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Effectiveness of the homologous Thai letterforms on visibility under a simulated condition of low visual acuity

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Abstract: Recognition tests of blurred conventional Thai fonts have suggested idealistic key features to improve some Thai characters with high legibility and visibility. From these idealistic key features, we designed the Thai characters set in aspects of variation to prove and measure the performance of Thai characters that were designed based on the idealistic key features. We conducted a blurred simulation experiment with thirty Thai people as the participants. The common findings revealed the idealistic key features could enhance better legibility. The idealistic key features involve jutting out of tail and loop with a serrated line, as well as character width that assists more visibility as well.

Key words: Typeface Design, Isolated Letters, Legibility, Letter Feature, Blur Simulation.

1. Introduction

We tested the tolerance of various conventional Thai characters under blurred conditions focused on legibility and visibility, both a qualitative and quantitative study (Punsongserm, Sunaga, & Ihara, 2015; Punsongserm, Sunaga, & Ihara, 2017a; Punsongserm, Sunaga, & Ihara, 2017b). The results suggest that the idealistic key features as the assumptions

indicate the possibility of improvement of some Thai characters may concern with the clearness of a serrated line and jutting of a part of the loops/size of a loop, character width, character shape, stroke shapes, and aspect of a terminal. Therefore, we designed the Thai characters set in aspects of variation to prove and measure the performance of Thai characters that were designed based on the idealistic key features. Moreover, then we experimented with legibility test methods, a blurred simulation method.

This study aimed to prove the hypothesis via measuring the performance of some isolated Thai characters that were designed based on some idealistic key features (Figure 1) and to compare with the highest and the lowest conventional Thai characters of correct responses from the previous study (Punsongserm, et al, 2017b).
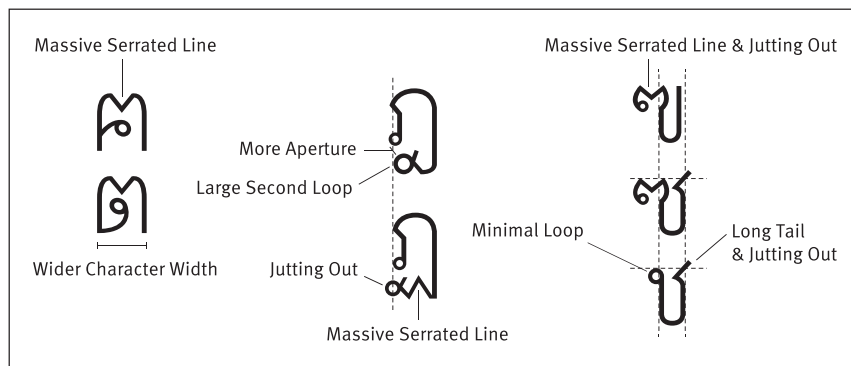

Figure 1. Some parts of the idealistic key features for improving Thai legibility

2. Stimulus

2.1 Glyph Variations

In this paper, we report the four homologous letter pairs that consist of Kho Khon /ฅ/ - To Tao /ต/, Do Chada /ฎ/ - To Patak /ฏ/, Kho Khai /ข/ - Kho Khuat /ฃ/, and Cho Chang /ช/ - So So /ซ/, which were designed the character glyphs based on the idealistic key features. However, each glyph of the characters set was designed dissimilarly in various aspects. Besides, we added the characters that obtained the highest of correct responses (the characters shown by ''XXs'' in Figure 2) and the lowest (the characters shown by ''YY'' in Figure 2) of correct responses from the previous studies (Punsongserm, et al, 2017b). There were no characters that obtained the highest and the lowest of correct responses character for Kho Khai /ข/ due to there was no measured this character in the previous study. As the stimulus for this study, there are seventy-one characters including fifty-four of new designs and seventeen of the previous study. We determined the selected characters as a black character on a white background.

Figure 2 illustrates the internal variation of the eight character sets were designed for investigation in this study, together with those characters that obtained the highest of correct responses and the lowest of correct responses from our previous study. The new designs are shown as the overlapped glyphs for differentiation, Figure 3. These variations provided distinctness of the key features in among each character set. The variations of the characters 'Kho Khon /ฅ/' and 'To Tao /ต/' were focused on to distinction of serrated line aspect, yet other features were not varied. There were two different glyphs for the characters 'Do Chada /ฎ/', first one was retained for a tail and another one was tailless. The aspects of serrated line for the characters To Patak /ฏ/ differ between the degrees of angles in four styles, the first set (e.g., To Patak A, B, C, and D), were still being treated their tail, while the second set (e.g., To Patak E, F, G, and H), were unavailable the tails. The variations of the characters 'Kho Khai /ข/' consist of differentiation between curve and straight baseline show as Kho Khai A and B. Besides, the two another, e.g., Kho Khai C and D, were formed as 'v' shape yet difference in aspect of degree of stems, front line, and backline. The characters 'Cho Chang /ช/', Cho Chang A and B, were made varied between curved and straight diagonal, with straight shoulder, while Cho Chang C and D have curve shoulder but both different in the type of baseline, e.g., curve and straight baseline. There had the first group of the characters 'So So /ซ/' (e.g., So So A, B, C, and D), were designed on a variation of the magnitude of a serrated line as well as a contrast between curved and straight baseline. Also, reproduced characters 'So So /ซ/' of the first group were created as So So E, F, G, and H, respectively, yet the characters in this second group were those san loops.
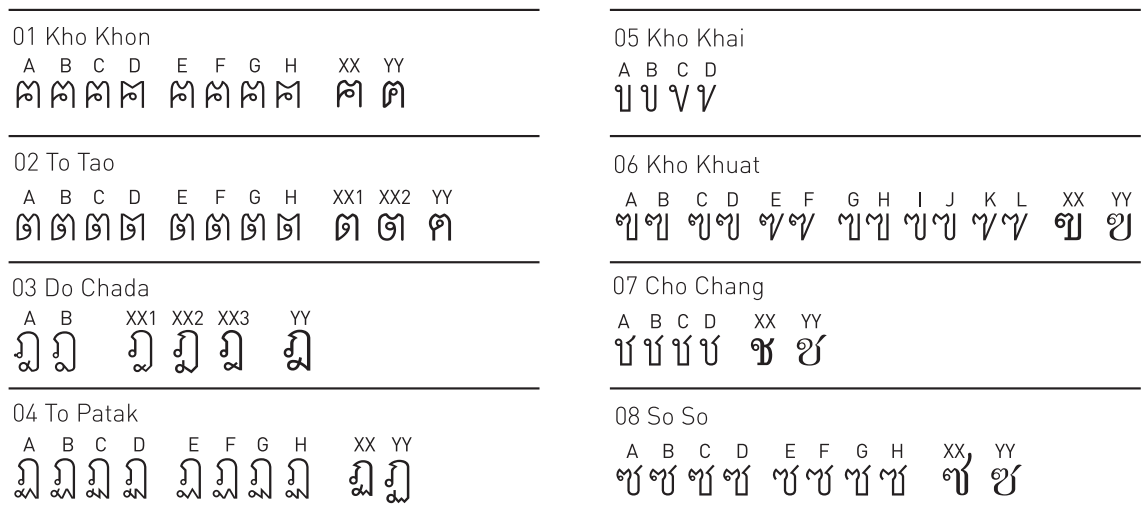

