

HANGUL AND THE KOREAN MANUAL ALPHABET

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제목: 한글과 한국 수화

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개요: 본 연구의 목적은 한국 지문자와 한글의 관계를 살펴보는 것이다. 첫번째로, 한국 지문자, 한국 지화와 한국 수화가 어떻게 다른지 설명한다. 두번째로 서양과 한국의 수화 언어에 관한 연구를 짧게 요약해서 적절한 한국 지문자의 분석하는 방법을 찾을 수 있다. 한국 지문자를 분석하기 위하여 수형소, 수동소와 수향소라는 수화 음운론의 개념을 소개한다. 한국 지문자의 수화 음운소와 한글 문자의 특성을 비교하기를 통하여 한글의 영향 때문에 한국 지문자의 구조가 유일하다고 주장한다.

본 연구의 결과의 요약이 다음과 같다. 한글 자음 중에는 평음 문자와 격음 문자의 변별적 특징이, 즉획, 수형을 통해서 반영한다. 그렇지만 문자의 특징을 조직적으로 반영하지 않는다. 반면에, 평음 문자와 격음 문자의 변별적 특징이 조직적으로 수동을 통해서 반영한다. 한글의 모음의 특징은 수형과 수향을 통해서 조직적으로 반영한다.

주제어: 지화, 지문자, 수화, 한글

Keywords: Sign language, fingerspelling, manual alphabet, KMA, Hangul

1. Introduction

1.1 Structure

This paper examines the relationship between the Korean indigenous writing system, Hangul, and the system used to represent it in the visual-gestural modality, the Korean Manual Alphabet (KMA). We discuss the analysis of signs in section 2, before going on in section 3 to describe the KMA in detail. We then briefly describe Hangul as a featural writing system and examine the regularity with which the graphical features of Hangul are reflected in the KMA. The remainder of this introduction is given to the definition of terms.

Transliterations shall be given using the Yale Romanisation and italicised, except in the cases of conventional spellings or personal names, the transliterations of which shall use the preferred transliteration of the person. Where the graphemes of Hangul are

referred to, no transliteration shall be provided and we follow Coulmas [1] in marking both the graphemes themselves and any individual graphical features with angled brackets, like so < 〉.

1.2 Korean Sign Language and the Korean Manual Alphabet

Despite the traditional presentation of the Korean Peninsula as linguistically homogeneous, the reality of the situation is that a diverse range of languages are used in Korea daily, including Korean Sign Language (KSL). The Deaf population is disputed, but likely lies between the government's official estimate of 180,000 people and the Korean Association of the Deaf's unofficial estimate of 300,000 people [2]. Furthermore, what proportion of this community use KSL regularly is unknown. This language is thought to be a member of the Japanese Sign Language family, and consequently to be related to Japanese and Taiwanese Sign Languages, as a result of its promulgation during the Japanese occupation of Korea. Its study and spread has been somewhat controversial over the latter half of the twentieth century [3], however it has received an increasing amount of attention in recent years.

In many Deaf communities bilingualism with a local Language of Wider Communication (LWC) is common. This is also the case in Korea. Since those members of Deaf communities who use regional LWCs most often deal with them in their written rather than spoken modality, systems of signs representing written forms of LWCs, known colloquially as either fingerspelling or manual alphabets, are also common. In contemporary KSL, any Korean words for which there are no corresponding signs and which a user may want to incorporate into their utterances, for example personal names, are signed using the Korean Manual Alphabet. The contemporary KMA is very closely based on a system developed in 1947 by a teacher working at the Seoul School for the Deaf, Yun Baek Won [3].

1.3 Manual Alphabets and Fingerspelling

Manual alphabets may be characterised as adjuncts to particular sign languages, rather than fully incorporated parts of them, as manual alphabets represent the written form of spoken languages in a signed modality. This attitude is exemplified by Choi Sang Bae's choice to exclude the KMA from his analysis of KSL handshapes on the grounds of these signs not being lexemes in their own right [4]. However, it is not uncommon for fingerspellings to become independent words. In addition to the process whereby fingerspellings of words originally

borrowed from spoken languages may become lexicalised or nativised [5], in many sign languages fingerspelled words may be used in place of a lexeme for which a sign already exists for pragmatic reasons and thus become independent, lexical signs [6].

