# SuperBreak: Using Interactivity to Enhance Ergonomic Typing Breaks

**Dan Morris, A.J. Bernheim Brush, and Brian R. Meyers**
Microsoft Research
Redmond, WA, USA
{dan,ajbrush,brianme}@microsoft.com

## ABSTRACT

Repetitive strain injuries and ergonomics concerns have become increasingly significant health issues as a growing number of individuals frequently use computers for long periods of time. Currently, limited software mechanisms exist for managing ergonomics; the most well-known are "break-reminder" packages that schedule and recommend typing breaks. Yet despite the proven benefits of taking breaks, such packages are rarely adopted due to the overhead of introducing periodic interruptions into a user's workflow. In this paper, we describe *SuperBreak*, a break-reminder package that provides hands-free interactions during breaks, with the goal of encouraging users to take more breaks and enhancing the benefits of those breaks. In a field study of 26 knowledge workers, 85% preferred SuperBreak over a traditional break-reminder system, and on average participants took a higher percentage of the interactive breaks suggested to them. Our results highlight the value of interactivity for improving the adoption and retention of ergonomic break practices.

### Author Keywords

Ergonomics, RSI, interruptions, physical interfaces

### ACM Classification Keywords

H5.2 [Information interfaces and presentation]: User Interfaces – Ergonomics, Input devices and strategies.

## INTRODUCTION

Repetitive strain injury (RSI) is a general term used to describe soft tissue damage as a result of sustained repetitive work, classified by the medical community as a musculoskeletal disorder. In 2001, the National Academy of Science issued a report [16] stating that "Musculoskeletal disorders of the low back and upper extremities are an important national health problem, resulting in approximately 1 million people losing time from work each year. Conservative cost estimates vary, but a reasonable figure is about $50 billion annually in work-related costs." Causes of RSI range from cooking to driving to keyboard and mouse use; any time there is repeated motion of a muscle group under strain without rest, the potential for injury exists [19].

Continuous keyboard and mouse use create precisely this scenario for information workers. A literature review [2] shows numerous studies linking the use of keyboard and mouse to RSI. We can expect these problems to be magnified tremendously as the current generation of children and teenagers – for whom computer use has been a daily activity since early childhood – enters the information workplace. These individuals have not only been subject to more long-term damage due to a lifetime of computer use, but are combining full days of office computer work with home computer use, which renders them more susceptible to RSI and other health problems caused by extensive typing and mousing. The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) states [18] that "performing this task [computer use] for several uninterrupted hours can expose the small muscles and tendons of the hand to hundreds or even thousands of activations. There may not be adequate time between activations for rest and recuperation, which can lead to localized fatigue, wear and tear, and injury." OSHA has issued a set of recommendations including, among other things, the following: "High repetition tasks or jobs that require long periods of static posture may require several, short rest breaks (micro breaks or rest pauses). During these breaks users should be encouraged to stand, stretch, and move around. This provides rest and allows the muscles enough time to recover." We believe that as ergonomic injury becomes a more acknowledged and more universal problem, incorporating ergonomics-related features into software environments will be critical as both a solution to a major health problem and a marketing feature in all computer software.

Software packages are now available, and are in some cases being distributed by employers, that remind computer users to take periodic breaks. Some popular examples include WorkRave[1], XWrits[2], Stretch Break[3], and RSIGuard[4]. These products remind a user to take short breaks and stretch his hands at regular intervals.



*CHI 2008*, April 5–10, 2008, Florence, Italy.


---

[1] WorkRave, http://www.workrave.org/
[2] XWrits, http://www.lcdf.org/xwrits/
[3] Stretch Break, Para Technologies, http://paratec.com/
[4] RSIGuard, Remedy Interactive, Inc., http://rsiguard.com/

The ergonomic benefits of taking periodic breaks are both powerful and well-documented [1,2,9,14,15,16,18,19], but since this type of software tends to interrupt workflow, users frequently ignore their break reminders or turn off this software shortly after installing it. Furthermore, though breaks do have significant preventative value, a user who is not already experiencing symptoms of RSI is unlikely to even install such software. Various studies have shown that despite the common perception of breaks reducing productivity, frequent short breaks actually increase productivity and reduce error rates [2]. Balci and Aghazadeh [1] found that short breaks significantly increased the speed and accuracy of both data entry tasks and mental tasks, and Hedge and Evans [8] found a 59% improvement in accuracy across several job classes. McLean et al. [14] and Saltzman [20] found that productivity, while not significantly improved, at least trended higher when study participants took short breaks throughout the work day. Out of 10 studies surveyed, no study reported a reduction in productivity despite the addition of breaks to the work schedule [2,8].

Given the compelling evidence of the benefits of breaks while working with a computer, it would be natural to assume that a majority of users take breaks regularly throughout the day. However, various studies have found that even when participants are specifically instructed to take breaks, voluntary completion of scheduled breaks ranges from 45-55% [9,15,20]. In some cases, participants were removed from the study group due to never completing a single recommended break [2,9].

In this paper we present SuperBreak, a software package that builds upon the traditional "break-reminder" theme. SuperBreak seeks to increase break completion by offering interactions *during* breaks that make the breaks less annoying and more productive. SuperBreak leverages a video camera as an alternative input system for use during breaks and offers a variety of in-break interactions, including reading documents, playing a game, and watching videos.

We evaluated SuperBreak in a two-week field study with 26 information workers. Each person used SuperBreak with interactive breaks for one week, and a control version of the software, in which breaks were not interactive, for one week. All 26 participants, even the 13 who had not previously tried break-reminder software, indicated that they planned to continue using break-reminder software after the study. Twenty-two participants (85%) preferred SuperBreak with interactive breaks to the control version, and on average participants took a higher percentage of the breaks offered in the interactive condition, while typing through more of the breaks suggested in the control condition. These data suggest that interactivity can improve the adoption and retention of typing-break-reminder software.

