Improving the Human–Computer Dialogue With Increased Temporal Predictability

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Objective: An experiment was conducted to investigate the impacts of length and variability of system response time (SRT) on user behavior and user experience (UX) in sequential computing tasks.

Background: Length is widely considered to be the most important aspect of SRTs in human–computer interaction. Research on temporal attention shows that humans adjust to temporal structures and that performance substantially improves with temporal predictability.

Method: Participants performed a sequential task with simulated office software. Duration and variability, that is, the number of different SRTs, was manipulated. Lower variability came at the expense of on average higher durations. User response times, task execution times, and failure rates were measured to assess user performance. UX was measured with a questionnaire.

Results: A reduction in variability improved user performance significantly. Whereas task load and failure rates remained constant, responses were significantly faster. Although a reduction in variability came along with, on average, increased SRTs, no difference in UX was found.

Conclusion: Considering SRT variability when designing software can yield considerable performance benefits for the users. Although reduced variability comes at the expense of overall longer SRTs, the interface is not subjectively evaluated to be less satisfactory or demanding. Time design should aim not only at reducing average SRT length but also at finding the optimum balance of length and variability.

Application: Our findings can easily be applied in any user interface for sequential tasks. User performance can be improved without loss of satisfaction by selectively prolonging particular SRTs to reduce variability.

Keywords: system response times, temporal variability, temporal attention, subjective task load, waiting times, human–computer interaction, user behavior, user experience

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INTRODUCTION

In a seminal study, Kubovy and Pomerantz (1981) stated that one dimension of human perception has largely been neglected, even though it is absolutely essential to human perception and action: time.

In computing systems, people encounter time in the form of system response times (SRTs), which are defined as the time elapsed from entering a command until its completion (Miller, 1968). For example, when one clicks on the "Save" button or on a hyperlink, the system needs some time to process the task before the prompt window asking where to save the file appears or before the linked file or webpage is loaded. SRTs are determined by system characteristics, such as processing capacity and network bandwidth, as well as situational factors, such as the complexity of the computational processes at a given time and processor or network load. SRTs can affect user response time (URT), the time the user needs to perceive and process the computer output and enter a further command after the system has responded, by two determinants: the average length of the SRTs and the variation of SRTs.

SRT Duration

Early studies on SRTs focused on the impact of SRT length on user performance. From conditioning experiments of the 1950s, Miller (1968) derived a critical upper SRT boundary of 2 s for human performance within one task, which has been widely diffused in application (Nielsen, 1999; Shneiderman & Plaisant, 2009). Participants had to search for a blank target space between two letters, mark it, correct it, and wait for the next trial, which had two different average SRT durations (2 or 8 s) and two different variability modes (1 fixed SRT vs. 7 SRTs). Although task execution time (TET) did not depend on SRT duration, failure rate decreased with increasing SRTs, but at the same time, physiological and subjective stress levels