Figure 2. The glyph variations designed based on the idealistic key features compare with the characters that obtained the highest and lowest of correct responses from the previous study.
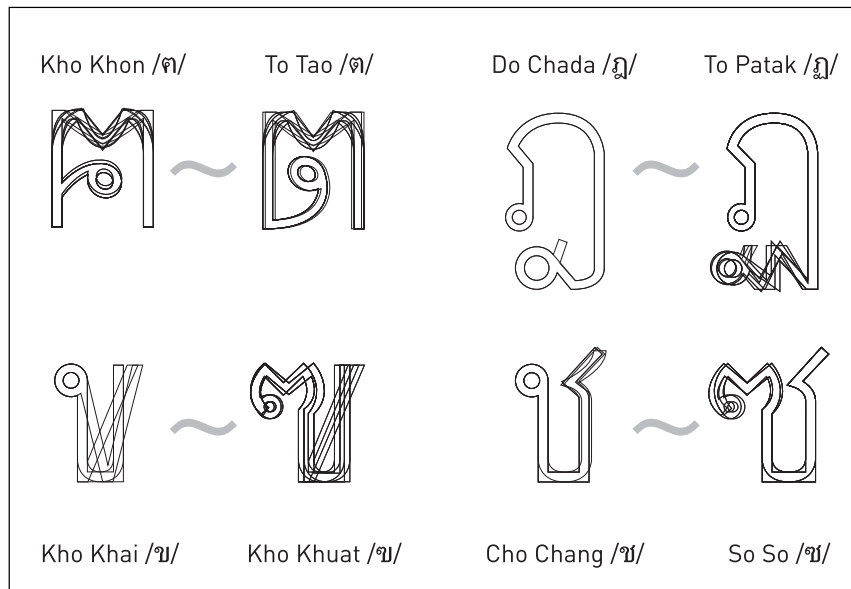
Figure 3. Four sets of Thai homologous pairs with the overlapping of designed variations

2.2 Character Height

Regarding the size of the Thai characters as the stimulus, we have considered prescribing as 'x-height' at most, which it can provide better consistency rather than 'point', as Legge and Bigelow (2011) have stated. In this study, The Bo Baimai heights selected are 4 mm (11 pixels in the display we used), which represent an average of quite a large font size. The conversion to a visual angle (VA) in degrees from physical print size is VA = 0.572 of 4 mm, for a viewing distance of 40cm, similarly our previous studies (Punsongserm, et al, 2017a; Punsongserm, et al, 2017b).

3. Methods

This study has investigated legibility of Thai character based on visual letter recognition that focused on visibility under a simulated condition of low visual acuity. There are several psychological studies employed method of blur simulation in order to simulate blurred vision (e.g., myopia, cataract, keratoconus, and corneal scarring), such as those studies of Legge, Pelli, Rubin, and Schleske, (1985); Nakano et al. (2010); and Arai et al. (2010), who have studied the legibility of fonts through a wide view ground glass filter, as well as the studies of Hakamada, Ohya, Sakai, Sakurada, and Tomomi, (2011); Waleetorncheepsawat, Pungrassamee, Ikeda, and Obama, (2013); and Panasonic Corporation, (2017), that have examined the efficacy of fonts and via pseudo-cataract experience goggles, and so on.

3.1 Participants

Thirty Thai native people with normal or corrected-to-normal visual acuity and aged from 18 to 40 participated in this study, an average of age is 25.9 years old, eight males and twenty-two females.

3.2 Apparatus

The Thai letters as stimuli were displayed on a 24-inches vertical monitor (Dell UltraSharp 24 Ultra HD Monitor - UP2414Q, resolution of 2160 px x 3840 px, refresh rate of 60 Hz). Participants sat at a distance of 40cm from the monitor in a dark room. They viewed the screen with their binocular vision while their head maintained against a chin-and forehead rest. Participants responded each perceived letter via a Thai wireless keyboard (Logitech MK235). A blurred glass in size 280mm x 356mm was employed to simulate the condition of low visual acuity as if those spatial filters were applied by Legge, et al. (1985), Nakano et al. (2010), and Arai et al. (2010). The blurred glass was approximately placed 5 cm from the front of the monitor. We measured the modulation transfer function of the blurred glass that are shown in Figure 4.
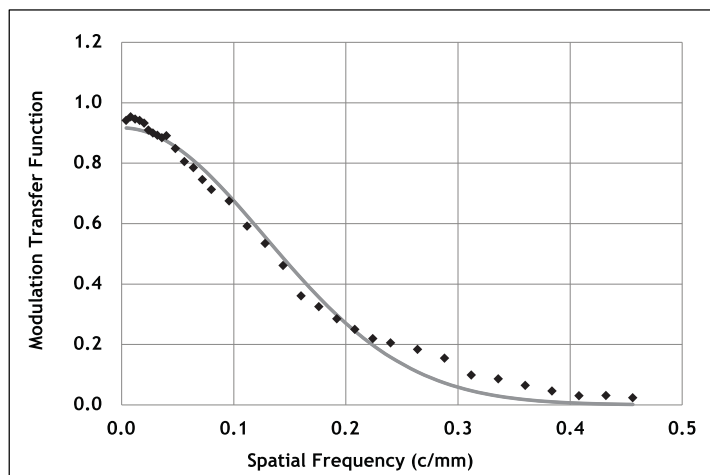
Figure 4. The properties of the blurred glass

