Do Interrupted Users Work Faster or Slower? The Micro-analysis of Computerized Text Editing Task

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Abstract

Previous research on the effects of interruptions on the speed of performing the computerized tasks gave rather non-homogeneous results: many authors insist that interrupted users always complete tasks slower than when performing the same tasks without interruption, but others showed that interrupting a user during some categories of tasks caused that user to complete the tasks faster. The micro-analysis of concrete text editing operations conducted in our experimental study revealed the difference between the effects of interruptions on cognitively simple and cognitively complex tasks. While the performance of simple tasks was not influenced by interruptions, interruptions slowered complex task performance. The task re-orientation after the interruption was found to be responsible for performance degradation.

1 Introduction

Research on the effects of interruptions on the computerized work has extensively proliferated in the last five years (see McFarlane & Latorella (2002) for detailed review of the research findings and the existing user interface design literature relative to coordinating human interruption).

In many cases, this research gave rather non-homogeneous results. For example, Bailey, Konstan & Carlis (2000, 2001) and Cutrell, Czerwinski & Horvitz (2000, 2001) insist that interrupted users always complete tasks slower than when performing the same tasks without interruption. However, experiments of Speier, Valacich & Vessey (1997, 1999) and Zijlstra, Roe, Leonova & Krediet (1999) showed that interrupting a user during some types of tasks (e.g., the document-editing tasks and simple decision-making tasks) caused that user to complete the tasks faster.

Clearly, the conclusions derived from these independent studies are inconsistent and further investigation into the effects of interruptions on a user's task performance is required.

It must be noted, that in abovementioned experiments, researchers used "macro" measures of task performance such as "time on task" (TOT) and did not conduct a micro-analysis of concrete operations, of which the the whole task consists. The main idea of our experiment was to conduct this micro-analysis of concrete operations.

2 Experiment

2.1 Design

In our experiment, 30 subjects performed a computer-assisted text editing tasks. The experimental task was to make corrections in a computer file, based on a hard-copy version of a text containing hand-written corrections. No a priori time limits for completing the tasks were given, and subjects could work at their own pace. Experimental sessions took approximately 40 minutes each, depending on the individual speed.

During the experimental sessions, subject's work activity was disturbed by a number of interruptions – phone calls – when the subject was told to perform another task, referred to as secondary task. Interruptions affected three types of concrete editing operations: (a) typing in new text – *new*; (b) regular editing (making simple corrections) – *regular*; (c) moving a block of text to a new location – *move*.

The independent variable was the presence/absence of interruption. The dependent variable was editing latency for concrete operations.

2.2 Apparatus and Materials

The experiment took place in a simulated office environment. The 40 m^2 laboratory was divided into two rooms by a wall. One room has been equipped as an office workplace (with furniture, personal computer, intercom telephone), while the other was used as a control room. At the office location a tripod video camera was placed to monitor the subject. The video signals from the camera and from computer screen were routed to a video mixer in the adjacent control room. From this room the experimenter controlled the experiment and watched the mixed video signal (view of the subject plus contents of the subject's computer screen) via the video monitor. The mixed video signal supplied with 0.01 second precision timecode was also recorded on a VCR for further analysis.

2.3 Moments Measured and Time Intervals Calculated

The general scheme of moments measured in the experiment and time intervals calculated for data analysis is presented in Figure 1.

Moments measured:

- T_{start} and T_{end}: start and end of operation;
- t_{ring}: moment of ringing of the phone;
- picking up the phone has been considered to be the start of the secondary task (t_{start});
- the last visible operation of the secondary task has been considered to be the end of the secondary task (t_{end});
- T_{stop}: stop of performing the main task, i. e. full switch to the secondary task;
- resumption of the main task ($T_{resumption}$): return of subject's attention to the main task after finishing the secondary task;
- point of continuation ($T_{continuation}$): first action in continuation of the main task after interruption.

