Time perception with a concurrent variable-speed progress bar

Julian Missig and Daniel Dickison

Carnegie Mellon University

Abstract

The aim of this study is to investigate how attention and temporal uncertainty play a role in the perceived duration of computer progress bars. One goal of computer interface design is to reduce the perceived duration of unavoidable delays, and progress bars are commonly employed to this end. The attentional gate model (Zakay, Block, & Tsal, 1999) predicts that the amount of attention paid to a prospective temporal task is positively related to its perceived duration, and that greater temporal uncertainty leads to higher attention to the temporal task. We manipulated temporal uncertainty of progress bars by varying consistency in the speed of progress bar movement. While the speed manipulations were insufficient to show significant differences, duration estimates when there was no progress bar was shorter than when there was a progress bar for the 5 second condition. We propose that, at least for relatively short durations when there is a concurrent non-temporal task (as in this experiment), more attention is paid to the temporal task when there is a progress bar. Thus in some instances it could be desirable to have no visual cue of duration.

Time perception with a concurrent variable-speed progress bar

What affects perception of time? If one is attending to a task and that task contains within it a representation of time, will one's perception of time be more accurate? What if that representation is misleading?

Computer users spend quite a bit of time looking at progress bars—visual indicators of the amount of time left until the computer completes its current task. These progress bars are a percentage representation of time, but often a misleading one. The computer is constantly re-adjusting its best estimate as to how long a task is going to take and responds by speeding up or slowing down the progress bar. It is hypothesized that the visual feedback a user receives from a progress bar can affect that user's perception of time.

Previous studies have been done on the time perception with concurrent non-temporal tasks (Hemmes, Brown, & Kladopoulos 2004) in which participants were shown to underestimate the amount of time a task takes. The current model for such underestimations is the attentional gate model (Zakay, Block, & Tsal, 1999), which posits an internal clock which outputs time pulses. These pulses are accumulated only if a person is attending to the internal clock—which they can only do in between attending to other tasks. Therefore any task which is not temporally-based will take attention away from the internal clock, causing a decrease in the number of time pulses accumulated, which in turn causes a decrease in apparent duration.

If a progress bar is a non-temporal task, it will take attention away from the internal clock, causing an underestimation in task duration. If, however, a progress bar is a temporal task, it will facilitate attention to the internal clock, causing an estimation of task duration closer to the correct duration. Even more interesting is what happens when the progress bar is giving misleading feedback—if it starts out slow and then speeds up, it is a temporal task providing misleading information about time. What happens then?

In this experiment, we will be presenting the participants with consistently-timed progress bars, no progress bar, and progress bars in which the speed is readjusted halfway through—fast then slow, and slow then fast. Unfortunately, it has been shown that people can accurately time tasks by counting, and we are not interested in knowing whether people can count correctly while watching a progress bar; we want to see their time perception without counting. We therefore have the participants compute a running sum while waiting for the progress bar to complete. This concurrent task should adequately interfere with any counting ability the participants may have had.

Another procedural difficulty arises in attempting to gauge perceived time. The standard in the field seems to be one developed by Hirsh et al (1956). After the progress bar completes, the participant presses a button to start a timer and then presses the button again to stop it.

The tested durations are 5 and 10 seconds long. With longer times the participants tend to become too inaccurate in their perceived duration. Shorter times seemed to be too short for there to be any effect of the progress bar.

Our hypothesis that an inconsistent progress bar will have an effect on the participants' perception of time compared to the consistent progress bar which gives more accurate feedback. We do not believe that participants will correctly compensate for the changes in speed of the progress bar.

Method

Participants

Fifteen undergraduate students participated in the study voluntarily because they were friends of the investigators. Five participated in the first version of this experiment and ten participated in the second.

Apparatus

The experiment was created using PsyScope for Mac OS X. It was a full-screen computer-run experiment using a white background with black instruction text. A piece of software was written to generate standard Mac OS X 10.3 aqua progress bars. The output from this program was recorded as movie files and incorporated into the PsyScope experiment. The experiment was run on one of two laptops.