3.3 Procedure

First of all, when a participant pressed the space key, a stimulus character was be presented on the screen in a randomized order. Second, the participant perceived and identified the stimulus character, one by one, and then reported to the Thai keyboard, the perceived character. Whenever the participant pressed any key for reporting, next, on the monitor appeared a sentence to inform the participant for his/her response, after that, the participant could choose to either accept his/her response by pressing enter key

or pressing responds again if the participant did not accept it. In this experiment, each character, seventy-one characters were randomized and shown one by one in three times of repetition, two-hundred-thirteenth trials, see Figure 5.
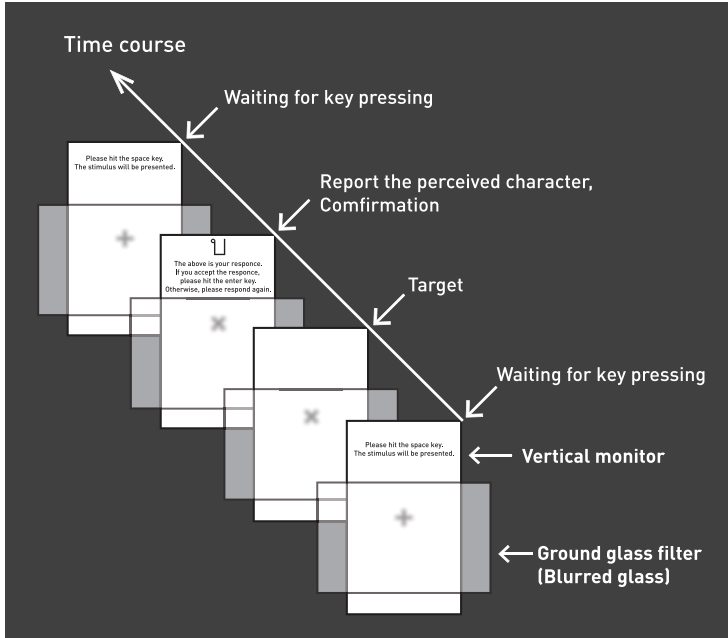
Figure 5. Sequence of events of blurred simulation method

4. Results & Discussion

4.1 The Characters /ฅ/ (Kho Khon)

Character	Amount (%)
Kho Khon A errors	56.7
Kho Khon B errors	60.0
Kho Khon C errors	48.9
Kho Khon D errors	52.2
Kho Khon E errors	58.9
Kho Khon F errors	45.6
Kho Khon G errors	51.1
Kho Khon H errors	53.3
Kho Khon XX errors	40.0 *
Kho Khon YY errors	92.2 **

Chi-square	$x^2(9) = 65.626$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate
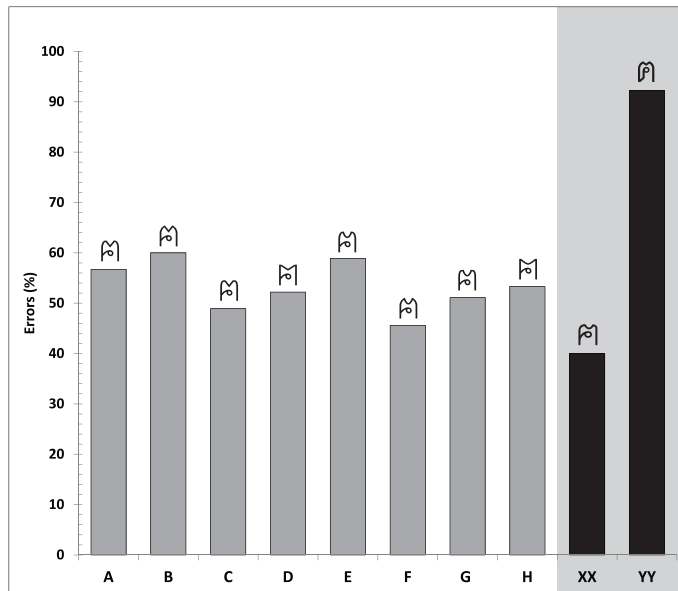
Figure 6. The occurred errors in the characters /ฅ/

Table 1. Confusion pair letter with amount of confusion on the characters /ต/

Character	Confusion Pair Letter with Amount of Confusion (%)				
	To Tao /ต/	Kho Khwai /ค/	So Sala /ศ/	DO Dek /ด/	Others
Kho Khon A	44.4	6.7	4.4	-	-
Kho Khon B	32.2	17.8	6.7	-	3.3
Kho Khon C	38.9	6.7	-	1.1	-
Kho Khon D	45.6	2.2	2.2	-	2.2
Kho Khon E	52.2 †	2.2	3.3		1.1
Kho Khon F	33.3	8.9	3.3	-	-
Kho Khon G	37.8	4.4	6.7	-	2.2
Kho Khon H	45.6	1.1	3.3	-	3.3
Kho Khon XX	18.9	10.0	8.9	-	2.2
Kho Khon YY	12.2	55.6 †	13.3	10.0	1.1

† A highest frequency of misreading for each confusion pair letter, each column

Figure 6 shows the findings have a great deal corresponding to the previous study (Punsongserm, et al, 2017b), the character 'Kho Khon XX' obtains the lowest incorrect response, and the character 'Kho Khon YY' obtains the highest incorrect response. Although those newly glyphs, the characters 'Kho Khon A~H', were designed according to the idealistic key features whereas they have considerable errors occur on their capability, especially, the character 'Kho Khon E' has the highest incorrect response for the letter 'To Tao /ต/.' However, the character 'Kho Khon YY' encounters confusion with the letter 'Kho Khwai /ค/', considerably, is shown in Table 1.

