

Report on Comparative Research on Readability of Morisawa Multilingual Fonts (UD Shin Go Hangul, UD Shin Go SC, UD Shin Go TC)

Morisawa Inc.

Overview

Since the release of universal design (UD) fonts in 2009, Morisawa has been conducting comparative research on font readability in response to requests from many customers. Morisawa UD fonts, backed by evidence (academic research findings), are now used in a wide range of fields.

Now, as society diversifies and more foreigners visit Japan, there is increasing need for multilingual UD fonts, such as UD Shin Go Hangul, UD Shin Go SC, and UD Shin Go TC.^{*1} Working with Prof. Yasushi Nakano of the Keio University Psychology Laboratory, Morisawa has been conducting comparative research tests to verify the readability of these fonts. For this research, tests were conducted on people with normal vision reading their native languages. In addition, in collaboration with educational institutions and groups of interested parties, tests were conducted in Seoul and Taipei on local people with low vision.

The same methodology used in the "Report on Comparative Research on Readability of Morisawa Multilingual Font (UD Shin Go Hangul) 2017" ^{*2} was used for this verification. The verification was conducted through paired comparison using digital devices. Using Scheffe's paired comparison method ^{*3}, Morisawa's fonts and five representative fonts in each language were compared for readability and a readability scale was constructed. Three groups of participants (participants with normal vision, participants with normal vision artificially impaired to give them low vision, and participants with a disability in terms of visual acuity, field of vision, etc.) compared fonts at three different character sizes. The research checked whether fonts were easy to read for those with low visual acuity, and whether fonts were easy or hard for people with high visual acuity to read, and it examined whether UD fonts expanded into multiple languages are easy for users to read.

Summary of the Comparative Research

The results of this research indicated that Morisawa's fonts were more readable than the other fonts compared for all languages and all groups of participants. The difference in score between Morisawa fonts and other fonts tended to diminish the greater the visual acuity of the participants and the greater the character size, but Morisawa's UD fonts still earned the highest rating. This suggests that UD Shin Go Hangul, UD Shin Go SC, and UD Shin Go TC are highly readable fonts for readers with all levels of visual function reading their native languages.

*1 This font is under development. Scheduled for release in autumn 2018.

*2 This research is a continuation of the "Report on Comparative Research on Readability of Morisawa Multilingual Font (UD Shin Go Hangul) 2017." It has been expanded to include simplified and traditional Chinese under the same conditions as the earlier report. The section "Morisawa UD Shin Go Hangul Readability Verification" (pages 4-6) uses data from the above test and gives results of multiple analysis combining analysis conditions with other languages.

*3 For statistical testing, we referred to the following papers:

Shin Sato, "Statistics-Based Sensory Test Method," the Japanese Union of Scientists and Engineers (2003) Yoshiro Kimiyama, "Models for Paired Comparison Method," Data Analysis Institute, Inc. (2010)

Test Method (common to all languages)

In this comparative research test, Scheffe's paired comparison method was used to evaluate the readability of six fonts in total: a Morisawa multilingual font (UD Shin Go Hangul, UD Shin Go SC, or UD Shin Go TC) and five representative fonts from each area.

Tests conducted

The tests were conducted by language (Hangul, simplified Chinese, or traditional Chinese), by vision characteristics of participants (1. normal vision, 2. simulation of low vision, or 3. actual low vision), and by character size (three different character sizes). (Table 1)

Paired comparison method readability scaling

Scheffe's method of paired comparison (Fig. 1) was used for all tests. A "scale value" was obtained from the probability of a font being selected and indicated evaluation differences in a one-dimensional scale. This research used the paired comparison method, in which two of fonts were taken for comparison. In every combination, the participant rated the ease of viewing on a five-level scale, and the results were compared statistically. An independently developed software was used for the tests.

Participants

Participants in Test 1 (normal vision) and Test 2 (simulation of low vision) were adults with corrected decimal visual acuity of 1.0 or greater. Participants in Test 3 (low vision) were people with low vision with corrected decimal visual acuity of about 0.1-0.3. In Test 2, people with normal vision with corrected visual acuity of at least 1.0 were tested under low vision conditions using a low vision simulator with a blur filter (Fig. 2). Participation in all tests was limited to participants whose native language was the language being tested.

