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UiTM study on road signs in Malaysia: The impact of information volume of road sign on level of visibility

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Abstract: This study was to investigate the information volume of road sign and level of visibility using real road sign. Five road signs of 5- and 10-letter word combinations were shown randomly to the subject for 2 to 3 seconds at 30 meters initially. The road sign was moved closer to subject, 1 meter at a time until the subject saw the road sign correctly. The distance of first correct response demonstrated the minimum distance any of the road signs was visible, while distance of all correct response indicated all the road signs can be recognized. Paired t-test showed that the difference in the distance of first correct response between the 5-letter and 10-letter word combinations road sign was statistically significant ($p < 0.05$), but no statistically significant difference in the distance of all correct response ($p > 0.05$). The information volume could affect the level of visibility of the road sign to a certain extent.

Keywords: Information volume, road sign, sign reading, traffic design, visibility.

Introduction

Road signs were available in various shapes, sizes and colors and were used to warn road users from potential dangers [1], such as regulatory sign, warning signs, guide signs, route markers and temporary sign. The types of road sign shapes available in Malaysia were circular, octagonal, triangular, diamond and rectangular [2]. The function of road sign varied with colors such as red on white background for prohibitive or warning for extreme danger; white on blue background for mandatory; directive or information on general services, white on green background for information on river name or information on historical and cultural interest area; yellow on dark green background for information on recreational area; black on white background for prohibitive or information for town name; black on yellow background for warning; black on orange background for temporary and red on blue background for prohibitive purpose. National languages were usually used for road signs including Malaysia. Malay language was used in traffic signs in Malaysia but English was also used for tourist attractions, airports, railway stations and immigration checkpoints. Sometimes, both Malay and English were used in road signs like along the Pengerang highway in Johor state and Genting Sempah-Genting Highlands highway. Road sign can be presented in pictorial, alphanumerical and combined modes. The cognitive precision and reaction time on computer alphanumeric, pictorial, and combined modes were reported to vary according to target population [3]. Each of pictogram and alphanumeric type of road sign has its own advantages and disadvantages. Pictographic format was easily identifiable from a larger distance and faster than words because image was in parallel processed, compared to words that need a sequential process [1].

Traffic accidents in Malaysia increased at an average rate of 9.7% per annum over the last three decades. Improper intersection design was also related to the problem in lack of safe sight distance [4]. The late identification of the sign while driving may lead to the last minute decision to change lane, which led to accident especially on busy highway [2]. Humans had limited capacity of receiving information in a short period of time [4]. For too much information within a short period of time, the short-term memory capacity overloaded resulting in omission. Increasing display time increased the level of understanding, but it also caused boredom. In order to create new road sign, consideration was given to non-ambiguous icons. The action and the object should be easily recognizable [1]. The ability of road user to interpret road sign related to the familiarity to the background knowledge of road usage. Driving experience gave advantages to road user to detect significant changes on driving environment. Roadway visibility systems consisted of various components, including fixed illumination systems, vehicular lightning, traffic signs, traffic signals and pavement marking [5]. The ability to process and respond appropriately to visual information of increasing volume remained inconclusive. Optimum information volume provided a good level of visibility. There were various types of information volume used in road sign and might give different level of visibility [1]. Current study on information volume and visual search information did not directly examine the visibility using the exact specification of road sign [4]. Our study was conducted to investigate the information volume of road sign and level of visibility using different word combinations of real road signs.

Materials and Methods

Twenty-nine young adults (between 20 and 26 years old) were recruited using convenience sampling with informed consent. The sample size was determined based on 95% confidence interval with the standard deviation of nearest distance of visibility was set at 0.8 m [6] in order to obtain data on the distance of visibility with the precision of 0.3. The ethical approval was obtained from the university ethical committee. The inclusion criteria was best-corrected 6/6 visual acuity [7], with the difference of refractive error between two eyes not more than 1.50 D to ensure a well-developed fusion and stereoscopic vision [8]. None of the subject had been exposed to the target before the procedure, but they were familiar with the words in Malay language. Alphabetical road signs were used as a target. There were 2 types of information volumes based on number of letter on each road sign. The first type of information volume had 5 letters on each road sign forming one word while the second type of information volume had 10 letters on each road sign forming one word. Each type of information volume had 5 different words that were almost similar in pronunciation and letters arrangement. The 5-letter word combinations were consisted of "makin, makam, mukim, makan, mekar "; while the 10-letter word combinations were consisted of "mengerikan, mengatakan, mengiyakan, menyatakan, mengotakan". The sample of the alphabetical road sign was described in Fig. 1.

Each of the road sign was obtained from an authorized company that manufactured road signs in Malaysia. These road signs were made at 'Pembinaan JMY Enterprise' company. So the letters used on the road sign in this study was similar to the road signs in Malaysia which was Series I letter type [9]. Letter height that was selected was according to local street and minor road of road categories. Standard letter height of local street and minor road was 100 mm. But the height of the letter had been minimized to one fourth of 100 mm which was the smallest value of road sign letter height standard which was local streets' and minor roads' letter height for this study purposes. All of the letters used in the road sign were lower case to standardize the letter height. Besides that, each of the road sign had a black border which size was also according to the size of the letter. The function of border was for aiding subject in tracking the location of the road sign [2]. The color of the letter was black and the background was white. The contrast level between letter and background was 0.88 in accordance to the minimum acceptable contrast level of 0.84 used for standard clinical measurement [10]. Room illumination for this study location was standardized at 502 lux, which near to the normal illumination for clinical optometry test room of 600 lux [11].