Although the new glyphs have a sizeable serrated line as we have suggested in the earlier study (Punsongserm, et al, 2017b), a critical problem of confusion for the letter 'To Tao /ต/' is to maintain character width because of insufficiency of providing character width. To improve legibility and visibility of character 'Kho Khon /ต/', it should be obtained extending of character width more than ever, as much as the character 'Kho khon XX', see Figure 7.

Figure 7. An approach to improving character 'Kho Khon /ต/'
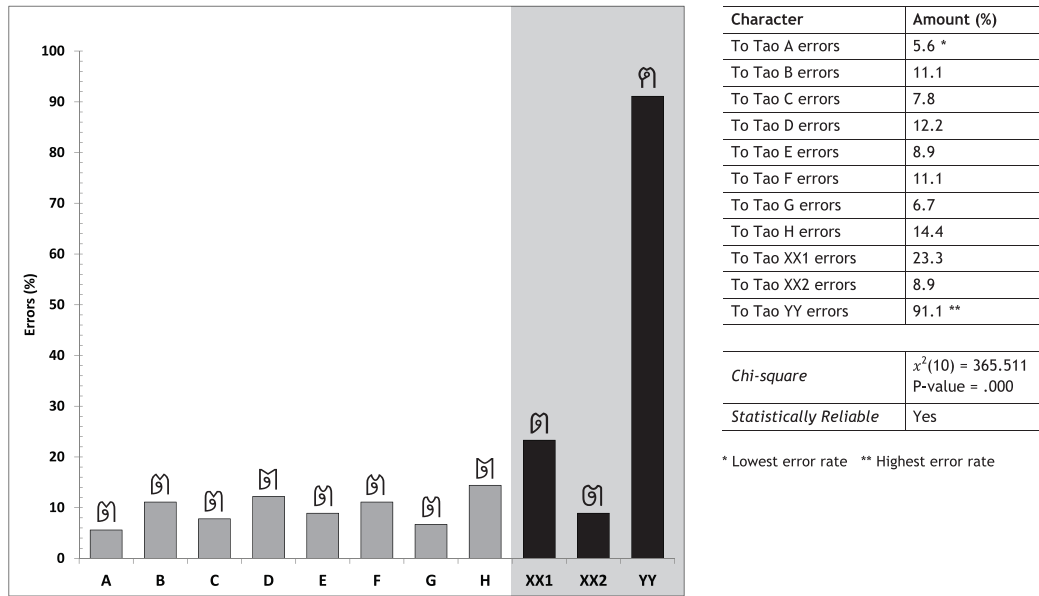
4.2 The Characters /ต/ (To Tao)

Figure 8. The occurred errors in the characters /ต/

Character	Amount (%)
To Tao A errors	5.6 *
To Tao B errors	11.1
To Tao C errors	7.8
To Tao D errors	12.2
To Tao E errors	8.9
To Tao F errors	11.1
To Tao G errors	6.7
To Tao H errors	14.4
To Tao XX1 errors	23.3
To Tao XX2 errors	8.9
To Tao YY errors	91.1 **

Chi-square	$x^2(10) = 365.511$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Table 2. Confusion pair letter with amount of confusion on the characters /ต/

Character	Confusion Pair Letter with Amount of Confusion (%)				
	Kho Khon /ฅ/	Kho Khwai /ค/	Do Dek /ด/	So Sala /ศ/	Others
To Tao A	3.3	1.1	1.1	-	-
To Tao B	5.6	2.2	1.1	-	1.1
To Tao C	3.3	2.2	-	-	2.2
To Tao D	6.7	1.1	-	-	4.4
To Tao E	4.4	-	2.2	-	2.2
To Tao F	4.4	-	2.2	-	4.4
To Tao G	4.4	1.1	-	-	1.1
To Tao H	7.8	-	-	-	6.7
To Tao XX1	7.8	4.4	6.7	3.3	1.1
To Tao XX2	3.3	1.1	-	-	4.4
To Tao YY	6.7	47.8 †	15.6	7.8	13.3

† A highest frequency of misreading for each confusion pair letter, each column

Figure 8 illustrates overall the findings have rather accorded with the idealistic key feature, and the assumption was confirmed. The character 'To Tao A' has somewhat incurred errors, a lowest incorrect response. There are insignificant incorrect responses for confusion as the letters 'Kho Khon /ฅ/' and 'Kho Khwai /ค/', except the character 'To Tao YY' has confusion for the letter 'Kho Khwai /ค/' inordinate than the other characters, are shown in Table 2.

4.3 The Characters /ญ/ (Do Chada)

Figure 9. The occurred errors in the characters /ญ/
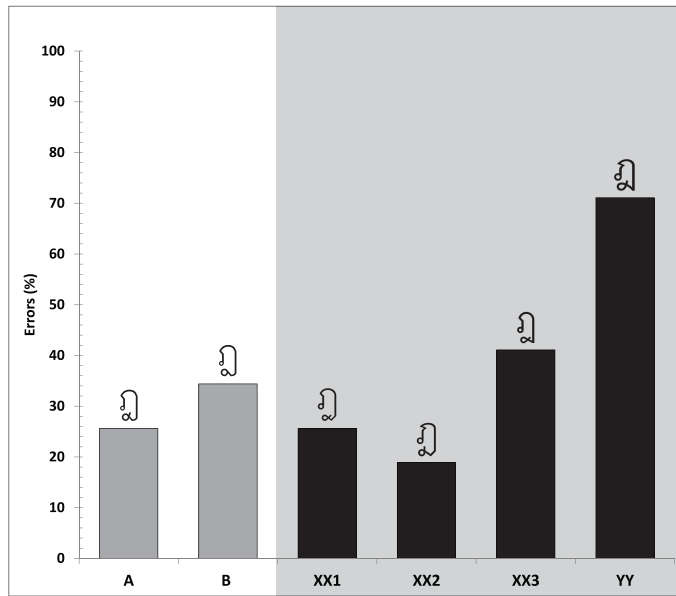
Character	Amount (%)
Do Chada A errors	25.6
Do Chada B errors	34.4
Do Chada XX1 errors	25.6
Do Chada XX2 errors	18.9 *
Do Chada XX3 errors	41.1
Do Chada YY errors	71.1 **