Fig. 1



The method constructs a scale of ease of viewing by showing the participant every combination of fonts to be compared and asking them which of the two is easier to view, and the degree of viewing ease.

Fig. 2



Simulation of low vision conditions by placing a special glass (blur filter) between the participant and object viewed.

Table 1 Test content and participants

Language	Test location	Participants' vision characteristics	Character sizes compared			Average visual acuity	Number of participants
		Test 1: Test of people with normal vision	8pt	10pt	12pt	1.1	24 persons
Hangul	Seoul	Test 2: Test with low vision simulation	8pt	10pt	12pt	0.3	24 persons
		Test 3: Test of people with low vision	18pt	22pt	26pt	0.12	18 persons
Simplified Chinese	Shanghai	Test 1: Test of people with normal vision	10pt	12pt	14pt	1.2	24 persons
		Test 2: Test with low vision simulation	16pt	18pt	22pt	0.2	24 persons
Traditional Chinese	Taipei	Test 1: Test of people with normal vision	10pt	12pt	14pt	1.2	24 persons
		Test 2: Test with low vision simulation	16pt	18pt	22pt	0.2	24 persons
		Test 3: Test of people with low vision	18pt	22pt	26pt	0.2	19 persons

Morisawa UD Shin Go Hangul Readability Verification

Test 1: Test of people with normal vision

This verification test shows the superiority of UD Shin Go Hangul. This page gives the verification results on normal visual acuity for people with normal vision.

Verification results

The results of the test on people with normal vision indicate that UD Shin Go Hangul is the most readable of all sizes (Tables 2 and 3). The results of multiple comparison show that when the character size is small, UD Shin Go Hangul is more readable than other fonts by a statistically significant margin.

Verification conditions

Device: Digital device (iPad) Character size: 8, 10, and 12 point Visual acuity: 1.1 on average

Fonts compared

UD Shin Go Hangul, Gothic (Company A), Gothic (Company B), Gothic (Company C), Gothic (Company D), Gothic (Company E) (six fonts total)

10pt 12pt 8pt Font name Scale value Font name Scale value Font name Scale value No.1 UD Shin Go Hangul 0.368 UD Shin Go Hangul 0.257 UD Shin Go Hangul 0.118 Gothic (Company C) Gothic (Company D) No.2 Gothic (Company D) 0.132 0.104 0.111 0.056 0.049 No.3 Gothic (Company C) 0.125 Gothic (Company A) Gothic (Company A) -0.042 0.028 No.4 Gothic (Company A) Gothic (Company D) -0.09 Gothic (Company C) No.5 Gothic (Company B) -0.236 Gothic (Company B) -0.146 Gothic (Company B) -0.125 No.6 Gothic (Company E) -0.347 Gothic (Company E) -0.181 Gothic (Company E) -0.181

Table 2 Test results by paired comparison method

Table 3 The greater the scale value (on number line figure) for character size 8 point, the greater the readability



Morisawa UD Shin Go Hangul Readability Verification

Test 2: Low vision simulation test

This verification test shows the superiority of UD Shin Go Hangul. This page gives the verification results under simulated low vision conditions using a blur filter.

Verification results

The results of the test with low vision simulation indicate that UD Shin Go Hangul is the most readable at all sizes (Table 4 and 5). Also, the results of multiple comparisons show that at all character sizes, UD Shin Go Hangul is more readable than other fonts by a statistically significant margin.

Verification conditions

Device: Digital device (iPad) Character size: 8, 10, and 12 point Visual acuity: 0.3 on average (low vision simulation with a blur filter)

Fonts compared

UD Shin Go Hangul, Gothic (Company A), Gothic (Company B), Gothic (Company C), Gothic (Company D), Gothic (Company E) (six fonts total)

	8pt		10pt		12pt	
	Font name	Scale value	Font name	Scale value	Font name	Scale value
No.1	UD Shin Go Hangul	0.688	UD Shin Go Hangul	0.611	UD Shin Go Hangul	0.507
No.2	Gothic (Company C)	0.278	Gothic (Company C)	0.25	Gothic (Company D)	0.139
No.3	Gothic (Company D)	0.007	Gothic (Company D)	0.062	Gothic (Company C)	0.062
No.4	Gothic (Company A)	-0.056	Gothic (Company A)	-0.069	Gothic (Company A)	-0.062
No.5	Gothic (Company B)	-0.458	Gothic (Company B)	-0.424	Gothic (Company B)	-0.278
No.6	Gothic (Company E)	-0.458	Gothic (Company E)	-0.431	Gothic (Company E)	-0.368

