Color Coding Japanese Kana for Second Language Acquisition

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Abstract
In this research, the pedagogical effects of endowing Japanese Hiragana with alphabetical properties by phonetically mapping the Kana syllabary to their respective vowel phonemes with a color code as well as mapping diacritical marks color coded to each character's respective consonant group are studied. This phonetic color coding system mapped to Japanese Kana was tested on a group of native English speakers with no prior knowledge of Japanese, and the results of a series of six tests examining Kana acquisition, pronunciation accuracy, and vocabulary retention were weighed against the results of a control group who received instruction without said color coding system. This phonetic color coding system proves to be far superior to the instructional methods used without the system in three distinct categories. First, the phonetic color coding system, once learned, allows the learner to forego all romanization and instead use only the Kana characters during study thus increasing the speed of Kana acquisition. Second, by not using romanizations to guide pronunciation, the learner is unaffected by the phonetic rules governing the English Latin alphabet thus improving the accuracy of pronunciation. Third, mapping a phonetic color code to a writing system arguably increases the retention rate of vocabulary. The implementation of this phonetic color coding system elicited striking improvements in the abovementioned categories throughout all six tests carried out in this study.

Keywords: Japanese as a Foreign Language, Second Language Acquisition, Phonology, Phonetic Color Coding, L2 Vocabulary Acquisition

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Introduction

Japanese is considered to be one of the most difficult languages for native English speakers to acquire proficiency in. According to the Foreign Service Institute of the US Department of State, it is estimated to take 2,200 hours of continual study to reach a level congruent with "general proficiency" in both reading and speaking. Japanese is a "Category V" language for native English speakers, the same category as Chinese (both Cantonese and Mandarin), Korean, and Arabic. Even amongst these other Category V languages, Japanese distinguishes itself again in terms of difficulty in second language acquisition by earning an asterisks footnote imparting that Japanese is considered to be more difficult to learn than other languages in the same category. To put this level of difficulty into perspective, a Category I language for native English speakers, such as French or Spanish, takes approximately 600 hours to reach general proficiency in reading and speaking. It is quite understandable then why a native English speaker might be intimidated by the prospect of beginning to study the Japanese language. From a pedagogical perspective, it is the duty of Japanese language instructors teaching non-native students to help unravel the complexity of the language and to structure the learning process in such a way so as to increase the efficiency of studying one of the world's most difficult languages. A logical start to understanding the pedagogical difficulty of teaching the Japanese language to native English speakers is to look at how Japanese is different than the English language.

Despite originating from a completely separate language family than the English language, Japanese originating as a language isolate in the Japonic Language Family (Kindaichi, 1988), and English originating from the West Germanic Language Family (Crystal, 2003), there is plenty of shared vocabulary thanks to large amounts of foreign words from numerous European languages and phrases adapted for Japanese use. There are, in fact, so many adopted foreign words commonly used in Japanese that one could make the case that, even though there is a disproportionately large amount of vocabulary completely foreign to European languages, the presence and usage of these foreign-born words in Japanese should provide a native English speaker with an innate knowledge of some common, everyday Japanese. Japanese grammar is also relatively easy when compared to some of the more grammatically difficult languages in the European linguistic family. German, for example, is arguably much more grammatically nuanced than Japanese. German however, even with its complicated three gender article system each with their own grammatical declensions, is only a Category II language according to the Foreign Service of the US Department of State. One is left to wonder as to what it exactly is that makes Japanese so much more linguistically complicated than other languages. The answer to this riddle may lie in the Japanese writing systems. Despite its simplified grammar and plethora of adopted foreign words (the grand majority of which come from English), the Japanese writing system is well outside the linguistic comfort range of the average native English speaker. Being well versed in Japanese grammar does one little good when one cannot write; similarly, being armed with an innate knowledge of the majority of adopted foreign words used commonly in everyday Japanese does one little good when one cannot read what is written. Unlike many European languages that use, with the exception of a few accent marks or unfamiliar letters, essentially the same Latin alphabet as English, Japanese has its own unique writing systems, and they just so happen to be extraordinarily complicated.

Japanese uses three completely different writing systems in conjunction with one another, all of which operate very differently than the Latin alphabet that English speakers are familiar with. The hybrid Japanese writing system utilizes two phonetic syllabaries, Katakana and Hiragana (otherwise known as simply Kana), and ideogrammatic characters called Kanji which are adopted from Chinese characters. These writing systems are similar to the writing systems used in modern day Korea (Hangul) and in Chinese speaking countries, however there are a number of unique properties inherent to the Japanese writing systems that make them more linguistically complex than those used by these aforementioned neighboring cultures.

Korean Hangul shares syllabic features similar to Japanese Kana. For example, the word "Hangul" is comprised of two syllables: "han" and "gul." Therefore, when written in Hangul, each syllable will be written as one character: 한 for "han" and 글 for "gul." Similarly, the word "Kana" is also comprised of two syllables: "ka" and "na." Therefore, when written in Kana, each syllable will be written as one character: か for "ka" and な for "na." However, Korean Hangul also incorporates alphabetic principles, whereby every phoneme in Hangul is represented by one letter independent of the character syllable, and can be used interchangeably with other character syllables: ㅎ is an "H," ㅏis an "A," and ㄴ is an "N." Any one phoneme can be replaced from the character syllable to alter the pronunciation, and the remaining phonemes are the same: 한 is "han" and 난 is "nan." On the other hand, Japanese Kana operates on non-alphabetic, purely syllabic principles, and cannot replace phonetic components of a character syllable without changing the symbol entirely: preserving the phonemes "K" and "N" and replacing both "A" vowels with "O" in かな (Kana) results in この (kono); despite the consonant phonemes remaining the same, due to the vowel shift, the whole character is changed (with the arguable exception of diacritic denotation of the unvoiced to voiced consonant shift, e.g. "K" to "G," or "S" to "Z") whereby か (ka) becomes が (ga) with two diacritical dashes to the right of the original character, and さ (sa) may become ざ (za) using the same process. This distinct lack of alphabetic features in the Kana phonetic syllabaries results in there being almost twice the amount of written characters when compared to Hangul, with each Kana syllabary containing 46 unique characters, and Hangul containing a mere 24 letter phonemes. Moreover, Japanese utilizes two syllabaries. Hiragana is principally used for all native Japanese vocabulary, and Katakana is principally used for all adopted foreign vocabulary. This raises the final character syllable count to 92, almost four times the amount of characters compared to Korean Hangul. This count of 92 characters does not even begin to consider the 2,136 Jōyō Kanji (literally: regular use Kanji) now considered necessary for general reading proficiency as reported by the Nihon Keizai Shimbun on November 24th, 2010.

