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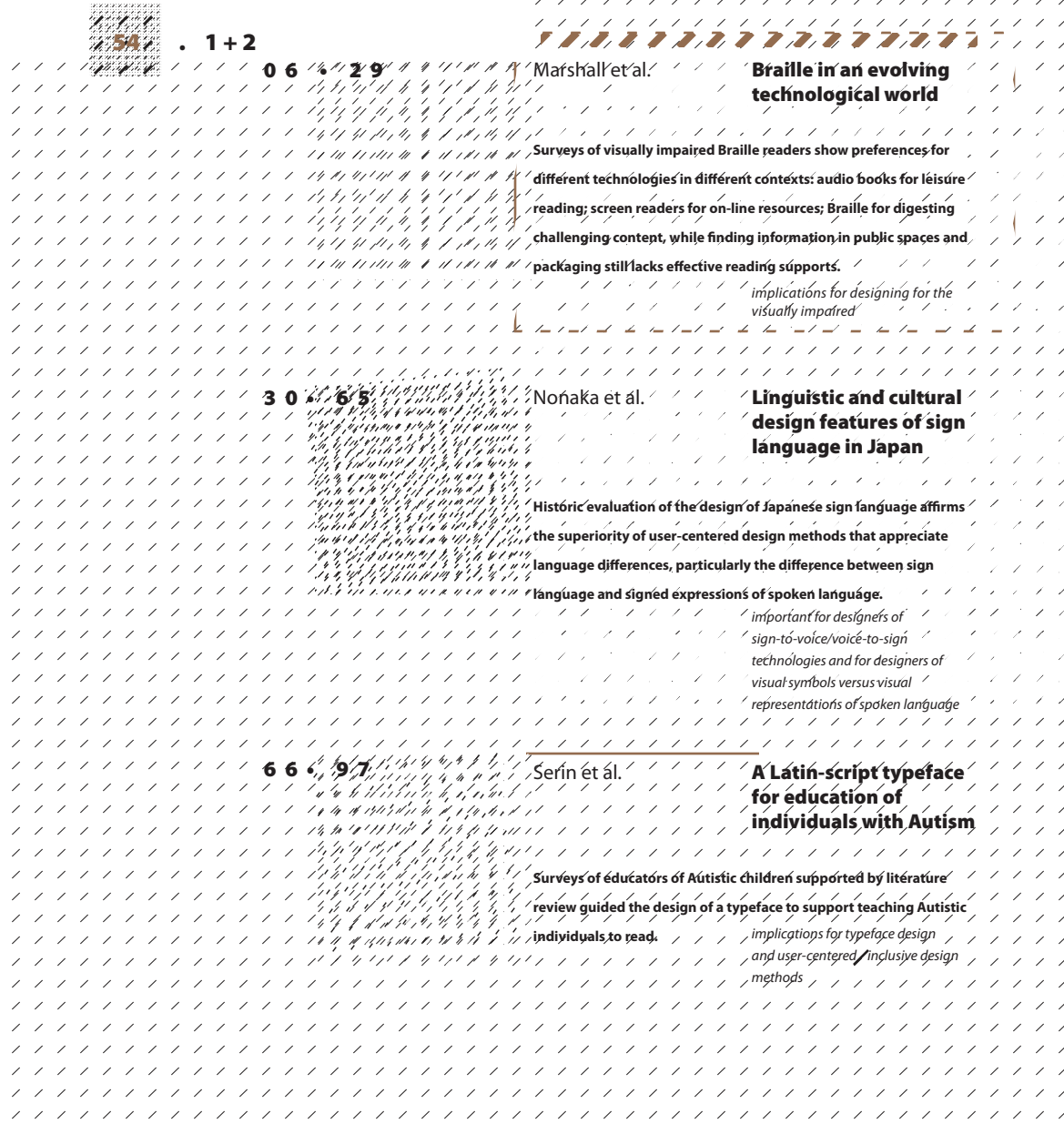
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Before there was reading there was seeing.

People navigate the world and probe life's meaning through visible language. *Visible Language* has been concerned with ideas that help define the unique role and properties of visual communication. A basic premise of the journal has been that visual design is a means of communication that must be defined and explored on its own terms. This journal is devoted to enhancing people's experience through the advancement of research and practice of visual communication.

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**s p e c i a l i s s u e**

**Inclusive Design**

**April + August 2020**



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## Special Issue: Introduction

Jeanne-Louise Moys

We often hear design researchers say about inclusive design research “a lot has been done” and it is certainly an established, multidisciplinary area of research with many examples of distinct and impactful research and practice. However, we’re still a long way off from an inclusive world and accessibility is of increasing priority for twenty-first century societies with aging populations. There also seem to be many more studies of inclusive design for the built environment and product design than there are for visual communication.

When Mike Zender and I wrote the Visible Language call for papers that might broaden discussions of inclusive design in visual communication and explore the complexities and subtleties of designing for diverse user needs, I did not anticipate how varied the responses would be. In hindsight, the diversity of the literature, methods and approaches in the received responses highlights how much scope there is for visual communication research to contribute to inclusive design practice and research. Within this issue, we are publishing a few of the submissions we received and hope a few more will be shared with Visible Language readers in forthcoming issues.

The first three articles presented in this issue respectively explore the role of braille and digital technologies for people who are blind and/or have visual impairments, the evolution of manual syllabaries in Japan for the deaf community, and how drawing on teachers’ experiences informed the design of a typeface intended to make learning resources more accessible for learners with Autism. These studies help provide insight into the reading needs, preferences and experiences of individuals with particular disabilities and the associated implications for visual communication. Together, they also highlight how people’s lived experiences of traditional and emerging media can be profoundly shaped by education, policy and other historical and contextual factors.

Publishing these articles alongside other studies of information design, reading, technology and typography, and the commentary on the intersection of culture and technology for the Persian script, is a considered editorial decision. Inclusive design is not about designing for disabilities but about supporting people’s independence through respectfully anticipating and considering a range of possible user needs and contexts. We hope that the juxtaposition of ‘inclusive’ and ‘regular’ articles encourages reflection about two themes. First, how our everyday design decisions and exploration of new genres and technological affordances might have implications for different individuals and contexts of use. Second, how the kinds of methods and materials we use in research might shape what we find out and how these findings can be translated to practice.

Research into reading and visual and material communication variables occurs across many disciplines. Studies that demonstrate generalizability and robust controls to isolate effects are more likely to be published across a range of disciplinary journals. Yet, for communication design research to effectively inform inclusive practices, it seems that more awareness of the range of readers rather than ‘the average reader’ experiences and projects might be helpful in our discipline.

Thank you to Mike Zender and all guest reviewers who contributed to the editorial process and provided invaluable feedback on the inclusive design articles included in this issue (and those which we hope to publish in forthcoming issues).

Jeanne-Louise Moys  
March 2020

## Linguistic and cultural design features of the manual syllabary in Japan

Angela M. Nonaka

Jean Ann

Keiko Sagara

DeafSpace is a design paradigm concerned with celebrating sign language and Deaf culture. Using a DeafSpace-informed analysis, this case study shows the importance of visible language for signing Deaf people and the power of the adaptation of the manual syllabary (known as *yubimoji* in Japanese) from written *kana* scripts to promote literacy and fuller inclusion of Deaf people in Japanese society. Starting in antiquity, we explain the circumstances under which the Japanese first began to write and the development of their indigenous syllabaries called the *kana*. By the Meiji Era (1868-1912), the educational establishment in Japan devoted itself to the idea of literacy for all Japanese; thus began their Deaf education system. Several manual syllabaries were invented by teachers of the deaf but failed to take root because of design flaws. The *yubimoji* system that survived has appropriate design features and contributes to literacy and fuller inclusion for Deaf Japanese.

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### Keywords

Japanese Sign Language *yubimoji*  
 manual syllabary  
 orthography  
 deaf education in Japan  
 literacy  
 DeafSpace  
 inclusive design

## Introduction

“DeafSpace” is a design paradigm that began in the early years of the twenty-first century at Gallaudet University, a higher educational institution for deaf and hard-of-hearing students. Born of a 2005 workshop between students, faculty, and administrators from Gallaudet and hearing architect Hansel Bauman, DeafSpace quickly became a full-blown research project that a decade later produced impressive deliverables: a new, state-of-the-art Living and Learning Residence Hall; an award from the International Association of Universal Design (IAUD); and an extensive set of inclusive design guidelines developed by and for target end-users who historically were excluded from the design process (IAUD, 2015). The influence of DeafSpace has spread beyond architecture to other fields of design and academic disciplines.

DeafSpace involves many different design principles, practices, and elements.<sup>1</sup> Here, however, discussion focuses on DeafSpace as “an expression of d/Deaf cultural identity based around sign language, rather than as a response designed to compensate for, or minimize, impairment. It distinguishes itself from UD [Universal Design] by articulating a more user-centered design process ...” (Edwards & Gill, 2014, p. 1350). The spelling convention “d/Deaf” captures the distinction between “little d” deaf and “big D” Deaf. “Little d” deaf people acknowledge an audiological hearing loss, which tends to be viewed negatively as an unfortunate medical condition in need of rehabilitation. “Big D” Deaf people claim a lingua-cultural community and identity centered around native or quotidian use of a sign language; not surprisingly, they view their linguistic and cultural diversity as a source of pride. While the two phenomena are often defined oppositionally, there are simultaneous or interwoven instances of overlap, the nuances of which are captured through use of the spellings deaf, Deaf, and d/Deaf, which we use throughout this paper.