Manual alphabets may be classified primarily as one-handed or two-handed manual alphabets, according to the number of hands used in the production of their signs, and secondarily according to the method by which the hands are used to encode the graphemes of a given writing system. Manual alphabets may be further divided into arthrological and dactylogical systems. For arthrological manual alphabets, specific areas or features on the hand are assigned the values of graphemes, whereas dactylogical systems encode graphemes in the shape, position and movement of the hands [7]. Thus, the KMA may be described as a one-handed, dactylogical manual alphabet.

Although fingerspelling and manual alphabets are often conflated, here we make a distinction. We characterise manual alphabets as collections of static signs corresponding to the graphemes of a given writing system and fingerspelling as the production of signed strings representing a signed form of a written form of a spoken form. In other words, fingerspelling may be considered the usage of manual alphabets. In the process of fingerspelling, manual alphabets do not appear as a series of static handshapes, rather as a smooth flow between handshapes representing one continuous signal. The transition between handshapes influences their formation and analogies have been drawn between fingerspelling and the production of spoken language [8]. This distinction is made here as the subsequent analysis of the KMA compares the features of each individual grapheme of Hangul with the features of the iconic form of the corresponding handshape, rather than any of the variants which arise from the production of one of the signs in a particular phonological environment.

To summarise, then, the KMA is a dactylogical manual alphabet, that is to say a system for encoding the graphemes of Hangul in the visual-gestural modality. It is used as an adjunct to KSL, usually in the form of fingerspelling; in other words, combinations of KMA signs are used as a representation of a string of Hangul characters which represent a phrase of spoken Korean for which there is no sign in KSL or which the signer makes the pragmatic choice to represent not in KSL. The focus of this paper is the signs which comprise the KMA rather than the phenomena which accompany their use in fingerspelling. We now go on to provide a brief overview of the description of signed

language followed by a more detailed examination of the signs of the KMA.

2. The Analysis of Signs

Signs were not considered analysable units until the latter part of the twentieth century [9]. The model which first recognised that signs were meaningful units composed of meaningless units proposed by Stokoe, holds that signs are analysable as simultaneously segmentable units. That is, they may be described as feature complexes, similar to phonemes – cheremes in Stokoe’s terminology. The key features of signs used under this model to distinguish minimal pairs were handshape, location and movement, designated *dez*, *tab* and *sig*, respectively. Subsequently, other models describing sign language phonology, suggest that signs may also be understood as sequentially segmentable, like spoken words [10].

Korean scholarship on the analysis of KSL began a little later than similar scholarship in the west, starting with Kim Sung Kwuk’s 1982 thesis “A Psycholinguistic Study of Korean Sign Language” [11]. This study introduced the concepts of sign language phonology as they apply to KSL, identifying 29 handshapes, 23 location features, 36 movement features, 20 orientation features and 20 non-manual features which could be considered distinctive in KSL [12]. Although these numbers are the subject of much debate (Choi Sang Bae’s 2012 analysis of KSL handshapes identifies 69 that may be considered distinctive, for example [4]) KSL is still analysed in terms of the five sorts of features which he identified. It has also been observed that Kim Sung Kwuk’s paper drew analogies between writing systems and signed language, using terminology derived from the description of Chinese characters (六書 - *yukse*) in order to create a taxonomy of signs [11].

In both scholarly traditions, the notation of signs has proven problematic. For purposes of general readability, we follow the example of pedagogic works on KSL here, where description of signs has traditionally been much more impressionistic, relying on text description rather than phonological notation. One specific piece of notation we shall make use of here, though, is the assignment of numbers to the fingers, running from one at the thumb to five at the little finger of each hand [13]. We use these terms to avoid the confusion that may arise from the differing finger names found in national varieties of English. Furthermore, in the following descriptions

of signs we shall refer to the joint between the finger and the hand “the first knuckle” and the next joint along as “the second knuckle”.