In the remainder of this paper, we first discuss previous work directly related to break-reminder software. We then describe the SuperBreak package, including a description of the specific interactions currently available to users during breaks. We then present the results of our field study, and we conclude with a discussion of future work

## RELATED WORK

While many researchers have documented the benefits of taking breaks, two studies [9] and [15] looked specifically at using software, Stretch Break[3], as a means of improving rest break completion, while Hedge and Evans [8] examined how a program called ErgoManager improved voluntary break-taking within two companies. These studies examined how typing break reminders could be effective in encouraging break-taking but did not examine the impact of break content, which is our focus.

Some previous work in using sensors and interactions to improve ergonomics focuses on postural problems: Dunne et al. [6] describe a postural sensor suitable for biofeedback applications, and Breazeal et al. [3] present an actuated monitor that can unobtrusively manipulate a user's posture. However, we know of no other computer systems that use interactions to motivate good ergonomic habits. In the related area of motivating exercise and overall activity, Consolvo et al. [5] and Lin et al. [12] used personal awareness and social pressures to increase daily walking habits, while Lo et al. [13] used game play to encourage better eating habits. This area is becoming known as persuasive computing [7]. Similarly, Bianchi-Berthouze et al. [3] show that body movement can improve players' engagement in computer games and can improve players' affective experience.

## SUPERBREAK

### Software Architecture

SuperBreak's core functionality is similar to that of existing break-reminder packages: the user configures typing break durations and inter-break intervals and is informed that a break is pending shortly before it is scheduled to begin. We adopt the terminology of existing software packages, calling shorter, more frequent breaks "micro-breaks", and longer, less-frequent breaks "rest breaks". A typical configuration might schedule a 20-second micro-break every 5 minutes, and a 5-minute rest break every hour (this is by no means universal; optimal scheduling will depend on a particular user's health needs). We focus primarily on micro-breaks in this paper, since we expect most users to either leave their desks or do non-computer-based work during their rest breaks. Between breaks, SuperBreak monitors keyboard and mouse activity so that naturally occurring breaks are taken into account. In other words, if a 30-second micro-break is scheduled to occur every 5 minutes, it will only be suggested if there is activity at the keyboard or mouse for 5 minutes without any pauses longer than 30 seconds.

Where SuperBreak differs from typical break-reminder packages is its support for "Activities" during breaks. An "Activity" is a software module intended to run for the duration of a break, with no keyboard or mouse input. When SuperBreak determines that a break is pending, it selects an Activity according to the user's pre-configured preferences and prepares the appropriate resources needed for that Activity (e.g. Web content, a video camera) so they are ready when the break begins. SuperBreak allows the user to configure the Activity-selection mechanism according to his or her preferences. For example, a user might configure SuperBreak to offer a preferred Activity 80% of the time, with an alternative Activity 20% of the time.

To start a break, SuperBreak provides display resources to the selected Activity and optionally locks out the keyboard and mouse. Additional notifications are provided to the current Activity shortly before a break is scheduled to end and at the end of a break, allowing resources to be deallocated and any necessary notifications provided to the user. After the break is finished, SuperBreak returns the user's desktop to its pre-break state. The goal of these resource management procedures is to ensure that Activities are available immediately when a break begins, and that the user's desktop state is restored seamlessly when a break ends.

SuperBreak is implemented in C++ and C#, and runs on Microsoft Windows operating systems.

## ACTIVITIES

Activities are intended to encourage the user both to complete the suggested break and to maintain a healthy ergonomic posture and activity level during the break. Although we could imagine a wide variety of options for Activities, we selected four for the study. Two of the Activities – a gesture-based document-reading system and a gesture-based game – are *active* in nature and the user is encouraged to physically move his or her body or arms during the break in order to interact with SuperBreak. Both make use of computer vision techniques and a video camera to allow keyboard-free, mouse-free interaction.

The other two Activities are *passive* in nature, as they do not require the user to physically do anything during the break. The first passive Activity allows the user to view online videos. The second passive Activity is the "standard break", which simply places a text reminder to take a break on the screen. The standard break was designed as a control condition for our experiment, and is consistent with the reminders provided by traditional break-reminder packages. We purposely selected both active and passive Activities, as well as Activities that are either entertaining (game, videos) or productivity-oriented (document-reading), to explore the space of possible Activity types.

The following subsections describe these activities in more detail.

### *Activity 1: Vision-Based Game*

A significant shortcoming of existing break-reminder software is that it is difficult to enforce or encourage active stretching during ergonomic breaks; many users – eager to continue with their work – will fail to move around during a short break and will maintain the same tense posture they employ while typing, minimizing the break's effectiveness. With this in mind, SuperBreak includes an activity that uses a vision-based game to encourage stretching (Figure 1).

The game break uses a standard webcam mounted above the user's monitor to capture a video image of the user at her desk. As shown in Figure 1, the user sees the image with one, two, or three on-screen targets superimposed (the red and green quarter-circles in Figure 1). To score points, the user moves his or her hands up to touch the target(s) and then down off the target(s). When motion is detected within the target(s) before a short time window elapses, the system plays a 'success' sound and the user scores points for each target hit. Points are deducted if the user fails to activate the target(s) or activates incorrect targets. New targets are then displayed in a different location. The targets are purposely placed such that the user is encouraged to reach above his head; this motion rotates the shoulders and encourages blood flow to the player's hands and wrists.