Indeed, DeafSpace-informed design “grows from the simple fact that, for Deaf people, vision and touch are a primary means of spatial awareness and orientation. Many use sign language, a visual-kinetic mode of communication, and maintain a strong cultural identity built around these sensibilities and shared life experiences” (Bauman, 2014, p. 378). Understanding this key point is crucial, but often difficult to grasp or maintain as a central focus for designers, most of whom are hearing non-signers. For inclusive design to be successful, Deaf people should be actively included as consultants, participants, or co-designers (Bauman, 2014; Raïke, Pylvänen & Rainò, 2014). Without their expert lingua-cultural input, design endeavors will be ineffective or unappealing to Deaf end-users.

Utilizing a DeafSpace-informed analysis, this paper reviews the historical development of *yubimoji* (指文字), the manual syllabary of Japanese Sign Language (JSL). Like all human languages, JSL developed naturally among native Deaf signers in much the same way as

<sup>1</sup> DeafSpace’s original five design elements—“space and proximity, sensory reach, mobility and proximity, light and color and finally acoustics”—are all interwoven with three larger concerns: “community building, visual language, the promotion of personal safety and well-being” (Gallaudet University, 2019).

spoken languages at one time naturally developed in hearing communities. However, the *yubimoji* system was actively created by hearing educators of the deaf. A manual adaptation of the written Japanese *kana* syllabary, *yubimoji* was devised for purposes of reading and writing pedagogy, and to promote literacy among d/Deaf Japanese.

It is a popular myth that “sign language” is universal. In fact, there are many distinct sign languages used by particular Deaf cultures around the world, and many (although not all)<sup>2</sup> of those sign languages include some type of dactylology or fingerspelling system. Systems of dactylology tend to be found in older “national” sign languages that are associated with a Deaf community and have been used as part of formal deaf education and professional sign language interpreting. Examples of the latter include Israeli Sign Language, Italian Sign Language, and Swedish Sign Language.

Systems of dactylology, like the systems of writing that they encode manually, are diverse. Manual alphabets/syllabaries can be expressed using one or both hands, and thus are referred to as “one-handed” or “two-handed” systems. Dactylology systems also vary in terms of how handshapes and movements are used to fingerspell. While there is some latitude, the possibilities are not limitless. Well-designed dactylology systems could potentially be adopted into a natural sign language and widely used in everyday communicative interaction. They are lingua-culturally appropriate for users—that is, they respond to the constraints on human languages as well to specific cultural norms. Fingerspelling systems that do not meet these criteria fail.

This case study analysis of the creation of the manual syllabary in Japan is but one outcome of a much longer process—the development of Japanese orthography—a multi-century effort to make the Japanese language visible and available for reading and writing, first by elites and then by the masses. Because Japan’s orthographic history started in antiquity by borrowing from Chinese, we begin our analysis there too, tracing the major events that led to the establishment of a distinct (ly) Japanese orthography—including indigenous development of two *kana* syllabaries—for writing spoken Japanese. Examination continues through the modern Meiji Period when 150 years ago, deaf Japanese became the object of the attention of an educational establishment intent on both providing and achieving literacy for all. Seeking a way to educate their new deaf students, late-nineteenth- and early-twentieth-century pedagogues eventually produced a manual syllabary.

Like the written *kana* syllabaries, the *yubimoji* system is organized according to the sleek and long-utilized *go-jū-on-zu* (五十音図) or fifty sounds chart, a simple and powerful format that encodes the basic building blocks of Japanese: its syllables. The creation of the current manual syllabary was a decades-long process of trial and error—one that

<sup>2</sup> From a descriptive linguistic perspective, the absence (or presence) of a dactylology system in a given sign language is neither a good nor bad thing. It is simply a fact. Readers should not assume either that sign languages without dactylology systems are somehow less complex and communicatively effective or that every sign language necessarily needs a fingerspelling system.



underscores the utility of good linguistic and cultural design features or the pitfalls of bad ones.

Since contemporary *yubimoji* were brought into being, they have been successfully adopted into daily use by members of the Japanese Deaf community, who are now the primary users of the manual syllabary. The *yubimoji* system has proven useful as an inroad to literacy for native JSL signers learning to read and write in Japanese. In the concluding discussion we review lessons learned from this historical case study through the lens of the DeafSpace design paradigm and offer some key take-away points and best-practices suggestions for designers and developers working on twenty-first-century inclusive design technologies for d/Deaf end-users.

---

## How Chinese and Japanese Compare as Languages

Japanese and Chinese are very different languages, despite being in relatively close geographical proximity. They belong to separate language families, a fact that strongly points to a number of differences in their basic structures. In fact, the word order and the word-building processes in Chinese and Japanese are quite different. Beyond that, the Chinese writing system of characters has always had both semantic (meaning) and phonetic (sound) properties. This left early Japanese questioning whether to borrow a character for its meaning or its sound. The periods of intense language contact between the Chinese and Japanese languages brought their differences—and how the Japanese mitigated them—into sharp relief. We examine each of these issues next.

Early in the process of contact, which occurred in waves between the third and sixth centuries of the Common Era (CE), the Japanese did not have a writing system, whereas the Chinese writing system was almost 2000 years old; in fact, the Chinese writing system is the oldest in continuous use in the world. The principle it uses to represent Chinese is different from any other writing system in use today; thus it requires some explanation (DeFrancis, 1984; DeFrancis, 1989; Wang & Asher, 1995).

Every true writing system attempts to capture aspects of speech, but not every writing system captures the same thing about speech (DeFrancis, 1989). One human invention to capture speech was that of an alphabet, a writing system that attempts to spell out single sounds with symbols that are ordered with respect to each other. Alphabets do not all look alike however. Both English and Korean are written with an alphabet, but written English and written Korean could not look more different. A second human invention to represent speech is that of a syllabary, which enables writers to represent entire syllables by using the symbols in the syllabary. A syllabary does not spell out individual sounds that a given syllable contains, as an alphabet would. Modern Chinese and Japanese each

are represented in writing by a syllabary (Daniels & Bright, 1996).

The symbols in the Chinese syllabary are referred to as “characters” in English. A character is a series of strokes (i.e. lines and dots on paper) that stands for one Chinese syllable. There is some evidence that the Chinese writing system might have begun as logographic (i.e. showing the intended referent by either a picture or a stylized picture of it) (DeFrancis, 1989), but even if that is true, it quickly changed to a system that recorded information about both the pronunciation and meaning of the intended syllable. Usually, a Chinese character requires a combination of characters or parts of characters to express a syllable. The exact principles of how these pieces are combined are ancient and a bit indirect: Chinese characters are constructed so as to give a “hint” on the left side about semantics, and a “hint” on the right side about pronunciation (DeFrancis, 1984; Wang & Asher, 1995). Thus, while it is true that a Chinese character does not spell out the individual sounds of a word, it is also true that a Chinese character (more often than not) does provide some information about how it is to be pronounced.

Japanese and Chinese also reveal big differences in terms of their sound systems. In order to learn Japanese, one begins with the approximately 110 different syllables in the entire language. Learners of Chinese would have to commit about 400 different syllables to memory (DeFrancis, 1984). In terms of word-building processes, Chinese almost never includes suffixes (such as *-ed* in *talked*), prefixes (such as *re-* in *redo*) or the like to express more about a word’s meaning or function in a sentence. And in a sentence such as *John fed the cat*, we would consider John the (grammatical) subject because John is the doer of the action of the verb *fed*. Similarly, we would consider *cat* the (grammatical) object, because *cat* is the receiver of the action *fed*. In languages such as Chinese (and English), such relationships are not marked with a suffix on the subject indicating that it’s the subject, or on the object indicating that it’s the object (Wang & Asher, 1995). But Japanese is a different sort of language, and it does include suffixes and prefixes that indicate that particular words play particular grammatical roles in a sentence. As we will see, the Japanese had to solve the problem of using Chinese to represent the Japanese language when Chinese had no ready way to express the grammatical inflections of Japanese.

---

## Early Language Contact with Classical Chinese and its Difficulties

Somewhere between the third and sixth centuries of the Common Era (CE), scribes from continental East Asia arrived at the Japanese imperial court (DeFrancis, 1989, p. 131; Miller, 1967, p. 91; Takemura, 2010, p. 10). Those emissaries brought with them the Chinese system of writing called *hànzì* (漢字), or what the Japanese refer to as *kanji*. Since the Japanese had no indigenous way to write their language (DeFrancis, 1989, p. 131; Kaiser, 1995,

## Early Hiragana and Katakana Syllabaries

It was during the Heian (平安) Period (794–1158 CE) that one of the most important steps taken by the Japanese occurred: in order to write and read in their native language, they developed the indigenous *kana* scripts. *Katakana* and *hiragana* are two distinct syllabaries that graphically represent the phonetic building blocks (the syllables) of the Japanese language. They are Japan's oldest extant native scripts and “constitute an important step in Japanese emancipation from Chinese characters” (Loveday, 1996, p. 7). Each of these scripts had different uses. The more angular *katakana* script was used for annotating more official texts, including Buddhist scriptures, scholarly chronicles, official records, and legal documents. Annotation by the use of assistive reading devices was necessary because, for one thing, Chinese did not possess characters that indicated grammatical functions of words, and Japanese required a way to mark this. Meanwhile, the more rounded and cursive-like *hiragana* syllabary was used to compose poetry, diaries, and some of Japan's greatest classical literature—e.g., *The Tale of Genji* (源氏物語 or *Genji Monogatari*).

