# Initial Results from a Study of the Effects of Meditation on Multitasking Performance

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## Abstract
This paper reports initial results from a study exploring whether training in meditation or relaxation can improve office workers' ability to multitask on a computer more effectively and/or with less stress. Human resource (HR) personnel were given 8 weeks of training in either mindfulness meditation or body relaxation techniques, and were given a stressful multitasking test both before and after training. (A third group, a control group, received no intervention during the 8-week period but was tested both before and after this period.) Results indicate that overall task time and errors did not differ significantly among the three groups. However, the meditation group reported lower levels of stress and showed better memory for the tasks they had performed; they also switched tasks less often and remained focused on tasks longer.

## Keywords
Multitasking, meditation, human attention, information overload, stress, knowledge workers, attention training.

## ACM Classification Keywords
H.1.2 [Models and principles] User/Machine Systems—Human information processing.

**General Terms:** Experimentation.

## Introduction

Multitasking is a much discussed and debated phenomenon today. It is no exaggeration to say that understanding the extent and consequences of multitasking has become not only a national concern, but also a national priority, insofar as there are strong demands for guidance and understanding coming from parents, educators, employers, and workers. The field of Human-Computer Interaction (HCI) has examined the effects of interruptions on multitasking performance [1,6,8,13], and the effects of multitasking on human performance itself [7]. Often in HCI, the focus is on ameliorating the negative effects of interruptions or multitasking by deploying a new technology. This paper, by contrast, investigates whether the negative effects of multitasking may be ameliorated by changing human behavior, in this case, through meditation.

The ongoing research reported here is meant to contribute guidance and understanding in two ways: by empirically evaluating the effects of meditation and focused attention on multitasking performance; and by furthering the development of meditation techniques that may increase people's ability to multitask more effectively and with less stress.

We describe an experiment in which human resource (HR) personnel were given 8 weeks of training in either mindfulness meditation (a form of attention training) or in relaxation techniques. Both before and after training, the participants were given a relatively naturalistic and potentially stressful test of their multitasking abilities. Although our full data analysis is not yet complete, we have already obtained several interesting results demonstrating that those trained in meditation show a reduction in stress, better memory for details of the task, and longer periods of time-on-task.

## Related Work

Results from a large number of cognitive experimental studies support the conclusion that human attention capacity is limited, and that multitasking requires rapid task switching (e.g., [11,12,15]), which is costly in speed and accuracy. Furthermore, a growing body of experimental work has explored the positive effects of "mindfulness meditation" as a form of attention training. Recent results suggest that seasoned meditators experience a reduced "attentional blink effect" (a particular form of switching cost) compared to novice meditators [14], and that persistent meditation practice enhances emotion regulation [9,10]. In contrast to the present study, these previous meditation studies have employed artificial laboratory tasks; in such cases the generalizability to naturalistic environments where multitasking typically occurs is questionable.

Much of the multitasking work in human-computer interaction (HCI) has aimed at discovering the nature and effects of multitasking on knowledge work. Major findings include that knowledge workers are perpetually fragmented across many simultaneous tasks [6], that stress, speed, and effort increase with increased interruption [8], and that the cost of interruption, the nature of the task, and the state of the user are intertwined [1,7,13].

## Method

For the study we recruited human resource (HR) personnel who were either given 8 weeks of training in

mindfulness meditation (N=18), or 8 weeks of progressive muscle relaxation/autogenic imagery training (N=14), or who were assigned to an 8-week waitlist control group (N=14) and given no training during this period. After the 8 weeks without intervention, the waitlist group underwent the meditation training, a standard feature of this kind of intervention trial design, allowing built-in replication for evaluation of the meditation training effects. Participants in all groups were women recruited from San Francisco (meditation group) and Seattle (random assignment to either the relaxation or waitlist groups). The decision to limit the study to women was made to maintain gender consistency across the three groups (few men volunteered to participate in San Francisco).

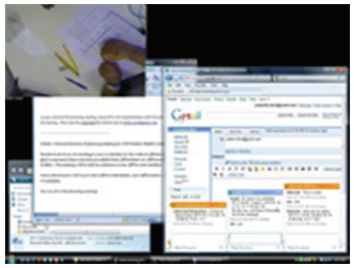

**Figure 1.** A participant's screen while performing our multitasking test, including an inset video showing use of pencil and paper. Folders, text documents, email, and multiple instant messages can be seen. Telephone activity and physical knocks at the door could be heard but not seen.

In each training, participants met collectively with the instructor one evening a week for approximately two hours. During class, participants were introduced to a variety of exercises, some of which they were also asked to practice at home. The meditation training, based on Zen teacher Darlene Cohen's book *The One Who Is Not Busy* [5], emphasized: (a) the ability to narrow or widen attentional focus voluntarily, and rest attention in the present moment or task; and (b) the flexibility to shift focus voluntarily from one thing to another. By contrast, the relaxation training emphasized progressive tensing and relaxing of major muscle groups, aided by relaxation imagery, which previous research has established as effective for enhancing relaxation [4].

Participants were given a relatively naturalistic multitasking test both prior to and subsequent to training. The third group, the 8-week waitlist control group, was given an initial multitasking test followed by 8 weeks without any training, then was tested a second time; after this, it was given the same 8-week meditation training as the first group, then tested a third and final time.

In designing the multitasking experiment, our intent was to create, as much as possible, a naturalistic setting for office-based knowledge workers. Participants were brought into a typical one-person office that was outfitted with a telephone and a laptop computer. They were asked to imagine that they were a new employee at a company and were being asked to perform a set of tasks. These tasks included (a) scheduling a meeting (finding a time when all attendees were available); (b) finding a free conference room; (c) writing a draft announcement of the meeting; (d) eating a small assortment of snacks and drinking a cup of water; and (e) writing a memo proposing a creative agenda item for the meeting. Information necessary to perform these tasks came in a barrage of email messages, instant messages, telephone calls, and knocks at the door. Text documents stored on the desktop were also used. Participants were instructed to complete all tasks in 20 minutes; those who took longer, however, were asked to continue on to completion.