Target activation is detected using simple frame-to-frame subtraction. A change image is created for an incoming camera frame by subtracting the intensity at each pixel from that observed in the previous frame. A threshold is applied to determine the set of active pixels; if a target area contains a sufficient number active pixels for a threshold period of time, it is considered "hit", and the user is rewarded or penalized depending on the set of targets currently displayed and the set of targets currently activated by hand movement. Throughout our field study, we found this simple approach to be remarkably robust to varying lighting conditions, office configurations, and camera orientations. Image processing is performed using the OpenCV library [17].

### *Activity 2: Vision-Based Document Reading*

We also wanted to experiment with activities that allow the user to continue working during breaks without using the keyboard and mouse. One productivity task that is particularly well-suited to typing breaks is document reading, which primarily requires passive viewing and periodic vertical scrolling. To allow users to defer document-reading

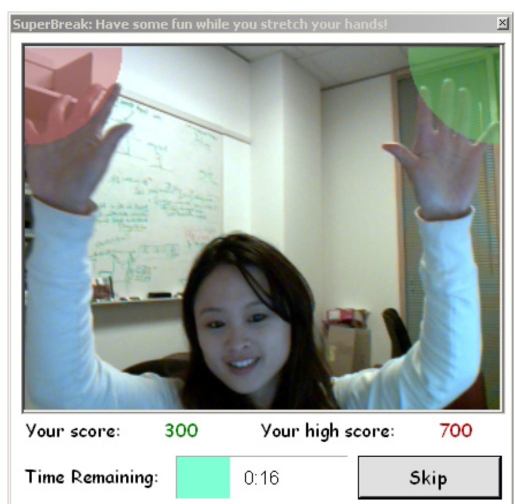
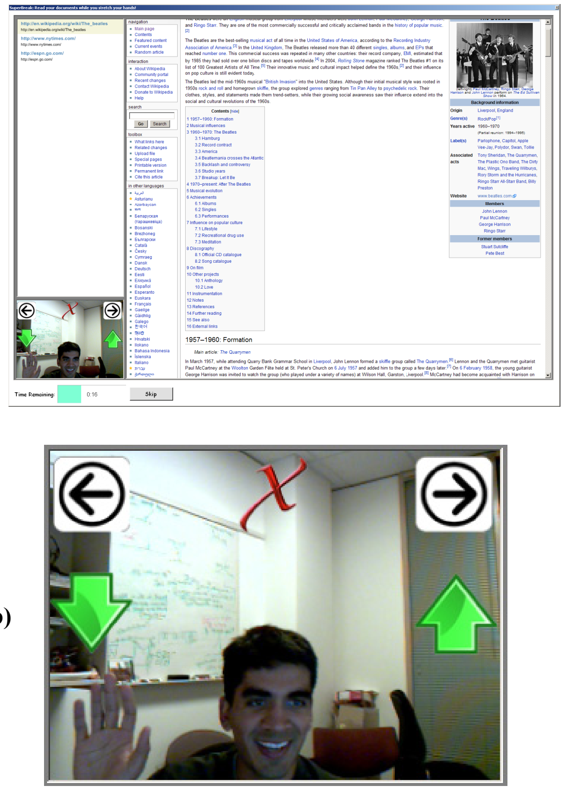



**Figure 1: SuperBreak's Vision-Based Game Activity.**


(a)

(b)

**Figure 2: SuperBreak's Vision-Based Document-Reading Activity. Within the Activity window (a), the user is presented with a list of available documents, a document-viewing area, and a gesture-based navigation area. The navigation area, expanded at the bottom of this figure, provides feedback about the locations mapped to each available navigation command.**

tasks to their ergonomic breaks, we have developed a SuperBreak Activity that allows vision-based reading of and selecting among documents (Figure 2). An associated Web browser plugin allows the user to queue documents during normal Web browser use for later reading, using an extension to the browser's context menu.

During a document-reading break, a video camera is used to detect simple hand gestures that allow the user to switch among documents, scroll within documents, and remove documents from the current reading list. These actions correspond to activation of the icons shown in Figure 2b: activation of the vertical green arrows scrolls the current document, activation of the horizontal black arrows switches among documents, and activation of the "X" icon removes the current document from the reading list. Once again, these gestures were chosen to encourage the user to raise his hands above his head during the break, and can also be easily classified in real-time using the simple computer-vision techniques discussed in the "game break" section above. In addition to the techniques used for the game break to recognize target activation, gesture classification is further simplified for the document-reading break by requiring that only a single icon be activated for a threshold period of time before navigation commands are issued. This tends to filter out most sources of noise to which frame-differencing is susceptible, such as large-scale background movement, changes in lighting, etc.

Since breaks are often too short for a user to read a complete document, the currently-selected document and the scroll position within that document persist across breaks.

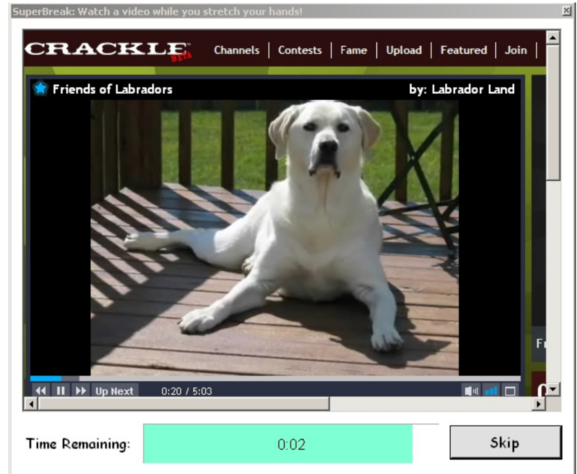



**Figure 3: SuperBreak's Passive Video-Viewing Activity.**

*Activity 3: Passive Video Presentation*

The passive video presentation Activity provides either informative or entertaining content that requires minimal user initiative, but still encourages break-taking. This activity leverages the growing popularity of the Web as a source of video content to provide a familiar form of passive interaction.

