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The Effect of Visual Display Unit (VDU) Near Task Under Two Different Surrounding Lightings on Accommodation Facility

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ABSTRACT

The purpose of the study was to compare the accommodation facility after electronic visual display usage was used under two different surrounding lightings: one with and the other without room light. Accommodation facility is the capability of the eyes to respond and focus on visual stimuli at various distances, and could be measured clinically. Twenty young subjects participated in this study where the subjects were assigned to read binocularly from electronic visual display unit (VDU) for one hour under 2 different surrounding lighting conditions (with and without room light) at random sequence. Binocular accommodation facility was measured via standard clinical vision examination protocol using a ±2.00 DS lens flipper with 6/9 near visual acuity target. Friedman test showed no significant changes in binocular accommodation facility, [χ^2 (2) =5.772, p=0.06]. The difference in accommodation facility after one-hour VDU near task between the absence and presence of surrounding room light was negligible. Future studies should investigate the temporal aspects of the accommodation process during VDU task to understand the accommodation related VDU symptoms especially under low lighting.

Keywords: *Visual Display Unit (VDU), lighting, accommodation facility.*

INTRODUCTION

Poor quality of lighting was associated with various vision symptoms and discomforts such as headache, fatigue, eye/strain and poor performance (Veitch & Newsham, 1998). These vision related-problems could affect the quality of life. As vision is an important aspect of daily life, modification on anterior built environment was made to improve visual comfort by innovating anterior design for residential needs (Frascarolo, Martorelli, & Vitale, 2014). As visual comfort was the result of visual interaction, it could also be influenced by human factors such as mood, preferences judgment and also light. With proper lighting, soft combination of contrasts and light was mostly preferred in ensuring high visual comfort for the users (Shen, Hu & Patel, 2014).

The quality of the retinal image especially during near task could be reduced due to the decreased illumination, contrast and spatial stimulus-free condition (Rosenfield *et al.*, 1994). Near task involved the stimulation of accommodation. During near task, the eye changed focus from distance target to a near object, by means of accommodation, altering the location of the retinal image point to optically conjugate with the retina as a result of contraction in the ciliary muscle. Thus, accommodation facilitated near task such as reading.

Under very low surrounding illumination, reading performance became significantly reduced due to difficulty in focussing (Chang, Chou & Shieh, 2013). Inadequate lighting conditions for long-duration of reading tasks using electronic visual display (VDU) was reported to hamper the near reading speed. This indicated that lighting affected the ability to do various near tasks including visual display unit (VDU) task. Prolonged near task could induce accommodative hysteresis and delay the ability of crystalline lens to change its dioptric power rapidly (Ebenholrz, 1983). This ability was known as accommodation facility, which referred to the capability of the eyes to respond and focus on visual stimuli at various distances and in different sequences in a given period of time (Pandian *et al.*, 2006).

There was a reduction in accommodation response up to 1.0 DS after conducting VDU tasks compared to only up to 0.25 DS reduction after the non-VDU task (Gur & Ron, 1992). Amplitude of accommodation was reduced to about 0.69 DS among VDU users compared to 0.18 DS reduction among non-VDU users (Gur, Ron & Heicklen-Klein, 1994). VDU near

tasks posed a higher demand to accommodation and convergence in relation to non-VDU near tasks. Significant myopic shifts were prominent after continuous VDU near-task compared to non-VDU task even among children (Teoh, Chen & Mohidin, 2012). VDU users might be more susceptible to vision related problems when working under insufficient lighting work environment. At lower lighting, the visual search time on electronic display became longer, indicating surrounding lighting was important to ensure visual performance (Shen *et al.*, 2009). VDU user also displayed difficulty to change focus to the distance due to the problem in accommodation (Sheedy & Parsons, 1990). This study aimed to compare the effects of one hour of VDU tasks with and without room light on accommodation facility.

METHODS

Two surrounding lighting conditions were used in this study; with and without room light. As for with room light, the light source was from normal fluorescent light of the experimental room, which was ceiling-mounted. The light was switched off during the without room light condition. Thus for without room light, the only source of light is from the VDU itself. In addition, the study was conducted in a dark experimental room with no lighting coming through from the window and corridor to ensure that the surrounding lighting exposure was controlled properly. The room itself was located in a confined area without any windows, the only opening being the door was sealed completely during the experiment. Using T-10A luxmeter (Konica Minolta, Japan), the illumination under room light was verified to be 700 lux, while without room light was below 10 lux. Both surrounding lighting conditions were exposed at random sequence.

Laptop (Compaq HP 6730s) was used as VDU with the brightness standardized through the computer setting at 100% and display resolution of 1280 x 800. The contrast of the VDU was standardized at 50% contrast for all surrounding lighting conditions. The VDU was positioned at natural near position of 40 cm to 50 cm from the eye.

