Abstracts

Poster: 0111

Using a Software as an Exposure Assessment Device to Measure and Detect Computer Users' Muscle Fatigue

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Purpose: The aim of this study was to determine whether changes in keystroke duration, which can be continuously and non-invasively measured by one's own computer, could be used as a surrogate to detect the computer user's muscle fatigue. We have developed a customized computer usage monitoring software to precisely record keystroke durations. If keystroke duration is related to muscle fatigue, then this software program, without additional instrumentation, would measure physiological changes of a user during exposure to computer work. As a step to developing such a measurement tool, the relationship between finger muscle fatigue and computer typing performance, specifically the keystroke durations recorded by the software, was tested in a laboratory study. The study tested the hypothesis that the keystroke duration during a typing task changes as the physiological changes of muscle. Our measure of muscle physiology was low frequency muscle fatigue, which has been associated with exposure to sub-maximal repetitive activities.

Methods: Sixteen right-handed touch typists volunteered for a laboratory experiment where their typing performance and muscle fatigue was repeatedly measured throughout three different conditions randomized on three separate days. Two exposure conditions with two different types of fatiguing exercise on the right ring finger were performed along with one control condition without exposure. The two exposure conditions consisted of 15 minutes of static exercise (constant isometric finger flexion at 15% MVC), and 15 minutes of fluctuating exercise (isometric finger flexion with force cyclic between 0% and 15% MVC 2.5 times per second), respectively. Typing performance and muscle fatigue were measured before exercise, immediately after exercise, and 30, 60 and 120 minutes after exercise for recovery. The typing performance was measured in a 5-minute typing test on a word processor where keystroke duration, the time between when a key is pressed and released, was recorded using the computer usage monitoring software loaded on the test computer. Typing speed and typing accuracy, which is the percentage of words correctly typed, were also measured during the typing test. The muscle fatigue was measured by isometric force response to 2Hz (twitch), 100 and 20 Hz electrical stimulation trains for both the right ring finger flexor and extensor muscle. Muscle contraction time was also measured during

muscle electric stimulations. Repeated measurement-ANOVA tested for differences in typing performance (keystroke duration) and muscle fatigue before exercise, immediately after exercise and during recovery.

Result: The keystroke duration decreased as finger flexor muscle fatigued, and recovered during the recovery period. Average keystroke duration of the keys hit by the right ring finger was 5.1ms (4%) and 10.3ms (8%) shorter after the static and fluctuating exercise, and recovered within 120 minutes afterwards. Typing speed (52 words/min) and typing accuracy (94%) remained constant across conditions and over the whole duration of the experiment. The right ring finger flexor exhibited muscle fatigue, and significantly faster muscle contraction after both exercises. Within the 120 minutes of recovery, the flexor muscle recovered from fatigue after the fluctuating exercise, but not the static one.

Conclusion: Changes in keystroke duration were associated with changes in muscle fatigue. Keystroke duration decreased with onset of muscle fatigue. These results indicated that keystroke duration can possibly be a surrogate measure of physiological change of the muscle – i.e. muscle fatigue. The next step is to understand the influences of actual computing tasks on muscle fatigue as well as the role and interaction of central fatigue on these measures of typing performance.

Application: This software-based tool aims to be an objective exposure assessment tool for field applications and scientific studies on large population of computer users or with long measurement periods. It has the potential to provide continuous direct surrogate measurement for muscle fatigue and to continuously record the patterns of exposure (distribution of activity and inactivity). The tool provides an alternative to the high cost of direct physiological instrumentation and their invasiveness on the human subject.

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