THE EFFECT OF FREQUENT VERSUS INFREQUENT INTERRUPTIONS ON PRIMARY TASK RESUMPTION

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Recent interruptions research suggests that the timing of interruptions can play a critical role in the level of task primary disruption. An unanswered question regarding interruption timing is whether greater task disruption in terms of primary task resumption time is experienced with more frequent interruptions. The present study used a VCR programming task with a pursuit-tracking interruption task to measure how quickly people resume the primary task after an interruption. The results showed that primary task resumption times were faster for more frequent interruptions, which was contrary to the predicted outcome. In addition, frequent interruptions did not result in the more resumption errors or longer time-on-task results as predicted. These results are discussed as evidence that more frequent interruptions may compel people to adopt aggressive goal maintenance strategies when dealing with interruptions, but further research is required to fully test this hypothesis.

INTRODUCTION

The ability to "multi-task" has become essential for modern professionals. Not only are they forced to timeshare between different projects, programs, and tasks on a daily basis, they typically deal with a barrage of interruptions, distractions, and delays on an hourly basis. A number of researchers have attempted to demonstrate and explain the disruptive effects that interruptions have on primary task performance (e.g., Czerwinski, Cutrell, & Horvitz, 2000; Gillie & Broadbent, 1989; Hess & Detweiler, 1994; McFarlane & Latorella, 2002). Miyata and Norman (1986) argued that interruptions are less disruptive when they occur between task or subtask boundaries, and recent research has supported this claim (Latorella, 1998; Monk, Boehm-Davis, & Trafton, 2002). These findings suggest that the timing of interruptions can play a critical role in the level of task disruption, but these studies focused more on the timing of interruptions relative to the primary task stage rather than the frequency of interruptions.

In a work-place study that independently examined Dutch and Russian groups, Zijlstra, Roe, Leonora, and Krediet (1999) found that more frequent interruptions led to worse performance for the Dutch office workers, but not the Russian office workers. It is important to note that the high frequency interruption conditions were operationally different for the two groups. The Dutch group had three interruptions in the high frequency condition, whereas the Russian group had only two interruptions in the high frequency condition. Because the frequency effect results were mixed, and the fact that participants used different strategies to time their engagement of the interruption task, the results are difficult to interpret. Conversely, Speier, Valacich, and Vessey (1999) found that more frequent interruptions led to lower decision accuracy and longer decision-making times. Participants were interrupted either 4 or 12 times per trial by a secondary task that demanded their attention immediately. Whereas Speier, Valacich, and Vessey focused on decision-making performance, it is not yet known how high frequency interruptions affect primary task resumption performance.

Under many circumstances, workers can determine when and how they will address an interruption. For example, if the phone rings while someone is typing an e-mail message, that person can choose to stop typing immediately and answer the phone, to finish typing the current thought and then answer the phone, or to ignore the phone completely. There are other situations when interruptions are forced upon workers, like when the boss stops in unexpectedly. Although forcing people to immediately engage the interruption task has been shown to be worse than letting them self-determine when to engage the interruption task (McFarlane, 2002), the latter method can result in different strategies for engaging the interruption (e.g., Zijlstra et al., 1999). Because the current study was focused on primary task resumption performance, it was imperative to precisely control the timing of the on-set and off-set of the interruptions. Therefore, a paradigm similar to those used in task switching studies (e.g., Rogers & Monsell, 1995) was used in the current study. Participants were forced to switch between the primary and interruption tasks at consistent intervals. Other researchers have used similar designs when controlling the timing of interruptions (e.g., Cellier & Eyrolle, 1992; Speier, Valacich, & Vessey, 1999).

The present study was designed to address the effects of interruption frequency in terms of how quickly operators resume the primary task after an interruption. The time lag between the on-set of the primary task after the interruption to the actual resumption of task performance has been successfully used to quantify the disruptive effects of interruptions (Monk, Boehm-Davis, & Trafton, 2002; Trafton, Altmann, Brock, & Mintz, 2003). This resumption time, termed the *resumption lag* by Altmann and Trafton (2002), is based on a cognitive theory about the activation of goals in memory. This study used a VCR programming task with a pursuit-tracking interruption task to investigate the effects of interruption frequency on resumption lag (see also Monk, Boehm-Davis, & Trafton, 2002).

