Journal of Pre-Clinical and Clinical Research, 2010, Vol 4, No 2, 154-157
www.jpccr.eu

ORIGINAL ARTICLE

A single case study of eye activity during relaxation

Ross G. Cooper[1], Robert Ashford[1], Jason Cooper[2], Usama ALAlami[3]

[1] *Faculty of Health, Birmingham City University, Birmingham, UK*
[2] *Optometrist, Nuneaton, UK*
[3] *Department of Natural Sciences & Public Health, Zayed University, Dubai, UAE*

Abstract: Eye strain at work may occur when using computers. A protocol of motivational issues, the use of appropriate middleware and visual scenarios to respond to selected accurately measured stress levels was used. Relief of stress as a consequence of a number of factors including eye-strain was discussed. A NeXus-4 was used to determine physiological responses to viewing and partaking in various computer-displayed tasks in a healthy volunteer member of the authorship team who participated non-invasively in playing stress-relieving games: "Asteroids" and "Space Invaders" clones; Pzizz relaxing therapy (a. energizer, b. meditation, c. sleep); selected photographs of wildlife scenes set as a slide show; and a slide show of randomly selected photographs. The non-significant electro-oculogram (EOG) in all the relaxation tasks *vs.* baseline suggested that the participant's eye movements were unstrained and mostly focused on the computer screen. For complete eye rest, our study suggested that Pzizz (sleep) was the most effective method. Looking at random photos was effective at creating a break from work screen-staring. Games, particularly Space invaders, were useful relaxation tasks as they provided more blinking episodes, thus alleviating eye strain resulting from prolonged computer screen staring which tends to dry out the eyes.

Key words: electro-oculogram, eye, NeXus-4, pervasive computing, physiology, relaxation, strain, stress

INTRODUCTION

Physiological stress involves changes in plasma (cortisol, adreno-corticotropic hormone, glucose/insulin, fatty acids, cyclic adenosine monophosphate, renin, aldosterone and white blood cells), urine (creatinine, sodium and potassium) and organ functional processes (heart rate, blood pressure, core temperature and peripheral blood perfusion) as a group of holistic mechanisms that affect body function [1].

Stress is the single largest cause of occupational ill health in the UK, accounting for around half of all days lost to work-related ill health [2]. Stress potentially reduced the effectiveness of those workers who did not take sickness leave. Eye strain may be caused by prolonged use of computers. Eye diseases may result in damage to the macula densa resulting in severe loss of visual acuity, and optic atrophy. Behavioural sleepiness is systematically reflected in spectral electro-oculogram (EOG) parameters [3]. Eye strain may be a consequence of infection, trauma, dryness, smoke irritation, over-work, repeated changes in focusing, and lack of sleep. The question we asked is: what can a person do between work breaks on a computer screen to alleviate eye stress during and after work tasks?

A protocol incorporating motivational issues, the use of appropriate middleware and visual scenarios to respond to selected accurately measured stress levels was used, from which the most appropriate suggestions or countermeasures for the user to relieve their stress, as a consequence of numerous factors including eye-strain.

MATERIALS AND METHODS

NeXus-4 single case subject. A volunteer member of the authorship team participated non-invasively in the study. No ethical approval was needed because it was a single case on one volunteer of the authorship team. After a trial study (20 min.), the NeXus-4 was used to determine physiological responses to viewing and partaking in various computer-displayed clips, previously unknown to the participant, during a state of sedentariness, and associated changes over 1 hr., 9 min. and 38 sec. of blood perfusion and eye movements. The participant was a healthy male (36 yr.; 76 kg b.wt.; 1.91 m (6'6") ht.; 21 kg/m^2 BMI) ("healthy weight" based on Canadian Guidelines for Healthy Weights 1988); and perfect vision (6:6 visual acuity) (no contact lenses, implanted prostheses, nor spectacles). The participant smoked 5 cigarettes/day and was a teetotaller.

NeXus-4 experimental protocol A NeXus-4 Physiological Monitoring and Feedback System (Schepersweg, The Netherlands) Blue-toothed (Linksys USB Adaptor Class 1) with a Toshiba laptop operating with a Windows-XP environment was used to determine EOG changes during relaxation tasks. Disposable Snap Electrodes (Bio-logic Systems Corp, Crawley,

Corresponding author: Dr. Ross G. Cooper, Faculty of Health, Birmingham City University, Edgbaston, Birmingham B15 3TN, UK.
E-mail: ross.cooper@bcu.ac.uk or rgcooperuk@yahoo.com

Received: 7 October 2010; accepted: 30 November 2010

UK) were placed vertically directly above the pupil on the right forehead, 0.5 cm above the eyebrow (positive – red – electrode, sensor A), and below the eye on the upper right cheek, 1.0 cm below the eye and 1.5 cm lateral to the nose (negative – black – electrode, sensor B) (Figure 1), and earthed appropriately. The equipment captured via blue-tooth, the physiological data using BioTrace software of the eyeball movements.