Despite having plenty of vocabulary in common with English, and despite the highly regular, straight forward grammar, Japanese remains one of the most difficult, if not *the* most difficult language for English speakers to learn. One reason for this might be in part due to the exceedingly complex hybrid writing system made up of two syllabaries (Hiragana/Katakana), as well as thousands upon thousands of ideograms each with numerous pronunciations (Kanji). From a pedagogical perspective, if an instructor wanted to make the process of second language acquisition of the Japanese language more efficient, or otherwise less overtly complicated for English speakers, approaching the instructional method pertaining to the writing systems would be a

logical place to start. Of the three writing systems used in modern Japanese, the two syllabaries Hiragana and Katana would be the far easier option to start any attempt on simplifying the educational process. This does not preclude the possibility of the creation of a pedagogical method to make acquiring general proficiency in Kanji more efficient, however even with improvements to the pedagogical method of instruction, the process of acquiring general proficiency in Kanji requires years of commitment. Hiragana and Katakana, on the other hand, are each comprised of only 46 unique characters, and would therefore be the more likely candidates to see immediate results from the implementation of an improved pedagogical method. This research presents just such a pedagogical method utilizing a color coding system applied to Hiragana and demonstrates the ability to increase the speed of acquisition in English speaking students with no prior study in the Japanese language. The following sections will discuss in detail how a color coding system is used to endow Japanese Kana with alphabetic properties, and how the implementation of this system in a test group of 20 research participants with no prior knowledge of Japanese improved the acquisition rates of the Hiragana syllabary, Japanese vocabulary retention, and pronunciation.

Japanese Kana Color Coding System

Introduction to the Color Coding System

Due to the pedagogical versatility of Hiragana within the Japanese language, Hiragana is the Kana system that was chosen to be used in this study. Although there are arguments in favor of starting English speakers with Katakana instead of Hiragana due to the majority of English derived foreign vocabulary written in Katakana, Hiragana is by far the most utilized of the two Kana in pedagogical settings, and so Katakana was not mapped or tested within this research. With that being said, the identical structures of Hiragana and Katakana combined with the universal compatibility of the color coding system with either of the two Kana syllabaries should yield near identical results if Katakana were to be mapped and tested in an identical fashion to the color coded Hiragana presented within this research. The following sections will delineate how the color coding system operates, as well as the pedagogical benefits that the implementation of this color coding system would bring to non-native learners of Japanese Kana.

The color coding system tested in this research applies one of the six primary and secondary colors (yellow, orange, red, purple, blue, and green) to the five Japanese Kana vowel groups in the same color order just mentioned: あ (A) to yellow, い (I) to orange, う (U) to red, え (E) to purple, お (O) to blue, and the lone consonant ん (N) to green. Each subsequent vowel/consonant monograph is also coded to the aforementioned vowel color sequence: か (ka) to yellow, き (ki) to orange, く (ku) to red, け (ke) to purple, and こ (ko) to blue. This color coding system also modifies the natural form of Hiragana by adding color coded diacritical marks to all monographs to denote the consonant. By adding color coded diacritical marks to each monograph, alphabetic properties are imposed on all monographs. In natural Hiragana, when the Dakuten diacritical mark (゛) is added to a monograph with a voiced phonetic pair (e.g. K/G), the Dakuten diacritic denotes the voiced “G” consonant, and no diacritic is used to denote the unvoiced “K” consonant: か (ka) and が (ga). In this color coding system, color coded Handakuten diacritics (゜) are used on all monographs that are either in unvoiced/voiced phonetic pair groups (K, S, SH, T, CH, TS, H, P, F) as well

as voiced consonants with no Dakuten phonetic pair (N, M, R, Y, W), and color coded to each respective consonant group. For those unvoiced consonant groups with voiced phonetic pairs, the voiced consonant Dakuten diacritic is coded to the same color as the unvoiced phonetic pair denoted with the Handakuten diacritic. The color code for か゜ (ka) is therefore yellow for the monograph か to denote the "A" vowel group, and cyan for the Handakuten (゜) to denote the K/G consonant group; the color code for が (ga) is the same, yellow for the monograph か, and cyan for the Dakuten (゛). By denoting all consonant sounds with the Dakuten and Handakuten diacritics already used in natural Hiragana, alphabetic features are created so that students do not have to rely on Latin alphabet equivalents. For a complete list of all coded Hiragana monographs and diacritics, refer to Figures 1 and 2 (for monochromatic versions, refer to appendices 1 and 2).

Vowels		°K	°S	°SH	°T	°CH	°TS	°N	°H	°F	°P	°M	°R	°Y	°W
A	あ	か°	さ°		た°			な°	は°		は°	ま°	ら°	や°	わ°
I	い	き°	し	し°	ち	ち°		に°	ひ°		ひ°	み°	り°		
U	う	く°	す°		つ	つ	つ°	ぬ°	ふ	ふ°	ふ°	む°	る°	ゆ°	
E	え	け°	せ°		て°			ね°	へ°		へ°	め°	れ°		
O	お	こ°	そ°		と°			の°	ほ°		ほ°	も°	ろ°	よ°	を
N								ん							
Silent		く	す	し		ち	つ								

Figure 1: Unvoiced Hiragana monographs mapped to the color code

	"V	"G	"Z	"J	"D	"(D)J	"(D)Z	°N	°H	°F	"B	°M	°R	°Y	°W
A	あ	か"	さ"		た"			な°	は°		は"	ま°	ら°	や°	わ°
I	い	き"	し	し"	ち	ち"		に°	ひ°		ひ"	み°	り°		
U	う"	く"	す"		つ	つ	つ"	ぬ°	ふ	ふ°	ふ"	む°	る°	ゆ°	
E	え	け"	せ"		て"			ね°	へ°		へ"	め°	れ°		
O	お	こ"	そ"		と"			の°	ほ°		ほ"	も°	ろ°	よ°	を°

Figure 2: Voiced Hiragana monographs mapped to the color code

Digraphs are color coded to the dominate vowel sound, and the diacritics remain color coded to each respective consonant group. Normally the color code for the

monograph き° (ki) would be orange for き to denote the “I” vowel group, and cyan for the Handakuten (°) to denote the “K” consonant group. However, the color code for the digraph き°ゃ° (kya) is yellow for both き (ki) and the 3/4 sized ゃ (ya) to denote the dominance of the “A” vowel group, and cyan and salmon respectively for the Handakuten to denote both “K” and “Y” consonant groups. Finally, the 3/4 sized geminate consonant っ is coded to the same consonant that it duplicates, whereby the code for も°つ° (mo-tsu) is blue for も (mo), gray for the Handakuten on も°, red for つ (tsu), and violet for the Handakuten on つ°; when the 3/4 っ is used in も°った° (mo-tta), the color code becomes blue/gray for も°, yellow for た (ta), and violet for both the 3/4 っ and the Handakuten in った° (tta). For a detailed list of color coded digraphs and geminate consonants, refer to Figure 3 (for monochromatic version, refer to appendix 3).

