this observation in a prosodic analysis, wherein wider constituents map to more than one prosodic unit, and curving only applies if there is material to the right within a prosodic constituent. Nevertheless, the width effect remains a mere tendency. The greater degree of lexicalization in curving is also suggested by examples like those in (4d), which anomalously show curving at the left edge of the whole character rather than at the left edge of an individual constituent. Unsurprisingly, then, curving showed weaker generalizability to nonce stroke groups in the character-likeness experiments reported in Myers (2019).

(4) a. 川 爪 月 丹 用 周 月 戈
b. 十 中 木 平 年 年 午 耳 斗
c. 門 書 内 内 向 兩 肉 同
d. 辣（cf. 辛, 東）

Even less productive is hooking, historically reflecting the flick of a brush pen at the end of a stroke but now heavily lexicalized. Hooking into concave strokes is virtually obligatory, as in (5a), but its very obligatoriness allows this type of hook to be analyzed as an intrinsic feature of the stroke rather than something added by productive rule. As illustrated
in (5b), rightward hooking on vertical strokes appears in another suspiciously specific environment, namely to the immediate left of crossed strokes; Myers (2019) provides historical evidence that this pattern spread by analogy from the first two examples. Hooks on the end of horizontal strokes, like those in (5c), are plausibly analyzed as short strokes, since uniquely they may form a chain with another stroke, as in the center example, or even alternate with full strokes, as in the final example. Leftward hooking on vertical strokes borders on lexically contrastive, as seen by the near-minimal pairs in (5d), though as first observed by Wang (1983) and confirmed quantitatively by Myers (2019), it never appears on the left edge of a constituent and is more common when the vertical stroke is topped with other material, as in the first set in (5e). These generalizations are quite weak, however, and again the character-likeness experiments in Myers (2019) failed to provide unambiguous support for the productivity of leftward hooking.

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By contrast, the stroke patterns that apply across constituents are highly productive. Regardless of constituent function as semantic or phonetic component, the lowermost horizontal stroke is diagonalized when followed by another constituent to its right, as in (6a), even when part of a complex stroke as in (6b), and the lower right falling diagonal becomes a dot in the same environment, as in (6c). These alternations help shorten the pen distance to the following constituent (from the lower right of the first to the upper left of the next) but are not synchronically reducible to this motoric process, as demonstrated by the reversal in stroke order in (6d): the vertical stroke is written last when the constituent is on its own, but when the constituent is bound to another it is the diagonal stroke that is written last. Neither diagonalization nor dotting has any exceptions that cannot be explained via some subregularity; for example, the less robust diagonalization in (6e) is probably due to the lowermost horizontal stroke not being the lowermost stroke overall.

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3. Borrowing, modifying, and ignoring formal Chinese character regularities

Having identified a variety of formal patterns in Chinese characters (principles of strokes and their combinations, dot axis, enlargement, curving, hooking, diagonalization, and dotting), we now turn to examine whether they have been borrowed into three otherwise quite different Sinoform scripts, all originating well after Chinese characters had developed their modern standard form: Tangut script, Japanese katakana, and Hangul.
3.1 Tangut script

Unlike standard Chinese script and Japanese katakana, but like several other Sinoform scripts (Song 1998), the Tangut script did not develop naturally over centuries of use but was instead consciously invented. It was promulgated in 1036 by the ruler of the Tangut Empire just west of the Song Empire in what is now north-central China, remained in limited use even after the Tangut Empire was annihilated by the Mongols in 1227, but was then almost completely forgotten until its rediscovery in the nineteenth century; even today analytical questions remain (Gong 1982, Kychanov 1996, Galambos 2015). Spoken Tangut was a Tibeto-Burman language with root morphemes that tended to be monosyllabic, as in Chinese, though it also had verbal inflections (Miyake 2017b), making a Chinese-inspired logographic script a good fit.