SuperBreak's implementation of this activity (Figure 3) allows the user to choose a set of "video sources" that will be polled daily for a list of available videos. Examples include `youtube.com` and `crackle.com`, with the ability to select among specific categories at each source, limited in our study to sources known to be filtered for office-appropriate content. Since longer videos tend to contain little content in the first few seconds, a typical micro-break would complete before meaningful regions of a long video could be presented to the user. Therefore, videos are sorted by duration and are optimally matched to break lengths.

*Activity 4: Standard Break*

For completeness, we mention the "standard break" here; during a "standard break" the user receives a simple notification window that shows the time remaining during the break (Figure 4). This break type is used as a control condition in the field study described below.

*Notifications and User Interface*

We briefly discuss the types of notifications provided to users by SuperBreak and the break-management actions a user can perform, as they are relevant to our field study.

Twelve seconds before each suggested break, the user receives an auditory notification and a visual reminder in the lower-right corner of his primary monitor (Figure 5a). This notification contains a "skip" button that allows the user to


**Figure 4: SuperBreak's "standard break".**

(a)
(b)

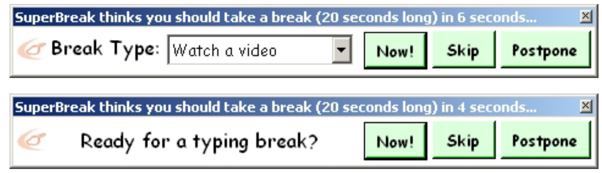



**Figure 5: SuperBreak's Pre-Break Notification Window. (a) The pre-break notification presented when interactive breaks are available. (b) The pre-break notification presented in our field study's control condition, in which only standard breaks are available.**

prevent a break from starting (this button resets SuperBreak's micro-break timer and skips the break entirely) and a "postpone" button that defers the proposed break for two minutes. During our field study, a default Activity was selected at random (game, video, or document); however, in general, the user can specify preferences for how often different types of Activities should be selected. The pre-break notification window also includes a drop-down box that allows the user to change the Activity that will be used during the upcoming break. During the control condition of the field study this drop-down box was disabled, allowing participants to take only the "standard" break; this simplified pre-break notification window is shown in Figure 5b.

All four Activity windows (Figures 1-4) also provide a "skip" button that allows the user to skip a break that has already started.

## FIELD STUDY

To evaluate the use of SuperBreak and the benefits of interactive breaks, we recruited 26 participants (12 male) within our organization[5]. We selected both participants that either currently used or had previously tried break-reminder software (6 men and 7 women) and participants that had never tried break-reminder software (6 men and 7 women). Each participant used SuperBreak for 10 working days (typically two calendar weeks, but occasionally longer to account for vacation days).

We configured SuperBreak to suggest a 25-second micro-break after every 8 minutes of interaction. This meant that a micro-break was suggested every time a participant typed or used the mouse for 8 minutes without a 25-second period of inactivity. A 25-second period of inactivity would reset SuperBreak's internal countdown to the next micro-break. Therefore, how frequently breaks were offered depended on each participant's typing habits. These defaults were chosen based on a pilot study to ensure breaks were proposed frequently enough to support the study, but did not overly interfere with participant productivity. Research by Slijper et al. [21] found the number of naturally occurring typing breaks follows a power law, such that increases in suggested break length decrease the number that naturally occur, supporting our choice of relatively short micro-breaks. Participants could adjust the length and frequency of breaks if desired, to maintain consistency with any previous use of break-reminder software, although we required micro-breaks to be at least 20 seconds long and to occur after at most 10 minutes of sustained input activity. The keyboard and mouse were not locked during breaks by default.

To evaluate SuperBreak, we used a within-subjects design in which participants used SuperBreak on their office PCs in "interactive mode" for 5 work days and "standard mode" for 5 work days. In interactive mode, SuperBreak randomly selected among the three novel break types (video, game, document) for each micro-break. In standard mode, SuperBreak was configured to be similar to existing break-reminder software, so every micro-break was a "standard break". Note that the difference in conditions applies only to micro-breaks; micro-breaks were the primary target of our investigation and the primary consideration when designing our Activities, as they are the focus of the relevant ergonomics literature. All rest breaks in both conditions were configured by default to be "standard" breaks, and participants were encouraged to use rest breaks to leave their desks or do non-computer work. Participants were provided with a USB web camera for the period during which they were using SuperBreak in "interactive mode", as a video camera is required for two of the three Activities. The order in which participants experienced standard or interactive mode was counter-balanced across participants. All participants completed the study with at least 5 work days in each condition except for two: one participant had only 3 work days in the standard condition due to a job change during the study, and another had only 4 days in the interactive condition due to unexpected travel.

Participants in the study filled out a pre-study survey, a mid-point survey (when they switched conditions), and a post-study survey (after using both versions of SuperBreak). We visited all participants at the beginning of the study to install SuperBreak, at the mid-point to switch conditions, and at the end to collect logging data from SuperBreak. During the study period, SuperBreak logged usage information including the breaks suggested and whether each break was taken or skipped. To account for variations in usage time and number of breaks offered across our participants, all log data is analyzed as percentages of each user's suggested breaks in each condition. At the end of the study, participants received a gratuity for their participation valued at approximately $20.

### Demographics

Our 26 participants were all between the ages of 20 and 55. All participants worked at our organization, but the study

[5] We began the study with 28 participants, but one participant was unable to complete the study due to hardware problems and another had to travel unexpectedly.

pool spanned a range of occupations, including researchers, software developers, and marketing specialists. Our selection criteria aimed to balance male and female participants, and participants who had previously tried break-reminder software with participants who had not. Our only additional selection criterion was that participants work at a single PC during the work day, on which we installed SuperBreak.