While writing entirely in the phonetic *kana* syllabary to express Japanese was/is possible, it never took root as a mainstream adult writing practice. Rather, as the centuries passed, it became increasingly common to write in mixed *kanji-kana* scripts. For example, as early as the twelfth century, when *kanji* were introduced into popular texts, those texts were “encoded in the cursive syllabary intended for the general public, a practice that is now the norm of the present-day Japanese writing system” (Loveday, 1996, p. 8).

## Mixed Styles and Mixed Scripts of Pre-modern Japan

By the Tokugawa (徳川) Period, synonymously called the Edo (江戸) Period (1600–1868), more than a thousand years had passed since Chinese characters were first adopted for use in Japan, and half or more of that amount of time had lapsed since the advent of the development of *kana*. By then, it was extremely rare to write in pure Chinese, and even Chinese styles of writing were increasingly blended with Japanese such that more and more texts were produced in what are termed Sino-Japanese styles with their many sub-styles/genres. Sino-Japanese blending of writing was expressed in many different ways, but broadly speaking, it involved either 1) writing in *kanji* characters but with robust use of assistive reading devices or 2) writing with heavily mixed *kanji-kana* scripts.

The long-standing tradition of writing formal/official documents in *kanji* persisted into the seventeenth century, so it was common to see *katakana* inserted into texts to provide Japanese phonetic pronunciation prompts. And, in order to bridge the underlying syntactic

p. 45; Miller, 1967), when the Japanese gained access to the Chinese system of writing, they desired it.

In fact, initially, literacy in Japan involved reading and writing in Chinese and required knowledge of classical Confucian texts and Buddhist scholarship. At first, writing was done by foreign scribes from continental Asia, but within 200–300 years (or less), the Japanese were doing the writing themselves. As they did so, they found writing in Chinese less desirable and wanted to read and write in their own language. Yet because Chinese characters were firmly established as part of the Japanese orthographic tradition, use of *kanji* continued.

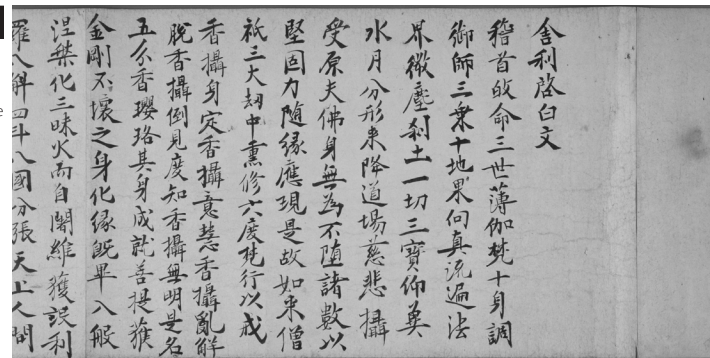
In time and for many centuries, writing strictly in Chinese grew rarer but writing in a Chinese style, called *kanbun* (漢文) in Japanese, became widespread. *Kanbun* encompasses a great variety of sub-genres and sub-styles of texts, including *hakubun* (白文). *Hakubun* are quintessential examples of classical Chinese texts (or Japanese emulations of them). Written in Chinese word order, *hakubun* “must be read either in Chinese, or by mentally rearranging the word order and interpreting the unwritten particles, conjugations, and so forth in order to read this Chinese-like form as Japanese” (“The Samurai Archives,” 2019).

A famous example of *hakubun* is provided in Figure 1, which depicts part of an address, dated 1278 CE. The address was to be given by Daikyū Shōnen (大休正念), a Chinese Buddhist monk who, at the invitation of Japanese regent Hōjō Tokimune (北条時宗), served as chief priest at several important temples in the city of Kamakura.

FIGURE 1

Example of thirteenth-century *hakubun* (白文) text written entirely in *kanji* in classical Chinese style without supplementary reading aids.

Source credits: Record of the Origin of [Sarira] (Buddhist relics) and Its Blessings address dated 1278 by the monk Daikyū Shōnen. Original manuscript designated “Important Cultural Property” held in the collections of the Tokyo National Museum (Collection B-2424) and made available through the Integrated Collections Database (ColBase) of the National Museums, Japan. Resized and processed for black and white print under database terms stated as compatible with CC-BY International 4.0. Original digitized image available in color at [https://colbase.nich.go.jp/collection\\_items/tnm/B-2424?locale=en](https://colbase.nich.go.jp/collection_items/tnm/B-2424?locale=en)



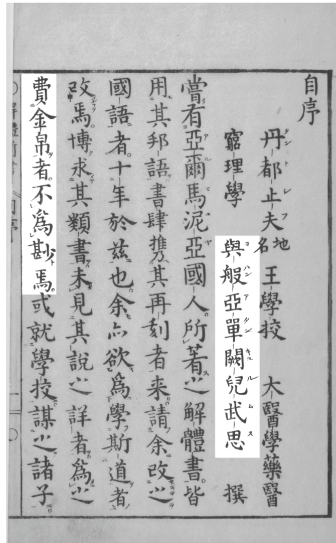
Although it must be read from right to left and from top to bottom (as is still the practice today),<sup>3</sup> without specialized training, it is not possible for readers of modern-day Japanese (and for that matter, Chinese) to make sense of the writing in Figure 1. This is because the thirteenth century text is written entirely in *kanji* in the classical Chinese style.

<sup>3</sup> The traditional practice of reading written Japanese from right-to-left and top-to-bottom continues in twenty-first century Japan. Since the rise of word processing and typewriting via computer, however, it is also common for Japanese to be organized on the page in a manner similar to English—i.e., reading left-to-right and down the page.

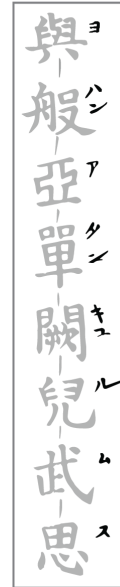
differences between Chinese and Japanese, Japanese readers needed to know the order in which the *kanji* should be read. The by-then standardized diacritical markings called *kundokuten* (訓読点) were used for this purpose. Figure 2 provides some examples.

## FIGURE 2

Example of eighteenth-century formal writing in *kanji* with robust use of supplementary reading aids—*katakana* pronunciation prompts and *kundokuten* diacritics. Source credits: Sugita, Genpaku, trans. (1774). *Kaitai Shinsho* (解体新書). Translation of Johann Adam Kulumus' *Tabulae anatomicae*. Head volume. Digital reproduction of public domain-designated work made available for use courtesy of the U.S. National Library of Medicine at <http://resource.nlm.nih.gov/101147255X1>, frame 17. Derived figure processed for black and white print, resized, excerpted, traced, and annotated with key by the authors.



Page of original *Kaitai Shinsho* text highlighting *katakana* pronunciation prompts (Part A, right side of the original) and *kundokuten* diacritics (Part B, left side of the original).



Part A: *Katakana* pronunciation prompts (highlighted on the right side of the original)



Part B: *Kundokuten* diacritics (highlighted on the left side of the original)

The image in Figure 2 is the first page from the preface of Sugita Genpaku and colleagues' *Kaitai Shinsho* (解体新書) or *New Book of Anatomy*. This was the 1774 Japanese translation of the Dutch author Johann Adam Kulmus's book, *Tabulae Anatomicae* (Sugita et al., 1774). Considered a historic achievement in *Rangaku* (蘭学), that is, Dutch Studies or Western knowledge, the *Kaitai Shinsho* is written entirely in eighteenth-century Japanese *kanbun*. Unlike the Figure 1 *kanbun* example, the excerpted text from the *Kaitai Shinsho* in Figure 2 is replete with examples of diacritical markings. Additionally, small *katakana* that provided Japanese phonetic pronunciations are deployed to the right of any *kanji* that was deemed difficult to read. The highlighted portions of text excerpted from Figure 2 illustrate both assistive reading aid phenomena.

Part A of Figure 2 shows how *katakana* were used to transcribe Johann Adam Kulmus's name syllable by syllable in 1774. The

*kana* indicate that the Japanese rendering was <yo ha n a ta n kyu ru mu su> (ヨハン・アタン・キュルムス or *Yohan Atan Kyurumus*). In modern Japanese, the same name is written as ヨハン・アダム・クルムス or *Yohan Adamu Kurumus*. These minor differences notwithstanding, after almost 250 years, contemporary readers have no problem understanding and pronouncing the *katakana* phonetic prompts written in the *Kaitai Shinsho*.

Part B of Figure 2 shows how diacritical marks were utilized to assist in syntactic decoding. For instance, in Part B's featured text, the small *re-ten* (レ) mark is "placed between two characters to indicate they should be read in reverse order" ("The Samurai Archives," 2019). The other small markings to the left of the *kanji* characters in the excerpted text in Part B of Figure 2 are number symbols (一 二), in this instance, "one" and "two" respectively. These small-sized number diacritics (often accompanied by still other *kundokuten*) provide information about the sequence in which phrases in *kanbun* texts should be read. Such reading prompts were necessary "because Chinese grammar employs a very different word order, and sentence structure, from Japanese" ("The Samurai Archives," 2019).

The foregoing demonstrates that by the seventeenth century, most writing in Japan was done in mixed *kanji-kana* script. Style/genre, however, heavily influenced which of the two *kana* systems would be combined with *kanji* characters. As a rule, the more official or formal the document (e.g., the *Kaitai Shinsho*) the more likely it would be written in *kanji* mixed with *katakana*. However, less official and informal texts were written in a mixture of *kanji* and *hiragana*. Notably, at that time the two *kana* scripts did not both appear in combination with *kanji* in one document as they do today.

