Feedback Preferences and Impressions of Waiting

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Objective: Three experiments examined the effects of various feedback displays on user preference, apparent waiting durations, waiting time reasonableness, and other user experience measures. **Background:** User interface guidelines advocate keeping users informed about system status; however, the duration estimation literature shows that focusing on temporal information makes the wait seem longer. How can designers reconcile these issues? **Methods:** In three experiments, students chose movies from a simulated movie database and then were shown feedback displays (static, sequential dots, constant-rate progress bars, or variable-rate progress bars) for different durations. Users judged how reasonable the wait was and how long it lasted and then ranked their preference for the dialogs. **Results:** The pattern of preference results was different from duration-related judgments. Users preferred feedback that provided more information. On the other hand, when judging duration, users perceived simpler interfaces as being most reasonable. **Conclusion:** Different types of feedback are required for reducing perceived wait and increasing preference. Ratings of wait time reasonableness were consistent with the attentional gate theory of prospective timing; attention-demanding activity caused the wait to seem less reasonable. Preference, on the other hand, requires keeping users informed about the progress of operations. **Application:** Users prefer more feedback rather than less, even if it makes the wait seem less reasonable. However, the constant progress bar performed at the top of both reasonableness and preference, keeping users informed without increasing arousal or focusing attention on temporal stimuli. Other options are also discussed to make duration perceptions more reasonable.

INTRODUCTION

Unfortunately, waiting is a common occurrence when using interactive devices, especially ones that access media and information from the World Wide Web. It has been demonstrated that users can begin to lose interest in the task at hand with wait periods as short as 2 s (Nah, 2004). However, users tend to be more satisfied when provided with feedback confirming that the device is processing their request. These simple premises are the basis for user interface guidelines, which suggest keeping users informed during waiting periods (Nielsen, 1994; Shneiderman & Plaisant, 2005; Wickens, Lee, Liu, & Becker, 2004).

Delays and Computer Interaction

Slow response is a major source of annoyance with computing. Even as broadband and other high-speed data streams connect devices, growing graphic and multimedia content mitigate speed improvements. As a result, download and response times remain primary concerns for most computer users.

There are several good reasons for users to be frustrated by such delays (Ryan & Valverde, 2006). When people use computers (even if just for entertainment), their activities tend to be goal directed. Achieving these goals requires some measure of planning, and computer delays can force the user to "make a mental note" to which

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they will need to return after the computer has finished processing. Such delays could place increased demands on the user, reducing cognitive resources available for other tasks. In essence, the user is being paced by the computer's performance rather than by their own goals (Lambert, 1984; Stokes & Halcomb, 1988). At the very least, this could frustrate users and, in the worst case, might have an impact on how effectively people achieve their goals.

Delays interrupt a sense of continuity and flow, reducing feelings of control and engagement in the task while potentially fostering a negative opinion of the task or material itself (Nielsen, 1996; Ramsay, Barbesi, & Preece, 1998; Rose, Lees, & Meuter, 2001; Sears, Jacko, & Borella, 1997; Selvidge, Chapparo, & Bender, 2002). Furthermore, operations that take a long time increase the penalty of making a mistake, because resubmitting operations or requests cannot be accomplished quickly.

User expectations of content may also influence duration perception. For example, Jacko, Sears, and Borella (2000) found that users who were required to wait a long time when accessing a Web page became more frustrated when the site contained substantial graphic material, as they assumed that the graphics were causing the delay. However, users who experienced the same delays for a text-only version did not express the same frustration. In fact, users preferred a text-only site to a text-plus-graphics site of the same information when waiting periods were long (Jacko et al., 2000).

Feedback Methods

Several methods are commonly implemented to provide feedback. Static displays (e.g., providing a message such as "Please Wait") are the simplest. Obviously, these types of displays do not indicate how fast the operation is progressing, how long it will take, or even if the system has crashed and left the message displayed. Dynamic displays, on the other hand, provide movement on the screen to indicate that the process is pending and that the system has not crashed. For example, dots may "move" across the screen in regular intervals while the user waits. Although these indicate that the system is working on the request, they do not help the user understand how much of the process has completed or how much longer it will take.

A third approach, the progress bar (Myers, 1985), provides more detailed information. Often represented as a bar that fills from 0% to 100%, the progress bar shows how much of the process has completed and enables the user to estimate how much longer the process will take. One issue with this approach is that for many operations, it is impossible to determine how long a wait will last. As a result, the rate of change is variable, reducing the progress bars' information value. Despite this limitation, progress bars set user expectations, reduce uncertainty, facilitate multitasking, and may reduce anxiety (Myers).