Materials

The progress bars were primarily grey/clear with a blue aqua fill color. The progress bar animation featured slight dark blue coloring which animates even when the bar itself is not moving or is only moving slowly, which is standard for Mac OS X. Audio files for each number were recorded by the experimenters and played over a set of headphones.

Design

The experiment was designed to be within-subject. The factors were duration of the task and progress bar type, which were crossed with one another. The dependent variable was duration estimate obtained from a reproduction of the task length, similar to Hirsh et al (1956). Two versions of the experiment were run because the first was found to be too long.

In the first version, the task duration was 2, 5, or 10 seconds and the progress bar either did not fill (none), filled at a consistent rate (consistent), filled slowly and then quickly (slow-fast), or filled quickly and then slowly (fast-slow). This totals to 12 conditions. The audio for the concurrent addition task was played randomly spaced between 0 and 5000 ms, with a maximum of 10 per trial. Ten trials were run for each of the 12 conditions, totaling 120 trials per experiment session.

Since the first version was found to be too long, a second version was created. The task duration was either 5 or 10 seconds, and all four progress bar conditions were kept for a total of 8 conditions. Only 5 trials were run for each of these 8 conditions, totaling 80 trials per experiment session.

Procedure

A trial began with the participant pressing the space bar. He or she was then visually presented with a progress bar while aurally listening to numbers. As soon as the 2-, 5-, or 10-second limit was reached, the audio stopped. The participant added up the numbers while watching the progress bar and at the end of the trial pressed the space bar followed by the last digit of the final computed sum (so it is a number between 0 and 9). The participant was then given feedback about whether the digit was correct or not and was asked to estimate the duration of the addition task. He or she pressed the space bar to begin an estimate, then again to end, thus mimicking the space bar at the beginning and end of the actual addition task.

Results

One of the participants misunderstood the instructions and tapped the space bar as fast as possible for the none condition. Her data was removed. For the other 14 participants, the median duration estimate was taken for all conditions. These estimates were transformed into a proportion of actual duration, as shown in Figure 1.

An analysis of variance shows a significant main effect of duration, $F(1,13) = 164$, $p < 0.05$. The 10-second task was estimated to be proportionally shorter than the 5-second task. There was also a significant interaction between progress bar type and duration, $F(3,39) = 3.70$, $p < 0.05$.

Paired t-tests were performed comparing each condition within the 5-second duration to each other condition in the 5-second duration. The same were performed for the 10-second progress bar type conditions. For the 5-second duration, none was found to be estimated significantly lower than consistent, $t(13) = -2.643$, $p < 0.05$. None was also found to be estimated significantly lower than the mean of the other three conditions, $t(13) = -2.287$, $p < 0.05$. None of the other pairs within the 5-second duration were found to be significantly different. None of the pairs of progress bar conditions within the 10-second duration were found to be significantly different.

Discussion

We did in fact find a difference between having a progress bar and not having a progress bar for the 5-second duration. This is what would be predicted using the attentional gate model if the progress bar is a temporal task (Zakay, Block, & Tsal, 1999). The progress bar increases attention to the internal clock, causing a greater accumulation of time pulses, which means a more accurate perception of how much time has elapsed.

Without the progress bar, the participant is attending to the concurrent task quite a bit more and does not accumulate as many time pulses.

Why, then, did we not see a significant difference during the 10-second duration? It would seem that our concurrent addition task might have taken a lot more attention. This could be because the participants have to add more numbers and spend more time refreshing the current sum in their mind, or it could be because the participants' attention simply wanders from the progress bar if too much time is taken. Regardless, it does seem that the lack of a progress bar has a greater effect for shorter time periods. It is unfortunate that we did not choose to continue with the 2-second and 5-second durations instead of choosing 5-second and 10-second, but it seemed that the reproduction task might not have been accurate enough for 2-second tasks.