Each participant reported spending at least 6-10 hours per work day at a computer, and 8 reported spending more than 10 hours per day at a computer. Our participants were long-time computer users; 11 participants had been using a computer more than 20 hours per week for 6-10 years, and the remaining 15 participants for more than 11 years.

We collected data on participants' self-reported experience and concerns with RSI, to inform interpretation of our results. In our pre-study survey, participants were asked to report their levels of concern about RSI and other related health problems on a four point scale from 'Not concerned' (1) to 'Very concerned' (4). Not surprisingly, given that they volunteered for our field study, the median response was 'concerned' (3). All participants reported experiencing some pain or discomfort they believed was related to computer use. Seven participants reported experiencing pain daily, three experienced pain several times per week, four experienced pain several times per month, and the remaining 12 reported experiencing pain previously but not on a regular basis. Fifteen participants reported they had visited a doctor for a health condition related to working on computers. When asked to estimate what percentage of their co-workers had experienced significant discomfort due to computer use, only one participant reported *not* knowing anyone who has been affected by ergonomic problems. Most participants (62%, 16/26) reported that between 1% and 25% of their co-workers had experienced problems, and the remaining nine participants reported that more than 26% of their co-workers had problems.

To address concerns about ergonomics, several participants were currently using non-standard computer peripherals such as ergonomic keyboards (12 participants), ergonomic chairs (7 participants), and ergonomic mice (6 participants). Participants had also made adjustments to their work practices including incorporating stretching exercises (15 participants) and alternating or permanently changing the hand they use for holding the mouse (9 participants). Six participants had consulted a professional ergonomist to assist in the configuration of their offices.

We asked the 13 participants who had experience with break-reminder software some additional questions. Of these participants, 7 were currently using the break-reminder software provided by our organization and most (6 of 7) reported running the software 75-100% of their work day. When asked how satisfied they were with the software, the median response was 'neutral' on a five-point Likert scale. All 7 had the software configured so that more than 15 minutes elapsed between micro-breaks, although we note that this software uses a strict timing mechanism so this interval cannot be directly compared with the input-based timing used by SuperBreak.

### Results: Questionnaire Data

On the post-study survey we asked participants explicitly which version of SuperBreak (interactive or standard) they preferred. The interactive condition was preferred by 85% (22 of 26) of participants. We were also particularly pleased that all participants, even those that had not previously used break-reminder software, reported they would continue using break-reminder software. Eighteen wanted to use interactive SuperBreak, four wanted the standard version, and four planned to use other break-reminder software. Eighteen of our participants retained the SuperBreak application on their computers at the conclusion of the study when the researchers offered to uninstall it as part of our final office visit.

When asked why they preferred the interactive version, responses by 11 participants highlighted that the breaks were more interesting and engaging. Representative comments included "love the game, love video. I hate sitting and just watching a clock tick" (P10), "More fun. Motivation to take a break" (P13), and "the breaks were more engaging" (P20). Four participants (P5, P12, P25, P28) commented on the fact that the encouraged hand movement and stretching. Three participants (P7, P17, P23) also commented on the variety of Activities, as exemplified by: "More variety in the breaks, motivation to take the break through game" (P17), and "I like the variety of activities. It made me want to take the breaks." (P7).

For the four participants (P4, P16, P19, P27) who preferred the standard version, two felt the interactive version was too intrusive. For example, P16 said "The standard version was not intrusive and worked." The other two participants each found two of the interactive break types annoying. P4 disliked document-reading and video-viewing, while P19 stated "I found that the game/document breaks in the [interactive] version a little annoying and preferred simple breaks for the short micro breaks."

### Results: Log Analysis

To evaluate participants' use of SuperBreak in more depth, we compared the percentage of breaks taken in each condition based on the log files produced by SuperBreak.

During the study, all participants were offered at least 20 micro-breaks in each condition and the average across participants was 81 micro-breaks offered in the interactive condition and 90 in the standard condition (not a significant difference according to a paired t-test). While participants' working style and typing habits impact the number of breaks offered, we feel comfortable that all participants experienced enough breaks during the study to give us informed feedback. We also stress that breaks were only suggested after periods of sustained keyboard or mouse activity, so all of these micro-breaks were suggested when participants were physically present at their computers.

| | Interactive | Standard |
|---|---|---|
| **% of breaks taken** | 65.5 | 49.9 |
| **% of breaks typed through** | 3.5 | 11.4 |

**Table 1: Summary of the key differences between the interactive and standard conditions; both differences are significant.**

Given that breaks offered are an interruption and that previous studies have found that voluntary completion of scheduled breaks ranges from 45-55% [9,15,20], we expected participants would skip a considerable percentage of their breaks. We calculated the percentage of breaks taken by participants in each condition by dividing the number of "taken" breaks by the total number of suggested breaks. A suggested break is counted as "taken" if the participant did not explicitly skip it (i.e. does not press the "skip" or "postpone" buttons) *and* did not continue typing through the break (recall that we did not disable input devices during breaks)[6]. We hypothesized that the percentage of breaks taken would be higher when participants were using the interactive version of SuperBreak.

On average, participants took 65.5% of the interactive breaks offered compared to only 49.9% of breaks offered in the standard condition (Table 1). A paired-samples t-test shows that these percentages are significantly different ($p=0.005$). Post-study survey responses are consistent with the logging data. On the post-study survey, when asked whether they were more likely to skip breaks in the interactive condition or the standard condition, most participants (69%, 18/26) reported that they thought they were more likely to skip breaks when using the standard condition, while 5 participants reported that the version had no effect and 3 felt they were more likely to skip breaks in the interactive version. Similarly, at the end of each condition we asked participants what fraction of micro-breaks they believed themselves to have skipped in that condition. Following the interactive condition, participants felt they skipped between 25%-49% (median response on a four-point scale) while the median for the standard condition was 50 – 74%. These medians are significantly different based on the Wilcoxon test with $z=-2.546$, $p = .011$.