"V	°K	"G	°SH	"J	°CH	°N	°H	°F	°P	"B	°R	°M
う"ぁ	き°ゃ°	き"ゃ°	し°ゃ°	し"ゃ°	ち°ゃ°	に°ゃ°	ひ°ゃ°	ふ°ぁ	ひ°ゃ°	ひ"ゃ°	り°ゃ°	み°ゃ°
う"ぃ								ふ°ぃ				
	き°ゅ°	き"ゅ°	し°ゅ°	し"ゅ°	ち°ゅ°	に°ゅ°	ひ°ゅ°		ひ°ゅ°	ひ"ゅ°	り°ゅ°	み°ゅ°
う"ぇ			し°ぇ	し"ぇ	ち°ぇ			ふ°ぇ				
う"ぉ	き°ょ°	き"ょ°	し°ょ°	し"ょ°	ち°ょ°	に°ょ°	ひ°ょ°	ふ°ぉ	ひ°ょ°	ひ"ょ°	り°ょ°	み°ょ°
っ	っ		っ		っ	っ	っ	っ	っ		っ	っ

Figure 3: Voiced/unvoiced Hiragana digraphs and geminate consonants

In a syllabic writing system without signifiers to denote both what the vowel and consonant are such as all 46 Japanese Kana monographs, there is only one way to become proficient: rote memorization. Although the same case may be made that one must also memorize the individual letters of an alphabetic writing system, when studying a true alphabetic system, phonetic characters will be used over and over in vocabulary and will therefore have a cumulative effect on the memorization process. For example, when looking at the following syllabic characters written in Korean Hangul 카 (ka), 키 (ki), 쿠 (ku), 케 (ke), 코 (ko), it is easy to identify that the “K” consonant is represented by the letter ㅋ; similarly, when the following phonetic sequence is written out in Hangul 아 (A), 카 (ka), 사 (sa), 타 (ta), 나 (na), 하 (ha), 라 (ra), 마 (ma), it is easy to identify the letter ㅏ as the phonetic marker for the vowel “A.” Due to the fact that the same phonetic markers will always appear in vocabulary utilizing the aforementioned consonant and vowel, the memorization process connecting the phonetic marker ㅋ to the “K” and ㅏ to “A” is considerably sped up.

When the same phonetic sequences are written in Japanese Hiragana か (ka), き (ki), く (ku), け (ke), こ (ko), for the “K” consonant group, and あ (A), か (ka), さ (sa), た (ta), な (na), は (ha), ら (ra), ま (ma) for the “A” vowel group, there is absolutely no

visual connection tying each of the above monographs to either the shared consonant phoneme “K,” or the vowel phoneme “A.” This means that to learn every possible combination vowel/consonant monograph with the phonemes listed above, one need only learn 12 phonetic letter components of Hangul syllabic characters (the five vowels ㅏ(A), ㅣ(I), ㅜ(U), ㅖ(E), ㅗ(O), and the seven consonants ㅋ(K), ㅅ(S), ㅌ(T), ㄴ(N), ㅎ(H), ㄹ(R), ㅁ(M)), however one must learn all 40 monograph characters in Japanese Hiragana (five vowel monographs multiplied by five vowel/consonant monographs for each of the consonant groups K, S, T, N, H, R, and M). It is precisely the lack of alphabetic representation in both vowel and consonant phonemes in Japanese Kana monographs that this color coding system addresses. By mapping specific color sequences to the monograph, the vowel phoneme may be distinguished; likewise, by mapping specific color sequences on both the Handakuten (゜) and Dakuten (゛) diacritics, the consonant phoneme may be distinguished. Should the color coding system proposed in this research be applied to the same phonetic sequences above, then one need only remember 12 colors (the same number as in the Hangul sequence) to be able to effectively read all 40 monographs. Through the implementation of this color coding system, the speed and effectiveness of the memorization process of Japanese Hiragana would be, on a theoretical basis, positively affected.

The increased speed at which a learner of Japanese as a foreign language could utilize the Japanese syllabaries with the color code intervention proposed in this research is not the only hypothesized benefit. Indeed, through the use of a color coding system, phonetic irregularities existing within the Kana syllabaries may be visualized as well. Unlike all other unvoiced/voiced phonetic pairs denoted by a Dakuten diacritic (K/G, S/Z, SH/J, T/D, and P/B), the F/V consonant pair is the only pair that is not visually linked by the same base monograph. The reason for this lies in the fact that there is no true “F” consonant group formally represented in Japanese Kana. The “F” consonant is a subcategory of the “H” consonant group and can only be denoted with the monograph ふ (fu/hu). Technically speaking, this monograph is not truly an “F” and is only used to denote the “F” phoneme due to the similarity between the Japanese pronunciation of ふ (hu), the “H” of which sounding more similar to an “F” than an “H.” Therefore the monograph ふ has become its own digraph subcategory (ふぁ (fa), ふぃ (fi), ふ (fu), ふぇ (fe), ふぉ (fo)) to be able to denote foreign born vocabulary using the “F” phoneme. The voiced phonetic pair to the “F” consonant is “V,” however due to fact the monograph ふ (fu) is actually a part of the “H” consonant group, when the Dakuten (゛) diacritic is utilized to denote a voiced consonant shift, the “H” consonant group becomes the “B” consonant group: ふ (fu) becomes ぶ (bu). The usual unvoiced/voiced consonant shift between the F/V consonant pair cannot be denoted in Japanese Kana with a simple Dakuten diacritic and is therefore shifted to the vowel う (U) which becomes ゔ (vu) when the Dakuten diacritic is added. Much like its unvoiced ふ (fu) counterpart, the voiced ゔ (vu) may use digraphs to complete the vowel phonetic sequence: ゔぁ (va), ゔぃ (vi), ゔ (vu), ゔぇ (ve), ゔぉ (vo). The visual link between the unvoiced/voiced phonetic pair F/V is lost in natural Japanese Kana, however, this visual connection may be reestablished when mapped to the color coding system. By mapping the Dakuten diacritic to the same color (in this circumstance, dark green), the Handakuten diacritic in the digraph ふ゜ぁ (fa) is visually linked by color to the Dakuten diacritic in the digraph ゔぁ (va).

