English Language Readability Task Performance in a Mobile Setting - The Effect of Gender

Zulquernain Mallick

School of Mechanical Engineering
Universiti Sains Malaysia
14300 Nibong Tebal
Engineering Campus
Penang, Malaysia.

Tel: +604-5996368
Fax: +604-5941025

zmallick2002@yahoo.co.in

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ABSTRACT

Mobile computing has become very common in the present day fast changing technological development. It is expected that in future, people will be more mobile than today and all kinds of tasks that are performed in the stationary environment will be undertaken in a mobile environment also. As traffic on the road and also the population are increasing at a very fast pace, the future generation will spend a lot of time in a mobile environment. Therefore, assessment of operators' performance in a mobile setting will become all the more important. Mobile environment is influenced by vehicular vibration for all kinds of tasks. The present study made an attempt to explore the English language readability performance of a target group. Fourteen subjects (seven males and seven females) from an English language teaching institute were selected for this study. The base line value of reading speed was obtained on the basis of stationary environment reading task performance. Reading speed was noted in the number of words read per minute (NWRPM). The same subjects were used for reading in the vibratory environment and difference in the performance was noticed. A stimulus was presented on a lap-top in both cases. Vibration was assessed on the basis of ISO 2631-1 (1997) guideline. ANOVA statistical tool was used to analyze the data. The result indicated that the performance of operators was significantly affected due to the presence of vibration and text/background color.

1. INTRODUCTION

The use of visual display unit with the rapidly increasing pace of computerization in almost every walk of life has been continuously on increase**.** The development in information system design suggests that VDU's will continue to be used as a medium for presentation of large amount of connected texts as in videotext, electronic journals, dynamic books or similar application.

With the passage of time the users interaction with their machines is increasing day by day. There are variety of factors that can affect the computational capability of operators. Some of them are working postures, distance from the VDU, level of illuminance in work place, color contrast of the background and projected matter, environmental variables like noise pollution, temperature, humidity etc. Throughout the 1980s the discipline of computer science become increasingly male dominated, a trend which has continued into the 1990s. There can be little doubt that throughout this period computing has developed a masculinised image such as physics or engineering traditionally have (Chivers, 1987; Hawkins, 1985). As a result males perceive themselves to be more competent than females (Collis, 1985; Wilder, 1985). Unsurprisingly, then, there is a large body of research highlighting that females report more computer anxiety and negative attitude towards computers than males do (Brosnan and Davidson, 1994; Maurer, 1994;Whitely, 1997). Recent researches has identified and highlighted psychological gender as the salient factor determining computer anxiety and attitude, irrespective of biological sex (Brosnan, 1996; Colley, et.al., 1994). Gender differences were found in respect of computing at school, a greater work orientation and liking for e-mail apparent in girls' while boys showed a greater affinity with computer games and mentioned limitations upon their access to machine more (Colley, 2003). Another study by Yelland & Lloyd (2001) found gender difference in the sense that boys obtain greater experience with computers by playing computer games than girls. Singh (2001) interviewed women who use the internet and found that they regarded it as a tool rather than as a technology for play or mastery. Herrmann, et. al (1992) studied the gender-linked differences in everyday memory performance. They found Meta-memory rating indicating differences in the success at performing memory tasks while influence of changes in memory tasks remained consistent with gender stereotypes. As feminist psychologists have pointed out, demonstrations of differences in themselves are of little interest; since the number of possible differences is infinite, and a subject's sex frequently confounded with many other variables (Deaux, 1984; Unger, 1979; Unger & Crawford, 1992). Numerous reports have observed that computer usage causes occupational problems and discomfort to user's eyes (Granjean, 1980). Developments in information system design suggest that VDUs will continue to be used as a medium for presentation of large amount of connected text as observed in videotext, electronic journals, dynamic books and similar applications. In addition the recently emerging WAP (Wireless Application Protocol) based technological systems like lap-top etc are expected to be common place entity in the HCI (Human Computer Interaction) environments of tomorrow. Such systems are to be widely used by executives while moving to their offices so that the performance of end-users needs to be evaluated ergonomically in a mobile environment of HCI. Since such stresses affect human performance. Chronic health effects were also reported with WBV by many researchers e.g. (Milby and Spear, 1974). Long exposures to vibration were found to be responsible for back injuries and digestive and circulatory disorders. Since, because of different body structures, threshold of tolerance to vibration is different for males and females, it is important to investigate the effect of vibration on the ability of male and female operators, in performing different kinds of occupational and non-occupational tasks. Studying gender-effects becomes all the more important when it is observed that more and more women workers are entering the job arena not only in developed nations but also in developing countries like India and Malaysia. Form the literature reviewed it was observed that computer task related capabilities of the operators have not been studied in a major way under the impact of vibration Text/background color of display constitute one of the variable that has been found to be having detrimental effect on performance of user population specially for desktop and lap-top type computing system. Ling and Schaik (2002) investigated the effect of color on the presentation of information in a navigation bar, and aims to contribute towards design guidelines for the use of color on the web. They studied the effect of combination of text and background color on visual search performance and subjective preference. From the analysis, the result showed that higher contrast between text and background color led to faster searching and were rated more favorably. Color can also be an effective way of communication if chosen properly. Recently researcher in color combination has exposed that the text/background color combination had a significant effect on reading performance (Wang and Chen, 2003). The author investigated the effect of text/background color combinations which were white on black, black on white, blue on white, red on white, blue on yellow and green on white. The result of the analysis of variances showed that different color combination settings of display had a significant effect on reading performance. This paper had suggested higher color difference of text/background color combinations to maintain good reading performance. The critical factor in text/background color combination is luminance contrast between the text and background colors. Wang, et al (2002) also reported that subjects' searching performance on leading display was improving when the color difference of text/background become larger.

