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Luminance Contrast of Thai Letters Influencing Elderly Vision

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ABSTRACT

We investigated the effect of luminance contrast between text and background on legibility of Thai letters. Three groups of subjects; young (18-23 yrs.), elderly (58-66 yrs.), and simulated elderly (young wored cataract experiencing goggle) participated in this research. The stimulus configuration was a row of ten random Thai letters presented on an LED display. The letter's size was 0.35 degree at 246 cm viewing distance. The luminance contrast between text and background was composed of five levels of positive polarity and five levels of negative polarity. The subjects viewed the stimuli in a room which illuminated at 0 and 300 lux. The first task of each subject was to report those 10 random letters. Reading performance was calculated in term of percentage of correct answer. For the second task, the subjects was asked to rate the reading easiness of those letters. The results showed that the elderly required higher contrast letter than the young. For positive polarity, reading performance and easiness score of the real elderly were slightly lower than those of the other two groups. For negative polarity, result of the real elderly under 0 and 300 lux was slightly different. However, at low luminance contrast, reading performance and easiness score of the young under 300 lux was suddenly declined and significantly different from reading performance under 0 lux. For all groups of subject, minimum required contrast for easy reading is higher than minimum required contrast for correct reading. Even though all groups of subject could read the lower contrast letter but they felt that the lower contrast is not easy to read.

1. INTRODUCTION

Number of elderly population in Thailand has been growing. In 2025, the percentage of elderly people will be more than 15% and will become more than 25% in 2050 (Institute for Population and Social Research 2006; United Nations 2002). Therefore, we cannot discard this severe situation and have to prepare for the aging society. It is important to study the elderly vision in order to prepare the elder-friendly environment so that the elderly can maintain their quality of life and also their performance to live by themselves. One important aspect for the elderly is their loss of vision due to the cataract. Their crystalline lens become hazy which caused more scattered light in their eye. Therefore, they cannot see some small details clearly such as small Thai letters. In this research we then investigated the effect of luminance contrast between text and background on legibility of Thai letters. We selected an LED display as a source to present the letters becuse nowaday LED display is generally used to present information. However, its characteristic was not the same as the reflected paper because the LED display is a self emitting source. We thought that the LED display generally emit stronger light intensity than the reflected light from paper. We varied the luminance contrast between text and background and examined the reading performance and easiness of young and elderly people.

2. METHOD

2.1 Apparatus

The apparatus was composed of two rooms (a test room and a subject room) separated by a wall. The dimension of this apparatus was shown in Figure 1. Inside the test room, an LED display (Toshiba LED40PU200T) was placed and connected to a PC via HDMI cable. This LED display was used for presenting stimuli. The test room was covered by a black curtain to minimize external light. In the subject room, the internal wall was covered by a white wall paper. The room was also decorated by some stuff such as artificial flower, a doll, and books on a shelf in order to simulate the daily life used rooms. There was a set of four fluorescence lamps attached to the room's ceiling. The intensity of this set of four fluorescence lamps was adjustable to obtain the required illluminance level. The illuminance in this room was measured by a chroma meter (Konica Minolta CL-200A) placed on the shelf closed to the front wall. On the front wall which connected to the test room, a 5 cm × 30 cm aperture was cut at the subject eye's level. The subject looked through this aperture to see the stimuli which were presented on the LED display. The distance between the front wall and the subject's eye was fixed at 2 m.

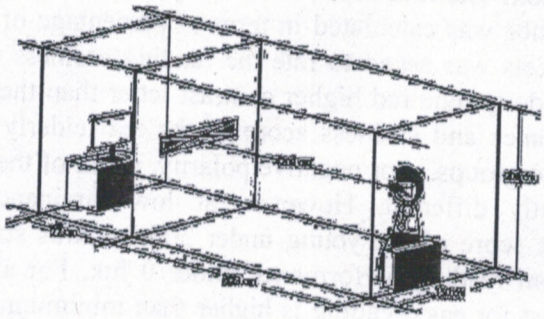

Figure 1: Schematic diagrams of the apparatus.(Rattanakasamsuk 2013)

2.2 Subjects

Three groups of subjects participated in this experiment. The first group was 30 undergraduated student (age between 18-23 years old.). We named this group as "*young*". The second group was five elderly people (age between 58-66 years old). This group was named as "*elderly*". For the third group, 30 young subjects were asked to wear cataract experiencing goggle during experiment. This cataract experiencing goggle was developed by Obama et al. (Obama et al. 2004). It was made from 58% transmittance filter, 14% of haze values filter and yellow filter in order to simulate the elderly vision. These 30 subjects was called "the simulated elderly". All subjects had normal or corrected to normal visual acuity.