Based on sheer number of interruptions, it follows that resumption performance should be better when there are fewer interruptions. Because a goal must be suspended, maintained, and resumed each time an interruption occurs, more interruptions should lead to greater goal retrieval interference. For the same reason, it was predicted that more frequent interruptions would result in more resumption errors. Another prediction was that time-on-task would be shorter for the infrequent interruptions simply because there would be fewer interruptions from which to recover.

METHOD

Participants

Twenty-four undergraduates from the George Mason University psychology subject pool participated in this study in partial fulfillment of a course requirement. Five men and 19 women participated and ranged in age from 17 to 25, with an average age of 19.5 years.

Tasks

The primary task was to program a VCR to record a show in the future. The interruption was a pursuit-tracking task that required participants to track a moving target. The VCR was a simulation built in Macintosh Common Lisp; the interface was designed for experimental use (Gray, 2000; Gray & Fu, 2001) rather than based on a commercially available VCR. Programming a show in the VCR included entering the target show's start-time, end-time, day of week, and channel number. The tracking task required the participant to use the computer mouse to follow an airplane (target) moving around the right half of the screen in a random pattern. The VCR and tracking tasks were presented side-by-side on a Macintosh G4 computer with a 17-inch VGA monitor. The VCR task was presented on the left side of the monitor and the tracking task was on the right side. Both tasks required only the computer mouse, and only one of the tasks was visible at a time. The participants were not required to memorize the show information to be programmed. Instead, the relevant information was posted to the right of the monitor on a 3x5 index card.

Design

The experiment was a single factor between subjects design with two levels of interruption frequency. Interruptions occurred every 10 seconds (frequent interruptions) or every 30 seconds (infrequent interruptions). Participants began each trial with the VCR task. At the on-set of an interruption, the VCR display would disappear and the tracking task would appear. After 5 seconds on the tracking task, the display would automatically switch back to the VCR task. There were 12 participants in each condition. The primary dependent measure was resumption lag, which was defined as the time elapsed between the on-set of the VCR task (off-set of interruption) and the first mouse-click on a VCR button. In addition, resumption errors and time-on-task were recorded. The error data focused on whether the participants clicked on the next appropriate button on the suspended VCR programming sub-task. For example, if the participant had adjusted the start-hour to the target setting by clicking the up-arrow just prior to the interruption, then the first click after the interruption would be the enter button. Clicks on any button other than the enter button were scored as resumption errors. Time-on-task was defined as the total time to complete the VCR program entry minus the interruption times.

Procedure

Each participant was first instructed on the VCR task through demonstration and then given two practice trials where the VCR was programmed without interruption. After completing the practice with the VCR task, the participants were given two 60-second practice trials with the tracking task. The participants were then introduced to the interruption trials, where they spent either 10 or 30 seconds on the VCR task followed by 5 seconds on the interruption task, alternating back and forth until the VCR program entry task was completed. The participants were instructed that the cursor position for each respective task would be saved and reset upon each switch so that dragging the mouse back and forth between the two sides would be unnecessary. Resetting the cursor position with each switch to the VCR task eliminated problems with carry-over cursor movements between the two tasks, which were essentially paused when not active. After the two practice interruption trials, the participants completed 12 experimental trials, each with new show information to be programmed.

RESULTS & DISCUSSION

Participants were interrupted an average of 1.32 times in the infrequent condition and an average of 4.68 times in the frequent condition. As seen in Figure 1, the mean resumption lag for the frequent interruption condition (*M* = 1575 ms, *SD* = 145) was faster than the mean resumption lag for the infrequent interruption condition (*M* = 2073 ms, *SD* = 417). A one-way ANOVA showed that this difference was significant, $F(1, 22) = 15.26$, $p < .001$. This shows that people were able to resume the primary task an average of 500 ms faster when they were interrupted every 10 seconds compared to every 30 seconds.