All twenty young subjects had the best distance visual acuity of 6/6, near visual acuity of N5 and stereopsis of 40" or better with Butterfly stereo acuity test. Subject with any known history of ocular disease or binocular vision problem was excluded. Ethical approval from Universiti Teknologi MARA and written consent was obtained prior to the study in ensuring adherence to the Helsinki declaration.

The VDU task consisted of reading on VDU for one continuous hour binocularly while wearing refractive correction. Binocular accommodation facility was measured before and after VDU near task. Binocular accommodation facility was taken via standard clinical protocol under bright room illumination of 700 lux. This was measured with T-10A luxmeter (Konica Minolta, Japan), using ±2.00 DS lens flipper using 6/9 near visual acuity card as the fixation target. The +2.00 DS was introduced prior to the -2.00 lens. Accommodation facility was determined by the amount of cycles that the subjects could clear the fixation target through the alteration of ±2.00 DS in 60 seconds. One cycle was indicated when the subjects could complete a rotation to clear the near fixation target once the +2.00 DS was firstly introduced, then clear the target with -2.00 DS and back to clear the target with the +2.00 lens again. To ensure valid measurement of accommodation facility, the following VDU task was assigned after a wash out period of 10 minutes to eliminate fatigue effects on accommodation.

RESULTS

Based on Shapiro-Wilk normality test, the data were not normally distributed ($p<0.05$,). Friedman nonparametric test were used to compare the independent variables of accommodation facility which were the pre-task measure, post-task surrounding room light measure and post-task no room light measure. The median (IQR) of binocular accommodation facility for pre-task, post-task room light and post-task no room light were 11.00 cpm (±2.00), 11.00 cpm (±1.75) and 10.50 cpm (±1.00) respectively, as illustrated in Figure 1.

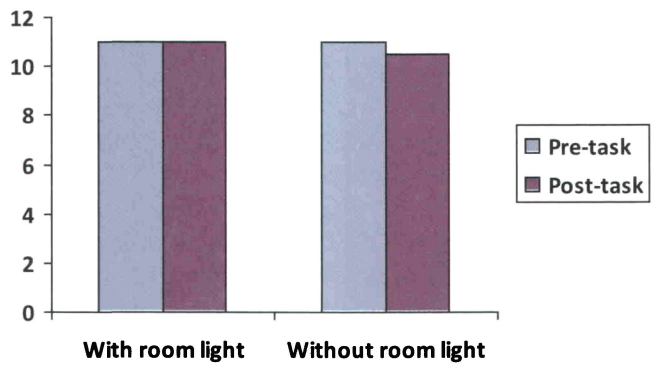

Figure 1: The difference in median of binocular accommodation facility for pre- and post-task under with and without surrounding room light.

The Friedman test showed no significant change in binocular accommodation facility after the VDU tasks under the two surrounding lighting conditions [χ^2 (2) =5.772, p=0.06]. There was no significant difference in binocular accommodation facility after VDU task with and without room light, [Z= -1.062, p=0.288] and [Z= -1.517, p=0.129] respectively based on Wilcoxon Signed Rank post-hoc test.

DISCUSSION AND CONCLUSION

This study showed that binocular accommodation facility showed only slight change between pre- and post-task between with and without surrounding illumination. However, there was no significant difference in binocular accommodation facility after one hour VDU task with and without surrounding room light. Previous studies found that the dark and bright illumination conditions affected the vision system differently. Under total dark conditions, there was a lack of stimulus and the stimulus-free condition reduced accommodation response compared to normal lighting viewing condition (Rosenfield *et al.*, 1994). The accommodation response moved towards the tonic position as the stimulus to accommodation was reduced. Thus, the quality of the visual target image was decreased due to the reduced illumination, decreased contrast and spatial frequency content or in the absence of visual stimuli (Fisher, 1997).

Nevertheless, our study showed no statistical difference after VDU task with and without surrounding room light, suggesting that one hour was a short duration which was insufficient to cause reduction in accommodation facility. The visual change after VDU task was most probably noticed as a symptom first, followed by problem in accommodation facility afterwards.

Under binocular viewing, accommodation status had strong interaction with a vergence system (Schachar, 2006). Binocular interaction might enhance the capabilities of the eye to quickly regain retinal image clarity during relaxation and stimulation of accommodation under dark and bright conditions. As the target image was alternately blurred using plus and minus lens, the eye repeatedly relaxed and accommodated (Rosenfield & Cohen, 1996), and at the same time both eyes diverged and converged accordingly. With the support of vergence system, different surrounding illuminations might not affect accommodation facility binocularly. It was

suggested that a variety of binocular cues were used to guide the dynamic accommodation responses (Seidel, Gray & Heron, 2005). Furthermore, the near VDU task was different from normal reading with books or any printed reading material (Iribarren, Fornaciari & Hung, 2001). Factors such as the type of font use, the brightness and the reading task with the VDU could contribute to the unchanged binocular accommodation facility even there was no surrounding illumination.