It is also unfortunate that we were not able to show any difference between progress bar consistencies. It is interesting that there is a visual increase in error for the fast-slow condition in comparison with the other two progress bar-existent conditions. The participants do seem to have been slightly misled. We do believe that this should be the cast, but this experiment simply did not adequately show it. The first possibility as to why this could be is simply a lack of power. The other is that we did not have enough of a difference in estimation—our progress bars were not going slow enough when they were going slow and not fast enough when they were going fast.

It is clear, though, that the lack of progress bar does cause an underestimation of time for the 5-second duration. While current models predict this, it is a somewhat counterintuitive result and has interesting applications for computer interface designers—progress bars should be left out if the task is 5 seconds long (and perhaps less).

References

Hemmes, N. S., Brown, B. L., & Kladopoulos, C. N. (2004). Time perception with and without a concurrent nontemporal task. *Perception & Psychophysics, 66(2)*, 328-341.

Hirsh, I. J., Bilger, R. C., & Deatherage, B. H. (1956). The effect of auditory and visual background on apparent duration. *American Journal of Psychology, 69(4),* 561-574.

Zakay, D., Block, R. A., & Tsal, Y. (1999). Prospective duration estimation and performance. In D. Gopher & A. Koriat (Eds.), *Attention and Performance XVII: Cognitive regulation of performance: Interaction of theory and application* (pp. 557-580). Cambridge, MA: MIT Press.

Figure Caption

Figure 1. Error of duration estimates shown as a proportion of actual duration. Zero would mean complete accuracy in reproduced duration.

Figures

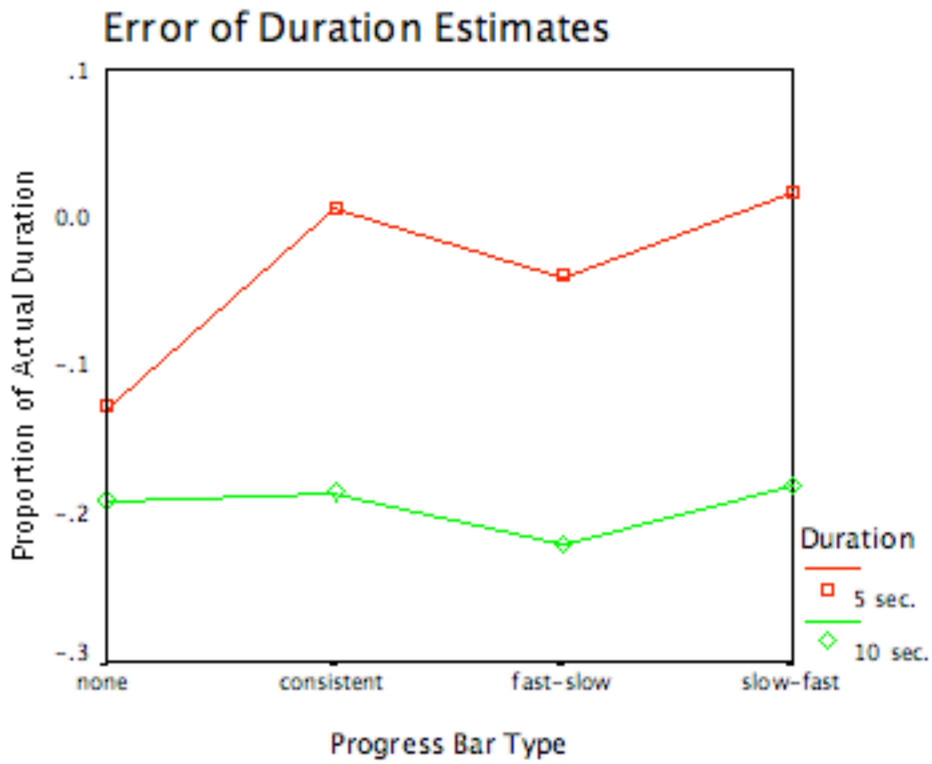

Figure 1