There are other irregularities within Japanese Kana that may be visually denoted when mapped to the color coding system. The most readily discernible irregularities lie within the “S” and “T” monograph consonant groups and in their subsequent voiced diacritic groups. The Japanese “S” consonant group encompasses both “S” and “SH” phonemes in the monograph group, as well as the voiced phonetic pairs “Z” and “J” in the diacritic group. The “T” consonant group encompasses the “T/D” phonetic pair, the “ch” phoneme in the monographち (chi) as well as the “ts” phoneme in the monograph つ (tsu). However, when the ち (chi) and つ (tsu) monographs within the T/D consonant group are accented by the Dakuten (゛) diacritic, the pronunciation shifts away from the T/D consonant group to the S/Z and SH/J consonant group, whereby ち (chi) becomes ぢ (dji), and つ (tsu) becomes づ (dzu), whereby the “D” inserted into the romanizations represents a stressing of the “J” and “Z” consonants, and not a true voiced “D” pronunciation.

From a phonetic standpoint, this irregular phonetic shift in the diacritic group is hardly surprising. Even though the unvoiced/voiced T/D phonetic pair is reflected in the characters た/だ (ta/da), て/で (te/de), and と/ど (to/do), the monograph ち (chi) is more accurately classified as a stressed し (shi); likewise, the monograph つ (tsu) is more accurately classified as a stressed “S” consonant. These phonetic relationships are reflected in the near identical pronunciation of the diacritic ぢ (dji) and じ (ji), as well as in the near identical pronunciation of the diacritic づ (dzu) and ず (zu). Although this relationship is reflected in pronunciation, the visual relationship between these phonetic pairs has been lost due to the stressed consonant phonemes ち (chi) and つ (tsu) being classified in the “T” consonant group instead of being denoted with different diacritical markings in the S/SH monograph group and the Z/J phonetic pair. However, when these irregular stressed diacritics are mapped to the color coding system, these phonetic relationships may be reestablished.

Not only do all the non-stressed/stressed phonetic outliers from both monograph groups “S” and “T” receive their own color code separate from their respective consonant groups, but the diacritic shifts may also be denoted. The color code for the consonant “S” is magenta, but the color code for “SH” is pink. Similarly, the color code for the “T” group is violet, but the color codes for “CH” and “TS” phonemes are rose and crimson respectively. Therefore, when mapped to the color coding system, the character し° (shi) is color coded orange in the monograph し to reflect the “I” vowel group, and the Handakuten diacritic (°) is coded pink to reflect the “SH” consonant; the diacritic じ (ji) is mapped to exactly the same color code but uses the Dakuten diacritic to reflect a shift to the voiced phoneme “J” in the SH/J phonetic pair. Similarly, the character ち° (chi) is mapped orange in the monograph ち to reflect the “I” vowel group, and the Handakuten diacritic is coded rose to reflect the “CH” consonant. In the diacritic group, however, the Dakuten diacritic in ぢ (dji) is coded pink not only to reflect the near identical pronunciation as the voiced “J” Dakuten diacritic, but also to establish a visual phonetic connection between the CH/SH consonants normally not reflected in natural Japanese Kana. Finally, the character つ° (tsu) is coded red in the monograph つ to reflect the “U” vowel group, and the Handakuten diacritic is coded crimson to denote the “TS” consonant. However, when the character づ (dzu) is mapped to the color code, the Dakuten diacritic is mapped to

magenta to denote the near identical voiced pronunciation as the voiced “Z” in the S/Z phonetic pair group.

The color coding system described in this section seeks to simplify the acquisition of Japanese Hiragana by endowing the monograph syllabic characters with alphabetic properties. This alphabetic transformation is accomplished by color coding each monograph to a vowel group, then applying either Handakuten or Dakuten color codes to a consonant group to each monograph. The next section describes the pedagogical basis for this study as well as the methods used to measure how well the color coding system described in this section aids native English speakers in acquiring proficiency in Hiragana.

Methodology

Pedagogical Basis for Study

In this study, color is used to represent phonetic information in conjunction with the phonetic information contained in the Hiragana syllabary itself. In this way, the color code presents to the learner two layers of information, the image of color as representing phonetic information as well as the symbolic representation of phonetic information in Japanese Kana. If we assume that the learner is processing the visual information presented in the color code as an analogical representation of a phonetic sound, then we can liken the use of the color code system to utilizing images simultaneously with educational material in the L2. Not only has there been research suggesting that the processing of analogical representations (imagery) forms stronger mental bonds than symbolic representation (Chun and Plass, 1997), but there is also a wealth of research suggesting increased comprehension of L2 material when presented simultaneously with imagery (Mueller, 1980; Carlson, 1990; Chung, 1994; Jones, 2003; Wrobetz, 2018 [2]). The color coding system presented in this study was created with the intention of mimicking this process by way of a dual representation (analogic and symbolic) of phonetic information.

By not relying on romanizations to represent phonetic information, native English speakers learning Japanese as a foreign language must retrieve the phonetic information with “non-automatic elaborations.” When the Latin alphabet is used to signify the phonetic information of Japanese Kana, a native English speaker will automatically fall back on the information denoted in the Latin alphabet and invest very little mental effort to make connections between the two pieces of phonetic information. However, due to the fact that the learner using the color code cannot automatically retrieve the phonetic information being represented, increased mental effort must therefore be invested in order to retrieve the phonetic information. These “non-automatic elaborations” have been shown to increase retention of L2 material (Salomon, 1983). Furthermore, the state of non-automatic elaborations fit in very nicely with the psychological state of “desirable difficulty,” whereby long term retention of memorized material has been shown to be positively affected by increasing the mental effort needed to comprehend information (Bjork and Bjork, 2011). The next sections will describe both the study materials and testing methods used to test the efficacy of the color coding system in a simulated educational environment.