The pace of research in the field of transportation vibration exposure specifically in computer related task has been rather slow in comparison to the growth rate of wide spread use of four wheelers. Present study was designed to explore.

2. METHOD

2.1 Subjects

One of the important requirements of performing the experiment was the selection of appropriate type of subjects.14 Subjects (7 male and 7 females) participated in this study. Mean height, weight and the age of subjects who participated in different experimental investigations undertaken in the present work were within small range. All the subjects had normal vision either with or without glasses. The subjects chosen had almost same educational qualification. The subjects selected were having almost same working experience of VDUs. None had any previous history of neuromuscular disorders. All the experiment sessions were conducted between 0900 hours and 1300 hours, so as to have no temporal effects on experimental results.

2.2 Stimuli and experimental task.

Subjects were presented the stimuli in the form of a text displayed on the screen of lap-top. It was written in English language and spacing between lines was 1mm. The characters per screen of text were arranged in 25 lines. Three text of required length were presented to subjects for readability task to avoid any learning effect included in the experiment. Subjects were instructed to scroll through the stimuli by clicking the down arrow button on the scroll bar as they read. Subject were required to sit on the vehicle seat (without back rest) with the two hands on the keyboard (as was observed to be the practice of the end-users) while working on VDU[5]. They were required to respond to the voice – signal START by starting the reading task taking care of both speed & accuracy as per instruction. Each subject participated in two different experimental sessions: one involving zero level vibration and the other associated with the vibration level of 1.1056 m/s^2. Human performance was measured in terms of the number of characters read per minute when the task was carried out by the subjects. Also the text/background color of lap-top was changed according to the experimental requirement. Three combinations of the T/B colors were explored in the present study. (T/B1, (T/B)2 and (T/B)3. Black character on white background, White character on black background and black character on pink background.

2.3 General Experimental Procedure

Digital lap-top Compaq: Armada (1500 model) was employed in all the experiments. The sensor of the vibration level meter was kept at a specially designed platform which did not affect the impact of vibration and the display was kept in front of the experimenter to constantly monitor the level of vibration.