Nevertheless, VDU task was associated with various visual problem such as asthenopia, visual discomfort, reduced near focusing and blurred vision (Gur & Ron, 1992; Gur, Ron & Heicklen-Klein, 1994; Teoh, Chen & Mohidin, 2012). Proper care should be given while working on VDU task to ensure minimal visual related problems especially under low lighting condition. As our study indicated that the difference in accommodation facility after VDU task under the presence and absence of surrounding room light is negligible, accommodation facility might not be adequate to relate with vision symptoms of VDU task. Future study should investigate on the actual accommodation process during the VDU task. Furthermore, near task was associated with a dynamic accommodation microfluctuation due to the exposure to target vergence demand (Day *et al.*, 2006). Therefore, the temporal aspect of accommodation during VDU might explain the occurrence of related VDU symptoms.

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REFERENCES

Veitch, J.A. and Newsham G.R. (1998). Lighting quality and energy-efficiency effects on task performance, mood, health, satisfaction, and comfort. *Journal of the Illuminating Engineering Society*, *27*(1), 107–129.

Frascarolo, M., Martorelli, S. and Vitale, V. (2014). An innovative lighting system for residential application that optimizes visual comfort and conserves energy for different user needs. *Energy and Buildings*, *83*, 217–224.

Shen, E., Hu, J. and Patel, M. (2014). Energy and visual comfort analysis of lighting and daylight control strategies. *Building and Environment*, *78*, 155–170.

Rosenfield, M., Ciuffreda, K. J., Hung, G. K. and Gilmartin, B. (1994). Tonic accommodation: a review. Ii. Accommodative adaptation and clinical aspects. *Ophthal. Physiol. Opt, 14*(3), 265–77.

Chang, P.C., Chou, S.Y. and Shieh, K.K. (2013). Reading performance and visual fatigue when using electronic paper displays in long-duration reading tasks under various lighting conditions. *Displays*, *34*(3), 208–2014.

Ebenholrz, S.M. (1983). Reports accommodative hysteresis: a precursor for induced myopia. *Investigative Ophthalmology & Visual Science*, *48*(6), 513–515.

Pandian, A., Sankaridurg, P.R., Naduvilath, T., O' Leary, T.D., Sweeney, D.F., Rose, K. and Mitchell, P. (2006). Accommodative facility in eyes with and without myopia. *Investigative Ophthalmology & Visual Science*, *47*(11), 4725–31.

Gur, S. and Ron, S. (1992) Does work with visual display units impair visual activities after work? *Documenta Ophthalmologica*, *79*(3), 253–259.

Gur, S., Ron, S. and Heicklen-Klein, A. (1994). Objective evaluation of visual fatigue in VDU workers. *Occupational Medicine*. *44*(4), 201–204.

Teoh, S.C., Chen, A.H. and Mohidin, N. (2012). The effect of sustained VDU and non-VDU near-work on visual acuity and refractive error in emmetropic and low-hyperopic primary school children. *Scandinavian Journal of Optometry and Visual Science, 2*(1), 22–27.

Shen, I.H., Shieh, K.K., Chao, C.Y. and Lee, D.S. (2009). Lighting, font style, and polarity on visual performance and visual fatigue with electronic paper displays. *Displays*, *30*, 53–58.

Sheedy, J.E. and Parsons, S.D. (1990). The visual display terminal eye clinic: Clinical report. *Optom Vis Sci*, *67*:622-6.

Fisher, K. (1997). Accommodative hysteresis under static and dynamic stimulus conditions. *Clinical and Experimental Optometry*, *80*(4), 139–144.

Schachar, R.A. (2006). The mechanism of accommodation and presbyopia. *International Ophthalmology Clinics*, *46*(3): 39–61.

Rosenfield, M. and Cohen, A.S. (1996). Repeatability of clinical measurements of the amplitude of accommodation. *Ophthal. Physiol. Opt.*, *16*(3): 247–249.

Seidel, D., Gray, L.S. and Heron, G. (2005). The effect of monocular and binocular viewing on the accommodation response to real targets in emmetropia and myopia. *Optom Vis Sci, 82*(4), 279–285.

Iribarren, R., Fornaciari, A. and Hung, G.K. (2001). Effect of cumulative nearwork on accommodative facility and asthenopia. *International ophthalmology*, *24*(4), 205–12.

Day, M., Strang, N.C., Seidel, D., Gray, L.S., and Mallen, E.H., (2006). Refractive group differences in accommodation microfluctuations with changing accommodation stimulus. *Ophthal. Physiol. Opt*, *26*(1), 88–96.