Table 4 Test results by paired comparison method

Table 5 The greater the scale value (on number line figure) for character size 8 point, the greater the readability



Morisawa UD Shin Go Hangul Readability Verification

Test 3: Test of people with low vision

This verification test shows the superiority of UD Shin Go Hangul. This page gives the verification results for people with low vision.

Verification results

The results of the test on people with low vision indicate that UD Shin Go Hangul is the most readable at all sizes (Table 6 and 7). The results of multiple comparisons show that at character sizes of 22 point and larger, UD Shin Go Hangul is more readable than other fonts by a statistically significant margin. At the smallest size, 18 point, no significant difference was found between UD Shin Go Hangul and the second-place font, Gothic (Company D). Results of analysis of individual data (Tables 8 and 9) show that at 18 and 22 point, 11 persons (61.1% of participants) judged UD Shin Go Hangul to be the most readable font, while at 26 point, 12 persons (66.7%) judged it the most readable.

Verification conditions

Device: Digital device (iPad) Character size: 18, 22 and 26 point Visual acuity: 0.12 on average

Fonts compared

UD Shin Go Hangul, Gothic (Company A), Gothic (Company B), Gothic (Company C), Gothic (Company D), Gothic (Company E) (six fonts total)

Table 6 Test results by paired comparison method

	18pt		22pt		26pt	
	Font name	Scale value	Font name	Scale value	Font name	Scale value
No.1	UD Shin Go Hangul	0.667	UD Shin Go Hangul	0.806	UD Shin Go Hangul	0.815
No.2	Gothic (Company D)	0.463	Gothic (Company D)	0.389	Gothic (Company D)	0.38
No.3	Gothic (Company C)	-0.009	Gothic (Company C)	0.019	Gothic (Company C)	0.056
No.4	Gothic (Company B)	-0.241	Gothic (Company A)	-0.269	Gothic (Company B)	-0.25
No.5	Gothic (Company A)	-0.315	Gothic (Company B)	-0.333	Gothic (Company A)	-0.444
No.6	Gothic (Company E)	-0.565	Gothic (Company E)	-0.611	Gothic (Company E)	-0.556

Table 7 The greater the scale value (on number line figure) for character size 18 point, the greater the readability



Table 8 Excerpted from individual data

Male in 20s, visual acuity 0.1 Character size 18 point

Major eye disorders: Glaucoma, macular degeneration, central scotoma, glare vision, color vision deficiency and nystagmus



Table 9 Excerpted from individual data

Male in 40s, visual acuity 0.05 Character size 18 point Major eye disorders: Aniridia, cataract, and optic atrophy



Reference Examples of common vision difficulties



Too blurry to see details



Too bright and too dim to see



Field of vision is too narrow to follow the characters



Center of field of vision is dark and the viewer cannot see the part he/she wants to see.

Source

From Yasushi Nakano, Koichi Oda, Kimiko Nakano (1993), "Research on Improving and Increasing Sensory and Motor Function in Children with Mental and Physical Disabilities," special research of the National Institute of Special Needs Education on preparing reading environments that consider the visual challenges of children with low vision

Morisawa UD Shin Go SC Readability Verification

Test 1: Test of people with normal vision

This verification test shows the superiority of UD Shin Go SC. This page gives the verification results on normal visual acuity for people with normal vision.

Verification results

The results of the test on people with normal vision indicate that UD Shin Go SC is the most readable at all sizes (Table 10 and 11). Also the results of multiple comparisons show that at all character sizes, UD Shin Go SC is more readable than other fonts by a statistically significant margin.