In addition to taking a smaller percentage of breaks offered in the standard condition, participants were also significantly more likely to continue typing through breaks – without explicitly canceling them – in the standard condition than the interactive condition. On average, participants typed through 11.4% of breaks offered in the standard condition and only 3.5% of those in the interactive condition ($p=0.001$).

[6] Breaks in which fewer than 5 keystrokes and fewer than 5 mouse-click events occurred were considered "taken"; this allows for cases where a participant took a brief period of time to stop typing in response to the initiation of a break.

### Results: Interactive Break Types

In addition to estimating the overall value of interactive breaks, we assessed the relative effectiveness and subjective perception of each of SuperBreak's Activities, to inform the design of future interactive break-reminder programs. We asked participants Likert-scale questions about whether they liked each of the Activities, and to rank the Activities in order of preference.

#### *Game Breaks*

Overall, the game break was most preferred by our participants. Fourteen participants (54%) ranked the game break first, and the median response when asked to respond to the statement 'I liked taking Game Breaks' was 'Agree' (4) on a five-point Likert scale from "Strongly Disagree" to "Strongly Agree." Positive comments about game breaks included "I prefer to move and stretch during breaks so I liked the game breaks the best" (P24) and "game breaks are great and don't really interrupt my work flow" (P10). However, not everyone liked the game breaks. Four participants (P9, P14, P19, P23) made comments about being worried about looking silly or unprofessional while playing the game. For example, P19 stated "I felt I looked strange playing the game breaks – my office is in a location where I am visible to passers-by."

#### *Video-Viewing Breaks*

Seven participants (27%) ranked the video-viewing Activity as their favorite break type. Supporting comments included "I enjoyed the video because it was a few moments of entertainment. If I'm going to break away from work, that gave the best mental break" (P14) and "The videos were entertaining and they took my mind away from work to relax for a bit." (P1). Ten participants commented that they found it frustrating that interesting videos ended abruptly at the end of breaks. This highlights an interesting design choice for Activity-based breaks: users were engaged in the video content, but an ideal experience within a break may sometimes come at the cost of extending breaks and thus risking additional interruption. Some participants' computers also had issues caching video appropriately before each break so that it started immediately, also highlighting an important point for software implementation of Activity-based breaks: for such a short interactive experience, appropriate preparation of resources before breaks is critical.

#### *Document-Reading Breaks*

Five participants (19%) rated document-reading breaks as their favorite. Positive comments focused on the ability to use breaks constructively, for example "the doc reading was educational, so I felt it was a good use of my time." (P8) and "Document reading is both interactive and potentially a useful way to pass the break, which is why I ranked it first." (P6). Eight participants commented about challenges using the hand gesture navigation, in particular accidently deleting documents, which we can address through further refinement of our gesture set and image-processing techniques. However, four participants found it difficult to switch contexts quickly enough to read documents during a

| Activity | Percentage of breaks taken |
|---|---|
| Game | 69.6% (28.0) |
| Video-viewing | 62.6% (29.1) |
| Document-reading | 63.4% (32.3) |

**Table 2: Percentage of breaks taken when each Activity was suggested, averaged across participants. Parentheses indicate standard deviations.**

micro-break. P10 states: "Document breaks were hard – shifting gears to ingest information from reading material and then going back to my work was time consuming and frustrating." This again highlights the unusual nature of interaction and content design for Activity-based breaks; minimizing the cognitive overhead of engaging with break content will leave more time for meaningful interaction during breaks.

#### *Impact of Activity type on break-taking*

Table 2 shows the percentages of breaks taken when each Activity was suggested to the user; these numbers are drawn only from the "interactive mode" data, since Activities are not used in "standard mode". The game break resulted in the highest percentage of breaks taken, which is consistent with the subjective questionnaire data discussed above, but differences among these percentages are not significant after correction for multiple comparisons.

In reviewing participants' comments, we were struck by the divergence in preferences among participants. Furthermore, numerous comments highlighted the inherent advantage of variety in keeping users' attention, for example: "variety is very important for something one interacts with so frequently" (P11). Coupled with the fact that no Activity results in an overwhelmingly higher percentage of breaks taken, this suggests that future design of Activity-based breaks should continue to include a variety of potential Activities.

### Rest Breaks

We focus primarily on micro-breaks (short, frequent breaks) in this evaluation, as the ergonomics literature has primarily identified short, frequent breaks as an appropriate strategy for reducing the risk of RSI and we have correspondingly designed SuperBreak's Activities under the assumption that they would be used for short durations. Participants in our study were encouraged to use suggested rest breaks (longer, less-frequent breaks) to leave their desks or do non-computer work. However, we briefly discuss here the data we gathered regarding participants' habits with respect to rest breaks.

During our study, SuperBreak was configured to suggest five-minute rest breaks every hour, using the same scheduling policy used for micro-breaks; i.e., a break was only suggested if a participant typed for one hour without a five-minute gap in activity. SuperBreak presented the "standard break" (Figure 4) during rest breaks

We present all statistics for rest breaks using data from both conditions in the study, as there was no difference in the behavior of rest breaks in the two conditions[7]. Participants received, on average, 32.5 suggested rest breaks (SD 19.8, min 0, max 69) throughout the course of the study. On average, participants took 25.3% of suggested rest breaks (using the same definition for a "taken" break that we describe above for micro-breaks). This number is actually somewhat higher than we would have expected, since rest breaks represent a relatively long interruption.

