Available Online at www.e-iph.co.uk
Indexed in Clarivate Analytics WoS, and ScienceOPEN

E-B
Environment - Behaviour
Proceedings Journal

CSSR 2018

https://cssr.uitm.edu.my/2018/
5th International Conference on Science and Social Research
Le Meridien Kota Kinabalu Hotel, 5 – 6 December 2018

e-IPH
e-International
Publishing House Ltd.,
United Kingdom

Accommodation Rock after Visual Display Unit (VDU) Activity under Two Different Ambient Lightings

Azmir Ahmad [1], Ai-Hong Chen [1], Nurulain Muhamad [2]

[1] Optometry & Vision Science Research Center (iROViS), Health and Wellbeing Community of Research (HW CoRe), Institute of Research Management & Innovation (IRMI), Universiti Teknologi MARA (UiTM) Cawangan Selangor, Malaysia
[2] Optometry Programme, Faculty of Health Sciences, Universiti Teknologi MARA (UiTM) Puncak Alam, Selangor, Malaysia

azmir5807@uitm.edu.my, aihong0707@yahoo.com, aein_muhamad@yahoo.com
Telr: +60123250630

Abstract
Dynamic accommodation under natural viewings, such as driving, could be affected by the lighting condition. This study aimed to investigate the accommodation rock after the visual display unit (VDU) activity with and without ambient lighting. It was measured in cycle minute (cpm) with Hart Chart before and after each lighting condition's VDU activity. The VDU activity involved a one-hour visual task in 30 young adults. There was significant different [$\chi^2(3) = 23.42$, $p<0.001$, Friedman test] in accommodative rock with VDU activity under different lightings. Low lighting lowered the rapid change of accommodation at different distances under natural viewing.

Keywords: Visual display unit (VDU); lighting; accommodation rock; natural viewing

DOI: https://doi.org/10.21834/ebpj.v5iSI3.2568

1.0 Introduction

In various daily activities such as driving, schooling, and even walking, the eyes needed an excellent visual ability to change fixation at multiple distances. This visual ability of dynamic accommodation was known as the accommodation facility. Accommodation facility was how fast to achieve clear vision when changing fixation demand (Jafarzadehpur et al., 2007). Furthermore, sustained focus, especially at near, led to an increment of tonic accommodation whereas, sustained focus at far led to a decrement of tonic accommodation (Ebenholrz, 1983). However, the accommodation facility which used lens flipper involved the minification and magnification effects on the subjects (Kędzi et al., 1999). Thus, another approach to represent dynamic accommodation was accommodation rock.

Accommodation rock utilized accommodative rock cards or Hart Chart to stimulate the accommodation system under more natural viewing conditions (Vasudevan et al., 2009). There were two parameters in accommodation rock, which were accommodation facility and saccadic eye movement. These two parameters were very much correlated. These parameters helped the visual system to change fixation very quickly and see a new fixation point promptly. As the two parameters played an essential role in visual efficacy, vision training on accommodation rock normally used Hart Chart, especially among athletes (Griffiths, 2002; Charman, 2008). A good athlete with an excellent ability of accommodation facility and saccadic movement may have an advantage in the ability to quickly clear the vision in different distances naturally (Jafarzadehpur et al., 2007).

eISSN: 2398-4287© 2020. The Authors. Published for AMER ABRA cE-Bsby e-International Publishing House, Ltd., UK. This is an open access article under the CC BYNC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/). Peer–review under responsibility of AMER (Association of Malaysian Environment-Behaviour Researchers), ABRA (Association of Behavioural Researchers on Asians) and cE-Bs (Centre for Environment-Behaviour Studies), Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Malaysia.
DOI: https://doi.org/10.21834/ebpj.v5iSI3.2568

In accommodation rock, the eye was in an accommodative state when changing the fixation from far-to-near and in disaccommodative state when changing the fixation from near-to-far (Kasthurirangan & Glasser, 2005). The change in fixation involved the saccadic movement component. Saccadic movement indicated how fast the visual system could fixate on various targets at different locations (Jafarzadehpur et al., 2007). Thus, accommodation rock represented more natural binocular viewing than accommodation facility.