At the same time, the social and political desire to distinguish themselves from the Song led the Tanguts to make their script differ much more from standard Chinese, in both internal characteristics and outer form, than more familiar Sinoform systems like Japanese kanji. The script morphology of Tangut characters, though sometimes borrowed directly from Chinese (Gong 1982), was much more likely to involve semantic compounds than the “affixation” of a semantic component to a phonetic component, the character type that dominates Chinese script, and the constituents were generally complex themselves, forcing the deletion of constituent-internal stroke groups when combined with others in order to preserve the dimensions of the ideal square (Tranter 2001). Given such complexities, Miyake (2017a: 37) expresses the consensus view (see also Kychanov 1996) when he notes that “[t]he true structure of many Tangut characters is obscure.”

Meanwhile, Tangut script phonology demonstrates the fallacy of reducing a script’s outer form to its stroke inventory, as illustrated in this section in a modern typeface (Tangut Yinchuan Version 12.0, copyrighted by Jing Yongshi for use in Li 2008, and expanded by Andrew West [https://www.babelstone.co.uk/Fonts/Yinchuan.html]) that was designed to reflect the actual form of printed and handwritten text (see facsimiles at https://www.babelstone.co.uk/Tangut/TongyinLookup.html, https://www.babelstone.co.uk/Tangut/WenhaiLookup.html). Despite being composed of mostly straight lines along the cardinal and major oblique axes, including complex strokes linking basic strokes into chains, and the occasional curve or hook, Tangut stroke groups still look decidedly un-Chinese, as can be seen in (7). This is primarily due to the greater use of the oblique axis, but also to the frequent use of complex strokes, like some of those in (7a), that are rare in Chinese and certainly never cross or make contact as they do here. Otherwise cardinal and oblique axes still tend not to mix. Dot axis is also like that in Chinese in lying along the main diagonal by default, as seen in (7b), and obeying symmetry when more than one dot is present, as in (7c). However, these similarities are also motivated by universal forces and need not be the sole result of direct borrowing.

(7)  a. 𘖦𘖦 𘖦𘖦 𘖦𘖦
b. 𗀎𗀎 𗙯𗙯
c. 𗐪𗐪 𗤢𗤢 𗕃𗕃

Tangut has nevertheless unambiguously borrowed the uniquely Chinese-like enlargement of the lowest of a set of horizontal or diagonal strokes, as in (8a-b), and of the rightmost of a set of vertical strokes, as in (8c); the example in (8d) shows that, just as in Chinese, both patterns may occur together (in the stroke group on the left).
Some of the above examples also show curving in the leftmost of a set of vertical strokes; further examples are shown in (9a). This left-edge position sometimes seems to be defined within a stroke group that is not at the left edge of the whole character, as in (9b). This is presumably another instance of genuine borrowing from Chinese character phonology.

Also as in Chinese script, curving is not always found at the left edge, but here the exceptions are much more predictable: a leftmost vertical stroke is consistently straight when topped by a horizontal stroke, as in (10a), or when a horizontal stroke contacts or crosses it, as in (10b). These restrictions may be generalized from similar but less robust constraints seen in Chinese characters like those in (11a) and (11b), respectively.

By contrast, hooking has not been productively borrowed as a process, appearing only within concave strokes, as in (12), with the hooked stroke in (12a) taken directly from the Chinese inventory, as in (13a), and that in (12b) a modification of the Chinese stroke in (13b). As noted earlier, even in Chinese such hooking may be most parsimoniously analyzed as an intrinsic feature of the stroke rather than a productive formal regularity.

Finally, despite fact that Tangut characters are virtually always made up of more than one constituent, there is no sign of the cross-constituent stroke alternations of diagonalization and dotting. However, this may be simply because neither has a chance to apply: left-edge constituents never have horizontal strokes at the bottom, presumably due to the universal principles of stroke direction and contact noted earlier, and falling diagonal strokes at the lower right of a constituent are always part of a cross, as in (14a), and such diagonals do not undergoing dotting in Chinese script either, as shown in (14b).
3.3 Japanese katakana

By the end of the 700s CE, influenced by a similar practice that already existed in Korea, Japanese writers were annotating Chinese text with a small set of graphemes based on Chinese characters to indicate their Japanese pronunciations (Whitman 2011). In modern Japanese script these evolved into two separate semi-syllabic (moraic) systems. The more common is hiragana, used for affixes, function morphemes, and native lexical items lacking kanji, but it has more in common with cursive Chinese calligraphy than with standard Chinese character forms. This section looks instead at katakana, which, despite being restricted primarily to transliteration, as in loans and onomatopoeia, has a script phonology much closer to that of standard Chinese.