As discussed in section 1.2, while manual alphabets are used alongside sign languages, they are distinct systems. For this reason, we must ask what approach should be taken to the signs of a manual alphabet rather than a sign language. It is not necessary to describe all of the features used to distinguish between the signs of KSL when describing the KMA. For example, while location is a feature which may be used to distinguish meaning in KSL this is not the case for the KMA, which tends to be signed in a signing space just in front of the speaker’s torso by convention. In addition to this, the presentation of the hands in isolation from the rest of the signer in pedagogic materials [13] bears this out and also demonstrates that non-manual signals, such as facial expression, are not distinctive with regard to the KMA.

We now go on to analyse the signs of the KMA in terms of the three remaining features, handshape, orientation and movement, all of which may be considered distinctive between the signs of the KMA. We shall pay particular attention to the sub-features which make up each handshape, for example digit extension, in order to demonstrate that the KMA generally reflects Hangul’s featural principles of design by systematically encoding the graphical elements which encode the distinctive features of spoken Korean. This is in stark contrast to other manual alphabets, which generally enjoy an entirely arbitrary relationship with the forms of the graphemes of the writing systems which they represent.

3. The Signs of the Korean Manual Alphabet

While there are substantial differences between the linguistic structure of Korean and KSL, outside of their differing modalities (Korean references?), there is substantially more overlap between the KMA and Hangul. Most notably, they are both “product[s] of a deliberate, linguistically informed planning” [14]. Further parallels with Hangul are drawn by comparisons of Yun Baek Won with King Sejong and the KMA’s nickname *hunnongjeongji* (訓聾正指 – correct fingers for the instruction of the Deaf), in light of the original name of Hangul *hunminjeongeum* (訓民正音 – correct sounds for the instruction of the people) [12]. Our description of the KMA shall be broken down into two parts, first an examination of the signs corresponding to the consonant graphemes of Hangul, followed by discussion of those encoding the vowel graphemes.

3.1 The Consonants of the KMA

The nineteen consonants of Hangul are represented by twelve KMA handshapes, all but one of which are also used in KSL. Thus the handshape parameter is of primary importance for distinguishing the signs of the KMA which correspond to the Hangul consonants. We choose not to reproduce images of the signs of the KMA in this paper, but refer the reader to Choi Sang Bae's analysis of KSL handshapes [4]. Alternatively, full images of the signs of the KMA, rather than just the handshapes in isolation, are to be found in the online *hankwuk swuhwa sajen*, produced by the *kuklipkukewen* [15], which may be retrieved at the following URL: <http://222.122.196.111/>. In the following table we provided the name of the KSL handshape as given in Choi Sang Bae's paper along with information on the Hangul grapheme or graphemes to which these handshapes correspond.

Handshape Name	Number of KMA consonant signs using handshape	Consonant graphemes corresponding to handshape
2 <i>hyeng</i>	4	<ㄷ, ㅌ, ㄴ, ㄹ>
6 <i>hyeng</i>	3	<ㄱ, ㅋ, ㆁ>
7 <i>hyeng</i>	2	<ㅈ, ㅊ>
4 <i>hyeng buthim hyeng</i>	2	<ㅅ, ㅆ>
3 <i>hyeng</i>	1	<ㄷ>
2 <i>hyeng kwuphimhyeng</i> (20 <i>hyeng</i>)	1	<ㅁ>
8 <i>hyeng</i>	1	<ㅍ>
7 <i>hyeng</i> <i>kemcikuphimhyeng</i>	1	<ㅋ>
N/A	1	<ㅍ>
10 <i>hyeng</i>	1	<ㅇ>
<i>Thikuth hyeng</i>	1	<ㅌ>
<i>Hiut hyeng</i>	1	<ㅎ>

Table 1. The handshapes of the KMA corresponding to Hangul consonant graphemes.

On the basis of this table, we may make the following observations. The sign corresponding to <ㅍ> is the only handshape not to appear in KSL, although it does somewhat resemble the handshape designated 4 *hyeng kwupim hyeng* (40 *hyeng*).