Intuitively, one might expect dynamic displays such as progress bars and moving dots to be preferred to static displays, as they at least provide something for the user to attend to while waiting. Furthermore, one might even expect the users' estimates of elapsed time to be shorter under these conditions for the same reasons.

Contrary to this intuition, Meyer, Shinar, Yuval, and Leiser (1996) found that when it comes to user feedback, more is not always better. Specifically, they found that cumulative displays (similar to progress bars) that updated with a fast tempo yielded longer duration estimates than those that updated with slow tempos. That is, providing more information, in the form of more frequent updates, actually made the wait seem longer, contradicting the intuitive approach described earlier.

Instead, these findings suggest that the volume of information one encodes while waiting leads to increases in perceived duration (Meyer et al., 1996; Thomas & Weaver, 1975; Zakay & Block, 1997). This is likely based on a simple heuristic that because events require time, waiting periods with more events must take longer than periods with fewer events. This is similar to watching a second hand on the clock while waiting for a period to end. When people focus their attention on temporal information, naturally, the duration is perceived to be longer (Macar, Grondin, & Casini, 1994).

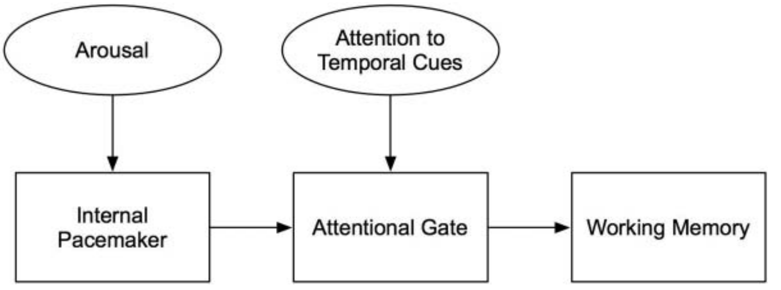

Figure 1. The attentional gate model of prospective time estimation. Adapted from "Temporal Cognition," by D. Zakay and R. A. Block, 1997, *Current Directions in Psychological Science*, *6*(1), p. 14. Copyright 1997 by Association for Psychological Science. Adapted with permission.

The Attentional Gate and Duration Estimates

These duration estimation findings are consistent with the attentional gate model of prospective timing (Block & Zakay, 1996; Zakay & Block, 1997). A simplified version of this model is illustrated in Figure 1. In this model, an internal process called a pacemaker produces pulses at a particular rate. This rate is increased or decreased as a function of arousal: The more aroused the person, the faster the pacemaker pulses.

A second part of the model is a gate that opens wider when people pay attention to time and closes tighter when they pay attention to something else or simply fail to pay attention to temporal stimuli. When this gate is open, more pulses are counted and proceed to working memory. When it is closed, fewer pulses are counted and are relayed to working memory. Working memory stores a representation of how much time has elapsed based primarily on the number of pulses it has received. The more pulses, the more time it assumes has elapsed. Thus, if the goal is to reduce duration estimates, one should either reduce arousal or discourage attention to temporal information.

Displays that emphasize change with many discrete movements may increase arousal or focus attention on temporal information, thus making durations seem longer. Conversely, displays that minimize changes should keep arousal in check and reduce the focus on time, making durations seem shorter. Unfortunately, it is difficult to know exactly which of the two processes are being affected—the pacemaker or the attentional gate—because they are likely to be affected by the same types of stimuli. Regardless, the message is clear: Reducing arousal or the focus on temporal information should reduce duration estimates. In addition, one would expect that the perceived wait duration should influence user satisfaction and preference.

Thus, although intuition suggests that duration estimates will be shorter, and preference will be higher, for displays that keep the user informed, attentional gate theory predicts that perceived duration should be longer for displays that provide a lot of detail and frequent updates. Furthermore, because preference is likely affected by peoples' perception of duration, preference might be lower for detailed displays that update frequently. In a series of three studies, we explored the relationship of feedback detail on user estimations of duration, reasonableness, and other user experience measures.

EXPERIMENT 1

In the first study, participants were given the task of ordering movies (to be delivered by mail, similar to popular online movie rental services) from a simulated movie Website and then were presented with one of three feedback indicators (static, sequentially filling dots, or progress bar) for one of two durations (15 s or 30 s). After each trial, the participants rated the reasonableness of the download time and estimated the number of seconds that the download required. The judged reasonableness of waiting was included in addition to duration estimation, as it is an evaluative measure and thus tends to be more stable than estimates of duration (Doob, 1971). Finally, at the end of the experiment, they chose which of the three feedback styles they preferred.