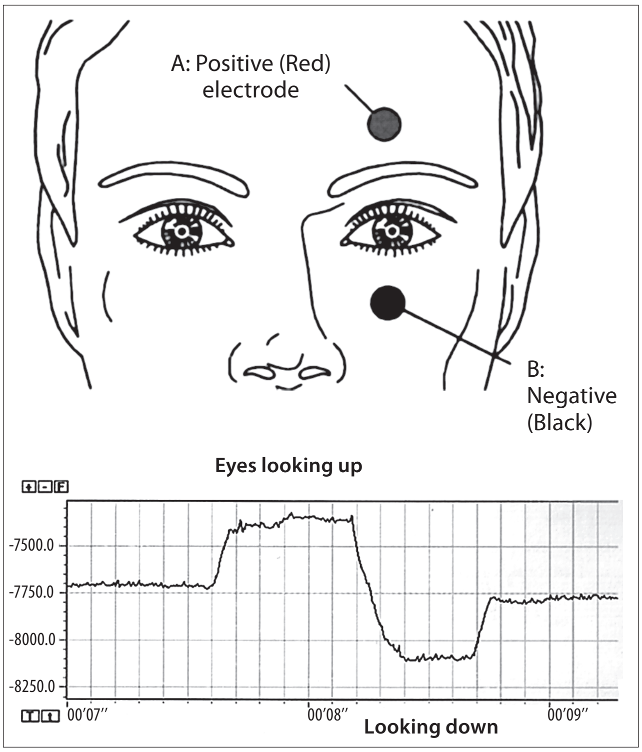

Figure 1 Position of two sensor electrodes and part of a NeXus-4 recording (Mind Media 2004/5 Manual, NeXus-4, p. 26).

A NX1-EXG2- Snap cable transmitted a DC signal (400 Hz) as the eyeball moved.. The EOG was measured horizontally (eyeball movements left to right) and vertically (eyeball movements up and down). Settings were between +200 and –200 μV *vs.* time (sec.). The sensor also recorded optical electro-encephalogram (EEG) signals. The sensors A and B dominant frequency and mean of sensor B were recorded.

A NeXus-4 BVP sensor was attached to the left finger to measure relative blood flow [BVP (general)]. Sensors A and B also measured BVP (eye). BVP was detected via an optical electronic system measuring infra-red light. During each heartbeat, blood flows through blood vessels and at maximal flow the BVP signal peaks. The height of the peaks (mV) indicates relative blood flow corresponding to the level of vasodilatation/vasoconstriction. The distance between the peaks can be used to calculate the absolute heart rate (HR). Limitations include: movement artefact and gravity.

The relaxation tasks involved the participant looking at an Acer AL1717 18" screen set to comfortable brightness/contrast, and included with permission (where appropriate from the publisher or originator): 1. and 2) playing stress relieving games: "Asteroids" and "Space Invaders" clones (Play.vg Copyright © Darren Hewer 2004); 3) Pzizz relaxing therapy (a. energizer, b. meditation, c. sleep) (© 2008 Pzizz Technology Limited); 4) selected photographs of wildlife scenes set as a slide show; and 5) a variety of randomly condensed photographs with images of interest set as a slide show. In order to eliminate bias, experiments were performed concurrently under separate categories commencing at 14:36 hr.

Simulated baseline (control) recordings were performed on the participant for 10 min. who was asked to stare at a blank wall, thus limiting eye movements (except for blinking). This was based on previous studies investigating stress and its impact on physiological parameters [4-9]. The experimental data was recorded in 5 successive slots of 10 min duration. Data was analyzed statistically using Microsoft Excel, using a Students' t-test, and a $p<0.05$ was considered significant. All tasks were analyzed by comparison with baseline values (Figure 1). Recordings were taken at a rate of 4.69/sec.

RESULTS

NeXus-4 analysis. The results obtained from the NeXus-4 were recorded and lotted (Figures 2, 3).