The modern form of katakana developed naturally over a millennium (Tsukishima 1977, 1997). Hansell (2002: 166) claims that in its derivation from Chinese characters “the simplifications are usually the loss of one or a few strokes, no more radical than many of those involved in the simplification of Chinese that has occurred in Mainland China” and that “there is no historical or structural principle” to distinguish them; thus “their only difference is the respective functions they perform within Japanese.” This claim is misleading in two ways. First, as Song (1998: 23) notes, the changes were actually often so great that “the origins can not be judged with certainty by the outer forms alone.” Second, in contrast to the full preservation of Chinese character grammar in simplified characters, modern katakana has retained only some of the formal patterns reviewed above, while developing new regularities of its own.

The stroke inventory in katakana is quite similar to that in standard Chinese script, including the preference for cardinal axes and the tendency to avoid mixing them with oblique axes, but even at this most fundamental of formal levels, katakana still manages to go its own way. As noted earlier, Chinese script has two anti-diagonal (/) strokes that differ only in writing direction, but unsurprisingly they never form lexical contrasts. However, katakana has not one but two pairs of graphemes differing in stroke direction, as illustrated in (15). The Romanization glosses and source characters (the latter based on Tsukishima 1977, 1997) confirm that pronunciation and history do not explain the modern forms, and indeed, some sources are ambiguous or unclear. Though the two oblique strokes also differ slightly in axis, Chinese characters only make such physically subtle distinctions between the conceptually quite distinct oblique and cardinal axes, as in (16).

(15) a. シ -n (< 専?) ソ so (< 曽)
b. シ shi (< 之) ツ tsu (< 津, 川, 州)

(16) 千 千

As shown in (17a), katakana also has a stroke slightly off from true vertical, a pattern completely absent from the Chinese system, though it does not form a direct lexical contrast with true vertical strokes (cf. the complex strokes in (17b)). Possibly this off-vertical stroke arose as the result of maintaining orthogonality with the source character’s (non-distinctively) off-horizontal stroke (ヤ < 也, attested by 810, according to Tsukishima 1977), which later spread (キ < 業, attested by 948).

(17) a. サ ya (< 也) キ ki (< 業)b. セ se (< 世?) モ mo (< 毛)
Some of the above examples show that the default falling diagonal dot axis is the same in katakana as in Chinese script, which may reflect either borrowing or universal motoric motivations, but the only instance of dot axis symmetry, in (18a), is inherited directly from the source character. The reemergence of default dot direction in (18b) with the loss of the adjacent parallel stroke from its source may hint at productivity, though it also makes the katakana form match the otherwise unrelated Chinese character constituent in (18c).

(18) a. ほ ho (＜保)
b. と to (＜止)
c. と

Enlargement of the lowermost and rightmost of a set of parallel strokes is also observed in katakana, but this is virtually always inherited directly from the source character, as shown in (19a-b). Even the apparently productive enlargement in (19c) may merely be due to ad hoc analogy with (19b), which emerged much earlier (based on the dates from Tsukishima 1977).