This idea of how a written language gradually changes allows us to observe a problematic divide between spoken and written Japanese over time. Language change always occurs more rapidly in spoken versus written language, but by the dawning of modernity, the communicative gap between how Japanese was actually spoken and how it was written—both stylistically and orthographically—had become untenable. Thus, the historical stage was set for vigorous debates about, as well as numerous attempts at, language reform. These included several initiatives aimed at script reforms and standardization, which were put in place earlier and subsequently fully realized after the Second World War (Seeley, 1984; Townsend, 2009; Twine, 1983).

## Meiji Era (1868-1912) Modernization and its Impact on Education and Literacy

Delineated historically by the regnal name Meiji (明治 trans., "Enlightened Rule"), the years 1868-1912 in Japan were a period of dramatic change—political, economic, technological, and social. It is difficult to overstate, let

alone to describe, the profundity of that change, which extended into every conceivable domain. In the arena of education, the breadth and rapidity of educational reform undertaken within just four-and-a-half decades remain astonishing.

Japan established a national Ministry of Education in 1871 and a year later instituted a national system of compulsory education. In addition to offering elementary education for the masses, the country also organized a system of middle schools, a system of “normal schools” specializing in teacher training, and a system of imperial universities. As if that were not enough, the Japanese government simultaneously set up separate systems of education for girls to promote women’s education, a state vocational school system, as well special schools for blind and deaf students (Canadian Heritage Information Network, 1999; Hall, 1905). Important here is that Meiji officials and contemporary educators also spent significant time, energy, and resources on debating, developing, and instituting curricular content as well as pedagogical theories and methods in every sphere of education, including the education of deaf and blind students.

Among Meiji leaders’ and educators’ myriad educational goals, promoting universal literacy was a top priority. The anthropologist Merry White explains the urgency of this aspiration as follows:

In the 1872 Fundamental Code of Education, the last vestiges of a class-based educational system were removed, and schooling for all classes was integrated. The centralization of schooling and the universalization of the experiences of learning depended not only on political and economic decisions at high levels, but also on a very new idea: that all children, whatever birth and class, possessed the capacity for improvement through a single curriculum and pedagogy. The first goal was universal literacy, as stated in the preamble to the Code: “Learning is the key to success in life. . . There shall, in the future, be no community with an illiterate family; nor a family with an illiterate person” (White, 1987, pp. 58-59).

To reach this goal, a new educational system had to be created, and it was implemented systematically and immediately (Platt, 2019).

The promotion of universal literacy was inextricably tied to Japan’s transformation from a feudal society into a modern nation-state. Thus, the first goal was to establish a national language (*kokugo* 国語) (Heinrich, 2012; Lee, 1996). Second, it was imperative to achieve unification of written and spoken Japanese (*genbun-itchi* 言文一致) by writing in a contemporary style rather than a (Sino-centric) classical one (Twine, 1983; Twine, 1978). A third objective centered on the extremely complicated matter of language ‘simplification.’ Toward that end, the proposed means encompassed three main options, the third of which was ultimately adopted: 1) jettisoning the Japanese language entirely and adopting English; 2) discarding *kanji* entirely and writing only in *kana* syllabary; or 3) continuing to write using a mixture of ‘simplified’ *kanji*—i.e., less numerous

and/or less internally complex characters—and *kana*. In fact, formal attempts at *kana* script reform began around 1900 but were not completely realized until after WWII. The fourth language reform that was inextricably interwoven with all the others involved standardization (Twine, 1988).

Consistent with the overarching aim of achieving “Civilization and Enlightenment” in the age of Meiji, the four aforementioned language reforms, undertaken in tandem, contributed to the creation of a new linguistic/cultural consciousness befitting Japan’s new status as a modern nation-state. These reforms also supported universal education, expanded mass literacy, and thereby advanced societal mastery of new information, sciences, and technologies.

### The Creation of Japan’s Manual Syllabary

By the Meiji Era, the current syllabary was largely in place, and, propelled by Meiji zeal for the education of *all* Japanese, deaf education in the country began. With Japan’s own indigenous syllabary in hand, hearing teachers, who had a mandate that every child learn to read, were brought into contact with young deaf students. These students, many of whom brought their own native sign language(s) to school, gained contact with a second language—Japanese—through the manual syllabary, which was made visible through the configuration of the hand and forearm to represent each of the syllables of Japanese. Thus began the first formal education in all of Asia of deaf children (Hodgson, 1953).

Like their counterparts tasked with initiating universal public education for hearing pupils, pedagogues who pioneered deaf education in Meiji Era Japan pursued the same aspirational goals and faced the same institutional constraints, only more so. Teachers of their time, they committed themselves to the then-novel concept of providing public education for *all* Japanese children, including those who were deaf or blind, thereby demonstrating and advancing the new modern nation-state’s collective pursuit of “Civilization and Enlightenment.” Consistent with that mission, Japanese government officials, private philanthropists, and pioneering teachers of the Meiji Period actively pursued both international study tours in the United States and Western Europe and educational exchanges with their professional counterparts there in order to gather first-hand information about then leading-edge technologies, pedagogical theories, and instructional practices germane to deaf education (*The Silent World*, 1872; *American Annals of the Deaf*, 1882).

Back in Japan, teachers of the deaf—who themselves were hearing—faced the daunting tasks of quickly developing new pedagogical techniques, curricular content, and instructional resources that were efficacious for student learning and that conformed to rapidly evolving policies and standards issued by the newly-established Ministry of Education. One pillar of their pedagogical mission was to teach deaf

students to read and write the national language. Unlike their hearing counterparts, whether sighted or blind, deaf children had not grown up hearing the Japanese language, thus, acquiring the building blocks of Japanese that inform its written scripts—a fact that posed unique challenges for developing the literacy skills of deaf children.

Meiji Japanese pedagogues and teachers were well aware that the education intended for hearing children would not suit deaf children without some adjustments. Yet the educational system of deaf children in Japan could not be a wholly separate one from that of hearing children, and solutions were needed immediately. New teaching techniques and educational resources tailored to the learning needs of deaf students were required. A millennium earlier, through trial and error, their cultural ancestors innovated in order to make it easier to write in Japanese by developing phonetic/syllabic *kana*, which were organized according to the *go-jū-on-zu*, or fifty sounds chart. Similarly, the first generation of teachers of the deaf in Japan quickly began developing new ways to represent the symbols of the *go-jū-on-zu* manually via the fingers, hands, and arms.

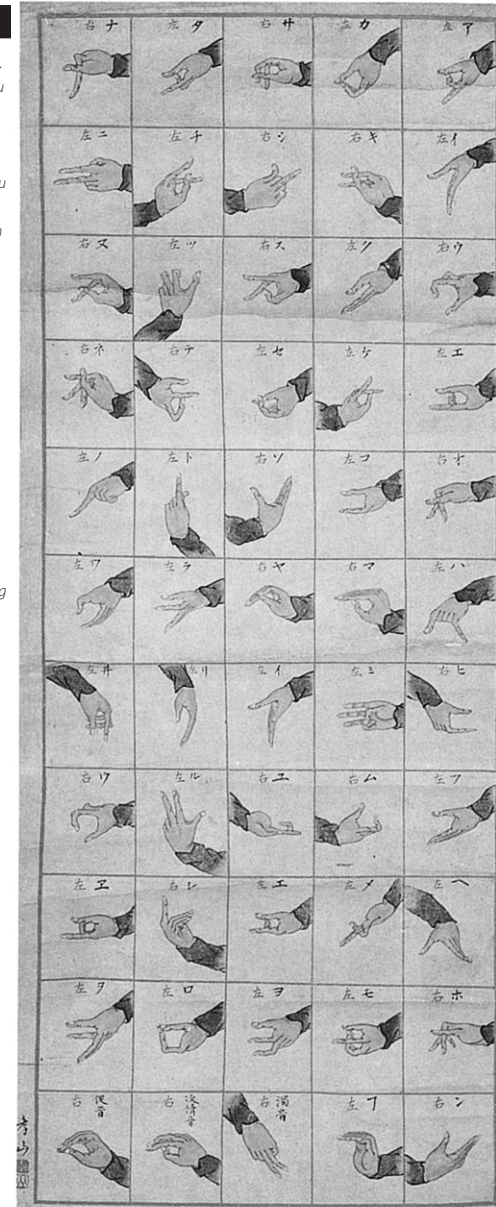
Whereas historical particularities discussed earlier in this paper led to the creation of two phonetically identical but orthographically distinct written *kana* scripts, deaf education pioneers were satisfied to create just one *yubimoji* system that could be used to teach the phonetic syllables undergirding the Japanese language. Several teachers of the deaf attempted to create their own *yubimoji* systems. According to Suemori (2013, p. 4), at least eight early systems were created. Relatively little is known about most of them. Here, we examine three: the Furukawa system, the Watanabe system, and the Ōsone system. We explain why the first two were not popular with the Japanese Deaf community, whereas Ōsone's system grew quickly in popularity.

### The 1879 Furukawa System

An early *yubimoji* system was invented (c. 1878–c. 1879) by Furukawa Tashirō (古河太四郎), the founder of the country's first school for the deaf in Kyōto. In Figure 3, we can see that Mr. Furukawa's fingerspelling system is represented by separate drawings of handshapes in which the fingers are configured in different ways to represent different syllables of Japanese. At the center of each cell of the chart is an idealized drawing of a handshape for a given *yubimoji*. Two additional pieces of important information are written above the featured *yubimoji*: to the left is a *kanji* indicating whether the handshape should be produced on the right (右) or left (左) hand, while to the right is the target *katakana* that the *yubimoji* is supposed to represent.

