

THE IMPACT OF COMPUTER MOUSE WORK WITH DIFFERENT SIZE OBJECTS ON SUBJECTIVE PERCEPTION OF FATIGUE AND PERFORMANCE

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The present study investigated subjective perception of fatigue in the wrist, the elbow and the eyes, and performance during a standardized computer mouse task (painting rectangles) performed under three manipulated conditions. In the first and third condition the motor demand was considered the same, while the visual demand was different. In condition 2, the motor demand was considered more constrained. At condition 1 the rectangles were 45×25mm², while in the other conditions the rectangles were smaller. Performance was highest when rectangles were small and movement constraint was the highest. Subjective perception of fatigue over time did not differ between conditions.

Computer work, subjective fatigue, performance

Introduction

Due to computerization of industry and business, workers are often seated at visual display terminals/computers for the most part of the work day. The prevalence of neck and upper extremity complaints among computer users is high (Jensen 2003; Karlqvist *et al.* 1996; Wigaeus Tornqvist 2000) and the frequency of symptoms related to computer mouse work is increasing (Cook, 2000). Computer mouse work involves working in a seated and fixed posture, and light repetitive hand/wrist movements (Flodgren *et al.* 2007). Studies have shown that the exposure to these repetitive and stereotype movements, fixed postures and static load during computer work are related to upper extremity complaints (Jensen 2003; Tittiranonda *et al.* 1999). Plausible hypotheses for explaining the mechanisms underlying the development of symptoms have been put forth and the role of fatigue in the development of hand-arm symptoms was elaborated in a model formulated by Johansson *et al.* (Johansson 2003).

Anecdotically, people perceive that they get more fatigued when working with small compared to large objects on the computer screen. It is, however, not yet investigated where this fatigue comes from - the hand/wrist, the elbow, the shoulder or the eyes? In a recent study from our laboratory, Flodgren *et al.* (2007) assessed the wrist kinetics (range of motion, mean position, velocity and mean power frequency in radial/ulnar deviation, flexion/extension, and pronation/supination) during a mouse-operated computerized task adopted from the mouse-use model used by Aarås and Ro (1997) involving painting rectangles on a computer screen. Furthermore, they evaluated the effects of the painting task on subjective perception of fatigue. The results showed that the painting task required constrained wrist movements. In addition, the painting task induced a perception of muscle fatigue in the arm and hand. According to Flodgren *et al.* (2007) the mouse-use model can be considered representative of mouse usage in computer-aided design (CAD). The present study is an extension of the study

by Flodgren *et al.* (2007) intending to investigate the importance of object size and thus motor constraints. The aim was to investigate subjective perception of fatigue in the hand/wrist, the elbow and the eyes, and performance during a standardized computer mouse task performed under three manipulated conditions emphasizing object size and thus motor constraints. This study is part of a larger study, in which physiological data were also monitored intended to shed light on mechanisms behind computer related disorders.

Methods

Study design and subjects

Ten healthy and right-handed female university students (age 25-35 years) who reported no history of musculoskeletal complaints in the upper extremities and/or oculomotor problems at the time of the study participated in the study. Subjects were given verbal descriptions of the experimental protocol, and gave their informed and signed consent to participate in the study. The study was designed as a 3 x 3 crossover study. The subjects performed a 60-min mouse-operated computer task on three occasions and under three different conditions, separated by 5-10 days.

Mouse-use model

As described by Aarås and Ro (1997) and Flodgren *et al.* (2007), the task consisted of using a computer mouse to fill the inside of rectangles (Aarås and Ro used squares) with colour (i.e., painting). Subjects were seated in front of a computer at a 60 cm viewing distance in a standardized position with the arms supported. At each occasion the rectangles were presented, one at a time, at random locations on the screen. The allotted times for painting the particular rectangle were randomized between 15 s and 25 s and subjects scored 1 point for every rectangle that was filled up to at least 80% of its area.