We also see that handshape is a remarkably distinctive parameter with regard to the signs of the KMA which represent the consonant graphemes and the features of orientation and movements are distinctive in very few cases. Generally, it is the graphemes for lax consonants and their tense counterparts which are encoded using a shared handshape. In these cases, movement is distinctive. In the one remaining case, where neither handshape nor movement is distinctive, the signs which represent <ㄱ> and <ㅋ> are differentiated by their orientation.

We now describe the handshapes discussed above in lieu of providing illustrations. A full extension of a digit describes the extension of both the first and second knuckles of the digit. Where digits are not mentioned, they may be taken to be fully flexed and not all extended. *2 hyeng* is a fully extended 2 and 3 digit; *6 hyeng* is a fully extended 1 and 2 digit; *7 hyeng* fully extended 1, 2 and 3 digit; *4 hyeng buthim hyeng* is a fully extended 2, 3,4 and 5 digit with all digits touching their neighbours; *3 hyeng* is a fully extended 2, 3 and 4 digit; *2 hyeng kwuphimhyeng (20 hyeng)* is the 2 and 3 digits extended at the first knuckle, but flexed at the second; *8 hyeng* is fully extended 1, 2, 3 and 4 digits; *7 hyeng kemcikuphimhyeng* is a fully extended 1 and 3 digit with the 2 digit extended at the first knuckle, but flexed at the second; *10 hyeng* is formed by the extension of the 1 and 2 digits at the first knuckle, and their flexion at the second to form a ring shape while the remaining digits are all fully extended; *thikuth hyeng* is formed by fully extending the 2, 3 and 4 digits, while keeping the 3 and 4 digits pressed together; *hiuh hyeng* is the full extension of the 1 digit; finally, the sign corresponding to <ㅍ> is the extension of the 2, 3, 4 and 5 digits at the first knuckle, while the second knuckle remains flexed.

In the next section we shall demonstrate that this gives the signs of the KMA which correspond to the Hangul consonant graphemes a much higher degree of iconicity than those which correspond to the vowels. This choice could be explained as an attempt on the part of the designer to make the signs for the consonant graphemes of Hangul strong visual matches to the graphemes which they encode, or alternatively, to prevent the signs from resembling one another. We now turn our attention to the vowels of KMA.

3.2 The Vowels of the KMA

Unlike the consonants, little effort seems to have been made to have the appearance of the signs of the KMA conform to the design of

Hangul graphemes. Only five handshapes are used to represent all twenty Hangul simple and complex vowel graphemes. Again, according to Choi Sang Bae's analysis, all of these handshapes are used in KSL. The names and uses of these handshapes in the context of the KMA may be seen in the table below.

Handshape Name	Number of KMA vowel signs using handshape	Vowel graphemes corresponding to handshape
<i>1 hyeng</i>	9	<ㅏ, ㅑ, ㅓ, ㅕ, ㅗ, ㅛ, ㅜ, ㅠ, ㅡ, ㅟ>
<i>2 hyeng</i>	4	<ㅓ, ㅕ, ㅗ, ㅛ>
<i>Yewuhyeng</i>	7	<ㅓ, ㅕ, ㅗ, ㅛ, ㅜ, ㅠ, ㅡ>
<i>Ceypihyeng</i>	2	<ㅓ, ㅕ>
<i>Yecahyeng</i>	1	<ㅓ>

Table 2. The handshapes of the KMA corresponding to Hangul consonant graphemes.

Two facts stand out from an examination of this table. First, the total number of vowel signs listed above exceeds the number of vowel graphemes in Hangul. This is due to the fact that two handshapes are used in forming the signs which correspond to the /w/ on-glides <ㅛ> and <ㅠ>, therefore these graphemes count towards the totals of the number of vowel signs using each handshape more than once. These are the only signs of the KMA which exhibit any local or hand internal movement. Second, only one handshape, *2 hyeng*, is shared with the set of handshapes which correspond to the consonant graphemes of Hangul. One result of this is the signs corresponding to the Hangul graphemes <ㅓ> and <ㅕ> are identical.