Chi-square	$x^2(5) = 69.134$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Table 3. Confusion pair letter with amount of confusion on the characters /ญ/

Character	Confusion Pair Letter with Amount of Confusion (%)	
	To Patak /ฏ/	Others
Do Chada A	25.6	-
Do Chada B	33.3	1.1
Do Chada XX1	23.3	2.2
Do Chada XX2	17.8	1.1
Do Chada XX3	40.0	1.1
Do Chada YY	71.1 †	-

† A highest frequency of misreading for each confusion pair letter, each column

Figure 9 shows the character 'Do Chada XX2' has reached the lowest incorrect responses while the character 'Do Chada YY' has obtained the highest incorrect responses. These findings were consistent with the previous study (Punsongserm, et al, 2017b). The result of 'Do Chada B' suggests that absence of its tail might not sustain better legibility. However, to improve to better visibility, the letterform of character 'Do Chada /ญ/' should be extended the length of the backline equal the character 'Do Chada XX2', see Figure 10. It might assist acceptable legibility.
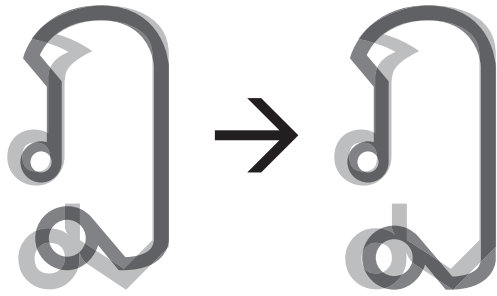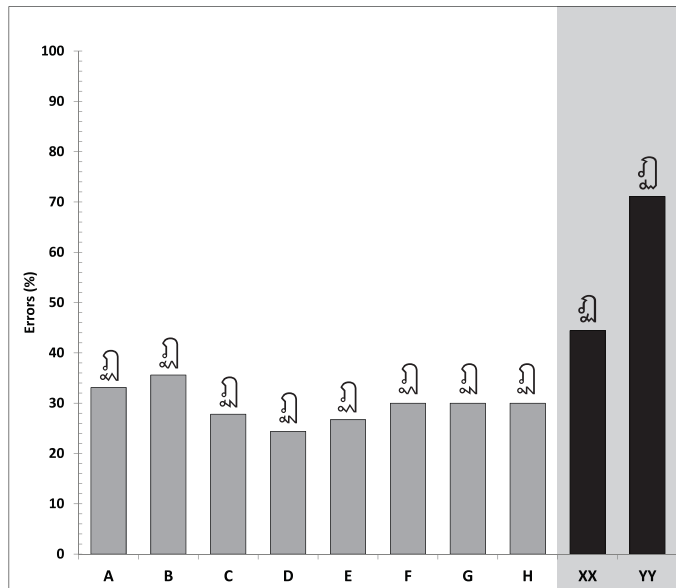
Figure 10. An approach to improving character 'Do Chada /ฎ/'

4.4 The Characters /ฏ/ (To Patak)

Figure 11. The occurred errors in the characters /ฏ/

Character	Amount (%)
To Patak A errors	33.3
To Patak B errors	35.6
To Patak C errors	27.8
To Patak D errors	24.4 *
To Patak E errors	26.7
To Patak F errors	30.0
To Patak G errors	30.0
To Patak H errors	30.0
To Patak XX errors	44.4
To Patak YY errors	71.1 **

Chi-square	$x^2(9) = 67.088$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Table 4. Confusion pair letter with amount of confusion on the characters /ฏ/

Character	Confusion Pair Letter with Amount of Confusion (%)	
	Do Chada /ฎ/	Others
To Patak A	32.2	1.1
To Patak B	34.4	1.1
To Patak C	27.8	-
To Patak D	23.3	1.1
To Patak E	25.6	1.1
To Patak F	26.7	3.3
To Patak G	28.9	1.1
To Patak H	28.9	1.1
To Patak XX	42.2	2.2
To Patak YY	71.1 †	-

† A highest frequency of misreading for each confusion pair letter, each column

Figure 11 illustrates the findings suggest the character 'To Patak D' should be an optimal letterform. The whole new designs obtain the percentage of incorrect response less than the characters from the previous study (Punsongserm, et al, 2017b), i.e., the characters 'To Patak XX' and 'To Patak YY'. These findings have been confirmed to the idealistic key feature for the character 'To Patak'.
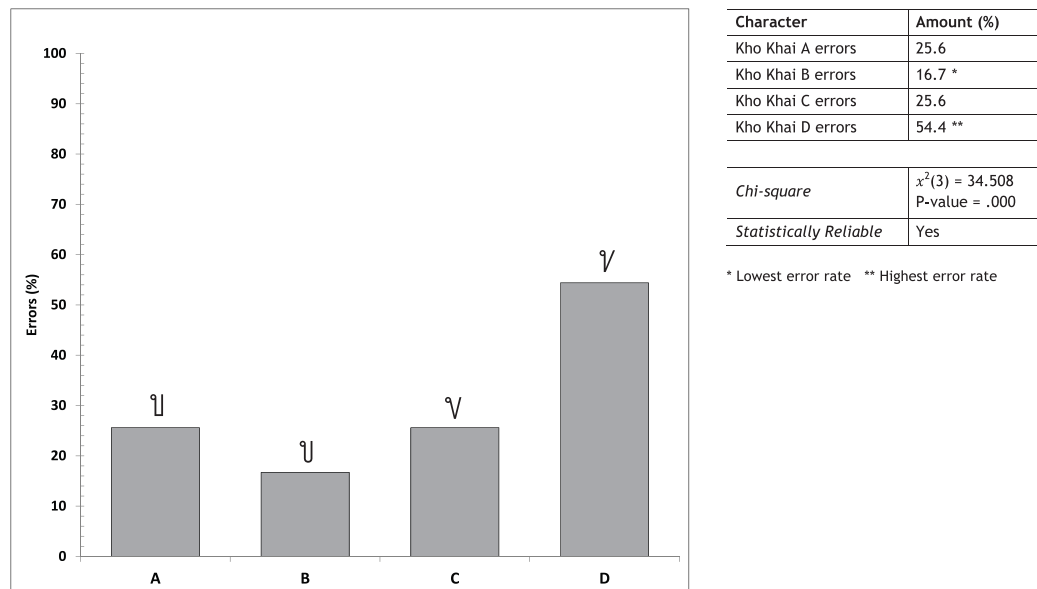
4.5 The Characters /ข/ (Kho Khai)