2.3 Stimuli and Experimental Conditions

The stimulus configuration was a row of ten random Thai letters presented on an LED display. The letter's size and viewing distance were kept constant at 0.35 degree and 246 cm, respectively. The luminance of *"black"* and *"white"* background was constant at 0.01 and 147 cd/m^2, respectively. Two polarities of luminance contrast between letter and background was applied to the stimuli as shown in Figure 2. The first one was positive polarity (dark letter on *white* background). Five levels of luminance contrast for the positive polarity were set at -1.30, -0.95, -0.54, -0.37, 0.65, and 4.17. The second one was negative polarity (light letter on *black* background). Five levels of luminance contrast for

the negative polarity were set at 0.30, 1.23, 2.48, 3.18, 3.60, and 4.17. Note that all luminance contrast was presented in term of log Weber contrast. The illuminance of the subject room was set at 0 lux for simulating night-time condition and set at 300 lux for simulating the indoor viewing condition.

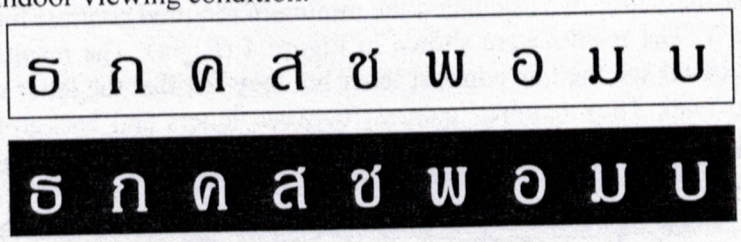

Figure 2: Example of stimuli. (Top) positive polarity and (Bottom) negative polarity.

2.4 Experimental Procedure

There were two tasks for each subject. The first task was reading performance task. The subject was asked to report each random letter. The reading performance was calculated by percentage of correct answer. The second task was reading easiness task. When the subject saw the stimuli, they were asked to rate the easiness of reading with five levels of score from 0 to 4. While 0 means *"unable to read/very difficult to read"*, 4 means *"very easy to read"*. These two tasks were done in separated sessions. Therefore, in each session, the experimenter selected one of the experimental conditions from the combination of two illuminance levels (0 or 300 lux), two contrast polarities (positive or negative polarity) and two tasks (reading performance or reading easiness). The subject was asked to sit in the experimental room and look around inside the room for two minutes. After two-minute adaptation, a line of ten random Thai letters was presented. The subject was asked to complete either reading performance task or reading easiness task. After finishing each trial, the new 10 random letter with different luminance contrast was presented. The subjects repeated the tasks until all five luminance contrast were presented.

3. RESULTS AND DISCUSSION

Positive Polarity (Dark Letter on White Background)

Figure 3 showed result of positive polarity. The two top panels showed results of reading performance task, and the two bottom panels showed result of reading easiness task. The left and right panels showed result obtained under subject room's illuminance at 0 and 300 lux. Circle, square, and triangle represented average result obtained from young, simulated elderly, and elderly respectively. The dashed lines were the regression line which obtained by fitting the data with logistic functions as shown in Equation 1.

$$y = \frac{1}{1+e^{(-ax-i)}} \tag{1}$$

For reading performance task, we calculated the minimum required contrast for good reading performance at 75% correct answer. The results were shown in Figure 4 (Left). It clearly showed that the result of the young was not the same as the elderly and the simulated elderly. The reading performance of the young was better than that of the other two groups. The young could also read lower contrast letter under both 0 and 300 lux conditions. However, there was difference between the real elderly and the simulated elderly. The Reading performance of the simulated elderly seems not to be strongly influenced by environment light. On the other hand, reading performance of the elderly

was significantly affected by environment. In case of 0 lux condition where all environments was dark but the adjacent background only looked bright, the reading performance was significantly lower than that in the 300 lux.

For reading easiness task, we calculated the minimum required contrast for easy reading at easiness score 3. The results were shown in Figure 4 (Right). The results showed that even all subjects could see the low contrast letter but they felt that the letter was uneasy or uncomfortable to read. They required contrast between letters and background at least -0.528, 0.095 and 0.253 for the young, the simulated elderly and the elderly, respectively.

