INFORMATION TECHNOLOGY PROGRESS INDICATORS: TEMPORAL EXPECTANCY, USER PREFERENCES, AND THE PERCEPTION OF PROCESS DURATION

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ABSTRACT

Users of information technology (IT) often encounter "progress indicators" during their interactions. These graphics (e.g., progress bars) appear on computing screens as a user waits for a task to complete. The purpose of a progress indicator is to inform the user of the progress being made as the task moves toward completion. This study employs the theoretical model of temporal expectation from the psychological research on human waiting to develop specific hypotheses related to the design of progress bars. The progress bar of interest is the "stalling progress bar." That is, a progress bar that moves consistently during most of the computing process, then stalls for an indeterminate period before completing. An experimental study compared the stalling progress bar to a progress bar that moves consistently in a linear manner. Results indicate that participants preferred the linear progress bar, and judged the process duration to be shorter with the linear progress bar thus confirming theoretical predictions.

INTRODUCTION

Users of information technology (IT) often encounter "progress indicators" during their interactions. Progress indicators are graphics that appear on the computer screen as a user waits for a task, such as down loading a file or updating software, to complete. Their purpose is to inform the user of the progress that is made as the task moves toward completion. Although progress indicators can take different forms, an extremely common progress indicator takes the form of a bar that moves across the screen as the task completes. As such, these indicators are referred to as "progress bars" [2] [3] [5] [14].

As a common feature in IT environments it is important to understand what form, content, and movement patterns of progress bars are appropriate to maximize the quality of the user experience. The research to date that has targeted the design features of progress bars has not been driven by structured theoretical frameworks. This has resulted in somewhat unrelated sets of results across studies. This study draws upon a theoretical model from psychological research on human experiences in waiting to develop specific hypotheses related to the design of progress bars. The idea is that progress bars appear on screen during a period of waiting as an underlying computing task completes. Accordingly, psychological models of waiting should apply in this context. Amer and Johnson [1] applied theoretical models of waiting to the design of progress bars that move in a consistent fashion across the computing screen during the duration of the computing process. The progress bar of interest in this study is the so-called "stalling progress bar." That is, a progress bar that moves consistently for most of the computing process but then stalls for an indeterminate period before resuming and completing. Results from an

experimental examination of the stalling progress bar when compared to a progress bar that moves consistently in a linear manner indicate that participants preferred the linear progress bar and judged process duration to be shorter with the linear progress bar.

BACKGROUND AND HYPOTHESIS DEVELOPMENT

Research efforts that examine the design parameters of progress indicators has been experimental in nature and has examined participants' perceptions of preference and process duration. Crease and Brewster [4] found that adding sounds to progress bars improved usability and increased user preference over progress bars without sound cues. Conrad et al. [2] varied the speed of progress bars in a manner to set user expectations regarding task completion. Participants in the study were more likely to "break-off" (i.e., abandon) from completing a survey if the progress indicator began moving slowly at the beginning of the task rather than one that began moving quickly at the beginning of the task. Matzat et al. [10] also examined the effect of progress bars in a survey scenario: a linear progress bar, a fast-then-slow progress bar, and a slow-then-fast progress bar. Their results were congruent with Conrad et al. [2] noted above. Harrison et al. [6] and Harrison et al. [7] examined several features of progress bars on user's perception of progress duration during a waiting period. In apparent contrast to Conrad et al. [2] and Matzat et al. [10], their results revealed that a progress bar that accelerates (speeds up) during the task was perceived faster than other types. Hurter et al. [8] explored the possibility of using "active progress bars" whereby users can switch to temporary (secondary) activities when a primary activity requires users to wait. Using the results of survey data they proposed samples of secondary activity applications, combining existing applications with a normal progress bar.

Waiting

A common aspect of the user experience addressed across the disparate studies cited above is waiting. Harrison et al. [7] suggest that in some user interfaces both novice and expert users have no choice but to watch and wait as progress indicators complete before moving forward with a task. Indeed, a key role of a progress indicator is to provide the user with feedback as they wait for a task to complete [2]. This experience is similar to other human experiences of waiting, such as waiting in physical queues at a bank or in queues while on the telephone waiting for operator assistance. Psychologists have examined these similar waiting scenarios from the perspective of psychological frameworks. We propose that applying psychological frameworks of human waiting can shed light on the design of progress indicators and perhaps more tightly focus research efforts and explain some of the varied findings in prior work on progress indicators. Two such frameworks are the sense-of-progress framework and the subjective-sense-of-time framework [11] [12] [14] [15].