Verification conditions

Device: Digital device (iPad) Character size: 10, 12 and 14 point Visual acuity: 1.2 on average

Fonts compared

UD Shin Go SC, Gothic (Company F), Gothic (Company G), Gothic (Company H), Gothic (Company J) (six fonts total)

14pt 10pt 12pt Font name Scale value Font name Scale value Font name Scale value No.1 UD Shin Go SC 0.694 UD Shin Go SC 0.667 UD Shin Go SC 0.632 No.2 Gothic (Company H) 0.382 Gothic (Company H) 0.368 Gothic (Company H) 0.403 -0.056 -0.028 -0.007 No.3 Gothic (Company I) Gothic (Company F) Gothic (Company F) -0.075 No.4 Gothic (Company F) -0.104 Gothic (Company J) -0.062 Gothic (Company G) No.5 Gothic (Company J) -0.125 Gothic (Company I) -0.153 Gothic (Company I) -0.118 No.6 Gothic (Company G) -0.792 Gothic (Company G) -0.792 Gothic (Company J) -0.16

Table 10 Test results by paired comparison method

Table 11 The greater the scale value (on number line figure) for character size 10 point, the greater the readability



Morisawa UD Shin Go SC Readability Verification

Test 2: Low vision simulation test

This verification test shows the superiority of UD Shin Go SC. This page gives the verification results under simulated low vision conditions using a blur filter.

Verification results

The results of the test with low vision simulation indicate that UD Shin Go SC is the most readable at all sizes (Tables 12 and 13). Also the results of multiple comparisons show that at all character sizes, UD Shin Go SC is more readable than other fonts by a statistically significant margin.

Verification conditions

Device: Digital device (iPad) Character size: 16, 18 and 22 point Visual acuity: 0.2 on average (low vision simulation with a blur filter)

Fonts compared

UD Shin Go SC, Gothic (Company F), Gothic (Company G), Gothic (Company H), Gothic (Company J) (six fonts total)

	16pt		18pt		22pt	
	Font name	Scale value	Font name	Scale value	Font name	Scale value
No.1	UD Shin Go SC	0.703	UD Shin Go SC	0.778	UD Shin Go SC	0.792
No.2	Gothic (Company H)	0.478	Gothic (Company H)	0.5	Gothic (Company H)	0.465
No.3	Gothic (Company F)	0.058	Gothic (Company J)	-0.035	Gothic (Company J)	-0.111
No.4	Gothic (Company I)	-0.225	Gothic (Company I)	-0.174	Gothic (Company F)	-0.118
No.5	Gothic (Company J)	-0.225	Gothic (Company F)	-0.208	Gothic (Company I)	-0.215
No.6	Gothic (Company G)	-0.79	Gothic (Company G)	-0.861	Gothic (Company G)	-0.812

Table 12 Test results by paired comparison method

Table 13 The greater the scale value (on number line figure) for character size 10 point, the greater the readability



Morisawa UD Shin Go TC Readability Verification

Test 1: Test of people with normal vision

This verification test shows the superiority of UD Shin Go TC. This page gives the verification results on normal visual acuity for people with normal vision.

Verification results

The results of the test on people with normal vision indicate that UD Shin Go TC is the most readable at all sizes (Tables 14 and 15). The results of multiple comparisons show that at all character sizes other than 12 point, UD Shin Go TC is more readable than other fonts by a statistically significant margin. At 12 point, no significant difference was found between UD Shin Go TC and Gothic (Company L), but there was a significant difference between UD Shin Go TC and all the other fonts.

Verification conditions

Device: Digital device (iPad) Character size: 10, 12 and 14 point Visual acuity: 1.2 on average

Fonts compared

UD Shin Go TC, Gothic (Company K), Gothic (Company L), Gothic (Company M), Gothic (Company N), Gothic (Company O) (six fonts total)

Table 14 Test results by paired comparison method

	10pt		12pt		14pt	
	Font name	Scale value	Font name	Scale value	Font name	Scale value
No.1	UD Shin Go TC	0.854	UD Shin Go TC	0.743	UD Shin Go TC	0.889
No.2	Gothic (Company L)	0.521	Gothic (Company L)	0.59	Gothic (Company L)	0.521
No.3	Gothic (Company O)	0.229	Gothic (Company O)	0.25	Gothic (Company O)	0.243
No.4	Gothic (Company N)	0.049	Gothic (Company N)	0.028	Gothic (Company N)	0.09
No.5	Gothic (Company K)	-0.708	Gothic (Company K)	-0.778	Gothic (Company K)	-0.833
No.6	Gothic (Company M)	-0.944	Gothic (Company M)	-0.833	Gothic (Company M)	-0.91

Table 15 The greater the scale value (on number line figure) for character size 10 point, the greater the readability



Morisawa UD Shin Go TC Readability Verification

Test 2: Low vision simulation test

This verification test shows the superiority of UD Shin Go TC. This page gives the verification results under simulated low vision conditions using a blur filter.