### Breaks as Workflow Interruptions

Although we have demonstrated that interactivity during breaks did encourage increased break-taking, a major concern for the design of break-reminder software is the workflow disruption created by breaks or even by break suggestions. We do not address this in detail, but point briefly to questionnaire results indicating that despite participants' desire to continue using break-reminder software, the median response to the statement "I found this version of SuperBreak annoying" was 'Agree' (4) in the standard condition and 'Neutral' (3) in the interactive condition (these medians are not significantly different). Quotes from participants support the notion that break reminders are a significant workflow interruption. P5 states: "…if I'm typing a bunch (and rapidly), I probably don't want to be interrupted, and providing me an opportunity to postpone doesn't work, because that still breaks my train of thought."

### Previous experience with break-reminder software

We recruited participants so as to balance individuals who had never used break-reminder software with those who had tried break-reminder software in the past or were currently using break-reminder software. We expected that participants in the latter category, who had been sufficiently motivated at some point to install traditional break-reminder software, might be more receptive to SuperBreak, i.e. that they would take more breaks and would provide subjectively more positive responses in both conditions.

Interestingly, we found no effect of previous experience with break-reminder software on either break-taking probability (in either condition or across conditions) or subjective response. It may be the case that our expectation of a significant effect of previous experience with break-reminder software was unfounded. However, we also note that we did not directly compare SuperBreak to other break-reminder packages that participants had used in the past, and are thus unable to explore whether even the standard condition of SuperBreak was sufficiently different from other packages, in its scheduling mechanism, UI, system integration, etc., to negate effects of previous experience.

[7] We performed all of the same analyses for comparing rest-break-taking across conditions that we describe above for micro-breaks, and, as expected, found no significant differences across conditions.

## DISCUSSION

We now highlight several important themes that emerged from our experience designing and studying SuperBreak.

### Interactive micro-breaks were successful

At the inception of this project, we realized that the length of a typical micro-break is rather short and we worried about whether interactivity during that time would be feasible. That most of our participants preferred the interactive condition shows that short activities were possible, and desirable, even in 25 seconds. However, in cases where breaks did not start smoothly due to inadequate pre-fetching of content, participants expressed significant displeasure. P27 states: “The video was my least favorite because it took so long for the video to load that the break was half over before it started.” This emphasizes the importance of having all necessary resources (e.g. videos, documents) cached before each break so that the break can start seamlessly with no waiting by the user. We will continue to improve the pre-break caching of content in SuperBreak; a particular design and implementation challenge here is preparing content without introducing computer load that disrupts the user even before a break is formally suggested.

One thing that did surprise us was the extent to which participants wanted to continue engaging in video-viewing and document-reading micro-breaks beyond the duration of a break. Despite the workflow interruption, participants rapidly became engaged in break content and in many cases desired that content to come to a natural conclusion. This highlights another important challenge for the design of interactive breaks: break activities should be self-contained and end at natural boundaries, but breaks that are *too* engaging can potentially result in decreased productivity.

We note that the “game” and “document-reading” breaks made use of interactions that users had not previously experienced, and the extent to which the success of interactive breaks depended on novelty cannot be assessed by the present study. We defer a longitudinal evaluation of SuperBreak – which would rule out this effect – to future work. However, we saw no statistical evidence of a decrease in breaks taken over time throughout the study period (although we acknowledge that this is not equivalent to a statistical demonstration that such a decrease does not exist).

The comparison of interactive and non-interactive breaks is also affected by a difference in window size among the break types. Our “standard break” is intended to approximately represent existing break-reminder software and was designed accordingly; the activities presented in our interactive breaks necessitate increased screen space to facilitate interactions. In our view, our study shows that participants chose not to skip interactive breaks despite the relatively high demands on screen space and consequent intrusiveness on workflow, which strongly supports the notion that interactivity is a strong motivator for break-taking. However, because screen size is an uncontrolled variable, we cannot, at present, comprehensively disambiguate all the properties of SuperBreak that render it effective.

### Diversity of Activities is important

While we anticipated that different participants might prefer different breaks types, we expected that participants might also appreciate variety in SuperBreak’s Activities. Some participants did appreciate variety, however the strength of preference other participants expressed to us for particular break types (e.g. only game or only document) was somewhat surprising. For example, P4 states: “if it didn't have the document-reading and video-playing, which were annoying, if the interactive version had just been the game-playing, with a variety of games, it would have been better.” This highlights the importance of providing a variety of break types to accommodate diverse users. Similarly, while we deliberately designed break content that encourages physical movement, participants’ levels of comfort doing physical activities varied based on their office environments.

We also note that all of the interactions we have described are individual activities, but collaborative or social breaks, such as brief video conferences or collaborative games, might also appeal to many potential users. For example, referring to game breaks, P1 states: “just beating my own high score is not as fun as perhaps playing against or challenging someone else's score.” We are interested in exploring the feasibility and social dynamics associated with similarly brief collaborative activities in future work.

### Scheduling of breaks could be ‘smarter’

This study focused on participants’ experiences during the breaks provided by SuperBreak, rather than on the scheduling of those breaks. SuperBreak schedules breaks based on keyboard and mouse activity, rather than on timed intervals alone, but does not otherwise optimize the scheduling of breaks so as to minimize annoyance or disruption. In both conditions, field study participants felt the software proposed breaks at inconvenient times. The median response was ‘Agree’ (4) in both conditions when participants were asked to respond to the statement “This version scheduled breaks at inconvenient times.” P25 states: “I hated the micro breaks. They almost always popped up at inconvenient times, and broke my concentration when I was trying to focus.” P22 commented “Rest breaks often appeared right before I was going to take a long break anyway (e.g., lunch or a meeting), and these I was particularly likely to ignore.”