The handshapes may be described as follows. The handshape designated *1 hyeng* is a fully extended 2 digit; *2 hyeng* is as described above in the discussion of the consonants of the KMA; *yewuhyeng* is a fully extended 2 and 5 digit; *ceypihyeng* is a fully extended 2, 3 and 5 finger; finally, *yecahyeng* is a fully extended 5 digit.

In the following section we offer a brief introduction to Hangul as a featural writing system before going on to argue that the graphical features of Hangul are encoded in the internal structure of the KMA.

4. The Korean Manual Alphabet as a featural system.

Hangul has been characterised as a featural writing system [16]. Unlike other writing systems which have purely arbitrary relationship

between graphical representation and sound, at the time of its creation, Hangul represented a phonological analysis of Late Middle Korean [17]. The graphemes representing the lax or lenis consonants of the language are thought to have been designed as stylised representations of the speech organs when they produce the corresponding sounds. These characters are regularly modified by graphical features to represent phonological distinctions.

The form of all the vowels of Hangul are built from three graphical elements: the vertical stroke - <|>, the horizontal stroke - <—> and the dot - <·>, now more commonly written as a short stroke perpendicular to a vertical or horizontal line. These represented the Confucian concepts “man”, “Earth” and “heavens”, respectively.

At the time of their creation, the structure of these graphemes was largely transparent. The vertical and horizontal lines both represented single sounds and the addition of a new graphical element would modify that sound in predictable ways. For example, the vertical line was both the grapheme <|>, representing the sound /i/ and could be added to other graphemes in order to represent /j/ off-glides as in the grapheme <ㅣ>, which is composed of <ㅣ> and <|>. It must be noted that the modern graphemes retain their archaic structure despite sound change since the LMK period. Thus, the /j/ off-glides are no longer present in the contemporary language.

4.1 The Encoding of Phonological Features in Hangul

As mentioned above, there are nineteen Hangul consonant graphemes. We may divide these into five consonant series, which share a place of articulation, however it must be noted that the grapheme <ㄷ> is a systematic irregularity which is not part of any consonant series. Modern graphemes of these consonant series along with their classification according to the *Hwunminchongumhaylye* are given below.

Name in <i>Hwunminchongum</i>	Graphemes
牙音 (Molar Sound)	<ㄱ, ㅋ, ㆁ>
舌音 (Tongue Sound)	<ㄴ, ㄷ, ㄹ, ㄷㄷ>
脣音 (Lip Sound)	<ㅁ, ㅂ, ㅃ, ㅄ>
齒音 (Tooth Sound)	<ㄸ, ㅌ, ㅍ, ㅍㅍ>
喉音 (Throat Sound)	<ㅇ, ㆁ>

Table 3. The classification of the contemporary Hangul consonants according to the Hwunmincengumhaylye.

The left-most grapheme in the right hand column of this table represents the “basic” shape of the consonant series, which is then modified. The two graphical features most commonly used to derive new consonant graphemes from the “basic” graphemes are stroke addition and character gemmination. For example, when a single horizontal stroke is added to the grapheme <ㄴ> to form <ㄷ>, the continuant /n/ becomes the stop /t/. A horizontal stroke is also used to mark aspiration, as it is when distinguishing between the graphemes <ㅍ> and <ㅍᄉ>. The gemmination of the “basic” grapheme represents a consonant pronounced with greater articulatory tension. While the modifications to the “basic” consonant graphemes are made systematically to represent the distinctive features of spoken Korean, it must be noted at this point that the relationship between phonemic distinction and its graphical representation is entirely arbitrary.

Finally, the gaps in the contemporary system must be acknowledged. The consonants classified as “throat sounds” have been re-assigned since their creation and one of their number is no longer used, so the graphemes are a better fit to the sounds of Contemporary Korean. Furthermore, the featural nature of the Hangul seems to be only very inconsistently retained in the labial series of consonants. The reasons for this are not known, but it has been suggested that this system maintains stroke addition in a less visually iconic form while minimising confusing similarity between graphemes [18].

While vowel harmony is no longer as important a part of the Korean language as once it was, it is still reflected in the graphemes of Hangul. Notably in the form of the simple *yang* and *eum* vowels, which are mirror images of one another, as in <ㅏ> and <ㅓ> and in the way that *yang* and *eum* vowel graphemes may not combine with each other to form /w/ on-glides, as in <ㅑ> and <ㅓᄉ>.