Verification results

The results of the test with low vision simulation indicate that UD Shin Go TC is the most readable at all sizes (Table 16 and 17). The results of multiple comparisons show no significant difference between UD Shin Go TC and Gothic (Company L), but there was a significant difference between UD Shin Go TC and the other fonts.

Verification conditions

Device: Digital device (iPad) Character size: 16, 18 and 22 point Visual acuity: 0.2 on average (low vision simulation with a blur filter)

Fonts compared

UD Shin Go TC, Gothic (Company K), Gothic (Company L), Gothic (Company M), Gothic (Company N), Gothic (Company O) (six fonts total)

16pt 18pt 22pt Font name Scale value Font name Scale value Font name Scale value No.1 UD Shin Go TC 0.799 UD Shin Go TC 0.725 UD Shin Go TC 0.797 No.2 Gothic (Company L) 0.618 Gothic (Company L) 0.551 Gothic (Company L) 0.703 0.201 0.152 No.3 Gothic (Company O) Gothic (Company N) 0.167 Gothic (Company O) -0.007 0.014 No.4 Gothic (Company N) Gothic (Company O) 0.087 Gothic (Company N) No.5 Gothic (Company K) -0.722 Gothic (Company K) -0.717 Gothic (Company M) -0.812 No.6 Gothic (Company M) -0.889 Gothic (Company M) -0.812 Gothic (Company K) -0.855

Table 16 Test results by paired comparison method

Table 17 The greater the scale value (on number line figure) for character size 16 point, the greater the readability



Morisawa UD Shin Go TC Readability Verification

Test 3: Test of people with low vision

This verification test shows the superiority of UD Shin Go TC. This page gives the verification results for people with low vision.

Verification results

The results of the test on people with low vision indicate that UD Shin Go TC is the most readable at all sizes. The results of multiple comparisons show that at all character sizes, UD Shin Go TC is more readable than other fonts by a statistically significant margin (Table 18 and 19). Results of analysis of individual data (Tables 20 and 21) show that at 18 point, 12 persons (63.2% of participants) judged UD Shin Go TC to be the most readable font, while at 22 and 26 point, 10 persons (52.6%) judged it the most readable.

Verification conditions

Device: Digital device (iPad) Character size: 18, 22 and 26 point Visual acuity: 0.2 on average

Fonts compared

UD Shin Go TC, Gothic (Company K), Gothic (Company L), Gothic (Company M), Gothic (Company N), Gothic (Company O) (six fonts total)

Table 18 Test results by paired comparison method

	18pt		22pt		26pt	
	Font name	Scale value	Font name	Scale value	Font name	Scale value
No.1	UD Shin Go TC	0.852	UD Shin Go TC	0.778	UD Shin Go TC	0.787
No.2	Gothic (Company L)	0.361	Gothic (Company L)	0.444	Gothic (Company L)	0.361
No.3	Gothic (Company O)	0.204	Gothic (Company O)	0.194	Gothic (Company O)	0.222
No.4	Gothic (Company N)	0.046	Gothic (Company N)	0.167	Gothic (Company N)	0.111
No.5	Gothic (Company K)	-0.704	Gothic (Company K)	-0.75	Gothic (Company K)	-0.602
No.6	Gothic (Company M)	-0.759	Gothic (Company M)	-0.833	Gothic (Company M)	-0.88

Table 19 The greater the scale value (on number line figure) for character size 18 point, the greater the readability



Table 20 Excerpted from individual data

Female in 30's, visual acuity 0.3 Character size 18 point Major eye disorders: Cataract, visual field constriction, nystagmus



Table 21 Excerpted from individual data

Male in 10's, visual acuity 0.16 Character size 18 point Major eye disorders: Nystagmus



End

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