Study Materials and Testing Method

The color coding system described in the previous section of this article has been used to test how the use of color coded phonics affects the acquisition of Japanese Hiragana for native English speakers with no previous knowledge or study of the Japanese language. Two sample groups comprised of 10 students each were administered a series of six tests (total sample size of 20). The participants in the Hiragana acquisition tests are between the ages of 19-70 (mean age of 32) and represent a random selection from varying educational, professional, and cultural backgrounds. Although some participants have experience in foreign language study, all participants' mother language is English. None of the participants had had any Japanese language instruction at the commencement of the study. Half of the 20 total participants were divided randomly into two groups of 10, a control group and a test group. The control group was tested on their acquisition rates of Hiragana, pronunciation accuracy, and vocabulary retention through study guides not utilizing the color coding system. The remaining half of the participant sample was assigned to the test group and tested on their acquisition rates of Hiragana, pronunciation accuracy, and vocabulary retention through the use of color coded Hiragana and study guides featuring explanations of the color code. The next sections will describe the testing procedures.

The efficiency of Hiragana acquisition in each sample group was measured by a series of six study guides and tests for each respective sample group. The Hiragana syllabary has been divided into the following sections for individual testing: Test 1 comprises the vowel group plus N, and K/G group; Test 2 comprises the N group, M group, and R group; Test 3 comprises the H/F group and P/B group; Test 4 comprises the S/Z group, SH/J group, Y group, and W group; Test 5 comprises the T/D group, CH/J group, TS/Z group, and geminate consonants; Test 6 comprises the F/V digraphs, Y group digraphs, T/D group digraphs, (T)S/Z group digraphs, (C/S)H/J group digraphs, and W group digraphs. Prior to testing, each participant was given up to 30 minutes to read through a study guide explaining pronunciation, the romanization, as well as introducing a selection of Japanese vocabulary with English definitions utilizing the Hiragana monographs and/or digraphs being tested in each respective test section. After the time period for the study guide was finished, a test covering that particular section was administered. Although there was a time limit of 30 minutes governing the use of each corresponding study guide, there was no time limit established for the subsequent tests.

Each test consists of three sections (hiragana acquisition, pronunciation accuracy, and vocabulary retention) and is designed to test the participants' ability to correctly romanize individual Hiragana monographs/digraphs (Figure 4), pronounce individual monographs/digraphs (Figure 5), read a selection of Japanese vocabulary utilizing the Hiragana monographs/digraphs being tested (as well as review characters from previous test groups), and provide an English definition of the same vocabulary (Figure 6). The questions featured in Figures 4 and 5 pertain the participants' score on how efficiently Hiragana has been acquired and accuracy of pronunciation, and Figure 6 pertains to the participants' score on how efficiently Japanese vocabulary has been retained.

	Kana	Latin Alphabet		Kana	Latin Alphabet
EX.	け	*ke*	8	く	
1	あ		9	こ	
2	が		10	ん	
3	う		11	か	
4	え		12	ぐ	
5	ぎ		13	お	
6	き		14	い	
7	げ		15	ご	

Figure 4: Romanization test for Hiragana monographs/digraphs

EX.	ん	*F*		A	v **o** te
				B	**o** ffer
1	あ			C	c **a** t
				D	f **oo** d
2	い			E	**ea** t
				F	Kha **n**
3	う			G	t **oo** k
				H	**e** gg
4	え			I	**go** t
				J	**Kha** n
5	お			K	**A** frica
				L	**i** sland

Figure 5: Pronunciation test for Hiragana monographs/digraphs

	Vocabulary	Latin Alphabet	English Definition
EX.	かな	*kana*	*Japanese writing*
1	げんき		
2	えんぎ		
3	あかい		
4	ぎんこう		
5	あう		
6	あんき		
7	あい		
8	かお		
9	あかん		
10	あおい		

Figure 6: Vocabulary retention test

Through the use of the above mentioned testing methods, the efficiency of Hiragana acquisition, pronunciation accuracy and vocabulary retention in both the control group and test group was tested. While it is the hypothesis proposed by this research that the alphabetization of Japanese Kana by mapping phonetic groups to a color coding system will positively affect acquisition rates of Hiragana, supported in part by similar research conducted in the same field on how the color coding of phonetic markers in English positively promotes correct English pronunciation for Japanese elementary school students learning English as a foreign language (Wrobetz, 2018 [1]), this research is also attempting to measure the effect, if any, the same color coding system has on the retention of Japanese vocabulary in native English speakers. In the next section, the results of the testing methods described in this section are analyzed.

Results and Discussion

The test group who received the color coding system applied to Japanese Kana outperformed the non-color coded control group in the Kana reading/romanization sections, pronunciation sections, and vocabulary retention sections in all six tests. In addition to providing an in depth analysis of all six tests in Kana comprehension, the following section will also delve into the possible reasons why instruction with the color coding system positively influences correct pronunciation and vocabulary retention.

In Figure 7, the total percentage of correct answers from all six Hiragana and vocabulary tests taken by the test group (instruction with the color coding system) and the control group (instruction without the color coding system) are charted, and the test group is shown to vastly outperform the control group. The test group answered on average with an 84.6% rate of accuracy throughout all six test blocks compared to an average 41.3% rate of accuracy in the control group. Both groups showed similar

rates of improvement over the course of the six tests, although the test group demonstrated a higher average rate of improvement at 20.4% from the first test to the last test compared to a 9% average rate of improvement in the control group. Both groups additionally show similar curves reflecting the difficulty of the tests with sharp increases in the rate of accuracy in tests two and three, and a gradual decline in accuracy carried through to the end of test six. These fluctuations in test scores can be explained very simply by the fact that the tests continually review Hiragana monographs and digraphs covered in previous tests, and that the gradual buildup of the number of characters learned have no regular review outside of the testing process. Although the color coding system did not manage to improve upon the decline in test scores from the third test seen in both groups, the color coding system gave the test group an immediate advantage over the control group which continued throughout all six tests as well as a rate of improvement that was more than double that of the control group.