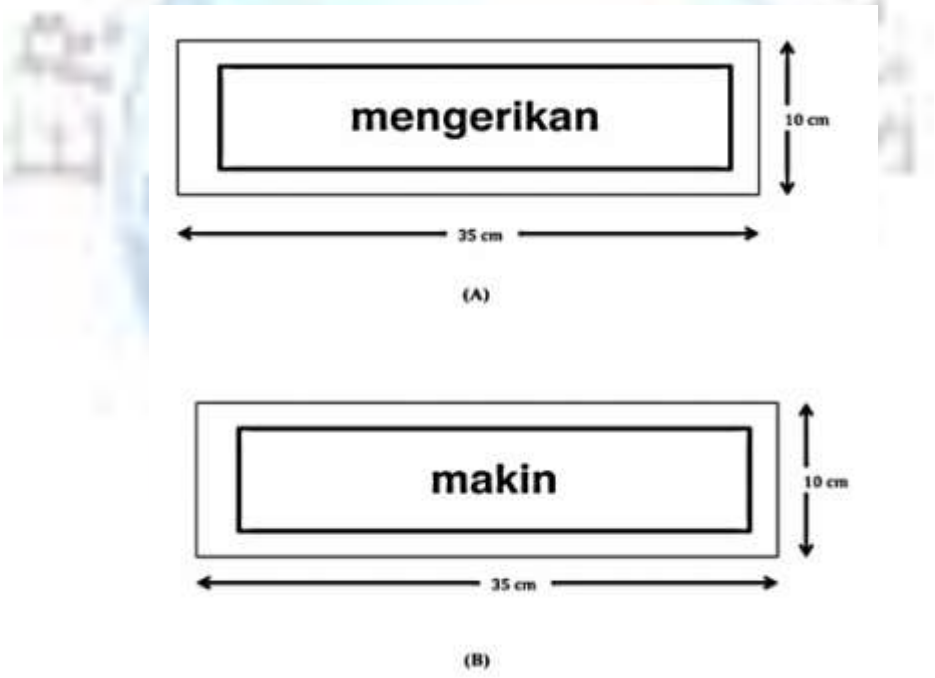

Figure 1: Sample of alphabetical road signs targets: (A) 10-letter word combinations road sign;

(B) 5-letter word combinations road sign.

Procedure

Ten sets of 5-letter and 10-letter word combinations road signs were shown randomly to subjects. With each letter represented 4.7 bits of information and 1 color represents 3 bits of information volume, 5-letter word combinations road sign had 29.5 bits of information while 10-letter word combinations road sign had 53 bits of information [4]. The 5-letter word combinations road sign represented low information volume as compared to higher information volume of 10-letter word combinations road sign. Each of the road sign was presented for 2 to 3 seconds since the maximum time of driver's gaze away from the road in front was 2.5 seconds [4]. The measurement started at a distance of 3om and the road signs

were moved gradually closer to subject at 1m step. The subject were required to write the answer in the answer sheet provided when the road sign presented could be recognized. A method of ascending limit [12] was used. All of the road sign were presented randomly at each distance until subject answered all road sign correctly.

Results

Parametric test were used to analyze the data (Shapiro-Wilk test: $p>0.05$). The visibility distance was measured based on the distance of first correct response and the distance of all correct response of both 5- and 10- letter word combinations road signs. The distance of first correct response was to show the distance at which any one of the total five signs can be correctly recognized, while the distance of all correct response indicated the distance that all five signs were accurately determined. For 5-letter word combinations road sign, the mean distance of first correct response was 24.24 m (±3.04) and the mean distance of all correct response was 22.97 m (±2.81). While for the 10-letter word combinations road sign, the mean distance of first correct response was 19.14 m (±2.40) and the mean distance of all correct response was 18.90 m (±2.24). Paired sample t-test was conducted to analyze the differences between paired distances between the 5-letter and 10-letter word combinations road sign. The difference in the distance of first correct response between the 5 letters and 10 letters was statistically significant ($t = 3.22$, $p < 0.05$). However, there was no statistically significant difference in the distance of all correct response between the 5-letter and 10-letter word combinations ($t = 0.98$, $p = 0.336$).

Conclusion

Sign-reading performance related to dynamic visual acuity as it involved movement while seeing [13]. As all subjects had the same level of visual acuity, the distance where subject responded correctly for the answer was a factor that contributed to a level of visibility. The visibility was considered better if subject can respond correctly at a farther distance compared to a closer distance between subject and road sign presented. From the findings, it showed that there was a difference in the distance of first correct response between of the 5-letter (24.24 m) and 10-letter (19.14 m) word combinations road sign. This difference might due to the letter confusion of the road sign as reported in previous study [14]. Since 10-letter word combinations road sign had more information volume than the 5-letter word combinations road sign, the 10-letter word combinations might contain more visual distractors [15]. These distractors affected the subjects from easily recognized the road sign and resulted to letter confusion. As the 10 letters road sign was more likely to be confused, the level of visibility of 10-letter word combinations was lower than the 5-letter word combinations. However, the letter confusion seemed only to happen during the initial effort to get correct sign-reading on any of the five road signs used.

Nevertheless, there was no difference in the visibility of all correct response between of the 5-letter (22.97 m) and 10-letter (18.90 m) word combinations road signs. This might imply that once the subjects were psychophysically able to recognize any of the road signs, the visibility of other road signs of similar characteristic could be improved. Thus, visibility was statistically similar for both low and high information volume. Another possible explanation was the learning aspect of task requirements to attend to the visual information [16]. Once the visual information were correctly appreciated, the brain could made quicker interaction of the visual stimuli of the following road signs, thus improved the visibility of other road signs.

In conclusion, this study indicated that the information volume could affect the visibility of the road sign to a certain extent. Once the visual information can be recognized accurately, road signs of similar information volume had no impact to the level of visibility.

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