FIGURE 3

Furukawa's 1879 *yubimoji* system. Source credits: Kyōtofu mōrō kyōiku hyakunenshi mōrō kyōiku kaigaku yakushū nenkinen jigō jikkō iinkai henshū-bu. (1978). Kyōtofu mōrō kyōiku hyakunenshi mōrō kyōiku kaigaku yakushū nenkinen jigō jikkō iinkai henshū-bu. Kyōto: Dōhōsha. (Blind Deaf Education School Founding Commemoration Executive Committee Editorial Department. (1978). Centennial History of Kyōto Prefectural Blind and Deaf Education. Blind Deaf Education School Founding Commemoration Executive Committee Editorial Department [internally self-published]. Kyōto: Dōhōsha.) Figure derived from unnumbered colored plates in "Primary Sources." Processed and resized for black-and-white printing with permission from the Kyōto Prefectural School for the Deaf.

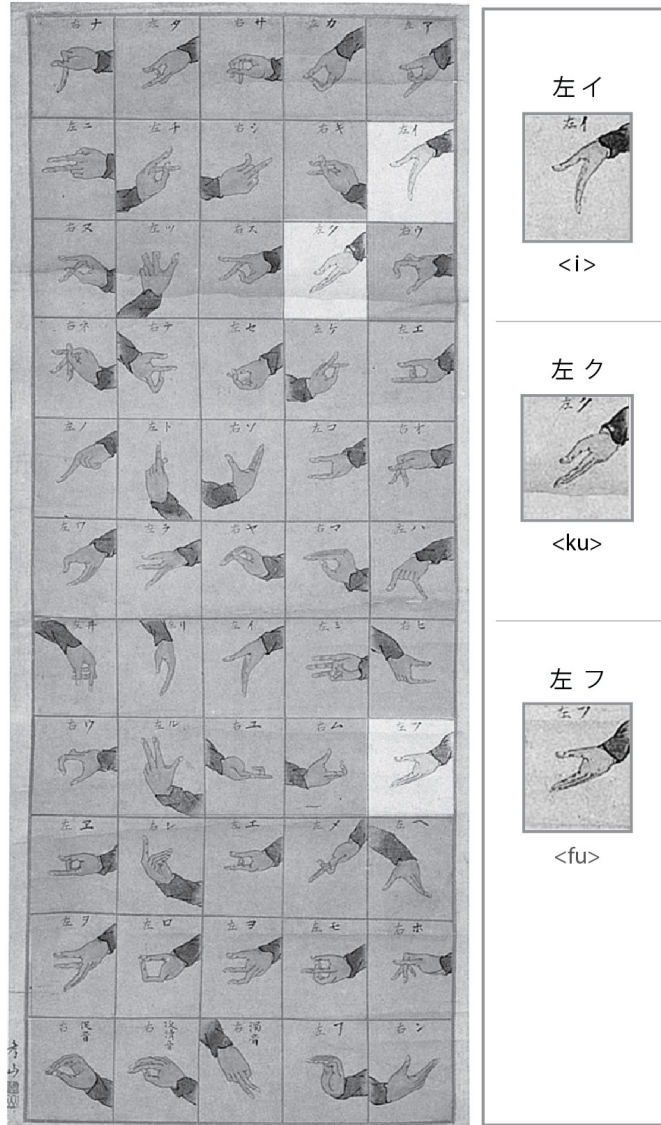


Examination of each of the *kana* and its corresponding handshape in the top row of Figure 3 suggests that Furukawa's idea was that the hand and fingers should assume various positions that would represent the shape of the *kana*. This is a formidable undertaking since two written *kana* may bear a resemblance to one another and yet be distinguishable on paper. It is much more difficult to use the fingers to represent *kana*. Due to their individual physiology, the five fingers are not all equally capable of assuming shapes and performing precision movements (Ann, 2006).

For instance, consider the excerpted examples from Furukawa's manual syllabary that are depicted in Figure 4. Each of the three examples shown in Figure 4 is essentially an open handshape with the palm oriented in approximately the same way. Again, the aim of Furukawa's system is apparent—to manually represent the shape of *katakana*. According to modern linguistic reasoning, however, these handshapes might be analyzed as variants of one another on the grounds that the articulatory and perceptual differences between them are not salient enough to result in a meaning difference in an actual sign language. These articulatory and resulting perceptual difficulties are but a few examples of problematic design features in Furukawa's manual syllabary that prevented the system from being adopted by signing Deaf people in Japan.

FIGURE 4

Three examples from Furukawa's 1879 *yubimoji* system of handshapes that today might be analyzed as variants of one another. Source credits: Kyōtofu mōrō kyōiku hyakunenshi mōrō kyōiku kaigaku yakushū nenkinen jigō jikkō iinkai henshū-bu. (1978). Kyōtofu mōrō kyōiku hyakunenshi mōrō kyōiku kaigaku yakushū nenkinen jigō jikkō iinkai henshū-bu. Kyōto: Dōhōsha. (Blind Deaf Education School Founding Commemoration Executive Committee Editorial Department. (1978). Centennial History of Kyōto Prefectural Blind and Deaf Education. Blind Deaf Education School Founding Commemoration Executive Committee Editorial Department [internally self-published]. Kyōto: Dōhōsha.) Figure derived from unnumbered colored plates in "Primary Sources." Highlighted, excerpted, resized for black-and-white printing with permission from the Kyōto Prefectural School for the Deaf. Annotations by the authors.



## The 1906 Watanabe System

A few decades later, around 1906, Watanabe Heinosuke (渡辺平之甫) developed a novel system for making the *kana* visible on the hands. Rather than attempting to represent the shape of the *kana*, he had another approach. In Mr. Watanabe's system, the entire arm (not just the hand) is involved (Suemori, 2013, p. 6). To understand the Watanabe system, examine Figure 5 which contains two pictures with accompanying informational keys that encapsulate his basic idea and explain what the pictures show.

FIGURE 5

Illustration of the organizing principles of the 1906 Watanabe *yubimoji* system. Source credits: Watanabe, Heinosuke. (1906). *Mō-a kyōiku (Blind and Deaf Education)*. Matsuda Shōyūdō. Unretouched black-and-white images from the National Diet Library of Japan Digital Collections designated "インターネット公開 (保護期間満了) (Internet Access (Copyright expired))" at <https://dl.ndl.go.jp/info:ndljp/pid/812438> (DOI: 10.11501/812438), frame 40. Resized and reproduced with additional explanatory keys by the authors.

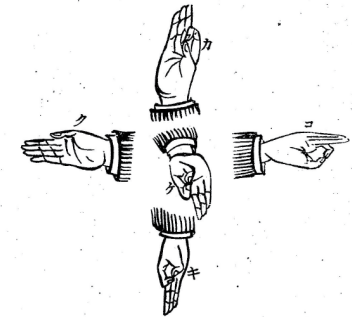



## Key:


- ア indicates the vowel <a>  
forearm straight up and to the side, palm facing front
- イ indicates the vowel <i>  
forearm straight down and to the side, palm facing front
- ウ indicates the vowel <u>  
forearm to the signer's left, palm facing front
- エ indicates the vowel <e>  
forearm to the front of the signer, palm facing up
- オ indicates the vowel <o>  
forearm crosses signer's chest, pinky side of the hand up, fingertips point right

## Key:

- カ indicates the vowel <ka>  
forearm straight up and to the side, palm facing front
- キ indicates the vowel <ki>  
forearm straight down and to the side, palm facing front
- ク indicates the vowel <ku>  
forearm to the signer's left, palm facing front
- ケ indicates the vowel <ke>  
forearm to the front of the signer, palm facing up
- コ indicates the vowel <ko>  
forearm crosses signer's chest, pinky side of the hand up, fingertips point right



The top picture in Figure 5 shows a man. Five different poses of the man's forearm emanate from the middle of the picture: fingertips straight up, fingertips down, fingertips to the left, and so on. Beside each of those poses is a *kana* which indicates each of the Japanese syllables that are composed of just a vowel; namely <a>, <i>, <u>, <e> and <o>. The key shows that Watanabe's manual representations of each of the five vowels are differentiated by their location in space. From Figure 5, then, what should be clear is the connection between each of the five *kana* in the picture of the man, the vowel syllable to which it corresponds, and a description of where that vowel syllable is located in space according to Watanabe's system. It is important to restate that each of the five syllables is indicated by the same handshape ; what differentiates them is their location in space.

Now consider the bottom picture in Figure 5, that of the disembodied forearm with the hand configured in a handshape . Beside each of the hand/arm positions is a *kana* indicating which syllable is represented, in this case: <ka>, <ki>, <ku>, <ke>, and <ko>. It should be obvious that the manual syllables k+vowel are produced with the designated <k> handshape put in the same place as each vowel. Thus <a> and <ka> are produced to the side of the signer with the fingertips up and palm facing front, but <a> and <ka> utilize different handshapes.

We can see, then, that the basis for Watanabe's system is that each of the Japanese vowels is represented by a designated handshape assigned to a particular location in the space in front of the signer. To produce the syllables <ka ki ku ke ko> and distinguish them from the syllables <a i u e o>, the designated handshape for <k> is put in the location of each vowel. Upon seeing this, deaf learners would be expected to blend location and handshape. Presumably the remainder of the Japanese syllables would be represented in similar fashion: a different handshape for each consonant would be moved around the signing space to each respective vowel location in order to represent the intended syllable.