In terms of natural viewing, lighting was among the crucial elements in vision and played a significant role in human perception (Sivaji et al., 2013). Lighting also exerted non-visual effects on a broad range of biological functions and human alertness level (Cajochen, 2007). Most people would get a headache, fatigue, and eye strain when working in low- or poor-quality lighting (Collins, 1989). Using a suitable type of light would increase visual performance. Children showed better near acuity under a bright environment compared to low lighting (Navvab, 2001). Thus, proper lighting environment could provide optimum visual performance. Therefore, this study investigated the accommodation rock after the visual display unit (VDU) activity with and without ambient room lighting.

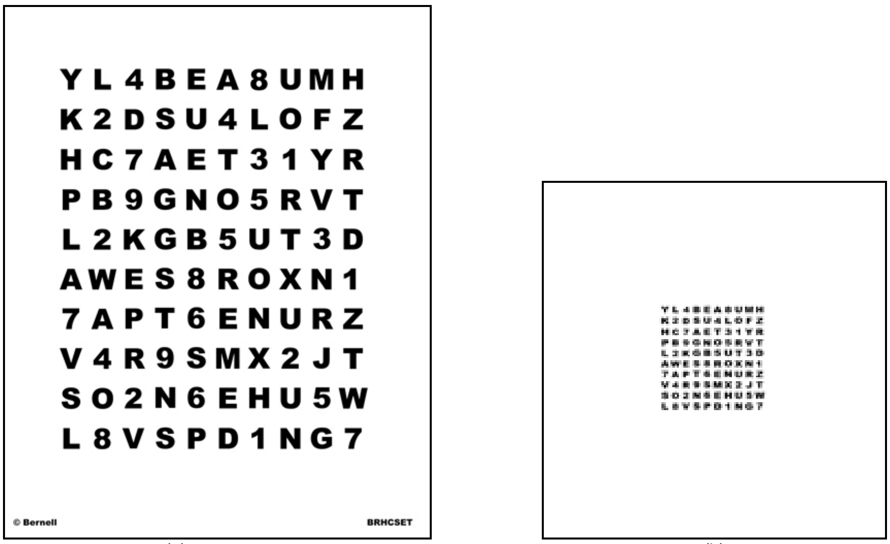
2.0 Methodology

The lighting setup and VDU activity were similar to the previous study (Ahmad et al., 2015). The VDU activity was done under two different ambient lights; with room light (approximately 700 lux) and without room light (below 10 lux, which relied only on the source of VDU light). Both ambient illumination levels were verified using the T-10A luxmeter (Konica Minolta, Japan). In between the lighting conditions, 30 minutes of break time was administered as a washout period for accommodation after effect.

The VDU activity involved visual reading tasks at a natural position from Compaq HP 6730s laptop (Hewlett Packard Compaq, Malaysia) for a one-hour duration. The subjects conducted reading activity at 40 cm to 50 cm from the VDU and regularly monitored every 15 minutes. The reading source was made up of black wording on a white background using N6 letters of Arial font type with 1.5 letter spacing and 2 inches margin and. The brightness of the computer screen was standardized at the highest brightness and resolution (1280 pixels X 800 pixels) with a 50% contrast for both ambient lighting conditions.

This study involved 30 young adults with the best distance corrected visual acuity of 6/6 and without any known history of ocular diseases and binocular vision problems. Ethical approval from Universiti Teknologi MARA and written consent from each of the subjects was obtained before the data collection.

Accommodation rock was measured by alternating the fixation between 6 m and 40 cm. Hart Chart (Bernell Corporation, USA) was used to measure accommodation rock (Hefner, 2006). The chart consisted of an 11-by-11-inch far distance card with font size 32 and a 3-by-3-inch near distance card with font size 6. Both cards contained similarly random letters arranged in columns and rows, as illustrated in Fig. 1 below. The subject read off letter starting in the upper left corner at the distance chart and then continued to the next letter in the top left corner of the near chart, alternately changing the fixation from distance to near and to the distance again continuality. A complete rotation to clear the distance fixation target, then clear the near target and back to clear the subsequent distance target showed that the subject could clear one cycle of accommodation rock. A cycle per minute (cpm) illustrated the number of cycles obtained in one minute. This study measured accommodation rock before and after each task condition (under typical room lighting).



