# The effects of pause software on the temporal characteristics of computer use

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**Abstract**

The study investigated the natural work-pause pattern of computer users and the possible effects of imposing pause regimes on this pattern. Hereto, we recorded the precise timing of computer events across a large number of days. We found that the distribution of the pause durations was extremely skewed and that pauses with twice the duration are twice less likely to occur. We studied the effects of imposing pause regimes by performing a simulation of commercially available pause software. We found that depended on the duration of the introduced pause the software added 25% to 57% of the pauses taken naturally. Analysis of the timing of the introduced pauses revealed that a large number of spontaneous pauses was taken close to the inserted pause. Considering the disappointing results of studies investigating the effects of introducing (active) pauses during computer work, we cast doubt on the usefulness of introducing short duration pauses.

*Keywords: computer use, pause software, exposure variability, work-pause pattern*

## 1. Introduction

It is commonly acknowledged that physical load factors such as excessive force, frequent bending and twisting, repetitive motion and static posture contribute to the occurrence of musculoskeletal disorders. Consequently, guidelines [1, 2], standards [2] and national legislation [3, 4] have been implemented to promote variation in loading patterns.

However, recent reviews of the literature by Burdorf and colleagues [5] and Mathiassen [6] indicate that the effects of increasing variation are only supported by vague or indirect empirical evidence. These authors argue that there are only few studies explicitly addressing variation and musculoskeletal disorders and that there are insufficient methods for quantifying variation.

For example, one of the most frequently recommended interventions against musculoskeletal disorders is the introduction of more rest breaks [7-14]. A reason why the effects of short organized rest breaks on fatigue and discomfort have shown to be only weak might be that the additional rest breaks are not sufficient to significantly alter the work-pause pattern. That is, the additional breaks might not contribute significantly compared to the large amount of variation already obtained through natural and regulatory breaks present at the job, and through exposure variability associated with the task(s).

In recent years several innovations have been developed to adjust break schedules to the actual work load, taking into account the breaks that subject take naturally. In particular, during computer use, work can be regulated by pause software, which can administer additional pauses depending on the actual computer use of an individual user.

Since pause software developers claim that their software reduces the risk of developing complaints of the upper extremity, we were interested to what extent the implementation of additional breaks can alter the work-pause pattern of computer users. Whether the administration of additional pauses has possible health benefits is beyond the scope of the current study.

In order to precisely determine the time-pattern of computer use during a working day, we developed a new software tool. This software records, during normal computer use, the times at which the mouse and the keyboard are used. This enables us to reconstruct time traces over extensive periods of time in a variety of computer users.

In order to determine the subject's natural working behaviour we performed a detailed analysis on the recorded time traces. To study the effect of different pause regimes on worker's pattern of computer use we performed a simulation of how this pattern, as measured by the registration software, would be altered under the influence of different pause regimes. That is, based on the criteria and thresholds that make up a pause regime we inserted pauses of specific durations in the recorded time traces. Using a simulation, instead of administering different pause regimes to different subjects in a controlled trial, allowed us to estimate the potential effects of a whole range of changes in the work-pause schedule without being influenced by non-compliance of the subjects, compensation for non-work periods (speeding-up) and other confounding factors that might influence subject's working behaviour.

In the current study we pose the following specific questions regarding the temporal variability of computer use and the influence of imposing different pause regimes:

1. What are the natural pause patterns that subjects display?
2. How many pauses would pause software administer to the subjects and how do these numbers compare to the number of pauses taken spontaneously?
3. Is the timing of the inserted pauses appropriate, that is, how long would it take before a computer user would take a similar pause spontaneously?

## 2. Methods

We installed custom built registration software on the computers that were used by 20 healthy employees of the academic hospital in Rotterdam, performing a variety of computer intensive jobs. The software registered with a frequency of 10 Hz the position of the cursor (x, y coordinates in pixels), whenever this position changed. Additional events that the software recorded were key presses, mouse clicks and mouse wheel use (temporal resolution 0.1 s). The software logged these data in the background in order not to interfere with the regular work of the subjects. A sample of 50 workdays of each subject was selected to ensure the data files (for each subject for every day) contained sufficient data. For each of the 1000 recorded files we extracted the times at which an event (a mouse movement, mouse click, mouse wheel use or keyboard stroke) was recorded. We used the obtained time traces to calculate pause distributions and simulate the effects of pause software. To this end we implemented the standard regimes administered by the most commonly used pause software in the Netherlands; Workpace (Niche Software). The pause software regimes consist of implementing micro pauses (durations varying from 5 to 30 sec) and macro pauses (5 to 30 min pause) after a specific duration of computer use has been exceeded (computer use limit). In accordance with the Workpace software, we used a pause definition of 30 seconds. During the simulation we inserted the appropriate pause after the computer use limit was reached. Since our subjects were without upper extremity complaints we will report on the results from the simulations of the 6 least stringent regimes.