Upon first inspection, Watanabe's system seems eminently learnable, but the manual *kana* syllables created in this system are located too far away from the signer's face to be clearly visible to interlocutors. Modern research shows that in conversation, signers look at each other's faces (not hands); thus, visual acuity is strongest in the areas closest to the face and weakest in areas farther from the face (Siple, 1978). Thus, researchers postulate a complex space around the signer in which signs are articulated. Constraints on what can happen in this space explain why not any sign can be signed anywhere. Specifically, signs that are produced close to the face can differ from one another in very fine-grained ways, such as by change of handshape. Conversely, signs that are articulated farther to the edges of the signing space cannot differ from each other in fine-grained ways. Because in Watanabe's system, all of the syllables are produced at the periphery of the signing space, and the syllables are distinguished by fine-grained handshapes, the syllables are harder to perceive. Thus, Watanabe's system seems awkward to the point of being unacceptable, indeed.

## Ōsone's Innovations and Development of the Contemporary Yubimoji

Finally, during the 1930s, a teacher at a deaf school in Ōsaka, Ōsone Gensuke (大曾根源助), traveled to the United States, met with Helen Keller, and contemplated how to devise a new and better Japanese *yubimoji* system (Ōsaka Prefectural Central Auditory Support School Auditory Support Center, 2017). His endeavor produced the contemporary JSL manual syllabary, shown in Figure 6. Mr. Ōsone's one-handed syllabary (much like Furukawa's) often attempted to represent the shape of individual *kana*, in whole or in part.

FIGURE 6

Chart of the contemporary manual syllabary in Japanese Sign Language.  
Source credit: Rō-a Renmei [Japanese Federation of the Deaf]. (1987). *Watashi tachi no shuwa* (3) [Our Hand Talk (3)] Tokyo, Japan: Japanese Federation of the Deaf, pages 6-7. Images reproduced with permission from the Japanese Federation of the Deaf.

	あ		か		さ		た		な		は		ま		や		ら		わ		ん
	い		き		し		ち		に		ひ		み		り						
	う		く		す		つ		ぬ		ふ		む		ゆ		る				
	え		け		せ		て		ね		へ		め		れ						
	お		こ		そ		と		の		ほ		も		よ		ろ		を		

Part A: First page of contemporary JSL *yubimoji*

	が		ざ		だ		ば		ぱ
	ぎ		じ		び		ぴ		
	ぐ		ず		ぶ		ぷ		
	げ		ぜ		で		べ		ぺ
	ご		ぞ		ど		ぼ		ぽ

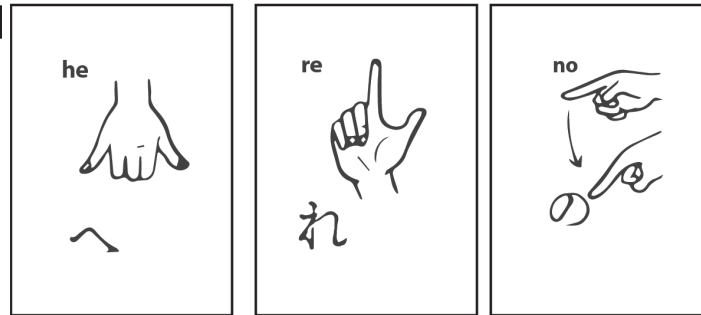
Part B: Second page of contemporary JSL *yubimoji*

In Ōsone's system, however, the major problems that bedeviled previous systems were ironed out. Rather than forcing the hand into shapes that could not be easily distinguished in signing (but could be on paper), Ōsone's semiotic motivations included primarily *katakana*, sometimes *hiragana*, and even air drawing (called *kūsho* 空書), a traditional Japanese literacy practice whereby orthographic symbols are traced in the air with the index finger. These three strategies for *yubimoji* formation (Figure 7) can easily represent all or most of the shapes of *kana*. For example, in parts A and B of Figure 7, the fingers and hand form the shape of the *hiragana* <he> へ and the *katakana* <re> レ respectively. Part C of Figure 7 demonstrates the *kūsho* air drawing strategy used to produce the shape of *katana* <no> ノ.

FIGURE 7

Examples of contemporary *yubimoji* derived from the shape of *kana*.

Source credit: Rô-a Renmei [Japanese Federation of the Deaf]. (1987). *Watashi tachi no shuwa* (3) [Our Hand Talk (3)]. Tokyo, Japan: Japanese Federation of the Deaf, page 6. Extracted images edited for clarity and reproduced with permission from the Japanese Federation of the Deaf.



**Part A:** *yubimoji* approximating the shape of the *hiragana* へ

**Part B:** *yubimoji* approximating the shape of the *katakana* レ

**Part C:** *yubimoji* articulated through air drawing of the *katakana* ノ

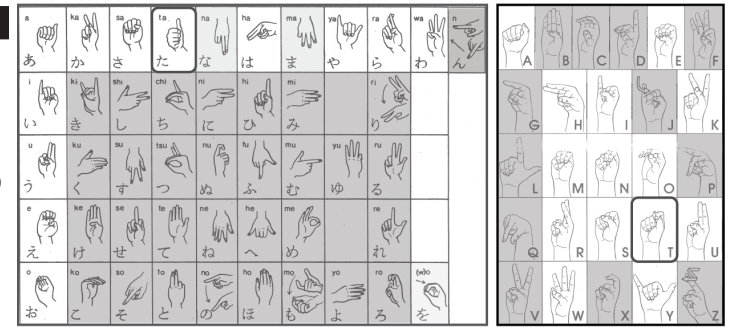
**Note:** The images in this figure are extracted from the contemporary *yubimoji* chart in Figure 6A. Consistent with standard Japanese orthographic practices adopted after WWII, *hiragana* is now the predominant system of *kana*, whereas *katakana* is used to represent foreign loan words. **Thus, while the chart itself uses *hiragana* to indicate pronunciation of the target Japanese syllable, many of the *yubimoji* actually approximate the shape of *katakana*.**

Another successful idea of Ōsone's was to borrow from an already established fingerspelling system used by a rather large deaf population in the U.S. in an educational context. As Figure 8 illustrates, Ōsone borrowed all five fingerspelled vowels (a, i, u, e, o) from American Sign Language (ASL), using them to form the first column of the contemporary *yubimoji* chart. And to form the top row of the chart, he borrowed the ASL manual letter handshapes for use as the Japanese consonants <k s t n h m y r w> combined with the vowel <a> to yield the syllables <ka sa ta na> and so on. Some of these borrowed handshapes eventually were altered to be linguistically or culturally appropriate. For instance, the JSL *yubimoji* <na>, <ma>, and <(w)o> were altered for linguistic reasons, while <ta> was changed for cultural reasons, namely: the handshape of the ASL finger-spelled letter "t" is considered a rude gesture in Japan and thus could not be borrowed into JSL (see Figure 8, points 3 and 4 in the explanatory key).

FIGURE 8

Comparative illustrations of the JSL *yubimoji* and ASL fingerspelling systems.

Source credits: Rô-a Renmei [Japanese Federation of the Deaf]. (1987). *Watashi tachi no shuwa* (3) [Our Hand Talk (3)]. Tokyo, Japan: Japanese Federation of the Deaf, page 6 (Part A below); Humphries, T., Padden, C., & O'Rourke, T. (1980). *A Basic Course in American Sign Language*. Dallas, Texas: T.J. Publishers, page 235 (Part B below). Resized images reproduced with shaded annotations and key by the authors with permission from the Japanese Federation of the Deaf and Carol Padden.



Part A: JSL

Part B: ASL

**Key:** Reading annotations on the JSL *yubimoji* and ASL fingerspelling charts shown above

- The unshaded handshapes on both charts above are shared by both dactylogogy systems. [On the JSL *yubimoji* chart, the unshaded handshapes were borrowed from ASL.] On the JSL *yubimoji* chart, this includes:
  - all the vowels
  - the first row of every consonant + the vowel <a>
  - the particle <(w)o> (を)
- Dark gray shaded cells on both charts indicate handshapes not shared by the two sign languages.
- Light gray shaded cells on the JSL chart indicate handshapes originally borrowed from ASL but altered for linguistic reasons. See <na>, <ma>, and <(w)o> above.
- Circled cell indicates handshapes altered for cultural reasons. Compare the JSL <ta> and the ASL "t" above. Because the ASL "t" was identical to a taboo gesture in Japan, the JSL <ta> handshape was altered.

Another successful design innovation in Ōsone's fingerspelling system is that it includes some JSL signs (Figure 9).<sup>4</sup> He did this in cases when a JSL sign for a monosyllabic Japanese word coincidentally sounded identical to a particular *kana* syllable. For example, the Japanese word for 'hand' is *te*, and the JSL sign HAND is a full hand, fingertips facing up, slightly to the right of the signer. Ōsone chose this JSL sign to function also as the fingerspelled *kana* syllable <te> (Part A of Figure 9). A similar situation holds for the fingerspelled *kana* syllable <ne>: the Japanese word for 'root' is *ne*, and the JSL sign ROOT was Ōsone's choice for the *kana* syllable <ne>.

But Ōsone's incorporation of JSL signs went even further. Ōsone was careful to establish visual connections between manual *kana* syllables by connecting them to signs for numbers (for example, the <hi> of *hitotsu*) or for other words/objects/concepts, all of which, crucially, are ubiquitous in Japanese culture (for example, *te*, *ne*, and *kitsune*). He decided that the *kana* syllable <ki> would use the handshape of the JSL sign KITSUNE 'fox' (Part B Figure 9).<sup>5</sup> Notice that the first syllable of the word for

<sup>4</sup> Technically, when a few of these signs became *yubimoji* that represented *kana*, some properties of the signs, such as location or movement, were altered slightly. Their handshapes, however, remained the same as both JSL signs and *yubimoji*.