Character	Amount (%)
Kho Khai A errors	25.6
Kho Khai B errors	16.7 *
Kho Khai C errors	25.6
Kho Khai D errors	54.4 **

Chi-square	$x^2(3) = 34.508$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Figure 12. The occurred errors in the characters /ข/

Table 5. Confusion pair letter with amount of confusion on the characters /ข/

Character	Confusion Pair Letter with Amount of Confusion (%)			
	Cho Chang /ช/	Kho Khuat /ฃ/	Sara Uu /อู/	Others
Kho Khai A	12.2	3.3	4.4	5.5
Kho Khai B	10.0	-	1.1	5.5
Kho Khai C	11.1	2.2	8.9	3.3
Kho Khai D	31.1 †	-	8.9	12.2 †

† A highest frequency of misreading for each confusion pair letter, each column

There was no character /ข/ was tested legibility in the previous study. In this study, we designed four variation aspects of letterform for investigation. Figure 12, the result reveals the character 'Kho Khai B' should be an appropriate glyph of whole tests, with curve baseline. We strongly believe that determining a minimal loop can assist better legibility as well. The recommendation that applying v-shape for character /ข/ should enhance better visibility (Punsongserm, et al, 2017a), may not support better legibility much as given curve baseline, as the finding of 'Kho Khai C'. In the same way, shaping vertical line joint with extreme diagonal line as the character 'Kho Khai D' can cause more

obscurity to the letter 'Cho Chang /ช/', in other words, the extreme diagonal line may delusive for the tail of the letter 'Cho Chang /ช/' as well as 'So So /ซ/'.
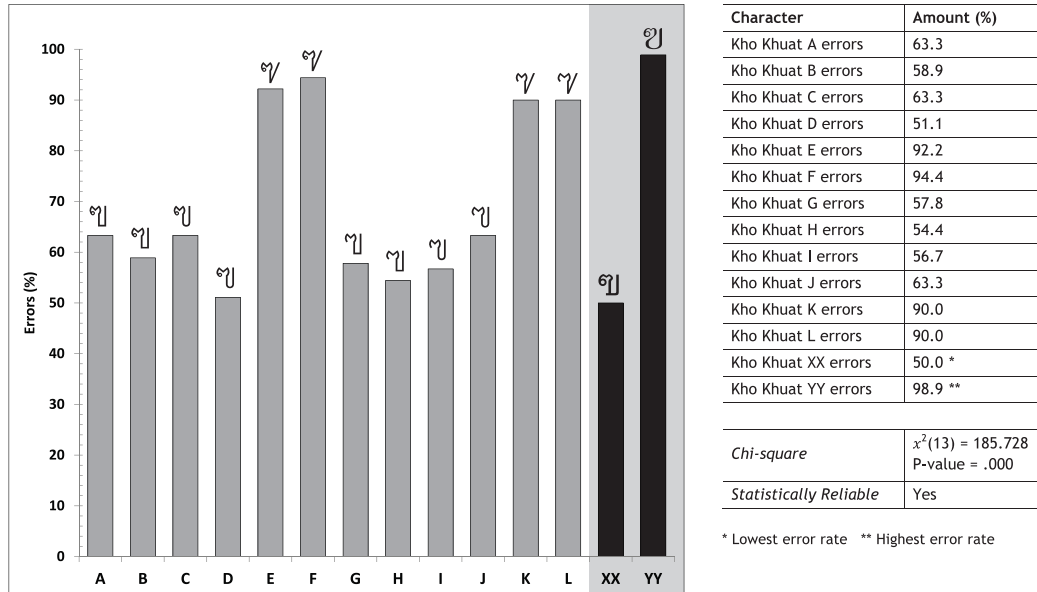
4.6 The Characters /ฃ/ (Kho Khuat)

Character	Amount (%)
Kho Khuat A errors	63.3
Kho Khuat B errors	58.9
Kho Khuat C errors	63.3
Kho Khuat D errors	51.1
Kho Khuat E errors	92.2
Kho Khuat F errors	94.4
Kho Khuat G errors	57.8
Kho Khuat H errors	54.4
Kho Khuat I errors	56.7
Kho Khuat J errors	63.3
Kho Khuat K errors	90.0
Kho Khuat L errors	90.0
Kho Khuat XX errors	50.0 *
Kho Khuat YY errors	98.9 **

Chi-square	$x^2(13)$ = 185.728 P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Figure 13. The occurred errors in the characters /ฃ/