(19) a. エ e (＜江) チ chi (＜千) テ te (＜天) ニ ni (＜二)
   は mi (＜三) モ mo (＜毛)
b. リ ri (＜利) (810)
c. サ sa (＜散) (1126)

Vertical stroke curving seems quite regular in katakana, but it works in almost the opposite way from Chinese script: only once does it occur at the left edge, in (20a), and otherwise it occurs at the right edge, as in (20b), or centrally, as in (20c). The instance of left-edge curving is inherited from the source character and right-edge curving started as a reanalysis of a hook (then apparently spread by analogy, as just noted). As for curving in central position, the forms in (20c) are ordered by when they began to be unambiguously and consistently curved (based on dates from Tsukishima 1977). The spark was the inheritance of curving from a left-edge curved stroke in two graphemes, but even these were only established over two hundred years after katakana’s origins, and the spread of curving to graphemes whose sources lacked it was also a very slow process. This history suggests that the Chinese curving rule remained a strong hindrance to the development of the new rule in the minds of Japanese writers, who still had to apply the old rule in kanji.

(20) a. る ru (＜流)
b. リ ri (＜利) サ sa (＜散)
c. テ te (＜天) (1020)
   ナ na (＜奈) (1020)
   チ chi (＜千) (1073)
   ケ ke (＜介, 介) (1196)
   ア a (＜阿) (1344)

The remaining Chinese character patterns show even less productivity in katakana. Hooking in convex strokes is absent, as seen in (21), in fact dropped from its source in (21a). Hooking on horizontal strokes (off-horizontal here) is either inherited directly from the source character, as in (22a), or by ad hoc analogy to this, as in (22b), the very long delay between the two (based on the dates in Tsukishima 1977) suggesting a lack
of productivity. Moreover, consistent with the analysis of this hook type as actually being a short stroke in Chinese script, earlier versions of the katakana form in (22b) looked more like its hiragana counterpart in (22c), with a separate short stroke rather than an attached hook. On vertical strokes in katakana, the hook is either inherited from the source character, as in (23a-b), or from a stroke group that was already optionally hooked within Chinese, as in (23c) (note the free variation in another character containing the same stroke group). The cross-constituent diagonalization and dotting alternations have no chance to apply at all, since each katakana is intended to fill up its own separate ideal square.

(21)  a. ひ hi (< 比)
    b. せ se (< 世？)

(22)  a. は ya (< 也) (883)
    b. せ se (< 世？) (1697)
    c. せ se

(23)  a. カ ka (< 加)
    b. オ o (< [obsolete variant of 於])
    c. ホ ho (< 保) (cf. 茶 ~ 茶)

3.3 Korean Hangul

Hangul (its most common name in English, but officially hangeul in South Korea and Chosŏngŭl in North Korea) is like Tangut script in that it did not evolve naturally but was instead promulgated by the Korean government in a specific year, in this case 1446. In stark contrast to Tangut script, however, it is often praised as one of the most elegant writing systems ever invented (e.g. Lee 2009): simplifying somewhat, each ideal square represents a syllable, each stroke group within the square represents a phoneme (a letter), and the strokes themselves provide information about the phoneme’s phonological features (e.g. vowel versus consonant, place and manner of articulation).

These internal characteristics have remained quite stable despite large changes in the outer form of Hangul letters (script phonology) that began “within a decade of their promulgation” (King 1996: 225). A change of writing medium was involved, as the simple geometric forms of the woodblock-printed foundation documents (circles, round dots, and lines along the cardinal and major oblique axes, both independent and combined into right-angled complexes and squares, though never crossing) had to be realized in handwriting (Ahn 2017). At least one of these changes also related to interpretation in pronunciation, namely the loss of the grapheme in (24) along with the consonant that it represented (Stonham 2011), but which also happens to be one of the few original Hangul graphemes that mixed cardinal and oblique axes.

(24) △ z (○ ◯ in most modern dialects)

Nevertheless, as with the other systems discussed above, modern Hangul does not simply preserve all of the formal regularities of standard Chinese script, but rather borrows some while modifying or ignoring others. The most obvious non-Chinese feature, of course, is the circularity in the letters in (25).
Dots are no longer round in modern Hangul, but they do not take on the Chinese default falling diagonal axis either. Instead they are realized as short strokes orthogonal to and contacting the adjacent stroke, as illustrated in (26a); compare the dot in the first example with that in the Chinese constituent in (27). Depending on the typeface, the short stroke in the modern Hangul in (26b) may also be realized as parallel to the adjacent stroke.