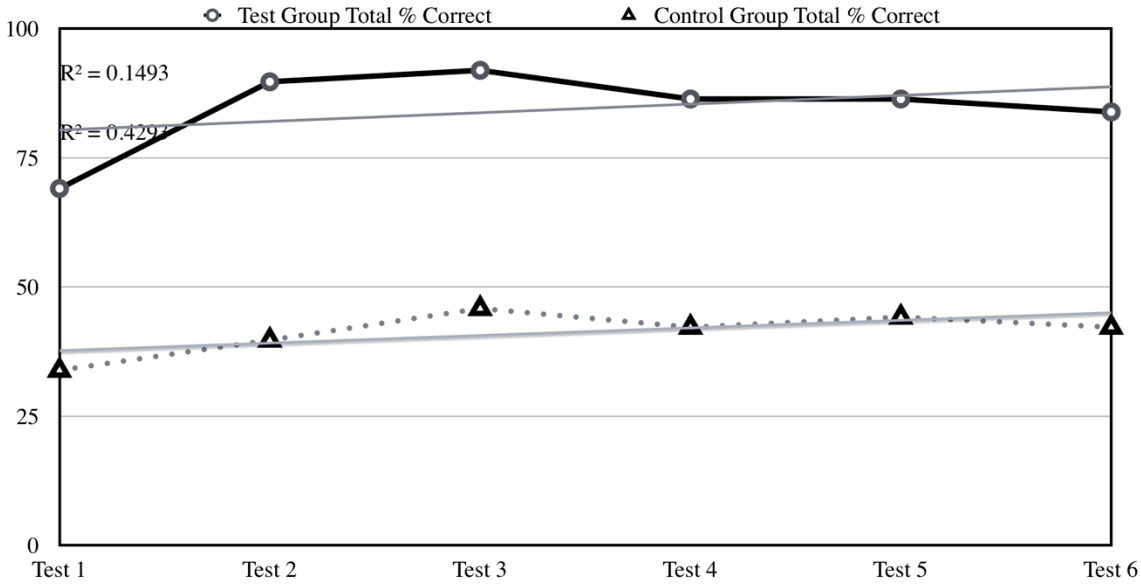

Figure 7: Averages of all six tests for both test and control groups

Another key difference in the test results is shown in Figures 8 and 9. In Figure 8, the average percentage correct scored in the test group (instruction with the color coding system) Kana comprehension and pronunciation tests are compared with the test group vocabulary retention tests. As is shown nicely in Figure 8, both curves match each other almost perfectly. This would seem to suggest that the color coding system links the comprehension of the Kana characters with the retention of the vocabulary in which they appear. These results are in contrast to the data presented in Figure 9, wherein the results of the control group (instruction without the color coding system) Kana comprehension and pronunciation tests are far more erratic and actually flip positions in tests two, four, and six. This would seem to suggest that the learners in the control group were not making as strong of a connection between the accurate reading of the Kana characters and the vocabulary in which they appear. Instead, the learner in the control group might have been focusing in on the English definitions of words rather than on the acquisition of the Kana syllabary. Moreover, the test group showed a far higher rate of improvement with a 26.4% average increase in accuracy

throughout all six tests, whereas the control group only showed a 14.8% average increase in accuracy.

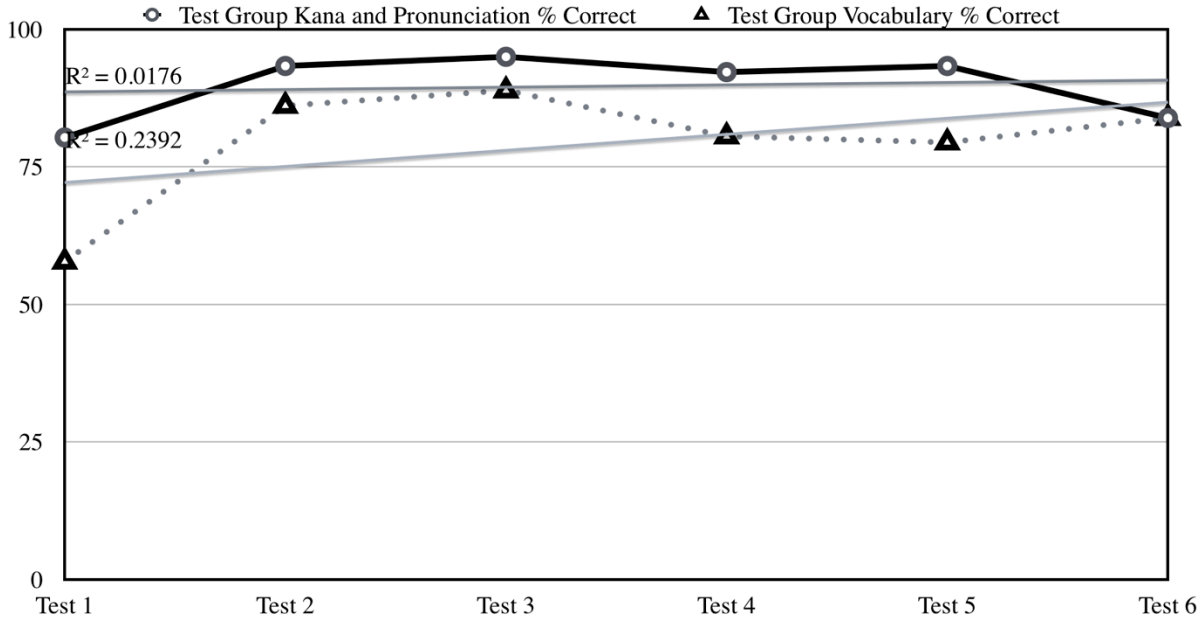

Figure 8: Test group romanization/pronunciation and vocabulary retention comparison