Method

Participants. Participants were 23 students at a large public university in the southwestern United States, who took part in this experiment for course credit.

Design. Using a within-subjects design, each participant experienced all combinations of three dialog types (static, sequential dots, and progress bar) and two durations (15 s and 30 s). Presentation order was randomized for each participant.

Materials. Participants interacted with a simulation of an online movie database programmed in Matlab (The MathWorks, 2008), run on an i386 architecture PC. Instructions displayed on the computer screen indicated that the experimenters were interested in studying peoples' choices of movies and that they would be acting as online shoppers to choose movies from an online database of 130 movies from various genres for six different audiences. Participants signed a consent form, which included an agreement not to discuss the experiment with others, as this might affect the validity of the research.

Procedure. Participants were seated in front of the computer, facing away from the wall clock, and were asked to turn off their cell phones. Because we did not want to highlight the fact that we were focused on timing, we did not ask participants to take off wristwatches. On the other hand, few participants wore wristwatches (nowadays college students often rely on their cell phones to keep time), and the experimenter monitored the participants to ensure that they did not watch time as they conducted the experiment.

On each trial, participants were informed of their audience for that trial (a young boy, young girl, teen boy, teen girl, adult male, and adult female) and were asked to choose three movies that would be appropriate for that audience. After the participant had chosen three movies and clicked the "Place Order" button, a modal feedback dialog appeared. Depending on condition, the dialog was static, sequential dots, or a progress bar and remained on the screen for either 15 s or 30 s. Each dialog contained the text "Processing your order. Please wait." The static display simply contained the text described and no additional information. The sequential dot display contained three empty circles, which filled at a rate of 1 per second until all three circles were filled, at which point all circles emptied and the cycle repeated. The progress bar filled in at a constant rate, producing the perception of a continuously filling bar, rather than definable increments (as the increments are so small).

After the wait dialog disappeared, participants rated the reasonableness of the wait on a scale from 1 (*very reasonable*) to 7 (*not reasonable at all*) and estimated the duration of the wait time by selecting from a list ranging from 1 s to 120 s. After completing these ratings, the next trial began.

After all trials were completed, participants were shown the three displays on the same screen and were asked to rank order the three dialog methods according to their preference. Participants were then debriefed and dismissed. The entire experiment took no longer than 30 min.

Results

Reasonableness. Mean ratings of reasonableness, as well as mean duration estimates, are presented in Table 1. Not surprisingly, participants judged short waiting periods to be more reasonable than long ones, $F(1, 21) = 57.04$, $MSE = 0.98$, $p < .001$. Furthermore, there was a main effect of dialog type, $F(2, 21) = 4.35$, $MSE = 0.96$, $p < .05$. Consistent with the attentional gate theory, post hoc analyses using a least squares difference correction indicated that participants rated wait times in the static condition as more reasonable than wait times in the sequential dots condition, $F(2, 21) = 8.13$, $MSE = 0.57$, $p < .01$. However, the static display was not significantly different from the progress bar condition, and no other comparisons or interactions were significant.

Duration estimates. There was a main effect of presentation length, as participants estimated that shorter durations really were shorter, $F(1, 21) = 86.50$, $MSE = 31.00$, $p < .001$. There

TABLE 1: Mean Ratings of Reasonableness for Experiment 1

Duration	Static Wait	Sequential Dots	Progress Bar
Mean judged reasonableness			
Short (15 s)	3.2 (1.8)	3.8 (1.7)	3.4 (1.9)
Long (30 s)	4.5 (1.8)	5.1 (1.5)	4.6 (1.6)
Mean duration estimates			
Short (15 s)	13.2 (6.4)	15.0 (5.7)	14.0 (6.7)
Long (30 s)	23.6 (8.1)	23.2 (9.6)	23.6 (10.8)

Note. Reasonableness of the wait was rated on a scale from 1 (*very reasonable*) to 7 (*not reasonable at all*). Duration estimates were selected from a range from 1 s to 120 s. Standard deviations are in parentheses.

was no main effect for dialog styles, nor was there any interaction between dialog style and duration.