The computer task was performed under three different conditions, in which the motor demand was considered the same for conditions 1 (C1) and 3 (C3), while the visual demand was different. In condition 2 (C2), the motor demand was considered more constrained. At C1 the size of the rectangles was $45 \times 25 \text{ mm}^2$, square print cursor size 6x6 pixels (corresponded to an area of 1.7 mm^2 on the screen) and cursor sensitivity 9 (mouse movements of 1 mm corresponded to 26 mm on the screen, which corresponds to normal). At C2 the same cursor size and sensitivity was used, but the rectangles were smaller, $15 \times 8 \text{ mm}^2$. At C3 the smaller rectangles were used, but the cursor size was 2x2 pixels (0.6 mm^2 on the screen) and sensitivity was 3 (1 mm corresponded to 8 mm).

Subjective perceptions of fatigue (Borg CR-scale) in the right shoulder, elbow, wrist/hand and eyes were obtained in the beginning, after 1.5, 21, 36, 51 and 60 minutes during the painting. Visual analogue scale (VAS) ratings of general tenseness were obtained at the same timepoints. Painting performances in terms of number of rectangles that were painted and total time outside the rectangles were measured.

Statistical analyses

For analyzing differences in ratings during the mouse painting task, repeated measures analyses with time and condition as within variables was used. For analyzing differences in performance paired samples t-test was used, i.e., C1 vs C2, C1 vs C3 and C2 vs C3.

Results

Subjective perception of fatigue increased in the

- shoulder from the first to the last rating (C1 from 0 to 2, C2 0-2, C3 0-1),
- elbow (C1 from 0 to 2, C2 0-2, C3 0-0.5),
- hand/wrist (C1 from 0 to 2, C2 0-3, C3 0-2) and in the
- eyes (C1 from 0.5 to 3, C2 0.5-5, C3 0.5-3).

General tenseness also increased (C1 from 1.4 to 17.9, C2 2.3-11.4, C3 2.2-12.6). However, the increase did not significantly differ between conditions. Figures 1-5 illustrate trends for subjective perception of fatigue and general tenseness.

Number of rectangles painted was highest in C2 when compared to the other two conditions (C1=231 vs C2=513, $p<0.001$, C1 231 vs C3=271, $p<0.065$, C2=513 vs C3=271, $p<0.001$). Time outside the rectangles did not significantly differ between conditions (C1=53, C2=48 and C3=55 s).

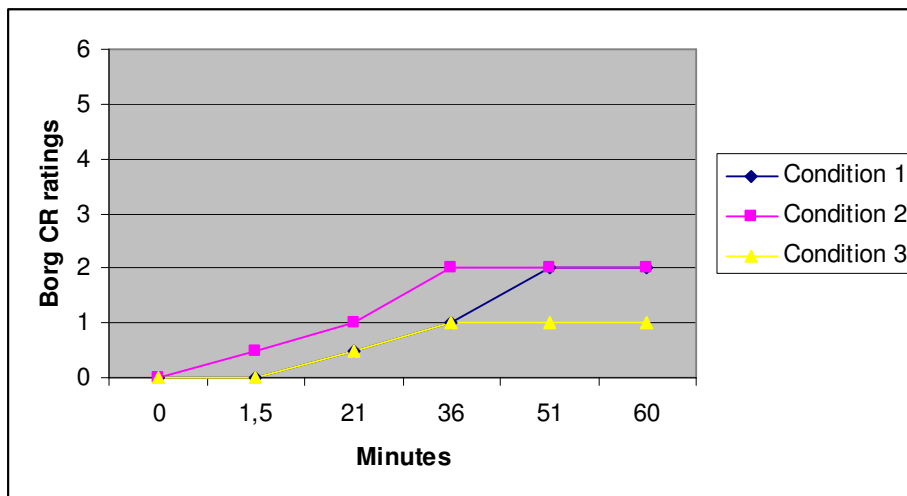


Figure 1. Median values of Borg CR ratings for the shoulder during the painting task.