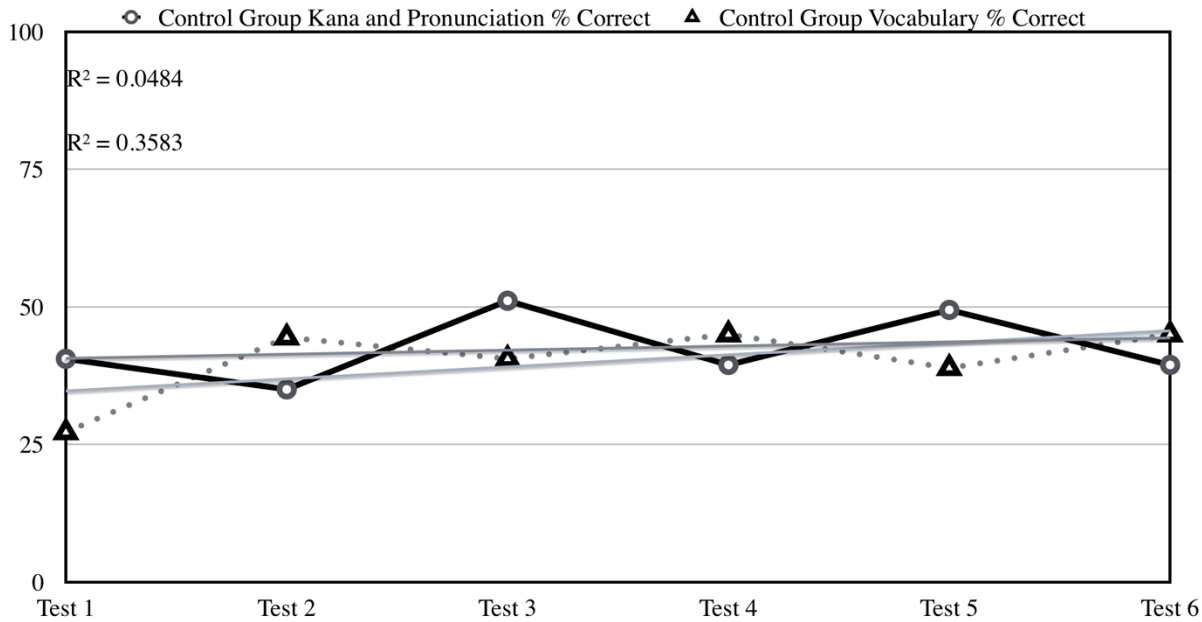

Figure 9: Control group romanization/pronunciation and vocabulary retention comparison

In both sets of data, the test group not only vastly outperformed the control group, but the test group also consistently showed higher rates of improvement in both Kana comprehension and vocabulary retention. Understanding why there is a difference in performance between the two testing groups should yield a deeper understanding of the potential pedagogical benefits that further intervention with the color coding

system presented within this research would have on native English speakers studying Japanese. As was touched on earlier, one potential reason for the higher rate of vocabulary acquisition seen in the test group could lie within how well the student recalls each of the Kana used in each vocabulary term. Due to the intentional structure of the vocabulary component of each test block to utilize those Kana covered in previous test blocks (e.g. the vocabulary in test block two only utilizes Kana from test blocks one and two, whereas vocabulary in test block three utilizes Kana from test blocks one through three), a more complete knowledge of the Kana used in previous test blocks should result in higher retention rates of vocabulary. This is exactly what we see happening in the test group. In the test group data, as scores rise with respect to Kana comprehension, so do vocabulary retention scores. Conversely, the scores with respect to Kana comprehension and vocabulary retention operate seemingly independent of one another in the control group.

The data presented in this section would seem to indicate that not only does the color coding system have the benefit of helping students acquire the Japanese syllabary at accelerated rates, but the utilization of just such a color coding system also has the potential of positively benefitting vocabulary retention. Although more research is necessary to firmly establish to what degree the implementation of the color coding system presented in this research would have on other areas of Japanese language acquisition, the potential surplus of benefits just such a system could have on other language processes such as reading skills, listening skills, and speaking skills is promising.

Even without considering the higher rates of Hiragana acquisition as well as vocabulary retention seen in the test group (instruction with the color coding system) over the control group (instruction without the color coding system), the point may still be made that all of the aforementioned phonetic descriptions depicted in the color coding system are accomplishable with simple romanizations of Japanese Kana. In this sense, it may be argued that complicating an already well-established writing system even though adequate romanization methods for acquisition are already set in place is unnecessarily complicating the instructional process regarding Japanese Kana. For example, the monograph ふ may be romanized as “fu” to denote the phonetic departure from the “H” consonant group. However, the benefits of utilizing this color coding system over simple romanization methods to instruct native English speakers stretches beyond the positive effect that the color coding system presented in this research has been shown to have on Hiragana acquisition and vocabulary retention.

The reason why this color coding system is superior to simple romanization is threefold: efficiency of memorization, accuracy of pronunciation, and the nature of color memorization. First, the color coding system, once learned, allows the learner to exclusively use Hiragana in the learning process. Without using the color code, native English learners’ focus is divided. Due to the fact that there are no alphabetic properties in Japanese Kana, the native English speaker using romanizations to acquire proficiency in Kana must constantly switch back and forth between writing systems until the Kana have been memorized. When mapped to the color coding system, however, each monograph is endowed with alphabetic properties, and the learning process is shifted to using Kana exclusively. While it may be argued that one must also memorize the color code in order to effectively interact with this pedagogical system, when compared to the 96 monographs for both Hiragana and

Katakana, the 19 colors required for color code proficiency is by a wide margin the more efficient route to memorization.

Second, using simple romanizations of Japanese Kana to aid in acquisition also has a concerning drawback: the accuracy of pronunciation may be negatively affected by romanization. While the utilization of romanization for Japanese Kana may have negligible effects on correct pronunciation for languages that use the Latin alphabet *and* have similar pronunciation of the base vowels (German, for instance), English vowel pronunciation is imbued with so much variety that a native English speaker using romanizations to aid in Kana acquisition runs the risk of having inaccurate pronunciation patterns taking root from the very onset of learning. Unlike the highly regular Japanese vowels あ (A), い (I), う (U), え (E), お (O) which always have the same pronunciation, the English vowels A, E, I, O, U, and (Y) host more than one pronunciation per letter. The potentially negative impact that this may have on accurate pronunciation of Japanese Kana for native English speakers when using romanization techniques is readily seen in the pronunciation of Japanese vocabulary adopted into the English language. The pronunciations of the following words are denoted using the International Phonetic Alphabet. The word カラオケ (ka·ra·o·ke) is pronounced "kaɾaˈoke" in Japanese, however the adopted word "karaoke" is pronounced "kæriˈoʊki" in English. Similarly, the car manufacturer 本田 (hon·da) is pronounced "honda" in Japanese, however in Standard American English it is pronounced "hɒndə." In both of these Japanese born examples, it is easily observable that the loose rules in English for vowel pronunciation have resulted in the mispronunciation of every single romanized vowel except the "O" in "karaoke." If we are to use the mispronunciation of these adopted Japanese vocabulary as a yardstick to gauge the efficiency of romanization techniques to effectively impart accurate pronunciation of Japanese vocabulary, then it is an easy assumption to make that strict reliance on romanization is not the most effective pedagogical method for native English speakers to acquire knowledge of accurate pronunciation in Japanese Kana. On the other hand, the use of the color coding system proves itself the more effective pedagogical tool for accurate pronunciation acquisition for one simple reason: colors do not have pre-assigned phonetic pronunciations, and can therefore be molded to fit any phonetic framework.

