# Associations between glare, eyestrain and neck and shoulder pain during reading on a computer screen

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## 1. Introduction

Computer work and musculoskeletal complaints in the neck and shoulder area are both common in today's working life [1]. Studies show that visually demanding computer work cause a significant increase in eye-related pain [2], that visual discomfort in computer work is related to pain in the neck and shoulder area [3], and that there is an association between sustained eye-lens accommodation at near and trapezius activity [4, 5]. The proposed relationship between eyestrain and discomfort in the neck and shoulder area indicates the need to also consider the visual conditions to prevent musculoskeletal symptoms in computer workers.

This study investigates how exposure to glare during reading on a computer screen affects the development of eyestrain and, neck- and shoulder pain. The study investigates associations between subjective symptoms, muscle load and muscle blood flow in m. orbicularis oculi and m. trapezius.

## 2. Methods

In this study 18 healthy, young subjects, age between 19 and 25 years, were included. The test subjects went through an optometric examination ahead of testing to exclude the possibility of eye problems to effect the test measurements. All testing were carried out at the same optimized computer work place. The assignment was to read a text on a computer screen. The test session was divided in two reading sessions; 30 minute reading with appropriate lightning and 30 minute reading with exposure to glare. The order of the test sessions was controlled and stratified to exclude the possibility for biased samples. Between the two reading sessions there was a 20 minutes break.

The glare source consisted of two large surface luminaries situated right behind the computer screen. This was to simulate a computer workplace with placement of a window in front of the person and to ensure symmetrical exposure of glare to both eyes. The luminance from the luminaries had a mean value of 4268 cd/m$^2$ (measured across the screen).

Muscle activity was continuously measured unilaterally from the upper part of the non-dominant m. trapezius, and from the orbital part of the left m. orbicularis oculi using electromyography (EMG) electrodes [2]. Each muscle had two active surface electrodes and one reference electrode attached. The skin was cleaned with alcohol and lightly abraded to reduce resistance before EMG electrodes were attached. The EMG signal from both muscles was normalized by performing calibration of the EMG response to force, using a calibration platform with a force transducer. The results were therefore given as

percent of the maximum voluntary contraction, MVC.

Muscle blood flow was measured unilaterally in the right m. orbicularis oculi and in the non-dominant m. trapezius using photopletysmography (PPG). PPG is a non-invasive measurement of local muscle perfusion where light from a light emitting diode (LED) is directed toward the skin and this light is absorbed and scattered in the tissue [6].

To control the test subjects sitting position throughout the test sessions inclinometers was used to measure postural angles [7] of the head, back and upper arm. Visual Analogue Scales [8] was used to register different subjective symptoms both before, during and after each test session.

Overall differences between groups was tested by comparing area under curve [9] with Wilcoxon signed-rank test. Wilcoxon signed-rank test was also used for comparing groups at different time points. A statistical difference was accepted at $P < 0.05$ (two-tailed). Statistical analyses was performed in IBM SPSS Statistics 21 (SPSS Inc., US).

## 3. Results

Preliminary results indicate that reading on a computer screen with exposure to glare compared to reading during optimal conditions, affect the computer worker by significantly increasing the muscle activity in m. orbicularis and the muscle blood flow in m. trapezius. The results also indicate a significantly increased incidence of pain and tiredness in and around the eyes, and photophobia. The incidence of pain in the shoulders and neck was also significantly increased in the rest period after the glare session, compared with the optimal session.

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