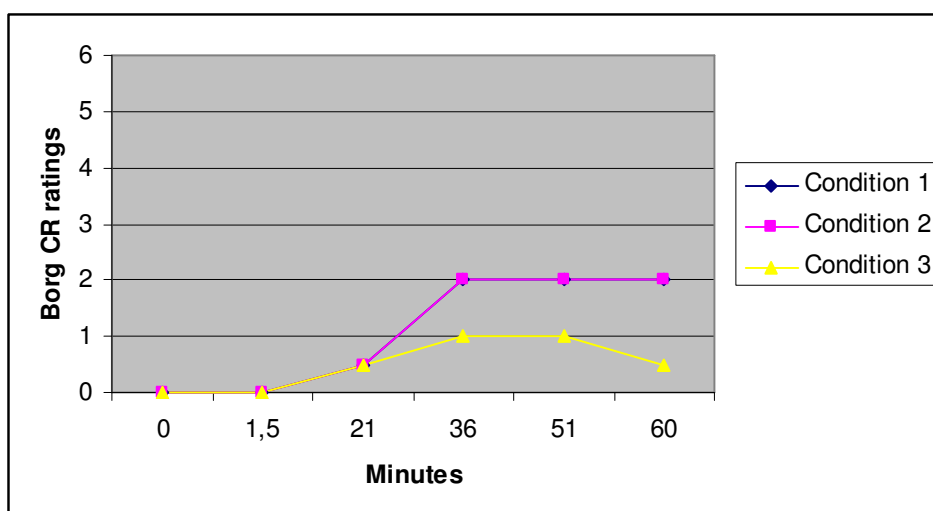


Figure 2. Median values of Borg CR ratings for the elbow during the painting task.

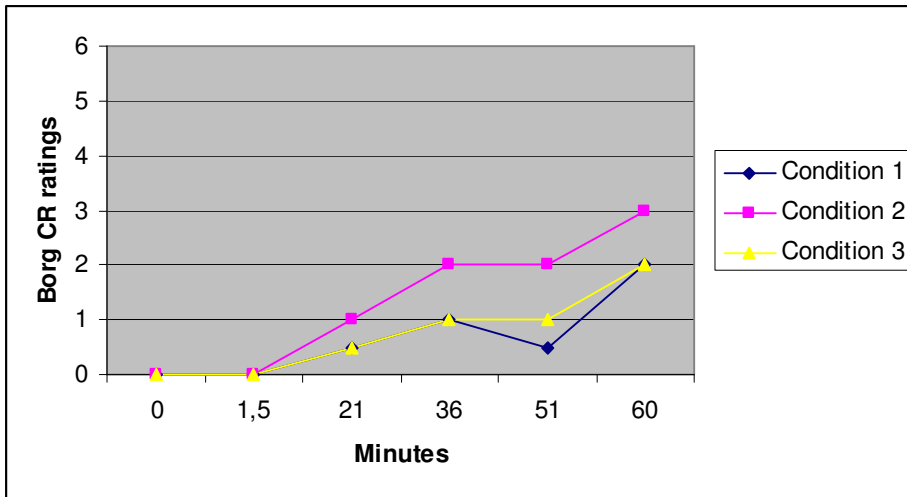


Figure 3. Median values of Borg CR ratings for the hand/wrist during the painting task

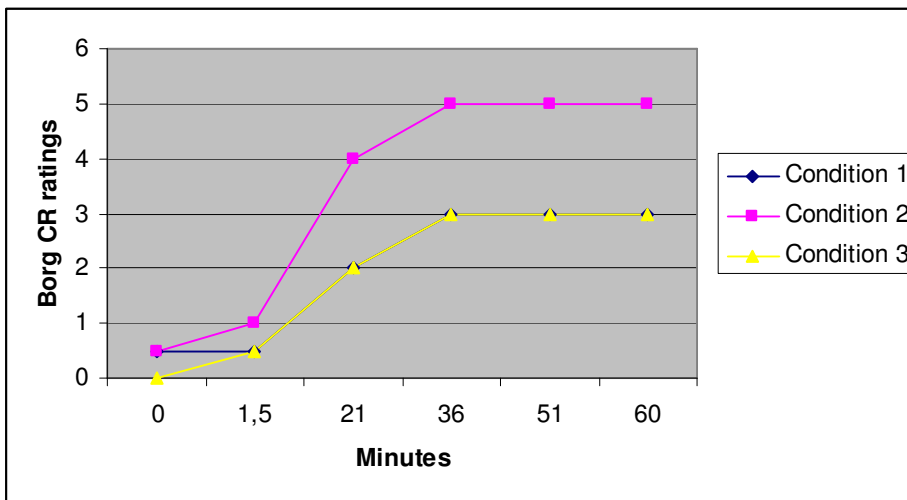


Figure 4. Median values of Borg CR ratings for the eyes during the painting task.