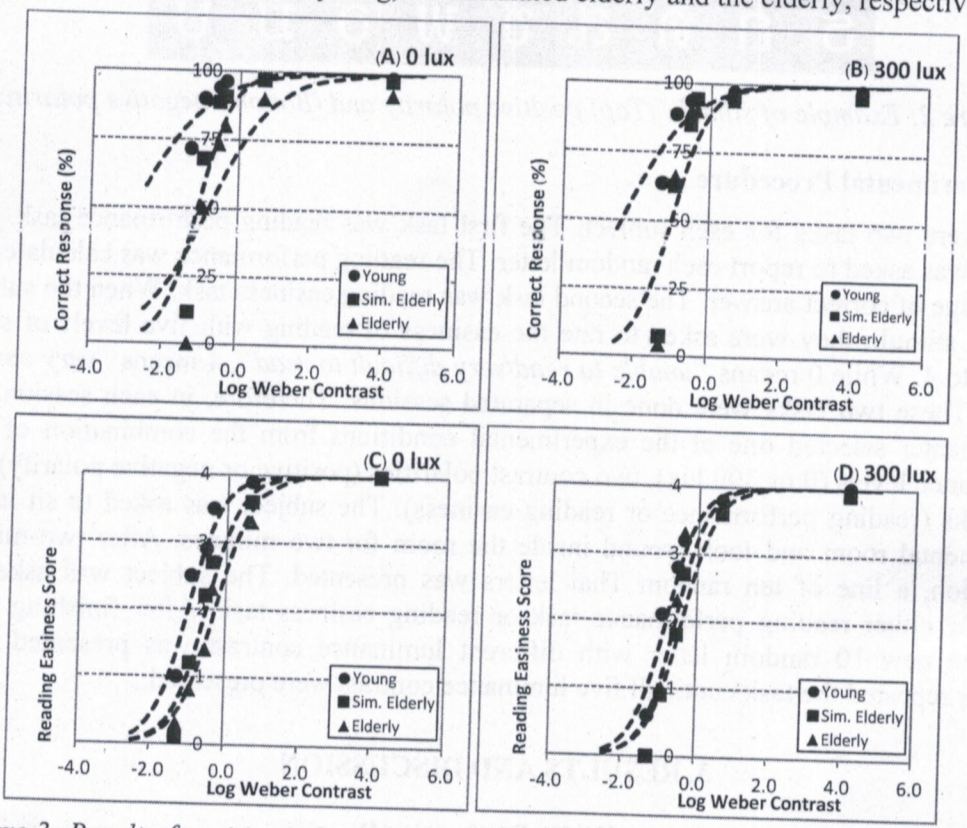

Figure 3: Result of positive polarity. (Top) reading performance task (Bottom) reading easiness task.

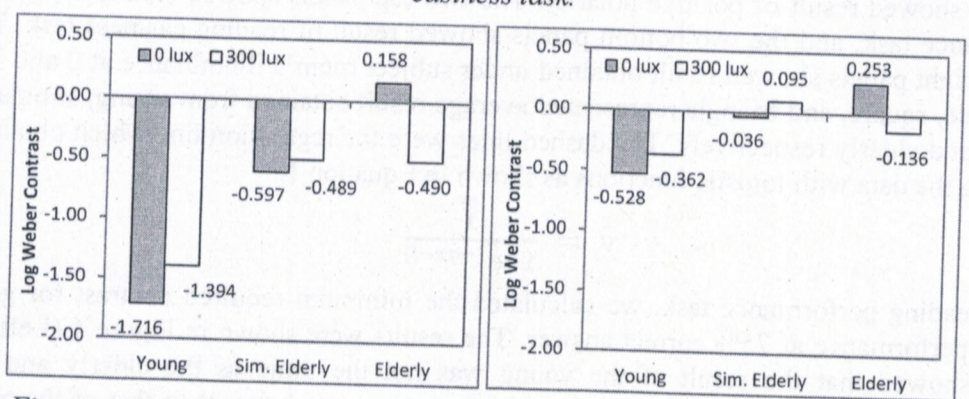

Figure 4: Minimum required contrast for positive polarity from (Left) reading performance task and (Right) reading easiness task.