## 3. Results

### *3.1. Natural computer pauses*

On average 50618 events were recorded for each subject every day (range 17772-97000, sd between subjects averaged across days: 14742; mean sd over days, within subjects: 9430). Considering that these events could be as close as 0.1 second apart the total amount of the events corresponds to less than 85 minutes of continuous computer use each day. In contrast, the total time subjects worked with the computer, that is, the time from the first recorded event till the last one for a particular day was on average 8 hours and 33 minutes (sd: 1.19 min).

To gain insight into the distributions of pause durations we counted the number of pauses per hour for a range of pause durations. The short duration pauses occur more frequently than the longer duration pauses. For instance, the majority (96,2%) of all pauses are shorter than one second. For pauses larger than half a second, as can be seen in Figure 1, a two-fold increase in pause duration leads to a decrease in the number of pauses with approximately a factor two. The straightness of the curves in the log-log plot of figure 1 indicates that the pause distribution follows a power

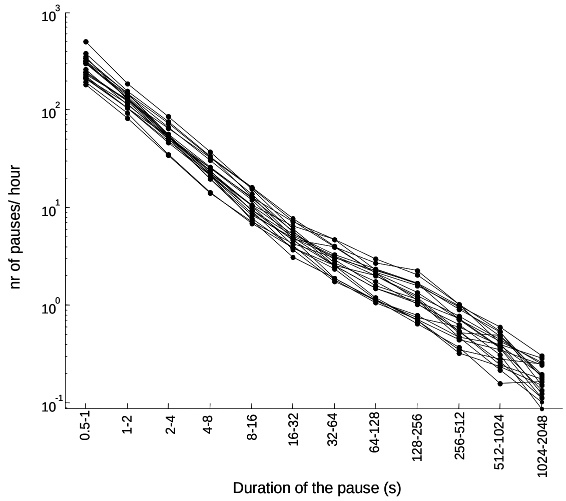


Figure 1. Histogram of pause durations for the different subjects (the different lines), across all days. On the x-axes the upper and lower limits for the pause duration are shown in seconds. Both axes are on a log scale. 512 to 1024 s is approximately 8.5 to 17 min.

law. The variability between subjects, as shown in the spread of the different lines in the graph, can partially be explained by the intensity with which subjects worked during each of the 50 days of recording.

When we applied a pause definition of 30 seconds, we found that on average (across days and subjects) a working day consisted of 64 working periods, with an average duration of 4 minutes. The longest period of continuous computer use (average over all subjects and days) lasted almost half an hour. The average duration of the pauses in between the working periods was somewhat longer, with the longest pause lasting on average one hour and 14 minutes.

*3.2. Artificial computer pauses*

During the simulation pauses were inserted every time the computer use limit was exceeded. In figure 2 the number of inserted pauses is shown for the first six pause regimes across all subjects and days. Notice that the majority (89 %) of pauses that are administered are micro pauses and that the more stringent the regime becomes the more pauses are administered. The daily limit of computer use is not taken into consideration in the analyses.

Using figure 3 the number of pauses before and after the implementation of the pause regime can be compared. Shown is, for each pause regime, the number of pauses with a length corresponding to the duration of the inserted pause or larger. Note that the amount of pauses given on top of the ones that occur naturally is rather small, especially for the micro pauses. For the micro pauses on average 25 % more pauses are inserted across the six pause regimes. For the macro pauses the number of additional pauses is larger; on average 57% more macro pauses were inserted.

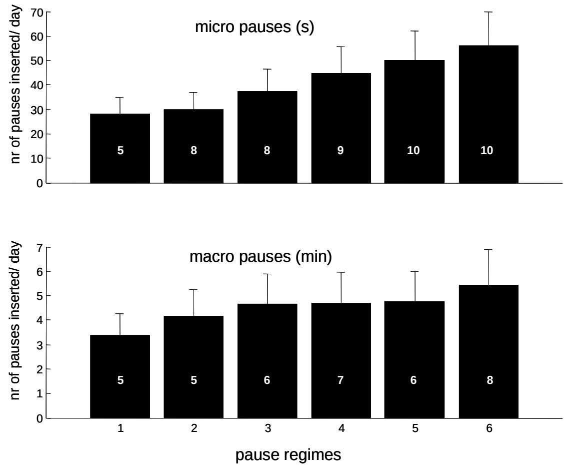


Figure 2. Mean number of micro (top) and macro pauses (bottom) per day inserted for all pause regimes across subjects and days. Error bars are standard deviations for variability across subjects. The numbers in the bars are the durations (top graph in seconds, bottom in minutes) of the pauses for that regime. Note the different scales on the y-axis.