(a) (b)

Fig. 1. (a) Hart Chart for far distance; (b) Hart Chart for near

3.0 Results and Discussion

Statistical analysis used non-parametric tests as the data were not normally distributed ($p<0.05$, Shapiro-Wilk). The median of binocular accommodation rock before and after 1-hour VDU activity with and without room light, was 26.5 cpm, 24.0 cpm, and 23.0 cpm, respectively, as shown in Fig. 2. There was a significant difference in binocular accommodation rock before and after 1-hour VDU activity under the two lighting conditions [χ^2 (3) = 23.42, $p < 0.001$, Friedman test]. Based on Wilcoxon Signed Rank post-hoc test, binocular accommodation rock after 1-hour of VDU activity without ambient room light showed significant difference (Z= -3.618, p <0.001), whereas accommodation rock after 1-hour of VDU activity with ambient room light had no significant difference (Z = -2.633, p > 0.001).

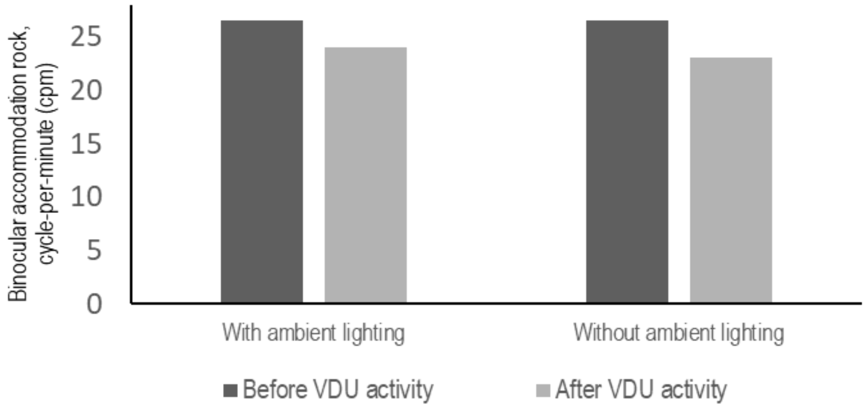


Fig. 2. The median of accommodation rock before and after 1-hour VDU activity under two different lightings

The present study demonstrated that the binocular accommodation rock was statistically different only after VDU activity without room light. The reduced binocular accommodation rock indicated that after conducting VDU activity with no ambient light, there was a reduction in eye's ability to focus quickly while changing fixation. The reduced binocular accommodation rock indicated that after conducting VDU activity with no ambient light, the ability of the eye to quickly focus while changing fixation reduced. This reduced ability could mean that extended time was needed for the accommodation to regenerate. Under dark conditions, there was a lack of stimuli to the vision and reduced accommodation response as compared to the bright lighting condition. With the absence of stimulus awareness under no ambient room lighting, the accommodation operated under open-loop conditions (Chen et al., 2003). Open-loop accommodation happened as the visual stimulus was too lacking, which led to continuous control-feedback in accommodation to obtain retinal-image clarity.

On the other hand, under bright ambient room lighting, the stimulus was sufficiently identified and elicited closed-loop conditions as the control-feedback could produce optimal retinal-image clarity. There were prolonged open-loop regressions under the dark condition than closed-loop regressions due to the pharmacological blockage of sympathetic stimulation (Gilmartin et al., 2002). The presence of blur feedback increased in closed-loop conditions, and it caused an increment in the accuracy of the accommodation response (Hazel et al., 2003). As the accommodation rock was taken in normal ambient room lighting right after the VDU activity in our study, the accommodation ability to different fixation targets after dark condition was still decreased. This suggested that there was a sustained open-loop accommodation after VDU activity without ambient room light under natural binocular viewing.

Following a period of sustained visual activity, especially near tasks, the accommodation shifted towards the myopic direction in which retinal defocus was introduced (Ebenholrz, 1983). A prolonged exposure to defocus could expand the depth of focus, which led to the occurrence of myopic defocus (Cufflin et al., 2007). As accommodation rock was to ensure rapid focusing of visual stimulus over the full range of distances under natural viewing, the ability to change focus based on blur feedback was gradual (Charman, 2008). Subjective sensitivity to blur in was influenced by the adaptation to defocus (Cufflin & Mallen, 2008). Thus, a continuous VDU activity without room light led to less accurate accommodation response and a more significant blur error signal. This low accuracy in accommodation response might eventually reduce the ability to change the focus at different distances even right after switching to the ambient room light.