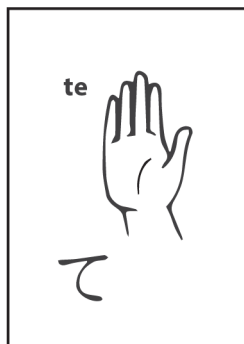
<sup>5</sup> Traditionally, the fox or *kitsune* (狐) has occupied an important place in Japanese culture. According to Japanese mythology, the god Inari protects rice agricultural cultivation and other forms of economic production. Because Inari's messenger takes the form of a *kitsune*, statues of foxes abound at Shintō shrines (Staff Editors of Encyclopedia Britannica, 1998), and *kitsune* representations are ubiquitous in traditional Japanese folk art and illustrated folktales.



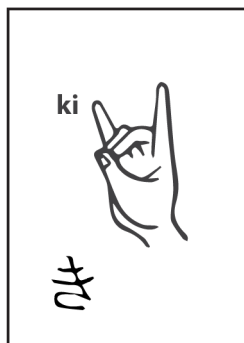
FIGURE 9

Examples of contemporary *yubimoji* derived from JSL signs (or their handshapes).

Source credit: Rô-a Renmei [Japanese Federation of the Deaf], (1987). *Watashi tachi no shuwa* (3) [Our Hand Talk (3)] Tokyo, Japan: Japanese Federation of the Deaf, page 6. Excerpted images resized, edited for clarity, and reproduced with permission from the Japanese Federation of the Deaf.



**Part A:**  
Example of a JSL sign for a common/ubiquitous, monosyllabic Japanese word with an identical sound to a particular *kana*.



**Part B:**  
Example of a JSL sign with an obvious visual resemblance to the meaning of a common/ubiquitous, polysyllabic Japanese word in which the first syllable of that Japanese is identical to the sound of a particular *kana*.

**Note:** These examples may also exploit similarities between the iconicity and meaning of the JSL sign.

fox is <ki>. In a similar case, the initial syllable of the Japanese word *hitotsu*, or (numeral) one, is <hi>; thus, the JSL sign ONE was used to represent <hi> in *yubimoji*.

Ôsone's last *yubimoji* design innovation allows for the representation of several types of special syllables that depart from the most frequent paradigm in Japanese, that of Consonant-Vowel (see again Part B of Figure 6). For example, Japanese has some syllables that add a <y> between the consonant and the vowel (such as *kyô* of *Tôkyô*). It also has some syllables that include a doubled consonant sound (such as the doubled <p> in *Sapporo*). These cases and others occur because of deep and longstanding phonological changes in Japanese (Pulleyblank, 1995; Tsujimura, 2007). Ôsone provided a way for all of these to be represented in his manual syllabary by incorporating movements of the hand/forearm in addition to having the fingers configured into a particular handshape.

## Contributions of *Yubimoji* to Communication and Literacy

In the years since its creation, and especially after the end of the Second World War, Ôsone's manual syllabary spread widely until it became the standard(ized) *yubimoji* system in Japan that facilitates manual and visual expression of written *hiragana* and *katakana*. Among the users who benefit are native Deaf JSL signers reading and writing in the Japanese language; hearing Japanese people studying JSL; and others engaging in ad hoc communication with Deaf strangers. Moreover, *yubimoji* may play an even a larger role in Deaf Japanese society: this well-accepted system may be important to literacy rates.

Putting aside the difficulties of interpreting statistical findings, the concept of literacy is difficult to adequately define and measure quantitatively because it has been variously defined for particular times and places, including in Japan. Historically, however, Japan has a high rate of literacy and a longstanding tradition of mass (woodblock) printing and popular "reading," albeit variously defined, that predated the Meiji Period by over two centuries (Unger, 1996).<sup>6</sup>

While the oft-cited statistic that Japan's literacy rate is 99% is now widely acknowledged to be a "myth" (Galan, 2005, p. 252; Nakashima, 2019, p. 332), the fact remains that contemporary Japan is a highly literate society even among other post-industrial societies (Ellington, 2005; Nakashima, 2019, p. 180) despite having one of the most complicated writing systems (Ellington, 2005; McCurry, 2013) in the world. In the twenty-first century, Japan consistently scores very highly on the Organisation for Economic Co-operation and Development's (OECD) Programme International Student Assessment (PISA) survey<sup>7</sup> in all areas (Mizuho, 2016; OECD Education GPS, 2019). As for reading scores, Japan maintains an impressive position somewhere among the top five to ten countries surveyed (OECD, 2015; Mizuho, 2016).

Neither PISA nor other international surveys, however, shed any light on literacy rates among deaf students in Japan (or elsewhere) because they were not included in the research (Hendar & O'Neill, 2016, p. 47). The gap in our understanding about literacy among deaf people in Japan is exacerbated by the fact that for many decades, they (and other "disabled" populations) were actively excluded from domestic literacy research. Fortunately, in recent decades, researchers have begun

<sup>6</sup> The ancient Chinese technology of woodblock printing, called *mokuhanga* (木版画), was utilized in Japan as early as the eighth century (Department of Asian Art, 2003), but it was 10+ centuries later, during the extended peace and prosperity of the Edo Period/Tokugawa Period, when the technology became a mass medium and the *ukiyo-e* (浮世絵) boom in woodblock print books and pictures occurred. *Ukiyo-e*'s were a form of escapism and diversion for their audiences. The subject matter they addressed—particularly the sensational aspects of popular and urban culture—stimulated the public imagination, creating eager audiences and widespread demand" (Pang, 1994).

<sup>7</sup> Coordinated by the OECD, the PISA survey is "an international assessment that measures 15-year-old students' reading, mathematics, and science literacy every three years" (National Center for Educational Statistics, 2019). While PISA research began in 2000, the most recent data was collected in 2015.

examining literacy among Deaf Japanese people in relation to JSL, bilingual education, and texting (see, Oda, 2006; Iurascu, 2009; Nakashima, 2013; Nakashima, 2016; Takahashi et al., 2017). While each study is interesting and useful in its own right, all of them utilize different definitions, methods, and linguistic assessment devices—the foundational analytical conundrum of literacy research itself. Those significant definitional and methodological differences notwithstanding, all of the aforementioned articles attest to the regrettable fact that literacy levels among deaf Japanese are much lower than those of their hearing counterparts—a pattern found globally (World Federation of the Deaf, 2007, p. 2).

All that said, whether considered historically or comparatively, there are many positive indicators of successful literacy achievement involving Deaf people in Japan. Unlike many non-Western countries, Japan has a comparatively long (141 years) and well-established history of formal deaf education, which began in the nineteenth century, just 52 years after its commencement in the United States. For many decades now, K-12 deaf education has been compulsory, with services available throughout the country. In 1990, opportunities for tertiary-level study were greatly expanded through the founding of Tsukuba University of Technology, Japan's first post-secondary educational institution (and the second of just three worldwide) dedicated to serving Deaf and hard-of-hearing students (Tsukuba University of Technology, 2019). Taken together and projected historically, these advancements in Japanese deaf education would suggest that literacy skills are sufficiently strong among enough deaf people in Japan to have warranted expansion of higher educational opportunities for them.

Still other evidence of Japan's comparative national accomplishments vis-à-vis Deaf literacy may be found beyond formal educational policies and institutions. The country has a long and pervasive "reading culture;" in fact, Kamei-Dyche (2017) goes so far as to say that, "Japanese society retains a strong emphasis on the social values of reading, understanding reading not primarily as an individual engagement with one's interests but rather as a means to acquire a consciousness of one's group and nation." For instance, among its many functions and endeavors, the Japanese Federation of the Deaf (日本ろうあ連盟 or JFD) has actively designed and published numerous dictionaries of JSL as well as dictionaries of other Asian sign languages for developing countries in the region (JFD, 2012). In Japan, reading *manga* (comic books) is a hobby that a sizeable number of deaf people share with hearing people. Anecdotally, there are Deaf clubs whose members gather to read, illustrate, and/or write *manga*.

As a form of manually coded Japanese, *yubimoji* are somewhat distinct from JSL. However, the now-routine incorporation and quotidian use of this manual syllabary in and with JSL (much like the frequent use of fingerspelling in other national sign languages like ASL, British Sign Language, etc.) underscores its utility. Thus, like the *kana* syllabary from which they were adapted, *yubimoji* are widely believed to support the development of at least basic literacy skills among Deaf people in Japan, although formal scientific research in this area has yet to be conducted. Put

another way, *yubimoji* seem to support literacy, clarify JSL-Japanese cross-linguistic communication, and even serve, by necessity, as a short-term communicative bridge. Understood from that perspective, it is clear that by rendering Japanese *kana* visible and linguistically available in the manual modality, Japanese *yubimoji* have expanded opportunities for literacy and communication for and between Deaf and hearing people in Japan. These perceptions seem in line with what is known about how alphabetic fingerspelling contributes to reading skills development among deaf students in the U.S. (Baker, 2010). Although a syllabary and an alphabet are different linguistic representations, it is intriguing to ponder whether Japanese Deaf children similarly harness their manual syllabary to learn to read.

## Discussion

Hindsight is indeed 20/20, and what is clear today is that the creation of Japan's successful *yubimoji* system was not a simple or quick process; it was predicated on centuries-long prior development of the two written *kana* syllabaries. Even when those were established, it still took almost half a century to invent a *yubimoji* system that the Japanese Deaf community was able to embrace. The current manual syllabary evolved out of much trial and error: several *yubimoji* systems were developed independently across time and space in Japan between the 1870s and the 1930s.