4.2 The Encoding of Graphical Features in the KMA

A particularly striking feature of the distribution of handshapes over the consonant series is the fact that, while the same handshape is used to represent the graphemes which are used to represent the lax and tense phonemes of Korean, with the same place of articulation, the aspirated consonants which share a place of articulation are typically encoded with a separate handshape. From this description, it seems that

the signs which encode the aspirated consonant graphemes of Hangul are not distinguished systematically from the signs which encode the lax consonants; this is an artefact of the description of signs. While it is not as regular a reflection of the graphical features of Hangul as the movement feature discussed below, aspiration tends to be marked by digit extension. This digit extension, though, is not systematic in that the digit which is extended cannot be predicted and seems to be determined by ergonomic factors, which digits are available for extension in addition to those which are already extended for the basic handshape and even visual fidelity to the graphemes of Hangul. It must also be noted that, where digit extension would lead to identical handshapes, other means are used to keep them distinct. For example the signs corresponding to <ㄷ> and <ㅌ> are distinguished only by the configuration of the extended 3 and 4 digits and the signs corresponding to <ㅈ> and <ㅊ> are distinguished by the contrast between the full extension of the 2 digit in the 7 *hyeng* handshape and extension of only the first knuckle in the 7 *hyeng kemcikuphimhyeng* handshape, respectively.

We now turn our attention to the encoding of the Hangul tense consonant graphemes. In these cases there is a regular feature of movement which corresponds to the graphical feature of character germination. This movement takes the form of a path movement, the sign representing the lax consonant being moved contralaterally along a path, right to left, usually in the signing space just in front of the signers torso. This movement is a shared feature of all the signs of the KMA which correspond to Hangul's geminate graphemes, therefore this path movement may be said to be analogous to the graphical feature of grapheme gemmination.

In some cases, handshapes are used to represent consonants from separate series, for example 2 *hyeng* is used to represent both dental stops and alveolar fricatives. Here, orientation is the means by which the signs corresponding to <ㄱ> and <ㅋ>, <ㄴ> and <ㄷ> and finally <ㅁ> and <ㅂ> may be distinguished. We may speculate that this choice was made so that the sign bears a greater resemblance to the grapheme than would be the case were another handshape used.

We now illustrate the foregoing discussion with an example. The dental series of consonants are prototypical of the featural approach taken to the design of the Hangul consonant graphemes. The KMA does not reflect this perfectly, however, since it is not digit extension alone which characterises the distinction between the signs

corresponding to <┘> and <□>, but a change in handshape. This decision was likely taken to ensure greater visual similarity between the handshapes and graphemes in question, however it is extension of the 4 digit which distinguishes the signs for <□> from the sign for <ε> and path movement, as described above which distinguishes the sign for <□> from the sign for <┘>. Thus we may say that this series of signs is also representative of the KMA as digit extension broadly corresponds to stroke addition, but other factors take precedence when determining which digit is extended or whether stroke addition is reflected by this mechanism at all. Character germination, though, is reflected entirely regularly in the path movement.

It is interesting to note that consonant series which do not have regular, systematic graphical distinctions, for example the labial series, lack such systematic, featural distinctions in the handshapes of the KMA. Reasons for these systematic gaps have been suggested based on orthographic naturalness [18]; however the reasons for choosing to reflect this irregularity in the KMA must remain a matter of speculation only.

Thus we see that the graphical features of Hangul consonants are encoded in the KMA as follows:

- Digit extension is roughly analogous to stroke addition in the Hangul consonants, although this is not wholly systematic or regular.
- While orientation is feature which distinguishes between some consonant signs of the KMA, it does not do so with any regularity.
- Contralateral path movement regularly maps to character gemmination.