TechSmith's *Morae* was used to record participants' computer screens, voice interactions, and uses of pencil-and-paper (which were required to complete the scheduling task). Figure 1 shows the experiment setup. Manual coding of our video data allowed us to obtain numerous performance measures, such as the number of tasks initiated, time on and between tasks, task order, and task correctness, among others. A variety of established instruments were used to obtain measures

of memory for the task, as well as self-reports of mood, anxiety, and trait mindfulness.

## Results

Data analysis from our initial investigation is ongoing, but several interesting results have already been obtained. All the analyses described here utilized group by repeated measures analyses of variance (ANOVA), with an alpha level of .05, unless otherwise noted.

***Memory.*** Memory for events and details during the multitasking test was assessed both pre- and post-training. Although participants in the meditation training group initially expected significantly (pre-intervention, one-way ANOVA, p=.03) less benefit than those in the relaxation or waitlist groups, they alone showed a significant memory improvement from pre-to post-training. (The relaxation training group did show a statistically non-significant trend (p=.07) toward improvement.)

***Negative affect.*** Standardized and widely-employed self-report measures of anxiety and negative affect (the Positive and Negative Affect Scale and the Profile of Mood States-Short Form) obtained before and after the multitasking test confirmed that all participants found the test stressful, as intended. In addition, for the meditation-training group (but not for the relaxation or waitlist groups), after training there was a decrease in self-reported negative affect, anxiety/tension, and fatigue following the stressful multitasking test. For the waitlist group, there was a similar post-test decrease in negative affect, anxiety/tension, and fatigue after this group had received the meditation training.

***Mindfulness.*** The meditation group, but not the relaxation or waitlist groups, also showed an increase after training in self-reported daily mindfulness (on the Mindful Awareness Attention Scale, MAAS, a measure of deliberate attention to occurrences in their daily lives [3]), and the waitlist group showed a non-significant trend (p=.08) toward a similar increase in mindfulness after the completion of their meditation training.

***Task performance/strategy.*** None of the groups showed post-training improvement in *overall* accuracy or speed, other than a practice effect (i.e., participants in all three groups took less time to complete the entire test in the post-training or post-waiting assessment, compared to that before the training). However, only the meditation group demonstrated a major change in multitasking strategy, namely, a marked tendency to spend more uninterrupted time on tasks.

## Discussion

These initial findings suggest that attention training, via mindfulness meditation, changes people's ability to multitask by reducing stress and task switching, improving memory, and increasing task focus as measured by time-on-task. An additional result—an increase in self-reported mindfulness in daily life—does not bear directly on the multitasking test, but is consistent with findings in other experimental tests of the effects of meditation [2].

It is noteworthy that neither meditation nor relaxation –training led to an improvement in either test speed or accuracy. Further work will have to determine whether this is a generalizable result or a result specific to our particular experiment and test design. The shift in strategy—to longer, uninterrupted stretches of time on

task—is also worthy of further study. It seems that the meditators may have made a conscious decision to prioritize their tasks and to delay responding to lower-status events, but further investigation is necessary to confirm or refute this hypothesis. (Several participants, in interviews conducted after they had completed their post-training multitasking test, suggested that they had tried to do exactly this.) Although this strategy did not result in improved overall speed or accuracy, it may have contributed to the improvement of memory for the task, or to a reduction in stress.

One limitation of the study is that it was largely designed around the availability of the Zen teacher Darlene Cohen. Thus, some of the recruitment, training and testing took place in the San Francisco Bay Area, where she was based, while the rest was located in Seattle. Because participants were recruited in two cities, we were not able to perform a fully randomized assignment to groups. We intend to correct this in a future study.

## Future Work

We envision additional work in two main areas: further analysis of the current data set, and the design of a subsequent study.

**Further data analysis.** As noted (see Negative affect, above), we gathered and analyzed participant self-reports of stress both prior to and subsequent to each multitasking test. At two-minute intervals during the multitasking test, we also asked participants to report their stress level on a seven-point scale. We intend to analyze these self-reports in relation to certain other measures, such as response time and time on task, to see whether changes in participants' multitasking behavior correlate with changes in their stress levels. We also intend to perform a qualitative analysis of the highest and lowest performers in the multitasking tests—by studying the recordings of these extreme cases in detail—in the attempt to generate hypotheses about which skills, capacities and strategies may lead to best (and worst) multitasking outcomes.

**Design of a follow-on study.** In a subsequent study, we intend to train and test a group of undergraduates (ages 18-23) as well as a group of 40+ year-old adults. This should allow us to compare the performance of the two cohorts—those "born digital" and those in their parents' generation—giving us a picture of the similarities and differences between their multitasking skills and strategies prior to training, as well as the differential kinds and extent of change post-training.

## Conclusion

The investigation reported here was novel and successful in three respects. First, the multitasking test was relatively naturalistic insofar as it asked participants to perform ordinary office tasks in a realistic office setting. To our knowledge, this is the first design of a controlled multitasking meditation-training evaluation experiment in this kind of setting. Second, participants were tested before and then after being trained in meditation or relaxation techniques. To our knowledge, this is the first time either of these techniques has been evaluated experimentally as a "treatment" for the negative effects of multitasking. Third, our preliminary results are promising: only the meditators experienced a post-training reduction in stress, increased daily mindfulness, better memory for details of the task, and longer, uninterrupted periods of time-on-task.

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