The sense-of-progress framework argues that affective response during a waiting scenario is regulated by the perceived distance between current position and goal. Progress toward the goal is necessary for user satisfaction. The subjective-sense-of-time framework contends that humans possess subjective mental timers that focus on the passage of time. Factors that draw attention away from the passage of time are argued to halt the timers and therefore positively affect the perceived passage of time. Amer and Johnson [1] applied both frameworks to the design of consistently moving progress bars presented to participants in a laboratory setting. Results indicated that the linear moving progress bar was preferred by participants and was judged to provide a greater sense of progress toward the completion of a file download task. They also discovered that a video progress indicator was preferred by participants and was judged to have shorter process durations during a file download as it drew participants' attention away from the waiting experience.

A third psychological framework is examined in this manuscript: the temporal-expectancy framework [9]. Under this framework temporal expectations regarding the duration of a wait may influence people's perceptions of pleasantness of the waiting experience. A key source in setting temporal expectations is prior experience. That is, people will base their expectation as to the duration of a wait based upon experience. It seems reasonable that this framework could apply to a situation where a computer user in a waiting setting is exposed to a progress bar that begins, moves consistently, but then stalls just prior to the completion of the task. This so-called "stalling progress bar" appears surprising often during computer interactions. Applying the temporal-expectancy framework to this waiting scenario would indicate that user expectations as to the duration of the wait are set during the initial movement of the progress bar but then are disrupted by the stalling of the bar just prior to completion. In contrast, a progress bar that moves consistently from beginning to end (a linear progress bar) establishes a defined sense of temporal expectancy related to the duration of the wait. Therefore, a stalling progress bar will be judged less preferable and judged to be of a longer duration than a linear progress bar [9].

> **H1:** A stalling progress bar will be less preferable to a linear progress bar during an IT process interaction.
>
> **H2:** A stalling progress bar will be judged to communicate a longer process duration than a linear progress bar during an IT process interaction.

RESEARCH METHODOLOGY AND DESIGN

Computerized Procedure

A laboratory experiment was conducted to test the hypotheses set forth above. Participants sat individually at computers in a laboratory setting and responded to prompts that were displayed on a computer screen. The programmed data-elicitation instrument controlled the presentation of the experimental factors, optimally ordering and randomizing the variables. In a within-subject design, participants viewed all possible configurations of progress bars while downloading photographs from a central server. All data collected was sent to a file stored on a central server.

Participants and Task

The authors recruited 65 upper-division students from a large university to complete the exercise. The participants were provided with a nominal level of extra-course credit as an incentive to complete the exercise. The participants were 60% male and younger than 25 years of age. At the start of the exercise, participants were informed that the purpose of the study was to obtain feedback as they downloaded files. Next, they read through a scenario on their computer screens explaining that they would download several photographs from a central server. The scenario described a common file-downloading situation in which the participant was interacting over a computer network to download photographs from a remote location. Progress bars (discussed below) were displayed on the screen as each photograph downloaded.

Progress Bars Utilized

One of two types of progress indicators was displayed on the computer screen as each photograph downloaded. The first progress bar shown in Figure 1.a. was a stalling progress bar where the bar moves consistently (linearly) to 95% of its total length in a period of time called the "advance-period," and then

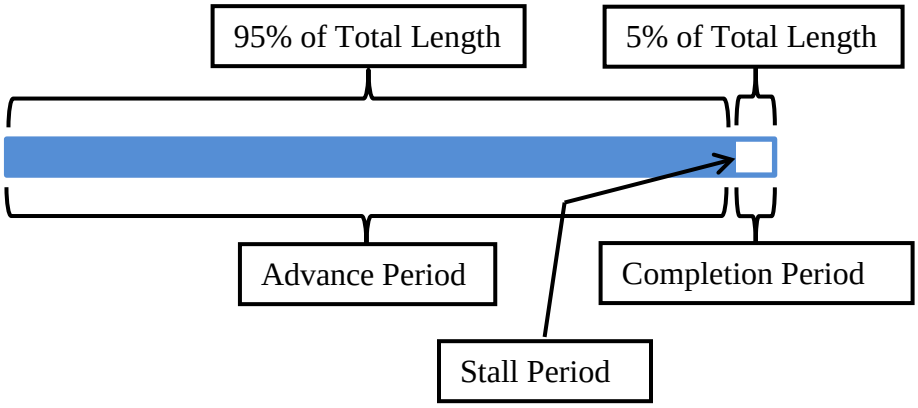
stalled for a period of time called the "stall-period". The bar then restarted and moved consistently to completion in a period of time called the "completion-period." This progress bar violates the temporal expectancy of the user as the consistently moving bar during the advance-period establishes expected download duration in the mind of the user. The stall period then disrupts this expectation leaving the user uncertain as to the total time of the download.