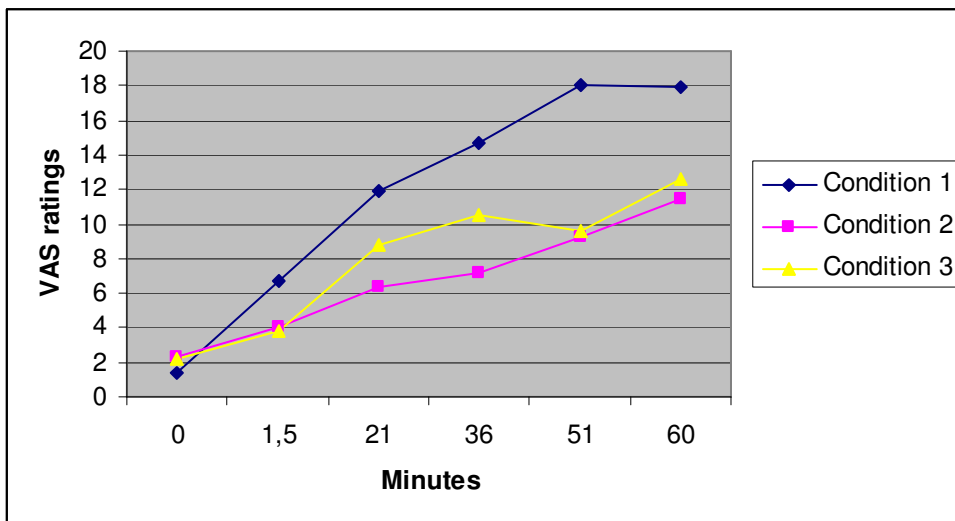


Figure 5. Mean values of VAS scale ratings for general tenseness during the painting task

Discussion

In the present study, we investigated performance during a standardized computer mouse task performed under three manipulated conditions. Furthermore, we assessed subjective perception of fatigue in the shoulder, the elbow, the hand/wrist, and the eyes.

Number of rectangles painted was highest for the condition when rectangles were small and the cursor size large (1.7 mm^2 compared to 0.6 mm^2). The reason why subjects were able to paint more rectangles during this condition (C2) is likely due to that the cursor covered a relatively larger area of the rectangles than for the two other conditions. Beforehand the relatively larger cursor area was considered to imply a more constraint movement and thus more fatigue. This was however not confirmed in the present study - the relatively larger cursor size did not affect the total time that the cursor was outside the rectangles during the painting task (total time outside was the same for all conditions). Furthermore, subjective perception of fatigue in the shoulder, the elbow and the hand/wrist was similar as in the other two conditions. The reason why this condition was not considered more fatiguing than condition 3 where a smaller cursor size was used might be that the mouse sensitivity was similar to the sensitivity mostly used by computer users in C2, but not in C3.

At C1 and C3 the motor demand was considered similar since the relation between size of the rectangles and of the cursor, and the relation between size of the rectangles and cursor sensitivity was the same. This might be confirmed by the fact that the subjects painted a similar amount of rectangles during these two conditions. Further, the total time that the cursor was outside the rectangles during the painting task was similar. The disparity between these two conditions was considered the visual demands. The smaller size of the rectangles at C3 was considered to be more visual demanding. No confirmation that this was the case was however provided and the fact that the fatigue profiles for the eyes were the same for both conditions may moreover suggest that visual demands for these conditions were similar. It could be that the size differences we chose between conditions 1 and 3 were not actually perceived as being different by the subjects, and thus similar results were obtained. This brings into question whether there exists a threshold of size difference needed to adequately address our research question.

C2 presented the most demanding visuo-motor tasks and because subjective perception of fatigue in the eyes tended to be maximum large in this condition it follows that the eye symptoms may have been mediated by the increased motor demands inherent in the C2 task.

In conclusion, performance was highest at the condition when objects were small and movement constraint was assumed to be the highest (C2). This, however, did not result in significant differences in subjective perception of fatigue or in general tenseness over time between conditions.

Referenser

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