(26) a. ㅏ a ㅓ eo ㅗ o ㅜ u
b. ㅎ h (cf. variant ሙ)

As pointed out by Myers (2019), however, such examples also suggest that Hangul has borrowed the enlargement pattern from Chinese script. A fuller set of examples reveals that bottommost enlargement does indeed work much as in Chinese script, as seen in (28); in fact, the lower of the two horizontal strokes in (28a) was already lengthened relative to the upper one even in its original geometrical form of the printed foundation documents (see facsimile in Kim 2005). What is borrowed here truly seems to be an abstract regularity rather than a specific stroke, since the requirements of the ideal square prevent Chinese script from applying bottommost enlargement to solitary vertical strokes, as illustrated by the equally long vertical strokes in the two characters in (29a); compare this with bottommost enlargement of the lower vertical stroke within the single-constituent character in (29b). This restriction does not affect the Hangul letters because they must always be combined to form complete ideal squares.

(27) ㅏ

(28) a. ㅍ p
b. ㅗ o ㅜ u ㅛ yo ㅠ yu

(29) a. 上 下
b. 卡

In Hangul, however, the nature of the targeted element does matter in horizontal arrangements. Only vertical strokes show enlargement on the right, as in (30a), whereas the short horizontal strokes (historically dots) are instead enlarged on the left, as in (30b). This latter pattern not only differs from Chinese script but also goes against the general motoric tendency towards final-gesture enhancement.

(30) a. ㅐ ae ㅒ yae ㅔ e ㅖ ye
b. ㅏ a ㅓ eo ㅑ ya ㅕ yeo

There is no curving of left-edge vertical strokes in Hangul, an absence that may relate to the Chinese restriction against curving without other material within the same “prosodic” domain (historically all of the modern two-vertical-stroke letters were two-letter diphthongs). Since Hangul never shows hooking either, a more general explanation may be that unlike highly predictable enlargement, curving and hooking were considered too salient by early
Hangul writers fluent in Chinese script, where they are often lexically specified, and thus too disruptive of the new system’s geometric logic.

The combination of Hangul letters into syllables within an ideal square provides ample opportunity for the cross-constituent alternations of diagonalization and dotting to apply, and indeed both do, just as in Chinese script (as observed by Myers 2019). While illustrated with simple letter combinations in (31), these generalizations also apply in full syllabic ideal squares. Diagonalization is seen in the letter combinations representing diphthongs, as in (31a–c), and consonant clusters, as in (31d–e), where the affected horizontal element is part of a complex stroke. Dotting (or stroke shrinking, since modern Hangul has no true dots) is seen in the doubled letters representing coda consonants with so-called tense or fortis phonation, as in (31f–g). Note that the application of diagonalization in (31b) also reconfirms that this pattern is not merely the mechanical effect of efficient pen movement, since due to the directional principles, the affected stroke here is not the last one written within its letter.

(31) a. ㅗ o ㅚ oe ㅘ wa ㅙ wae
b. ㅜ u ㅟ wi ㅞ we ㅝ wo
c. /w/ ㅡ ui

d. ㄴ n ㄵ nj ㄶ nh

e. /l/r /l/ lg ㄹ/lm ㄹ/lb ㄹ/ls ㄹ/lt ㄹ/lp ㄹ/lh
f. ㅅ s ㅆ ss

g. ㅈ j ㅉ jj

4. Discussion

It has long been noted that the four Sinoform systems discussed here (Chinese script, Tangut script, Japanese katakana, and Korean Hangul) share formal properties, but observations have generally been restricted to the ideal square, traditionally vertical text lines, the stroke inventory, and the mechanical effects of ink-brush calligraphy. As reviewed in Table 1, however, more careful analysis reveals a number of deeper similarities and differences. Some formal regularities of Chinese script are inapplicable and some are ignored; some may be shared solely due to universal visual or motoric constraints and some are directly inherited from source characters or strokes; some are modified and some are unambiguously borrowed just as they are from Chinese script.

Table 1. Chinese character phonology in some non-Chinese Sinoform scripts.