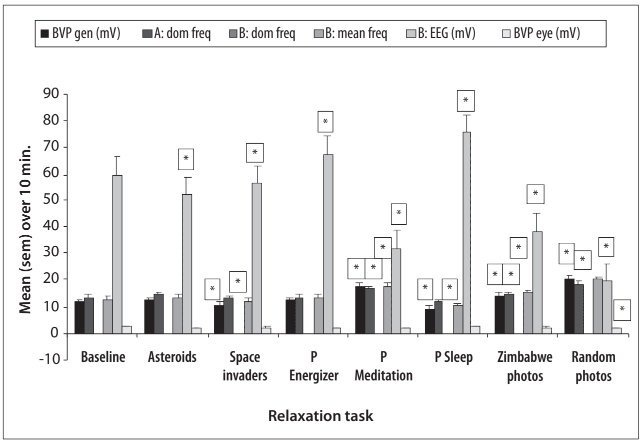

Figure 2 Mean ± sem of physiological responses during relaxation tasks of 10-min duration (*p<0.05 vs. baseline).

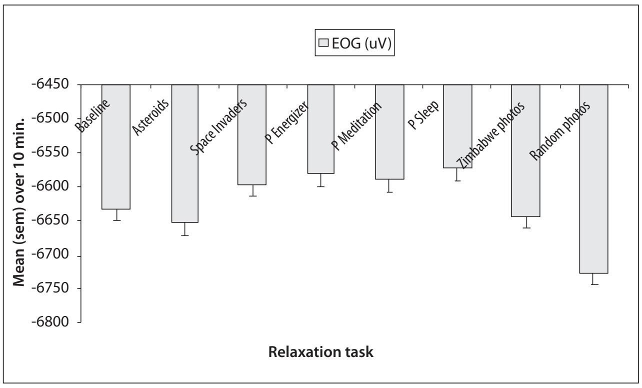

Figure 3 Mean ± sem of electro-oculogram (EOG) (μV) responses during relaxation tasks of 10-min duration (*p<0.05 vs. baseline).

There was no significant change in EOG between any relaxation task compared with the baseline (Figure 3). BVP (general) was significantly ($p<0.05$) attenuated in space invaders and Pzizz (sleep) episodes, but elevated in Pzizz (meditation) and the two sets of photographic slide shows (Figure 2). Measurements from sensor A (dominant frequency) were significantly ($p<0.05$) increased during Pzizz (meditation) and the random photos (Figure 2). For sensor

B, (dominant frequency) space invaders and wildlife photos responses were significantly ($p<0.05$) elevated (Figure 2). Sensor B (mean frequency) saw significant ($p<0.05$) elevations of Pzizz (meditation) and the two photo slide shows, and a reduction in Pzizz (sleep) (Figure 2). All EEG values were significantly ($p<0.05$) deviant from baseline values – decreased [Asteroids, Space invaders, Pzizz (meditation) and the two slide shows] and increased [Pzizz (energiser) and Pzizz (sleep)] (Figure 2). All values for BVP (eye) did not differ significantly from the baseline recording (Figure 2).

Direct observation of the participant and expression from the participant to the recorder revealed some insightful information. During the playing of Asteroids there were more blinking and eye movement episodes when a space ship sound was heard prior to it appearing on the screen, with intervals of irregular face scratching. More blinking and eye movement. was also observed when a space saucer flew across the top of the screen and when there were multitudes of missiles to avoid. There were more blinks when the first life was lost. During the Pzizz energizer there were a lot of blinks and eye movements during soothing speech, whereas during the meditation, eye movements were only recorded during the gongs. The fewest eye movements occurred during the sleep episode. During the wildlife photograph slide show, the images were recognised and associated with finger touching on the face, talking, and leaning forward on the chair. These activities were less noticeable during the random image slide show.

Limitations. As this is a single case study, more participants could be used in a larger study. Slight variations existed due to hand movement and posture. Movements occurred as a consequence of adjustment of posture due to comfort on the chair; neck adjustments especially during the games and when a life was lost; when the game became more difficult; responses to the appearance of sudden images, especially those associated with sound; fingers placed in the mouth; scratching the face; and slight hand movements during manipulation of the keyboard. The size of the laptop and the short battery life for the NeXus-4 Physiological monitoring systems were possibilities, where further work was carried out, for impediment of the current experimental design. It would be useful to have more than one recorder – one operating the laptop and the other observing the behavioural changes of the participant during each task.