The mean value of the angle between eye-sight level and the centre of the screen of the lap-top for all the subjects remained at approximately 15^0 (SD = $\pm 3.16^0$). The temperature of the vehicle was maintained at approximately 26ã degree Celsius. While performing the experimental task the level of vibration in the driving environment was kept at pre-specified value by constantly monitoring the level of vibration in the x, y and z directions and running the vehicle at the desired speed. As far as zero level vibration condition was concerned, the readability performance was measured before running the test vehicle. Before performing the readability task experiment in the mobile environment the subject sat in the test vehicle at a prespecified level of vibration for a period of 60 minute and then the subjects started reading task experiment. Each subject performed the readability task for 15 minute duration and with a rest period of 5 minute repeated the readability task for two more periods thus approximately consuming one hour to complete the readability task per subject. Human performance in terms of characters read per unit time was recorded at approximately the same time of the day on each day of experiment. This has been kept in view in order to eliminate any temporal effect in experimentation that might have had its impact on the subjects' performance.

2.4 Measurement of vibration

A tri-axial accelerometer from Bruel & Kjaer Deltatron (Type 4504) was mounted on the test vehicle seat to register the vibration level. The measuring range for the above accelerometer is 5 m/s^2 to 7500m/s^2. The frequency range in which this instrument can work is 1 to 1000 Hz. In this instrument simultaneous 3-channel measurement in X, Y and Z direction can be made. The vibration levels were measured with respect to the standard biodynamic coordinate system according to ISO 2631-1 (1997). The vibration level meter was calibrated in X, Y and Z direction prior to measurement. To check the suitability of the basic evaluation method, the crest factor was calculated for X, Y and Z directions. According to ISO 2631-1 (1997), the crest factor is defined as the modulus of the ratio of the maximum instantaneous peak value of the frequency weighted acceleration signal to its rms value. The peak shall be determined over the duration of measurement. The crest factor values for X, Y and Z directions obtained were within the limit prescribed by ISO 2631-1 (1997). As per ISO 2631-1 (1997) recommendations, for vibration with crest factors below or equivalent to 9, the basic evaluation method is normally sufficient. The accelerometer is connected to Whole Body Vibration front end (Bruel & Kjaer Type 2693) and this is connected to modular sound level meter which in this case is used for data collection and display (Bruel & Kjaer Type 2260) and later downloaded to a personal computer for further analysis. Total equivalent vibration was calculated as per the recommendations of ISO 2631-1 (1997). Equivalent vibration level means the power average of the amount of vibration measured in a specific period of time and has been derived from the equivalent noise level of the sound level meter.

Total equivalent vibration = $[(1.4a_{wx})^2 + (1.4a_{wy})^2 + (a_{wz})^2]^{1/2}$

Where a_{wx} , a_{wy} and a_{wz} are the weighted rms acceleration values in the X, Y and Z direction and the factor 1.4 is the ratio of the longitudinal to the transverse acceleration limits for the frequency range in which humans are sensitive.

2.5 Experimental Design

A 2 (gender level) X 2 (levels of vibration) X 3 (text/background color) factorial design with repeated measures on the last two factors was employed for the analysis of variance (ANOVA). All the tests were conducted at the significance level of 0.05

3. RESULT

3.1 Analysis of variance

Mean value of the number of characters read per minute (NCRPM) for both males and females under different conditions of testing were obtained. The data collected were analyzed through 3–factor repeated measures kind of the analysis of variance (ANOVA). Results of the ANOVA summarized in Table 1 implied that the gender effect was statistically non-significant ($F<1$, NS). This indicated that the performance on readability task, expressed in terms of number of characters read per minute was independent of the gender of the operator. The gender factor significantly interacted with the variable vibration ($F (1,12) = 4.75$; $p<0.05$) and so was case with the variable text/background color ($F (2,24) = 3.40$; $p<0.05$). However, the second order interaction i.e. gender X vibration X text/background color was found to be statistically non significant ($F<1$; NS). Further the results indicated that levels of vibration also significantly affected human performance in terms of number of characters read per minute in the HCI environment. The factor vibration also significantly interacted ($F(2,24) = 3.40$; $p<0.05$) with the factor text/background color when operators performed the experimental task. Since all the variables investigated were found to be statistically significant except one it necessitated further analysis of the data to establish which means statistically differed from each other. Accordingly simple main effects analysis was carried to determine statistical significance of various factors. The details of the analysis are presented Tabble-2 & 3..