Moving on to the signs of the KMA which represent the vowels of Hangul, we see a much more regular and systematic encoding of graphical features than was the case for the consonant signs of the KMA. The handshape *l hyeng* generally encodes graphemes which are combinations of the graphical elements <·> and either <|> or <—>. The one exception is the grapheme <—> which is also represented by this handshape, perhaps for reasons of visual fidelity with the grapheme. It is only the feature of orientation which distinguishes the signs which correspond to the graphemes <┘>, <┘>, <┘>, <┘> and <—>. The orientation of the handshapes is largely arbitrary, although it may be observed that the orientation of <┘> is fingertips upwards with the

palm towards the signer, while the orientation <┘> is the mirror image of this as the grapheme is, that is, fingertips downwards with the palm towards the signer. This mirroring of pairs of *yang* and *eum* vowels is not a consistent feature of the signs for the vowels of Hangul, though, we may speculate for ergonomic reasons. The only so-called basic vowel to be encoded using a handshape other than *Ihyeng* is <|>, which is encoded by the handshape *yeca hyeng*.

The graphical feature which regularly indicates a /j/ on-glide for the simple vowels is an additional dot or short stroke. This is regularly reflected in the KMA by the modification of the handshape of the basic vowel signs from *1 hyeng* to *2 hyeng* by the extension of the 3 digit. Furthermore, the archaic /j/ off-glides of Hangul are regularly reflected by the extension of the 5 digit, the digit which is selected in the *yeca hyeng* handshape. Finally, archaic /j/ on-and-off-glides, for example <ㄱㅣ>, can be formed by forming the <ㄱ> handshape and extending the 3 and 5 digits. Signs which derive from the same “basic” vowel share their orientation. Thus we see that digit extension is analogous to stroke addition in the formation of the signs which encode the vowels of Hangul, too, but it is more regular than the digit extension reflecting stroke addition to the consonant graphemes of Hangul.

The /w/ on-glides of Hangul graphemes are formed by combining two other Hangul graphemes. The KMA forms the signs which correspond to these graphemes using a similar method, however in the signed modality these signs must be combined sequentially, rather than simultaneously as they are in the written modality. Therefore, these are the only vowel signs in the KMA which exhibit any movement. In contrast to the path movement, which distinguishes the signs for lax consonants from those of tense consonants, we see these signs exhibit hand-internal or local movement, specifically a change of orientation in the case of <ㅏ> and <ㅓ> which is supplemented by a change in handshape in the case of <ㅏㅣ> and <ㅓㅣ>. As a result of reflecting the graphical features of these graphemes rather than their spoken phonological features, we may say that the LMK restrictions on combining *yang* and *eum* vowels are retained in the encoding of these graphemes in to the KMA.

The graphical features of Hangul vowels are encoded in the KMA as follows:

- Orientation of the hand encodes the “orientation” of basic vowel graphemes on the page, but arbitrarily.

- Extension of the 3 digit is analogous with short-stroke addition as in the /j/ on-glides of Hangul.
- Extension of the 5 digit is analogous with long-stroke addition as in the archaic /j/ off-glides of Hangul.
- Graphemes may be combined in processes analogous to the composition of the /w/ on-glides of Hangul.

5. Conclusion

The signs of the KMA which correspond with the vowels of Hangul represent the featural nature of the script particularly well. However, while the graphical features of the consonant system are reflected in the signs of the KMA to some extent, it is not as systematic an encoding as the graphical features of the vowels, with the exception of character germination.

Within the broader context of manual alphabets, it is not unknown for movement [19] or digit extension (as in the contrast between the American Sign Language alphabet's signs for <v> and <w>) to be used to reflect graphical features. However, due to the featural structure of Hangul, which we established in section 4.1, we may say that the KMA is unique the features of the signs of which it is composed represent not only the graphical distinctions between Hangul graphemes or the phonemes which they represent, but the minimal features of the phonemes of the spoken language that the writing system encodes. Thus the KMA is a manual alphabet, the signs of which enjoy a singular, systematic relationship with the script which it represents. In light of this analysis, further research on the KMA, particularly on the phonological process which accompany its actual usage in fingerspelling would be particularly instructive.

In summary, the signs of the KMA make ingenious use of the minimal features of signs while demonstrating great economy design in that so many graphemes may be represented by so few handshapes.

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