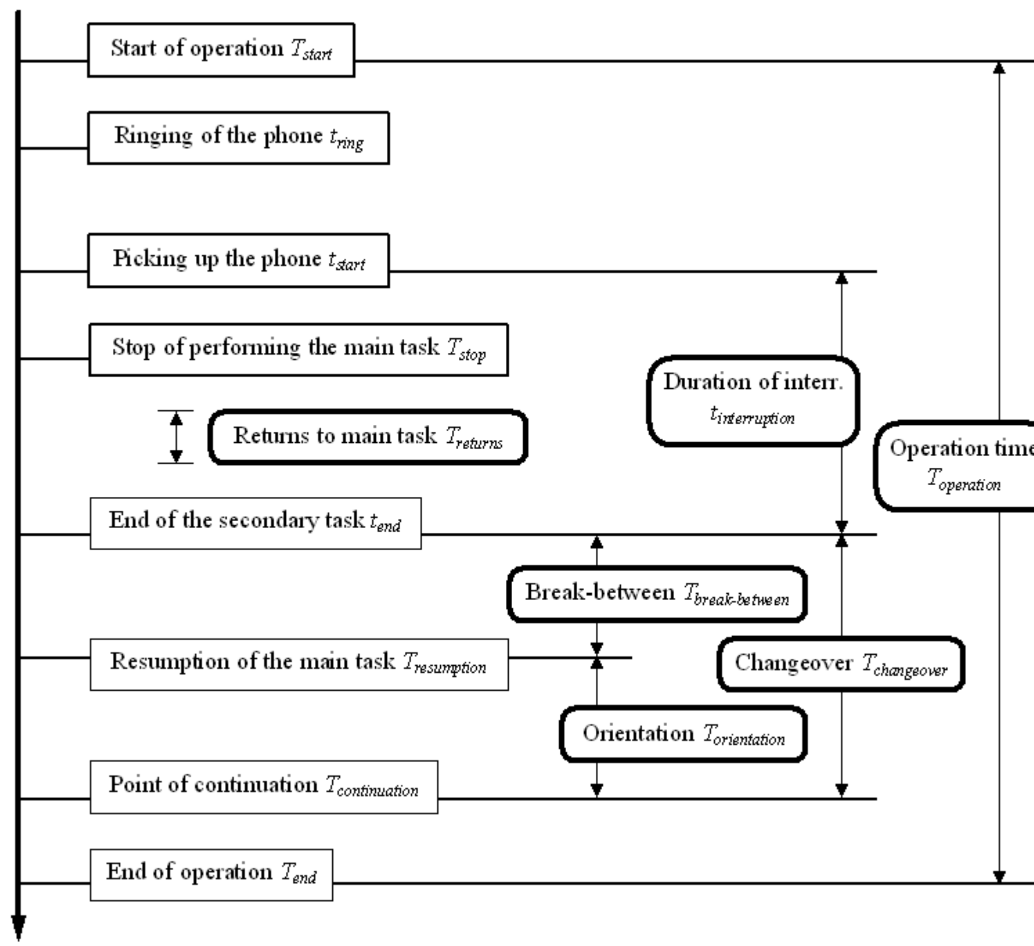

Figure 1: Moments measured in the experiment and time intervals calculated for data analysis

Time intervals calculated:

- operation time ($T_{operation} = T_{end} - T_{start}$): time spent to perform the operation including the secondary task;
- duration of interruption ($t_{interruption} = t_{end} - t_{start}$): time between picking up the phone and the last visible operation of the secondary task;
- returns to main task ($T_{returns}$): sum time of returns to the main task while working on the secondary task;
- break-between ($T_{break-between} = T_{resumption} - t_{end}$): time interval between the last visible operation of the secondary task and starting the resumption of the main task;
- orientation ($T_{orientation} = T_{continuation} - T_{resumption}$): time between starting the resumption of the main task and the first action in continuation of the main task;
- changeover ($T_{changeover} = T_{break-between} + T_{orientation}$): a sum of break-between and orientation;

- net operation time ($T_{net} = T_{operation} - t_{interruption} + T_{returns}$): operation time minus duration of interruption plus returns to the main task;
- net operation time minus time of orientation ($Q_{net} = T_{net} - T_{orientation}$).

3 Results

3.1 Effects of Presence of Interruptions on Concrete Operation Performance

The ANOVA revealed significant main effect of the presence of interruption on the net operation time (T_{net}) for operation *move*, $F(1,93) = 9.91$, $p = 0.0022$, but showed no significant effect of the presence of interruption for operations *new* and *regular*.

After obtaining this result, we made an attempt to answer the question why net operation time increases when operation is interrupted. Our working hypothesis was that this increase could be explained by the time of re-orientation in the main task after completing the secondary task ($T_{orientation}$). In order to confirm this hypothesis, we conducted the same analysis for the net operation time minus time of orientation (Q_{net}). Difference between experimental conditions *Yes Interruption* and *No Interruption* became nonsignificant. This finding suggests that namely the orientation interval ($T_{orientation}$) is mainly responsible for increase in the net operation time (T_{net}) for interrupted operations.

3.2 Factors That Influence the Orientation

In order to explore factors that may influence orientation interval ($T_{orientation}$), we have analysed its dependence on the type of interrupted operation. Mean values for $T_{orientation}$ for operations *new*, *regular*, and *move* were 5.4, 8.7, and 12.8 seconds, respectively. The difference was significant between operations *new* and *regular*, $t(38) = -2.15$, $p = 0.038$, and between operations *new* and *move*, $t(55) = -3.04$, $p = 0.004$.

4 Discussion

Statistical analyses revealed the significant effects of presence/absence of interruptions on the editing latencies for cognitively complex editing operations (such as moving a paragraph to a new location), while the performance for cognitively simple editing actions (e. g. typing in a new paragraph) were not affected by interruptions. A probable explanation to this fact may be that operation *new* is the simplest operation in text editing. It involve neither search and location of some point in the text (as for operation *regular*) nor include complex sequences of actions and additional mental load caused by the necessity to mentally track the contents of the clipboard (as for operation *move*). Operation *move* is an example of a “functional thread”, i. e. a series of commands or actions, and effects of interruptions on this type of operations were more disruptive.

These results are consistent with findings of Speier, Valacich & Vessey (1997, 1999), where interruptions were found to facilitate performance on simple tasks, while inhibiting performance on more complex tasks, and also results of Bailey, Konstan & Carlis (2000, 2001), where interruptions slowered all categories of tasks except *registration* task, because the latter required the lowest memory load at the point of interruption and less effort to resume the main task after interruption.

Our results also suggest that the task re-orientation after the interruption is mainly responsible for increase in net operation time (T_{net}) for interrupted operations.

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