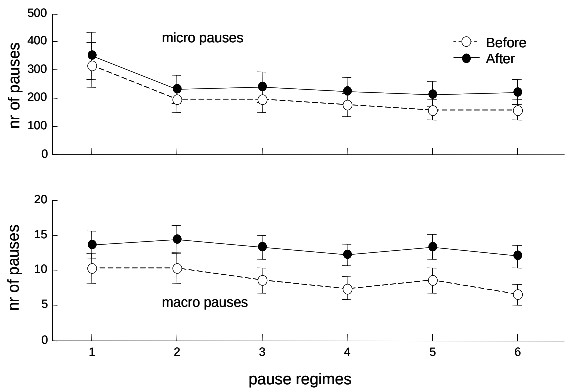


Figure 4. Number of micro (top graph) and macro pauses (bottom graph) before (dashed lines, open markers) and after pause insertion (solid lines, filled markers) for six pause regimes across subjects and days. Error bars are standard deviations for variability across subjects. Note the different scales on the y-axis.

*3.3. Changes in the working day*

For the six pause regimes studied, the working day increased on average by 37 minutes (7.2 %). In only 3% (range 0 to 11.7 %) of the days this daily limit was reached during simulation of the six pause regimes. The total amount of time classified as 'work' hardly increased for the six pause regimes studied (maximally 8 min. for regime 6). Because 'work' is defined by the pause definition of 30 seconds, pauses smaller than 30 seconds will lead to an increase of the total amount of 'work' performed. Counter intuitively, this means that by adding micro pauses, work time is increased.

*3.4. Timing of the inserted pauses*

We calculated the time differences between the moments an artificial pause would have been administered and the subsequent moment a natural pause of equal or greater length occurred. This time difference is a measure of the amount of time subjects would be stopped using the computer earlier than they would naturally do (or the amount of time subjects continue to use the computer while the software would have stopped them). These data, averaged across all subjects and days and for the 6 pause regimes, is shown in figure 4.

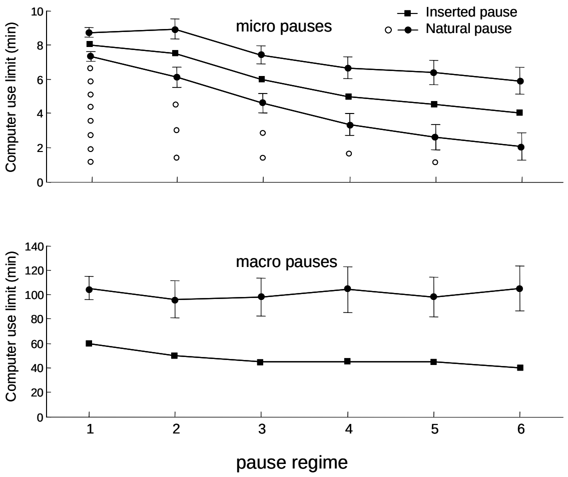


Figure 4. The amount of time after a pause of 30 s or more before the software would notify the subject to pause (computer use limit) is shown in the lines with the square markers. The top lines show the time it took subjects to spontaneously take a pause of a length equal or greater than the one just administered. Since the pause definition is larger than the administered micro pauses, subjects also showed micro pauses preceding the inserted pause. The lower line in the top graph shows the time at which the previous pause of equal or greater length was spontaneously taken. The open circles indicate the number of pauses of these durations taken in the period up to administration of the pause. Timing of these pauses is not taken into consideration and numbers are rounded off towards integers (for actual values see text).

The top graph (compare the top two lines) shows that for short duration pauses the software administered the pause only shortly (45 s (=8%)) before the natural pause would occur and that this time increases with the stringency of the imposed pause regime (up to 2 minutes or 32 %, earlier). In contrast, the lower graph shows that this time difference is much larger for the macro pauses. Subjects are stopped much earlier (on average 53 minutes (=52%)) than they would naturally do.