Third, outside the unique ability of color to denote any phonetic framework once a system of phonetic pronunciation has been established, color has one more unique property: the memory of color is linked with the linguistic terms ascribed to them (Lucy and Shweder, 1979). Writing systems must rely on shapes to convey their phonetic pronunciation. However, color has the ability to reinforce this process, because the memorization of color relies on the same linguistic processes when committed to memory. This is also perhaps why color can be so universally used for communication that does not require words: generally speaking, red can be used to mean "stop," and green can be used to mean "go." By using color to represent phonemes, the color reinforces the memorization of the shape of the character it represents and can therefore help the non-native Japanese Kana learner understand the structure of the Kana system.

The color coding system described in this research is an efficient pedagogical tool to help non-native speakers acquire not only proficiency in reading Japanese Kana, but also to train accurate pronunciation and retain acquired Japanese vocabulary. This

color coding system utilizes the unique properties of color to help visually depict irregularities within the Japanese Kana system, and it may provide the learner with insight into the structure of the Kana system before the user can read all Kana monographs. Finally, the use of color promises to have positive effects on the speed of memorization. Japanese is indeed a highly complex language, and there is no panacea to make the acquisition of Japanese as a second language vastly easier. However, by utilizing a pedagogical approach such as the phonetic color coding system presented in this research, we can give our students the extra push they may need to continue down the path to fluency in the Japanese language.

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Appendices

Appendix 1: Monochromatic unvoiced Hiragana monographs mapped to the color code

Yellow (Yl)	Orange (Or)	Red (Rd)	Purple (Pr)	Blue (Bl)
Green (Gr)	Dark Green (DGr)	Cyan (Cy)	Magenta (Mg)	Pink (Pn)
Violet (Vt)	Rose (Rs)	Crimson (Cr)	White (Wh)	Gold (Gl)
Gray (Gy)	Brown (Bw)	Salmon (Sm)	Black (Blk)	Non-Coded (Black Text)

Vowels		°K (Cy)	°S (Mg)	°SH (Pn)	°T (Vt)	°CH (Rs)	°TS (Cr)	°N (Gr)	°H (Wh)	°F (DGr)	°P (Gl)	°M (Gy)	°R (Bw)	°Y (Sm)	°W (Blk)
A (Yl)	あ	か°	さ°		た°			な°	は°		は°	ま°	ら°	や°	わ°
I (Or)	い	き°	し	し°	ち	ち°		に°	ひ°		ひ°	み°	り°		
U (Rd)	う	く°	す°		つ	つ	つ°	ぬ°	ふ	ふ°	ふ°	む°	る°	ゆ°	
E (Pr)	え	け°	せ°		て°			ね°	へ°		へ°	め°	れ°		
O (Bl)	お	こ°	そ°		と°			の°	ほ°		ほ°	も°	ろ°	よ°	を
N (Gr)								ん							
Silent		く	す	し		ち	つ								

Appendix 2: Monochromatic voiced Hiragana monographs mapped to the color code

	"V (DGr)	"G (Cy)	"Z (Mg)	"J (Pn)	"D (Vt)	"J (Pn)	"Z (Mg)	°N	°H	°F	"B (Gl)	°M	°R	°Y	°W
A (Yl)	あ	か"	さ"		た"			な°	は°		は"	ま°	ら°	や°	わ°
I (Or)	い	き"	し	し"	ち	ち"		に°	ひ°		ひ"	み°	り°		
U (Rd)	う"	く"	す"		つ	つ	つ"	ぬ°	ふ	ふ°	ふ"	む°	る°	ゆ°	
E (Pr)	え	け"	せ"		て"			ね°	へ°		へ"	め°	れ°		
O (Bl)	お	こ"	そ"		と"			の°	ほ°		ほ"	も°	ろ°	よ°	を°

Appendix 3: Monochromatic Hiragana digraphs and geminate consonants mapped to the color code

Yellow (Yl)	Orange (Or)	Red (Rd)	Purple (Pr)	Blue (Bl)
Green (Gr)	Dark Green (DGr)	Cyan (Cy)	Magenta (Mg)	Pink (Pn)
Violet (Vt)	Rose (Rs)	Crimson (Cr)	White (Wh)	Gold (Gl)
Gray (Gy)	Brown (Bw)	Salmon (Sm)	Black (Blk)	Non-Coded (Black Text)

	"V (Dgr)	**°K (Cy)**	**"G (Sm)**	**°SH (Pn)**	**"J (Sm)**	**°CH (Rs) (Sm)**	**°N (Gr) (Sm)**	**°H (Wh) (Sm)**	**°F (DGr)**	**°P (Gl)**	**"B (Sm)**	**°R (Bw) (Sm)**	**°M (Gy) (Sm)**
A (Yl)	う゛ぁ	き゜ゃ゜	き゛ゃ゜	し゜ゃ゜	し゛ゃ゜	ち゜ゃ゜	に゜ゃ゜	ひ゜ゃ゜	ふ゜ぁ	ひ゜ゃ゜	ひ゛ゃ゜	り゜ゃ゜	み゜ゃ゜
I (Or)	う゛ぃ								ふ゜ぃ				
U (Rd)		き゜ゅ゜	き゛ゅ゜	し゜ゅ゜	し゛ゅ゜	ち゜ゅ゜	に゜ゅ゜	ひ゜ゅ゜		ひ゜ゅ゜	ひ゛ゅ゜	り゜ゅ゜	み゜ゅ゜
E (Pr)	う゛ぇ			し゜ぇ	し゛ぇ	ち゜ぇ			ふ゜ぇ				
O (Bl)	う゛ぉ	き゜ょ゜	き゛ょ゜	し゜ょ゜	し゛ょ゜	ち゜ょ゜	に゜ょ゜	ひ゜ょ゜	ふ゜ぉ	ひ゜ょ゜	ひ゛ょ゜	り゜ょ゜	み゜ょ゜
	っ	っ		っ		っ	っ	っ	っ	っ		っ	っ