Table 6. Confusion pair letter with amount of confusion on the characters /ฃ/

Character	Confusion Pair Letter with Amount of Confusion (%)						
	Kho Khai /ข/	So So /ซ/	Cho Chang /ช/	Tho Thong /ธ/	Ro Rua /ร/	Ho Nokhuk /ฮ/	Others
Kho Khuat A	24.4	14.4	8.9	1.1	4.4	-	10.0
Kho Khuat B	17.8	30.0	6.7	-	-	-	4.4
Kho Khuat C	22.2	18.9	6.7	-	3.3	-	12.2
Kho Khuat D	10.0	30.0	1.1	1.1	1.1	-	7.8
Kho Khuat E	6.7	74.4	1.1	-	1.1	-	6.7
Kho Khuat F	6.7	80.0 †	1.1	-	-	-	6.7
Kho Khuat G	18.9	24.4	2.2	1.1	3.3	-	7.8
Kho Khuat H	15.6	25.6	1.1	2.2	3.3	-	6.7
Kho Khuat I	18.9	20.0	4.4	-	4.4	-	7.8
Kho Khuat J	16.7	36.7	1.1	-	2.2	-	6.7
Kho Khuat K	6.7	68.9	2.2	-	4.4	-	5.6
Kho Khuat L	8.9	70.0	2.2	-	2.2	-	6.7
Kho Khuat XX	26.7 †	15.6	3.3	-	-	-	4.4
Kho Khuat YY	2.2	-	7.8	11.1	-	46.7 †	31.1 †

† A highest frequency of misreading for each confusion pair letter, each column

Refer to the earlier studies (Punsongserm, et al., 2017a; and Punsongserm, et al., 2017b), jutting out of the loop with the serrated line has provided better legibility for character /ฃ/, see Figure 13. The characters without loop (e.g., Kho Khuat G, H, I and J), might encourage better legibility and visibility. Mention to the finding of the character 'Kho Khai D' (see topic 4.5) which has an extreme diagonal line of the backline and can camouflage

as a tail of Cho Chang /ช/. It also influenced those same exotic forms for characters 'Kho Khuat E, F, K, and L' that have more confusion to the letter 'So So /ซ/'. Even though character 'Kho Khuat XX' obtained overall incorrect response fewest, nevertheless, it had the highest misreading for a letter 'Kho Khai /ข/'. While the character 'Kho Khuat D' had overall incorrect response identical with the character 'Kho Khuat XX' yet the finding suggests it obtained incorrect response for the letter 'Kho Khai /ข/' lower than character 'Kho Khuat XX', see Table 6.

The findings suggest the existence of massive serrated line and curve baseline may enhance legibility for character 'Kho Khuat /ฆ/', i.e., Kho Khuat D. Moreover, the character 'Kho Khuat /ฆ/' with too wider character width and shrunken position of loop with serrated line, i.e., Kho Khuat YY, could be confusing to letter 'Ho Nokhuk /ฮ/'. To improve legibility of character 'Kho Khuat /ฆ/', should extend more jutting out of the serrated line as well as be decreasing a height of the backline, slightly, see Figure 14.
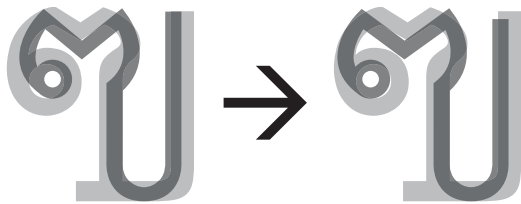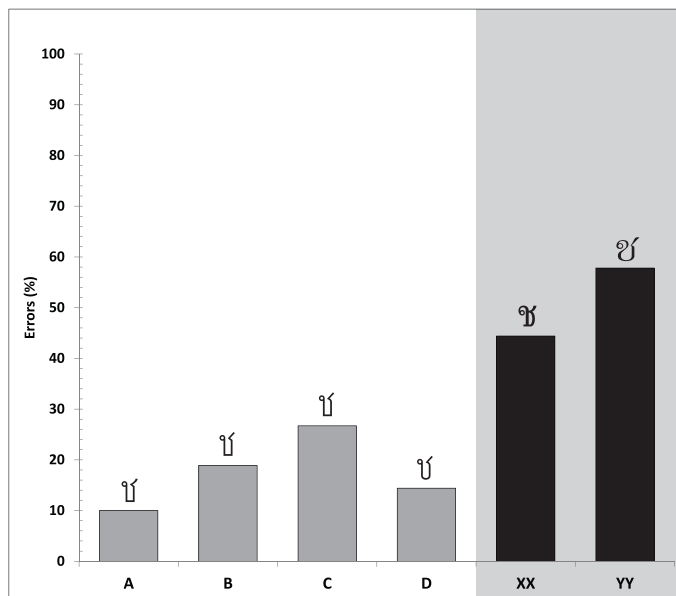

Figure 14. An approach to improving character 'Kho Khuat /ฆ/'

4.7 The Characters /ช/ (Cho Chang)

Character	Amount (%)
Cho Chang A errors	10.0 *
Cho Chang B errors	18.9
Cho Chang C errors	26.7
Cho Chang D errors	14.4
Cho Chang XX errors	44.4
Cho Chang YY errors	57.8 **

Chi-square	$x^2(5) = 76.817$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Figure 15. The occurred errors in the characters /ช/

Table 7. Confusion pair letter with amount of confusion on the characters /ช/

Character	Confusion Pair Letter with Amount of Confusion (%)				
	So So /ซ/	Kho Khai /ข/	Tho Thong /ธ/	Ho Nokhuk /ฮ/	Others
Cho Chang A	2.2	5.6	2.2	-	-
Cho Chang B	11.1	5.6	2.2	-	-
Cho Chang C	10.0	12.2	3.3	-	1.1
Cho Chang D	5.6	7.8	1.1	-	-
Cho Chang XX	25.6 †	14.4 †	2.2	1.1	1.1
Cho Chang YY	6.7	-	4.4	43.3 †	3.3