Since the administered micro pauses have a duration which is shorter than that of the pause definition, micro pauses of the same length could also have occurred in the 'work-period' prior to the administration of the micro pause. We calculated at what time before the insertion of the micro pause the last spontaneous micro pause occurred. As can be seen in figure 5 the time difference between the spontaneous pauses prior and after and the inserted micro pause are quite similar. Additionally, we calculated the number of micro pauses, with a length larger than the administered pause, in the computer use period prior to the administration of the pause (shown as circles in top graph, figure 4). For the 6 regimes, 8.76, 4.15, 3.27, 2.22, 1.65, 1.44 pauses occurred naturally before the administration of the inserted micro pause.

## 4. Discussion

In the Introduction we asked three questions regarding the possible effects of pause software on computer use. We will shortly address the answers to these questions and we will discuss how the current results should be interpreted in the light of possible health benefits of pause software.

*What are the natural pause patterns that subjects display?* The results show that the distribution of pauses, the time between two computer events, is extremely skewed. That is, the vast majority (96%) of pauses, is shorter than one second and only a small number of pauses is of long durations. The distribution of pause durations follows a power law with a slope of approximately minus two, meaning pauses with twice the duration are twice less likely to occur. When we applied a pause definition of 30 seconds, the work-pause pattern consisted of on average 64 short duration (4 minutes) work periods, interlaced with slightly longer pause periods (5 minutes). The work-pause pattern of computer users can thus be described as a highly intermitting behaviour with short duration work periods being followed by slightly longer, and very variable, pauses.

*How many pauses does pause software administer and how do these pauses compare to the number of pauses taken spontaneously?* When we applied our simulation of the pause software we inserted pauses of different durations when a computer use limit was exceeded. For an average working day of 8.5 hours 38 micro pauses (5 to 10 s) and 4 macro pauses (5 to 8 min.) were administered, a nine fold difference. Compared to the amount of pauses taken spontaneously, an additional 25 % micro pauses were inserted. For the macro pauses an additional 57% pauses were inserted compared to the number of natural pauses with the same or longer duration. The inserted pauses add on average only 7.2 % extra pause time to a working day. Only in a very small percentage (3%) of the days a day limit would be imposed.

*Is the timing of the inserted pauses appropriate?* The amount of pauses that the software would administer seems to be quite significant, also when compared to the number of pauses taken spontaneously. However, when we looked closer into when these pauses were inserted we found that, specifically for the micro pauses, a large number of spontaneous pauses was taken just before and after the inserted pause. The spontaneous pauses just before and after the inserted micro pause occurred on average within 90 sec. This means that pause software, through the administration of micro pauses, does not seem to alter the work-pause pattern of computer users to a large extent. For longer duration pauses (5-8 min), the software would administer a pause long before the computer user would take a pause of equal or a longer length, spontaneously. The administration of longer duration pauses, although they compromise only 11% of the total amount of pauses, seems therefore a method for altering the work-pause pattern.

In the literature two possible mechanisms are described that explain how additional rest breaks could influence computer user's health (e.g. reduce fatigue, discomfort and other complaints of the upper extremity) [15]. Firstly, rest breaks might lower the cumulative loading during a workday which might in turn give muscles the chance to recover from fatigue, promote blood circulation or promote some other form of recovery [10, 16]. Secondly, rest breaks might introduce an increase in the variation of the physical exposure. By increasing variation, i.e. reducing stereotypy of the work, selective exhaustion of muscles, tendons and nerve tissue could be alleviated [17, 18].

As stated in the Introduction the benefits of additional rest breaks on fatigue and discomfort have found only marginal support in the scientific literature. One of the reasons for this modest effect might be that the additional breaks do not contribute to the decrease in cumulative loading. A review by Lötters and Burdorf [19] concluded that substantial (14%) reduction in physical load is needed to result in a corresponding decline in complaints. In the current study we found that the additional rest breaks added only 7.2 % extra 'pause time' to the working day. This seems to suggest that, regardless whether a changed work-pause pattern might influence workers health, it is very unlikely that pause software contributes to reducing cumulative load.

For long-lasting work at low load levels, like computer work, increases in exposure variation are thought to be better met by introducing more activity than by introducing more rest. Studies on active breaks, like specific exercises or stretching, have shown however very disappointing results [20]. The results of our study suggest that the effect of micro pauses on exposure variability is probably quite low considering the large number of spontaneous micro pauses taken just prior and after the administration of the pause (see fig. 4). In all our analyses we did our best to verify possible effects of pause software on temporal characteristics of computer use. Despite this it seems very unlikely that the introduction of micro pauses (those below 10 seconds) has a possible benefit. It therefore seems a logical step for computer users to switch off this functionality in their pause software.


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