<table>
<thead>
<tr>
<th></th>
<th>Tangut</th>
<th>Katakana</th>
<th>Hangul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardinal axis preferred</td>
<td>Universal (with modification: more oblique)</td>
<td>Universal (with modification: off-vertical and off-horizontal axes)</td>
<td>Universal</td>
</tr>
<tr>
<td>Avoid mixing cardinal and oblique axes</td>
<td>Universal (with modification: more mixing)</td>
<td>Universal</td>
<td>Universal</td>
</tr>
<tr>
<td>Default falling diagonal dot axis</td>
<td>Borrowed (with universal motivation)</td>
<td>Borrowed (with universal motivation)</td>
<td>Ignored (dots instead orthogonal or parallel to adjacent stroke)</td>
</tr>
</tbody>
</table>
Despite the very small size of this sample, certain generalizations can safely be drawn. First, none of these systems borrowed Chinese character phonology in total, for fairly obvious reasons: the writing cultures of Tangut script, Japanese katakana, and Korean Hangul all wanted to distinguish themselves from that of China, katakana and Hangul also had to be visually identifiable as separate systems even when combined in text with Chinese characters (much like the visual distinctness of digits, punctuation, and uppercase and lowercase letters in Western alphabetic scripts), and Hangul had its origins in a unique and utterly non-Chinese geometric logic. Second, all of the systems have nevertheless borrowed regularities of Chinese character phonology, not merely characters or strokes, and among these are true borrowings unexplainable via universal forces. Third, the likelihood that a regularity was borrowed depends in part on its productivity within Chinese script: enlargement is highly regular and was readily borrowed, the more exception-prone left-edge curving tended to be modified or ignored, and the highly lexicalized hooking was never borrowed as a productive
process at all. Fourth, even when Chinese regularities were modified in the adopting systems, these systems still have script phonologies of their own: katakana non-left-edge curving and Hangul left-edge enlargement may differ from Chinese but they are internally consistent.

Finally, and perhaps most interestingly, the borrowing of script form regularities applied at more than one level of representation. At the superficial level (script “phonetics”) was the influence that the non-distinctive off-horizontal stroke in Chinese 也要 had on the lexically specified off-horizontal stroke of katakana 也要. More abstract (script phonology) was the application of bottommost enlargement in vertical strokes in Hangul  unconditional and  unconditional, despite the lack of direct Chinese models. Still more abstract was the sensitivity of left-edge curving to constituent boundaries (script morphology), borrowed from Chinese into Tangut script.

There are many more Sinoform scripts than these, of course. Some seem to have adopted Chinese character phonology wholesale, creating new constituents by combining standard Chinese strokes in standard ways, as in the semi-syllabic Khitan small script (Wu and Janhunen 2014), or in a variety of logographic scripts (thoroughly surveyed in Handel 2019) that also built on Chinese character morphology: Khitan large script, Jurchen script, Korean hanja, Japanese kanji, Vietnamese chữ Nôm (see also Myers 2019), and Zhuang script. The semi-syllabic Zhuyin system for Mandarin, developed during the early years of the Republic of China and still used in Taiwan (Chang 1981, Wippermann 2017), also seems to have modified standard Chinese character phonology only minimally. Other Sinoform scripts have such a different stroke inventory that standard Chinese regularities are generally inapplicable, such as the semi-syllabic Japanese hiragana and syllabic Sinitic Nüshu (Van Esch 2017, Zhao 1998), and Yi script (Shi 1996), both the logographic classical script (which also borrows aspects of character morphology) and the modern syllabic script. Even a quick glance, however, suggests that each of these latter systems has developed a coherent script phonology of its own.

There seems no reason not to extend the analogy between areal script form patterns and areal sound patterns beyond the Sinosphere, although in more transparent systems there is necessarily much more interaction between the spoken and script phonologies. The key is to search for the underlying formal principles that give rise to a script’s “look”, including universal motivations in vision and motor control, and to recognize that just as phonology is not mere physics, even outer form has a rich inner life.

References