4.0 Conclusion

Although the illuminating display factors such as brightness and contrast might enhance the accommodation response, the ability to change fixation after adaptation to different lighting conditions still could be affected. The affected ability might explain the daily scenario of which the eyes took time to focus on different distances under low lighting, including the visual activities conducted in the nighttime under insufficient illumination, such as driving on a dark road. In conclusion, this study indicated that dark adaptation during VDU activity lowered the capability to accommodate various ranges of fixation after adaptation; thus, required proper lighting conditions, especially when conducting VDU related tasks.

Acknowledgment

This study was financially supported through the Fundamental Research Grant Scheme (600-RMI/FRGS 5/3 (20/2015)) under the Ministry of Higher Education of Malaysia.

References

Ahmad, A, Chen, A. H., Ahmad A. R. (2015) The effect of the Visual Display Unit (VDU) near task under two different surrounding lights on accommodation facility. *Social and Management Research Journal*, 12 (2), 46-52.

Cajochen, C. (2007). Alerting effects of light. *Sleep Medicine Reviews*, 11(6), 453–464.DOI:10.1016/j.smrv.2007.07.009

Charman, W. N. (2008). The eye in focus: accommodation and presbyopia. *Clinical & Experimental Optometry*, 91(3), 207 – 225.

Chen, J. C., Schmid, K. L., & Brown, B. (2003). The autonomic control of accommodation and implications for human myopia development: a review. *Ophthalmic & Physiological Optics*, 23 (5), 401 - 422.

Collins, J. B. (1989). Fluorescent lighting, headaches, and eyestrain. *Lighting Research and Technology*.DOI:10.1177/0960327189021004 08

Cufflin, M. P., & Mallen, E. H. (2008). Dynamic Accommodation Response Following Adaptation to Defocus, *Optometry & Vision Science*, 85(10), 982-991.

Cufflin, M. P., Mankowska, A., & Mallen, E. A H. (2007). Effect of blur adaptation on blur sensitivity and discrimination in emmetropes and myopes. *Investigative Ophthalmology & Visual Science*, 48 (6), 2932 – 2939.

Ebenholrz S. M. (1983). Reports Accommodative Hysteresis: A Precursor for Induced Myopia., *Investigative Ophthalmology & Visual Science*, 48 (6), 513 – 515.

Gilmartin, B., Mallen, E. H., & Wolffsohn, J. S. (2002). Sympathetic control of accommodation: evidence for inter-subject variation. *Ophthalmic & Physiological Optics*, 22 (5), 366 - 371.

Griffith, G. (2002). Eye speed, motility, and athletic potential. *Age*, 34 – 37.

Hazel, C. A, Strang N. C., & Vera Diaz, F. A. (2003). Open-and closed-loop regressions compared in myopic and emmetropic subjects. *Ophthalmic & Physiological Optics*, 23 (3), 265 – 270.

Jafarzadehpur, E., Aazami, N., & Bolouri, B. (2007). Comparison of saccadic eye movements and facility of ocular accommodation in female volleyball players and non-players. *Scandinavian Journal of Medicine & Science in Sports*, 17 (2), 186 – 190.

Kasthurirangan, S., & Glasser, A. (2005). Characteristics of pupil responses during far-to-near and near-to-far accommodation. *Ophthalmic & Physiological Optics*, 25 (4), 328 – 339.

Kedzia, B., Pieczyrak, D., Tondel, G., (1999). Factors affecting the clinical testing of the accommodation facility. *Ophthalmic & Physiological Optics*, 15(19), 12-21.

Navvab, M. (2001). A comparison of visual performance under high and low color temperature fluorescent lamps. *J. Illuminating Engineering Soc*., 30(2), 170–175.

Sivaji, A., Shopian, S., Nor, Z. M., Chuan, N.-K., & Bahri, S. (2013). Lighting does Matter: Preliminary Assessment on Office Workers. *Procedia - Social and Behavioral Sciences*, 97, 638–647