The second progress bar was a linear progress bar as shown in Figure 1.b. The movement of this progress bar was consistent and perfectly correlated with the total duration of the download. As such, this progress bar does not violate the temporal expectancy of the user as the bar moves consistently during the entire download period.

FIGURE 1

Progress Bars Used in the Experiment

a. Stalling Progress Bar – Violation of Temporal Expectancy



b. Linear Progress Bar – Non-Violation of Temporal Expectancy

Four different total duration periods for the progress bars was incorporated in the experiment: 12 seconds, 16 seconds, 18 seconds, and 27 seconds. Therefore, each participant received a total of eight different progress bars while downloading eight different photographs: Four stalling and four linear. It should be noted that the sum of the three periods of the stalling progress bars (advance-period + stall-period + completion-period) equaled the total time of the linear progress bars.

RESULTS

Each participant responded to questions after completing the eight file downloads. The questions elicited data regarding the participant's preference for one of the two progress indicators they experienced, their expectations as to the movement pattern, and their judgment as to the duration of the download duration. Table 1 displays the results for the 65 participants. The data in the top panel of Table 1 indicates that the participants had a strong preference for the linear progress bar: Approximately 90 percent of the

participants said they preferred this progress indicator. Moreover, 74 percent indicated that when the progress bar appeared on screen and began to move they anticipated that the bar would move consistently across the screen at the same speed and without stopping during the entire download. This later statistic indicates that temporal expectancy was instilled in the participants as the progress bar began to move. Taken together, these results provide strong support for hypothesis **H1 –** A stalling progress bar will be less preferable to a linear progress bar during an IT process interaction. All results were statistically significant ($p < .0001$).

The last elicitation question queried the participant's assessment of process duration. Sixty-eight percent perceived that the photographs downloaded faster with the linear progress bar even though the duration of the downloads was identical across both linear and stalling progress bars. This statistic provides support hypothesis **H2 –** A stalling progress bar will be judged to communicate a longer process duration than a linear progress bar during an IT process interaction ($p < .01$).

TABLE 1

Elicitation Regarding Preference

	Linear	Stalling
Which did you find the wait to be the most PLEASANT?	60	5
Which would you LIKE TO ENCOUNTER?	58	7

Elicitation Regarding Expectancy

When the progress indicator appeared on screen and began to move, did you ANTICIPATE the bar would move CONSISTENTLY across the screen at the same speed and without stopping during the entire download? **Yes** 48 **No** 17

Elicitation Regarding Process Duration

	Linear	Stalling
Which downloaded the files FASTEST?	44	21

SUMMARY AND DISCUSSION

This study investigated the application of a psychological model of waiting to progress bars in IT environments: the temporal expectancy framework. The results have implications for both practice and research. Systems designers can use the results reported in this paper to improve the user interface by incorporating appropriate characteristics in the design of progress indicators. Combined with the results reported by Amer and Johnson [1] models of waiting can be used in the effective design of progress indicators. Based upon our data, designers should avoid violating users' expectations regarding process duration during the waiting period by incorporating a stalling progress bar. In addition, as reported by Amer and Johnson [1] the "cycling" progress indicator should be avoided. This indicator provides neither a sense of progress nor any information regarding the duration of the waiting time.

Future research could apply these and other frameworks of waiting to IT progress indicators exhibiting other relationships and design parameters. For example, future research could investigate the relative preferences when comparing the linear progress indicator and the video progress indicator examined by Amer and Johnson [1]. Other types of progress indicators can also be examined, such as offering a textual message (for example, "26% completed") as the task moves toward completion. Finally,

additional waiting frameworks could also be applied to progress indicators and the waiting experience in IT environments. For example, Maister [11] notes that uncertain waits are perceived to be longer than known, finite waits. This may have implications for IT interface design in the context of waiting, such as structuring the system to provide information in a manner that reduces user uncertainty.

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