In many ways, those efforts were laudable. They were designed to promote inclusion of d/Deaf people in the new, modernizing Japanese nation-state a century prior to commencement of the inclusive design discourse. This historical case study of the development of Japanese *yubimoji* underscores the idea that necessity really is the mother of invention. Educators who were pioneering formal deaf education at the time did what they thought best and hoped that it would work to promote literacy development in their students. Unfortunately, however, those prior manual syllabaries suffered various design shortcomings—flaws so serious that ultimately the manual syllabaries were ineffective or unworkable.

Examined through a DeafSpace analytical lens, those design failures are unsurprising. Because the inventors of most of the early *yubimoji* systems had no access to scientific knowledge of sign language linguistics (established circa 1960), they designed manual syllabaries that failed to adhere to or actively violated numerous foundational rules of natural human languages expressed in the manual modality. JSL Deaf signers (like native users of other languages) would have intuitively been able to identify those manual representations of the Japanese syllabary that were acceptable in their language. Unfortunately, in keeping with practices of those times, native JSL signers with linguistic expertise were not consulted in the design process.

Understood against that backdrop, the independent and ad hoc development of different *yubimoji* systems in pre-WWII

Japan is unsurprising, even predictable, but ultimately that design pathway wasted considerable time and energy for teachers and students, as well as budgetary resources for schools and other institutional stakeholders. Additionally, it delayed by many years Japanese d/Deaf students' and the broader Deaf community's access to a well-designed *yubimoji* system.

The lessons of this case study are worth pondering today. In the twenty-first century, as in the Meiji Era, we are experiencing a period of profound technological—and by extension economic and sociopolitical—change. In the nearly 200-year interim, there have been major advancements both in education and services for d/Deaf people, although the need for greater accessibility and inclusion remains a challenge. Significant monies are being spent in countries around the world to meld various sign languages with language translation software and artificial intelligence technology. There exists great hope that these efforts will succeed in producing: dual sign-to-voice/voice-to-sign translation; virtual translators; cyberglove and artificial technologies, and so forth (e.g., Dangsaart et al., 2008; Hersh et al., 2003; Hodal, 2019; Ma et al., 2000; Mehrez & Jemni, 2012; Labios, 2017; Vanjikumaran & Balachandran, 2011).

All things being equal, those technologies, will be as good (or bad) as they are designed to be. Good design is likely to be enhanced and bad design limited by the adherence to DeafSpace principles and practices. We conclude by providing a short-list of key points and a discussion that designers should keep in mind as they plan and conduct their research and development on twenty-first-century inclusive design technologies for d/Deaf end-users:

- 1) Recognize the lingua-cultural expertise of d/Deaf people, the target technology end-users, by actively consulting with them. Assumptions should not be made about d/Deaf people's technological needs and wants. Whenever possible, co-design and include d/Deaf people in the R&D process.

History has shown that Gensuke Ōsone avoided the pitfalls of both the Furukawa and Watanabe systems, both of which included handshapes and locations that, by modern analyses, were articulatorily or perceptually uncomfortable or difficult to perceive. Due to these inherent design flaws, it stands to reason that Furukawa's and Watanabe's systems would not have caught on, while Ōsone's did. Processually, Ōsone's system benefited not only from the trial and error of precursor systems but also from active investigation of the successful ASL fingerspelling system as well as consultation with the d/Deaf community in the U.S.A., especially with Helen Keller. Ōsone's efforts surely helped him grasp which handshapes and locations would (not) be embraced by Deaf Japanese.

Notably, Ōsone did not discount the views, knowledge, and experience of d/Deaf people, even though he did his work long before the awakening of the hearing world to the value of d/Deaf people, their experiences, and their sign languages. Ultimately, Ōsone borrowed the handshapes and locations of the ASL vowels and some consonants. This

demonstrates that Ōsone had at least a tacit understanding of the idea of co-designing the things meant for d/Deaf end-users with d/Deaf people.

- 2) Utilize resources to learn more about d/Deafness—e.g., World Federation of the Deaf, Registry of Interpreters for the Deaf, national and state Centers on Deafness, and so on. Similarly, network and consult with sign language linguists, anthropologists, and other professionals who can assist in developing lingua-culturally appropriate research and deliverables.

The state of communication, transportation, technology, and scientific knowledge at the time of the establishment of Ōsone's system were not what they are today. However, Ōsone's perspicacity was undoubtedly an extension of the Meiji Era desire to achieve "Civilization and Enlightenment" through rapid creation and mastery of transformative new technologies. From the Meiji Era up until a few years before WWII, a remarkable number of Japanese government officials, private philanthropists, and educators of the deaf made long sea voyages to the United States and Western European countries in order to conduct study tours and educational exchanges with their Occidental counterparts. During this remarkable period in Japanese history, all available means were marshaled to seek out information and methods that would serve their purposes—including in education—rather than relying on what they already knew. While great emphasis was placed on mastery of then-disruptive technologies, equal emphasis was placed on actively contemplating and anchoring technological change in the service of advancing larger and more equitable sociopolitical aims—e.g., establishment of universal education, spread of literacy, and social inclusion of d/Deaf, blind, and other "disabled" individuals.

- 3) Know that there is no such thing as a universal sign language. Linguistic diversity is characteristic of both spoken and signed languages.

Today it is acknowledged as scientific fact that there is no such thing as a universal sign language. The absence of rigorous linguistic investigation of the properties of sign languages notwithstanding, pioneering Japanese educators of the deaf in the late nineteenth and early twentieth centuries would have instantly recognized the obvious differences among JSL, ASL, and other signed languages that they encountered.

Internationally, modern research has broadened our understanding of such differences; we have shown that families of sign languages with similar histories and linguistic structures exist.

Perhaps more to the point, while not all sign languages belong to the same family, research continues to uncover the properties common to all sign languages. Thus, we now know that for universal

access to be achieved inclusive design efforts must be prepared to grapple with linguistic and cultural diversity as inherent variables in development of technologies aimed at signing Deaf target end-users.

- 4) Realize that different sign languages will not only exhibit different vocabulary but also different syntax and other linguistic features, including sociolinguistic and pragmatic ones.

Besides not being universal, signed languages, like spoken ones, have very different properties. For this reason, designers of access-enhancing technologies for signing Deaf people must ground their work not only in knowledge fields such as engineering and computer science but also in sign language linguistics and Deaf studies, for only then can the depth and breadth of linguistic variation between and among languages expressed in the manual modality be adequately appreciated, anticipated, and addressed by designers. Rarely has wholesale importation and adoption of a dactylogogy system used in one sign language proved successful in another lingua-cultural context without some adjustments. Moreover, the greater the difference between sign languages of the Deaf and also between the written orthographic systems associated with their respective dominant hearing cultures, the less feasible it will be simply to transplant a dactylogogy system developed in one context to another. In such instances, significant reworking will be required.

In the case of the contemporary JSL *yubimoji*, Ōsone's willingness and ability to borrow from ASL was laudable, and ASL elements that were inappropriate in Japan were amended. But Ōsone did more than this. He also used the semiotic resources to which d/Deaf people in Japan would have ready access. For instance, he borrowed certain signs (highly iconic ones) from JSL to represent the syllables in the manual syllabary. As motivations for such *yubimoji*, he chose JSL signs for objects or concepts that are ubiquitous in Japanese culture, thereby ensuring plenty of opportunities for new learners of the JSL manual syllabary—both Deaf and hearing—to make sense of *yubimoji*.

- 5) Understand that natural human sign languages such as JSL, ASL, Thai Sign Language, etc. must not be confused with systems such as Signed Japanese, Signed Exact English, and manually coded Thai. The former exhibit their own unique grammars whereas the latter are manual representations of Japanese, English, and Thai, etc. that follow the grammar of those languages.

This idea is perhaps the most opaque and historically has been the most difficult point for hearing innovators, ranging from educators to technology designers, to grasp. Naturally-occurring sign languages, like JSL and ASL, often are conflated with invented signing systems such as Signed Japanese (Sagara, 2014, pp. 3-10) or Signed Exact English (Bornstein & Saulnier, 1986). The former developed naturally among

communities of Deaf signers, while the latter are actively created in an effort to represent the dominant spoken language on the hands with the belief that this will assist d/Deaf learners in school and make the mastery of literacy easier.

Designers working on issues at the intersection of translation and artificial intelligence must be particularly cognizant of these differences and their implications. It goes without saying that developers would not deem successful software that rendered either a written or spoken Japanese translation that produced Japanese words in accordance with English grammatical structures and word order. Such an occurrence would present a dilemma to be solved. And so it would be for JSL, ASL, and other sign languages of the Deaf, if they were not represented faithfully. In short, if inclusive design endeavors are to be effective, engineers and software developers must keep in mind that while all languages can potentially be encoded for expression in the manual modality, not all "signing" is linguistically appropriate to or compatible with the communicative needs and preferences of native Deaf signers.

- 6) Remember that although there are great affinities among Deaf communities around the world, there also are real differences between Deaf cultures as well as between hearing and Deaf cultures.

All of the foregoing attests to the idea that the world's people are simultaneously both similar *and* different. Promoting inclusion of and access for everyone is an appealing, even noble, idea that, in order to be accomplished, requires not just commitment but regular rededication in light of new knowledge and evolving best-practices. When designing technologies and services for signing Deaf end-users, DeafSpace is an important and highly useful design paradigm. It reminds hearing designers to check assumptions before making decisions. The paradigm also empowers every Deaf community by ensuring that their linguistic needs and cultural values are foundational considerations in the design process. Finally, because it foregrounds as urgent priorities the lingua-cultural preferences of Deaf end-users of technology, DeafSpace-informed design is a crucial pre-condition for real inclusion.

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