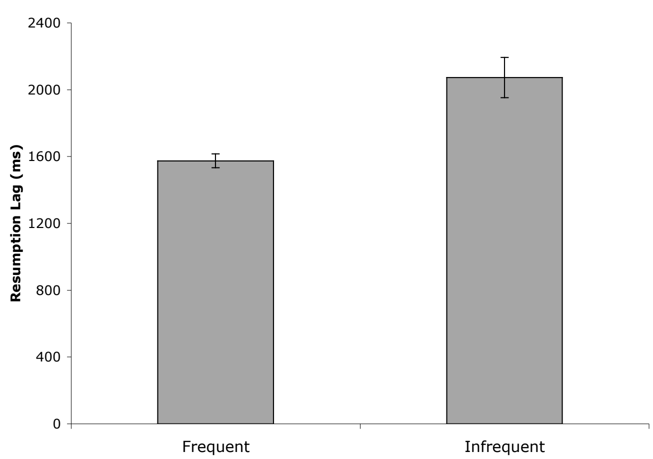

Figure 1. Average Resumption Lags for the Interruption Frequency Condition

Resumption lags were predicted to be shorter for the infrequent condition compared to the frequent condition because of interference from the multiple suspended goals in the frequent interruption scenario. However, the results of this experiment show that the opposite was true; people were faster to resume suspended goals in the frequent interruption condition. It may be that the rapid switching between tasks compelled the participants to adopt a strategy to more actively rehearse their suspended goals during the interruptions, leading to faster resumption times. The tracking task was not especially demanding of higher level cognition, therefore goal rehearsal was possible during the interruptions. Because the interruptions occurred so seldom in the infrequent condition, participants may not have been motivated to actively rehearse their suspended goals. Both Altmann and Trafton (2002) and Trafton et al. (2003) have demonstrated that active rehearsal of suspended goals is essential to successful interruption recovery. If this explanation is correct, then the resumption error data should reveal fewer errors in the frequent condition because the more actively maintained goals should be correctly resumed more often.

Because there were more interruptions and therefore more resumptions in the frequent condition, the error rates are presented as opposed to raw error scores. Overall, the resumption error rate was 8.2% across all subjects in both conditions. The mean resumption error rate for the infrequent condition (*M* = 10.1%, *SD* = 8.7) was higher than the frequent condition (*M* = 5.9%, *SD* = 4.3), however this difference was not statistically significant, $F(1, 22) = 2.25$, $p = .15$. Despite the lack of a reliable difference, the higher resumption error rate in the infrequent condition seems to support the goal rehearsal explanation of the resumption lag results; however, this interpretation should be considered with caution. In addition, the error rates argue against a speed-accuracy trade-off explanation for the resumption lag results. If participants were sacrificing accuracy for speed in resuming the VCR task after the interruptions, there should have been more resumption errors in the frequent condition. Because the resumption errors were not reliably higher in the frequent condition, this interpretation requires further experimentation before strong conclusions can be made.

Another surprising trend was that time-on-task in the frequent condition (*M* = 50.6 s, *SD* = 5.4) was slightly shorter than in the infrequent condition (*M* = 54.2 s, *SD* = 14.2); however, this difference was not statistically significant, $F(1, 22) = 0.67$, $p = .42$. The lack of difference in time-on-task between the two conditions is consistent with the notion that participants adjusted their performance to the pace of the alternating tasks (Cellier & Eyrolle, 1992). Interestingly, the average resumption time for the frequent condition was faster than in the infrequent condition by 500 ms, on average. However, the greater number of interruptions, and therefore resumption lags, in the frequent condition probably negated this benefit. Despite having fewer resumption lags, the infrequent condition did not result in reduced time-on-task. More research is required to test this explanation. As noted with the resumption lag results, the frequent and predictable shifts between the tasks may have led the participants in the frequent interruption condition to adopt a time-sharing strategy that allowed them to rehearse suspended goals during the interruptions, and as a result they completed the VCR task more quickly.

The current study used a paradigm with predictable and forced switches between the primary and interruption tasks. It could be argued that this approach is not representative of the interruptions that people typically encounter. However, there are examples of interruptions that force people to immediately stop what they were doing to focus on the new task (e.g., surprise visit from the boss). There are also cases where interruptions occur in a predictable pattern. For example, it has been shown that drivers often attempt to interlace the driving task with an in-vehicle information system task (e.g., destination entry into a navigation system) in a regular pattern; alternating between the two tasks every one or two seconds (Gellatly & Kleiss, 2000).

A future study that used an interruption task with greater cognitive demand than the tracking task used in the current experiment, and that randomized the interruption on-set times to eliminate predictability would help to address concerns about the ecological validity of the results. Indeed, these manipulations would result in interruptions that are more representative of real-world interruptions, and would help to minimize goal rehearsal during the interruption. If the ability to adopt rehearsal strategies during interruptions was minimized, the resumption lag, resumption error, and time-on-task data might show that more frequent interruptions are indeed more detrimental to primary task resumption. It would also be interesting to test these manipulations with a variety of different primary tasks.

The current study demonstrated that more frequent interruptions can have a positive effect on post-interruption primary task resumption times. However, this finding may be due to people adopting more active goal maintenance strategies when presented with more frequent interruptions. More research is required to confirm this hypothesis.

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