We defer to future work the integration of more sophisticated mechanisms for enhancing the input-activity-based scheduling of breaks used by SuperBreak. For example, digital calendar data is frequently available; this could allow future break-reminder software to avoid proposing breaks when the user is about to leave the office (and thus will implicitly be taking a break) or is conducting an in-office meeting (and thus is unlikely to welcome an interruption). Similarly, in-office sensors could be used to determine whether a user is currently engaged in physical activity that alleviates the need for a break, or is engaged with co-workers and thus would probably prefer not to be interrupted. We also point to related work on using probabilistic models to assess the cost or annoyance associated with interruptions based on computer or sensor state (e.g. [11]); this work presents a natural basis for the “smart” scheduling of typing breaks. In incorporating any such mechanisms for reducing annoyance, there is clearly a balance that will need to be struck between determining “good” times to interrupt a user and making sure that breaks are proposed even when no perfect break time occurs, according to the user’s ergonomic needs. We highlight that this area is critical for improving the wider adoption of ergonomic break-taking practices through break-reminder software, as users who are not *immediately* concerned about RSI may be unlikely to tolerate poorly-timed interruptions in the interest of long-term ergonomic benefits.

## CONCLUSION

Our study of SuperBreak with 26 knowledge workers highlights the benefits of interactivity and diverse activities during breaks in encouraging people to take micro-breaks from typing. As we believe that the need to encourage people to engage in healthy ergonomic behavior will only increase as people spend more time using computer input devices, we are excited by the response to SuperBreak and its potential to contribute to a potentially high-impact health issue.

Additionally, the design of SuperBreak focuses on minimizing continuous *typing*, but there are other ways in which working at a computer can detrimentally impact a user’s health. In future work, we will explore mechanisms that encourage users to adjust posture or engage in gross physical movements, reducing potential spinal problems. Similarly, the design of breaks that use non-visual stimuli might leverage the benefits of interactivity demonstrated in this paper while encouraging users to look away from the monitor during breaks, reducing the potential for eye strain associated with computer use. In both of these scenarios, using computer vision techniques may allow us to provide closed-loop feedback about posture or gaze and encourage corresponding adjustments to ergonomic behavior.

## REFERENCES


1. Balci, R., Aghazadeh, F. 2004. Effects of exercise breaks on performance, muscular load, and perceived discomfort in data entry and cognitive tasks. Comput. Ind Eng. 46, 3 (Jun. 2004).
2. Barredo, R. Mahon, K. The Effects of Exercise and Rest Breaks on Musculoskeletal Discomfort during Computer Tasks: An Evidence Based Perspective, Journal of Physical Therapy Science, Vol. 19, 2007.
3. Bianchi-Berthouze, N. Kim,W., Darshak,P. Does Body Movement Engage You More in Digital Game Play? And Why? *Affective Computing and Intelligent Interaction*, Springer, LNCS 4738, 102-113
4. Breazeal C, Wang A, Picard R. Experiments with a Robotic Computer: Body, Affect, and Cognition Interactions. 2nd Intl Conf on Human-Robot Interaction, 2007.
5. Consolvo, S., Everitt, K., Smith, I., Landay, J. A. 2006. Design requirements for technologies that encourage physical activity. Proc CHI 2006.
6. Dunne, L.E., Walsh, P., Smyth, B., Caulfield, B. Design and Evaluation of a Wearable Optical Sensor for Monitoring Seated Spinal Posture. Proc 10th Intl Symp on Wearable Computers, 2006.
7. Fogg, B.J. Persuasive Technology: Using Computers to Change What We Think and Do, San Francisco, CA: Morgan Kaufmann Publishers, 2003.
8. Hedge, A., Evans, S. J. (2001): Ergonomic Management Software and Work Performance: An Evaluative Study. Cornell University Technical Report/RP 2501.
9. Henning, R.A., Jacques, P., Kissel, G.V., Sullivan, A.B., Alteras-Webb, S.M.. Frequent short rest breaks from computer work: effects on productivity and well-being at two field sites. Ergonomics 40(1) (1997).
10. Horvitz, E., Apacible, J., Koch, P. BusyBody: Creating and Fielding Personalized Models of the Cost of Interruption. Proc CSCW 2004.
11. Horvitz, E., Apacible, J. Learning and Reasoning about Interruption, Proc. ICMI 2003.
12. Lin, J., Mamykina, L., Lindtner, S., Delajoux, G., Strub H.B. Fish’n’Steps: Encouraging Physical Activity with an Interactive Computer Game. Proc UbiComp 2006.
13. Lo, J-L., Lin, T-Y., Chu, H-h., Chou, H-C., Chen, J-h., Hsu, J., Huang, P. Playful Tray: Adopting Ubicomp and Persuasive Techniques into Play-Based Occupational Therapy for Reducing Poor Eating Behavior in Young Children. Proc UbiComp 2007.
14. McLean, L., Tingley, M., Scott, R.N., and Rickards, J. Computer terminal work and the benefits of microbreaks. Applied Ergonomics 32(3) (2001).
15. Monsey, M., Ioffe, I., Beatini, A., Lukey, B., Santiago, A., James A.B. Increasing compliance with stretch breaks in computer users through reminder software. Work; 2003, Vol. 21.2.
16. National Academy of Science. *Musculoskeletal Disorders and the Workplace: Low Back and Upper Extremities*. National Academy Press (2001).
17. OpenCV: http://intel.com/technology/computing/opencv
18. OSHA Ergonomic Solutions: Computer Workstations eTool, Work Process and Recognition: http://osha.gov/SLTC/etools/computerworkstations/workprocess.html, viewed 9/12/2007.
19. Pascarelli, E. *Complete Guide to Repetitive Strain Injury*, Wiley & Sons, 2004.
20. Saltzman, A. Computer user perception of the effectiveness of exercise mini-breaks, Proc ErgoCon, 1998.
21. Slijper, H., Richter, J., Smeets, J., Frens, M. The effects of pause software on the temporal characteristics of computer use. Ergonomics. 50(2):178-191, 2007.