Table 1 : Summary of the analysis of variance (ANOVA) pertaining to the studies on gender effects when operators performed the readability task under varying levels of vibration at different text/background color of the lap-top.

Sources of Variation	SS	Df	MS	F
Between Subjects	3241344.00	13	249334.16	
A (Gender)	163212.76	1	163212.76	0.94
Subject within groups (Error 1)	3078132.00	12	173213.50	
With the Subjects	559832.00	70	7997	
B (Vibration)	311954.31	1	311954.31	66.47**
A X B	22507.45	1	22507.45	4.80**
B X Subjects within group (Error 2)	56314.26	12	4692.85	
C (Text/background color)	18878.00	2	9439.00	3.79**
A X C	46326.00	2	23163.00	9.30**
C X Subjects within group (Error 3)	59802.02	24	2491.75	
B X C	11929.69	2	5964.84	4.80**
A X B X C	2290.31	2	1145.16	0.92
B X C X Subjects within group (Error 4)	31656.10	24	1319.00	

**P<0.05

Table 2. Summary of the ANOVA of simple main effects when male and female operators performed the readability task under the impact of varying levels of vibration.

Sources of Variation	SS	Df	MS	F
A (Gender) at :				
B1 (zero level of vibration)	430869.46	1	430869.46	1.42

B2 (at 1.1056 m/s^2 level of vibration)	754420.02	1	754420.02	24.4**
Within treatment (Error)	2224508.6	72	30895.95	
B (vibration) at :				
A1 (Male)	83437.71	1	83437.71	2.70
A2 (Female)	251024.02	1	251024.02	8.12**
Within treatment (Error)	2224508.6	72	30895.95	

** $p<0.05$

Table 3. Summary of the ANOVA of simple main effects when male and female operators performed the readability task under the impact of varying levels of text/background color combination of lap-top.

Sources of Variation	SS	Df	MS	F
A (Gender) at :				
(T/B)1	414315.57	1	414315.57	13.41**
(T/B)2	212454.32	1	212454.32	6.88**
(T/B)3	582337.29	1	582337.29	18.85**
Within treatment (Error)	2224508.6	72	30895.95	
(Text/background) color				
A1 (Male)	62169.191	1	62169.191	2.01
A2 (Female)	3.34.714	1	3.34.714	0.98
Within treatment (Error)	2224508.6	72	30895.95	

DISCUSSION

From the result it was observed that males and females statistically did not differ significantly in their performance while carrying out readability task under the influence of vibration and text/background color combination of lap-top. The finding gets support from many researchers. Fairweather and Hult (1972) had reported that adult males and females performed equally well in choice reaction types of tasks. Muzammil (2004) found gender independent performance while investigating cognitive performance under the impact of vibration in a driving environment. Papastergiou and Solomonidou (2005) concluded on the basis of their study that internet activities, such as communication via e-mail, chat or videoconferencing, Web surfing and information search for personal or school purposes, are independent of the gender effect. In the same study Papastergiou and Solomonidou (2005) concluded that boys use the Internet for entertainment and Web pages creation more than girls do. Colley (2003) demonstrated gender differences in approaching the technology. Boys approach to computers for play and mastery while girls approach computers as tools for accomplishing tasks. Hermann et.al. (1992) found that in case of memory task female were found significantly superior than male counter part while learning directions to go to a particular location was marked by better performance by males. As it is evident that the process of readability task requires viewing and then reacting to reproduce the same in terms of words. As memorizing capability is better in female and locating a particular thing is better in male this might have led to an absence of gender related differences in human performance so far as the data entry task is concerned. While males were faster in movement time (Landauer, et. al., 1980) females were found to be superior to males in their cognitive performance (Carlson, 1990). The difference in decision time and movement time of the choice reaction time can expected to nullify each other in the two cases of males and females.

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