† A highest frequency of misreading for each confusion pair letter, each column

Due to all new glyphs were designed along with minimum loop, they have had more advantage than the two characters from the previous study, Figure 15, and therefore, this hypothesis was confirmed. Table 7 shows character 'Cho Chang A' obtains the lowest incorrect response, as well as the character 'Cho Chang D' is subordinate to 'Cho Chang A'. A maximum loop set of 'Cho Chang XX' reveals disadvantage of its legibility; there is confusion as the letters 'So So /ซ/' and 'Kho Khai /ข/' rather than the others. The character 'Cho Chang YY' obtains a high frequency of misreading for the letter 'Ho Nokhuk /ฮ/', similar to the finding of 'Kho Khuat YY' (see topic 4.6). To improve effective legibility of character 'Cho Chang', it should be added the length of the tail and maintain a minimal loop.
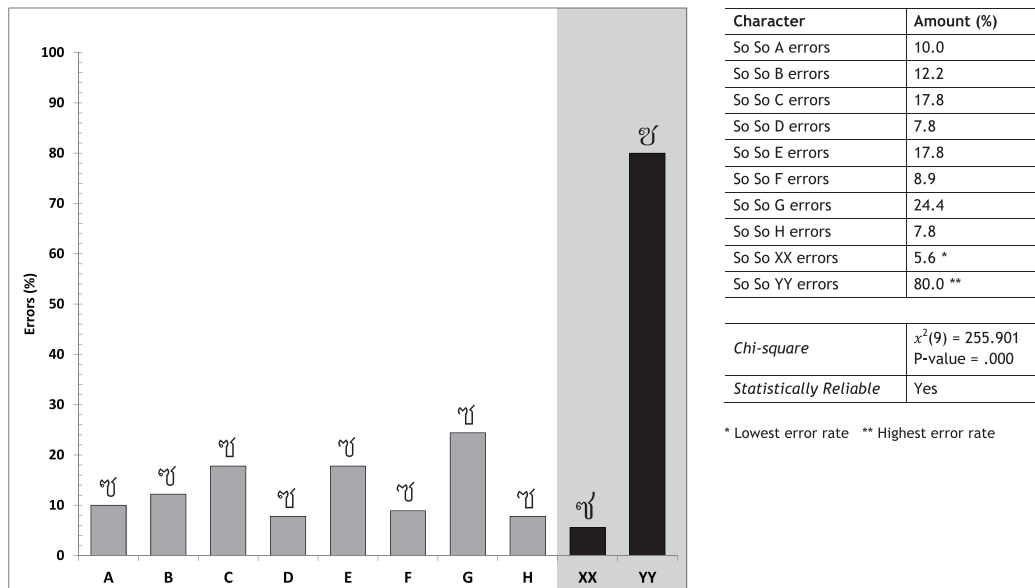
4.8 The Characters /ซ/ (So So)

Character	Amount (%)
So So A errors	10.0
So So B errors	12.2
So So C errors	17.8
So So D errors	7.8
So So E errors	17.8
So So F errors	8.9
So So G errors	24.4
So So H errors	7.8
So So XX errors	5.6 *
So So YY errors	80.0 **

Chi-square	$x^2(9) = 255.901$ P-value = .000
Statistically Reliable	Yes

* Lowest error rate   ** Highest error rate

Figure 16. The occurred errors in the characters /ซ/

Table 8. Confusion pair letter with amount of confusion on the characters /ช/

Character	Confusion Pair Letter with Amount of Confusion (%)					
	Cho Chang /ช/	Kho Khuat /ฃ/	Kho Khai /ข/	Tho Thong /ธ/	Ho Nokhuk /ฮ/	Others
So So A	7.8	2.2	-	-	-	-
So So B	4.4	3.3	2.2	-	-	2.2
So So C	15.6	1.1	1.1	-	-	-
So So D	5.6	1.1	1.1	-	-	-
So So E	12.2	3.3	1.1	-	-	-
So So F	5.6	1.1	1.1	-	-	1.1
So So G	17.8 †	1.1	2.2	-	-	3.3
So So H	3.3	3.3	-	-	-	1.1
So So XX	4.4	-	-	-	-	1.1
So So YY	15.6	-	-	8.9	48.9 †	6.7

† A highest frequency of misreading for each confusion pair letter, each column

Corresponding to our previous study, Figure 16 illustrates character 'So So XX' obtains the lowest incorrect response in this study. Furthermore, the characters 'So So D' and 'So So H' have reached low incorrect response, less than 'So So XX' slightly. Consequently, it may be considered that hypothesis, i.e., providing extensive serrated line and jutted long tail, was supported. Similarly, with the findings of the characters 'Kho Khuat YY' (see topic 4.6) and 'Cho Chang YY' (see topic 4.7), the presence of too large character width cause of confusion for letter 'Ho Nokhuk /ฮ/', see Table 8.

5. Conclusion

Most of the results have reflected to significantly congruence for the previous pilot studies (Punsongserm, et al., 2017a; and Punsongserm, et al., 2017b) which employed computer software for simulation of blurred vision as a paper-based study. This study, as the testing on a computer display, has suggested that the assumptions for the selected the homologous Thai letterforms contribute to developing useful Thai characters based on low visual acuity.

Concerning the effectiveness of those various glyphs based on the idealistic key features, the providing extensive serrated line should be adequate for characters 'Kho Khon /ฅ/' and 'To Tao /ต/' yet merely the character 'Kho Khon /ฅ/' should require full character width than ever. Along with jutting out of the tail with the loop of character 'To Patak /ฏ/' is precious indispensability for enhancing optimal legibility while shrinking the tail with the loop of character 'Do Chada /ฎ/' is a necessity rather than ever, as well as improving more considerable its backline. Additionally, the curve baseline together with a small loop can contribute useful legibility for the characters 'Kho Khai /ข/' and 'Kho Khuat /ฃ/', whereas applying v-shape for the character may not advocate better legibility for both characters. Similarly, the minimum loop of those characters /ช/ which

conformed to idealistic key features have had over advantage than the character that has a broad curve line joined with a loop (Cho Chang XX). In the same way as the results of the characters 'Kho Khuat /ฃ/', allowance to jutting out of extensive serrated line for the characters 'So So /ซ/' can encourage the feature as the first priority, evidently.

Acknowledgement

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