DISCUSSION

NeXus-4 Physiological data. The non-significant EOG in all the relaxation tasks *vs.* baseline suggested that the participant's eye movements were unstrained and mostly focused on the computer screen. The slide show of random photos, however, did result in more episodes of looking down, suggesting a greater visual scanning of each image, some of which were recognised by the participant. The decrease in BVP (general) during the participation of Space invaders and Pzizz (sleep) suggested a more relaxed mode. Indeed, the participant said that he enjoyed playing Space invaders. The elevated BVP (general) during Pzizz (meditation) and the two photo slide shows suggested sympathetic responses to recognition and indeed, the participant moved numerous times in response to the appearance of photos. He described imagining the meditation scenes accurately, although this was not expressed in an altered EOG. There was no correlation between sensor detection in A and B (dominant frequency) outputs. The elevated recordings in sensor A (dominant frequency) for Pzizz (meditation) and the random photos was presumably associated with optical musculo-neurological responses resulting in a preponderance of lateral eye movements. The greater upwards eye movements [sensor B (dominant frequency)] for Space invaders and wildlife photos suggested a greater visual interaction throughout the session. Although the Pzizz (energizer, meditation and sleep) and the random photos recorded the eyes looking down more, mean values did not differ from baseline. The mean frequency of sensor B was highest in Pzizz (meditation) and the two slide shows, suggesting more complete and circular eye responses with combinations of numerous lateral and inferior movements, which dissipated during the Pzizz (sleep) exercise, suggesting the latter is better for eye rest. The EEG recordings clearly showed involvement of musculo-optical responses with Pzizz (energiser and sleep) showing greater responses, suggesting engaged limbic-cortical-visual brain pathways. A more detailed investigation of neurological pathways would be useful. It was reassuring to note that the eyes were not indirectly strained in any specific relaxation task by changes in blood pressure, as shown by the non-significantly altered BVP (eye) values.

For complete eye rest, our study suggested that Pzizz (sleep) was the most effective method. Looking at random photos was effective at creating a break from work and computer screen staring. Games, particularly Space invaders, were useful relaxation tasks as they provided more blinking episodes, thus alleviating eye strain resulting from prolonged computer screen staring which tended to dry out the eyes. The sem values throughout the study were very low and indicated strong reliability of results by sufficient recordings/sec. and accuracy of electrode sensors. This study provided a unique platform for the use of pervasive computing applications to alleviate work stress and assist eye strain. This suggested the important role that computing applications may play in supporting and enhancing health care delivery via alleviation of stress, e.g. during visually-stimulated breaks between work tasks. Using similar methodologies, there is potential to extend the investigations to other roles/professions in order to identify the activities associated with stress and eye strain.

REFERENCES

1. Cooper RG, Al-Muhtadi J, Ashford R: Smart spaces with real-time Physiological measurement and mitigation of stress. Proc. ICPCA08, vol. 1, 6-8 Oct. 2008, Alexandria, Egypt; 3-8.
2. http://www.hse.gov.uk (accessed on 13 February 2009).
3. Torsvall L, Akerstedt T: Extreme sleepiness: quantification of EOG and spectral EEG parameters. *Int J Neurosci* 1988, **38**(3-4), 435-441.
4. Cooper RG, ALAlami U, Jackson C, Stevens K, Jutla J, Khan S, Ashford R: Proposed-study – a trial and indicative health status determination of participants working in institutions of higher learning in Birmingham and the West Midlands using the NeXus-4 physiological monitoring system. Proc. ICPCA07, 26-27 July 2007, Birmingham, UK; 251-255.
5. ALAlami U, Cooper RG, Jackson C, Hu B, Ejtehadi H, Ashford RL: A preliminary study and proposed methodology: Utilisation of pervasive computing (NeXus-4) and questionnaires to determine selected physiological and psychological parameters in participants working at a Higher Education Institute in the UK. Proc. ICPCA08, 6-8 Oct. 2008a, Alexandria, Egypt, vol. 2; 768-771.

6. ALAlami U, Johnson P, Cooper RG, Ejetehadi H, Jackson C, Nelson P, Ashford RL: Multi Method Analysis of Stress Indicators during a Choral Performance: A case study. Proc. 4th Annual Res. Conf., 21 Nov. 2008b, Birmingham City University, Birmingham, UK; 10.
7. Cooper RG, ALAlami U, Jackson C, Stevens K, Jutla J, Khan S, Ashford R: Proposed study – a trial and indicative health status determination of participants working in institutions of higher learning in Birmingham and the West Midlands using the NeXus-4 physiological monitoring system. Proc. 3rd Annual Res. Conf., 23 Nov. 2007a, Birmingham City University, Birmingham, UK; 12.
8. Cooper RG, ALAlami U, Jackson C, Stevens K, Jutla J, Khan S, Ashford R: Proposed study – a trial and indicative health status determination of participants working in institutions of higher learning in Birmingham and the West Midlands using the NeXus-4 physiological monitoring system. Proc. ICPCA07, 26-27 July 2007b, UCE Birmingham, Birmingham, UK; 251-255.
9. Saha S, Gandhi A, Das S, Kaur P, Singh SH: Effect of noise stress on some cardiovascular parameters and audiovisual reaction time. *Indian J Physiology Pharmacol* 1996, **40**(1), 35-40.