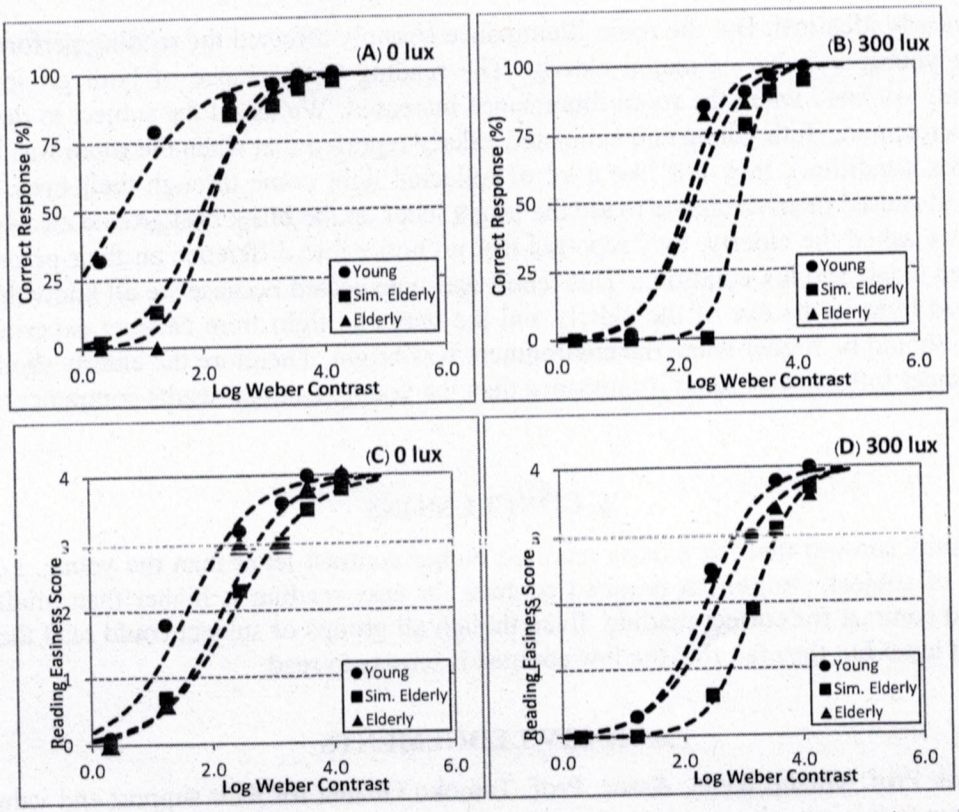

Figure 5: Result of negative polarity. (Top) reading performance task (Bottom) reading easiness task.

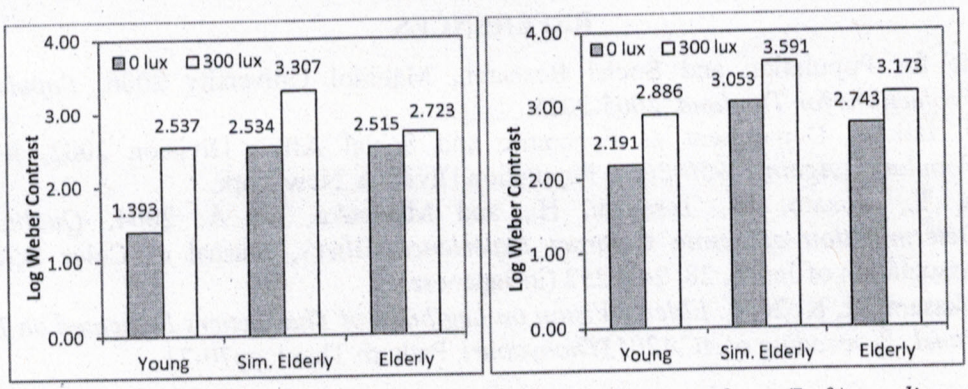

Figure 6: Minimum required contrast for negative polarity from (Left) reading performance task and (Right) reading easiness task.

Negative Polarity (Bright Letter on Black Background)

The results of negative polarity were shown in Figure 5 and 6. At any contrast level, the reading performance of the young was still better and the easiness score was still higher than the simulated elderly. These lowering reading performance and easiness score of the simulated elderly were mainly due to the cataract experiencing goggle. The goggle caused scattered light which disturbed the sharpness of letter and possibly covered some minor detail of the letter so that the subject could not clearly and comfortably see the letter. However, we found that the room illuminance showed slightly effect on reading performance of the elderly. The minimum required contrast for the elderly under both case

were nearly identical. But the room illuminance strongly affected the reading performance of the young and the simulated elderly. The reading performance of both groups was suddenly declined when the room illuminance increased. We asked the subject to describe their perception. Both young and simulated elderly reported that when the room was bright (300 lux condition), they felt like a lot of reflected light come through their eyes. This situation caused them to unable to see the bright letter on the black background clearly. But when we asked the elderly, they reported that no noticeable difference on their perception between 0 and 300 lux condition. This report was unexpected because we all know that the scattered light in the eye of the elderly and the scattered light from cataract experiencing goggle should be higher when the environment was bright. Therefore the elderly should be more under influence of room illuminance than the young. But our results contradict to this fact.

4. CONCLUSIONS

Our results showed that the elderly required higher contrast letter than the young. For all groups of subject, minimum required contrast for easy reading is higher than minimum required contrast for correct reading. Even though all groups of subject could read the low contrast letter but they felt that the low contrast is uneasy to read.

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REFERENCES

Institute for Population and Social Research, Mahidol University 2006, *Population Projections for Thailand, 2005-2025.*

United Nations, Department of Economic and Social Affair Division 2002, *World Population Ageing 1950-2050,* Population Division, New York.

Obama, T., Uozato, H., Terauchi, H., and Matsuoka, M. A. 2004. *Qualitative Determination of Senile Cataract Experience Filters*, Journal of Color Science Association of Japan, 28, 245–252 (in Japanese).

Rattanakasamsuk, K. 2013. *Elderly Vision on Legibility of Thai Letters Presented on LED Panel, Proceeding of ACA2013Thanyaburi,* Pathum Thani, pp70-73.

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