Preference. Preference data are in the form of ranks, so lower scores indicate greater preference. These data were analyzed using a repeated measures Friedman's ANOVA for rank data. The analysis indicate that some dialog types were clearly preferred, $\chi^2(2) = 31.72$, $p < .001$. (Because Friedman's ANOVA is nonparametric, it uses a chi-square distribution. As a result, it reports a chi-square rather than an F statistic.) Post hoc analyses using a Wilcoxon signed rank test showed that consistent with the intuitive model, and in disagreement with attentional gate theory, participants preferred the progress bar ($M = 1.09$, $SD = 0.29$) to the sequential dots ($M = 2.09$, $SD = 0.60$), $Z(1) = 3.73$, $p < .001$, and the sequential dots to the static wait dialog ($M = 2.69$, $SD = 0.56$), $Z(1) = 2.65$, $p < .001$.

Discussion

Consistent with the attentional gate (Zakay & Block, 1997), durations were judged to be less reasonable for sequential dots than for static displays. Conversely, consistent with the intuitive model, users preferred the progress bar, followed by sequential dots and finally the static display. This replicates the findings of earlier studies (Meyer et al., 1996; Myers, 1985). Finally, counter to both the intuitive and attention gate theories, there was no difference in reasonableness judgments between the static display and the feedback bar. What could account for this pattern of findings?

The pattern of preference has a simple explanation: User preference likely prioritizes being informed above the perceived duration of a given event. For example, if forced to choose, it is likely more important to know that the order is being successfully processed than for the wait to seem slightly shorter. Because the progress bar provides an indication that the process is working, as well as an idea of how much of the process has been completed, it is preferred to both moving dots and the static display. In other words, preference ratings adhere to our intuitive model: Users prefer to be informed about the progress of computing operations.

The judged reasonableness findings may have a fairly direct explanation as well. Although both the progress bar and sequential dots show movement on the screen, only the progress bar indicates the rate at which the order is progressing and how far along the process is. In just a glance, people can estimate of how much longer the process will take according to the proportion of the bar filled and the elapsed time so far, so there is no need to continuously monitor the progress bar.

However, the sequential dots move constantly but provide no indication of how far along the process is or how much longer it will take. As a result, people pay closer attention to temporal information on the sequential dot dialog, making the wait seem longer. Furthermore, because the progress bar updates continually at a fixed rate, it seems more like one constant event, whereas the filling and emptying of dots has the impression of many discrete events. Thus, although user preference depends on keeping the user informed, duration estimates adhere more closely to the attentional gate theory.

To further test the ability of attentional gate theory to predict duration estimates, a second experiment was conducted that added a degree of unpredictability to the behavior of the progress bar. For example, it is not always possible for programmers to predict exactly how long a computing process will require (Harrison, Amento, & Belf, 2007), and thus, progress bars stop from time to time, making it difficult for users to estimate how long the process will take. As a result, users may dedicate more attention to monitoring the process in addition to the fact that each time the bar stops or starts, this disruption may be perceived as a separate event. If attentional gate theory is correct, these changes should make the wait seem longer and less reasonable.

Furthermore, Experiment 2 remedied weaknesses that might reduce the ecological validity and generalizability of the findings of Experiment 1. For example, as Experiment 1 was programmed in Matlab (which has a rather graphically deprived interface), participants may have failed to recognize that the interface was supposed to represent a Web-based application, despite instructions to the contrary. It is possible that the closer resemblance to a desktop application than an online database in Experiment 1 may have influenced subsequent participant ratings. To address this issue of realism, the interface was reprogrammed in Macromedia Flash format, which is used frequently for online applications. Additionally, the second experiment expanded this investigation of feedback displays across several additional periods in the hopes of uncovering any additional interactions between length of time and feedback content.

EXPERIMENT 2

Method

Participants. Participants were 56 students at a large public university in the southwestern United States, who took part in this experiment for course credit. None of the participants was the same as in Experiment 1, and Experiments 1 and 2 were conducted during different semesters.

Design. Feedback duration was a within-subjects variable with four levels (30, 40, 50, and 60 s). Presentation order was randomized for each participant. Feedback format was a between-groups variable. Participants were randomly assigned to one of four conditions of display format (static, sequential dots, fixed-rate progress bar, and variable-rate progress bar).

Materials and procedure. The room and ground rules were the same as Experiment 1. Participants interacted with a simulation of an online movie database programmed in Flash CS3 and run on an i386 architecture PC. The simulation enabled the participants to choose from a list of eight recent movies of various genres. Instructions indicated that the participants' task, during each of eight trials (two trials for each of four levels of duration), would be to select a movie trailer that they would like to see and to download it by clicking the "Download" button.

After "Download" was clicked, participants were presented with a static display, sequential dots, constant-rate progress bar, or variable-rate progress bar depending on condition (for 30, 40, 50, or 60 s). Each dialog contained the text "Downloading your Movie Trailer. Please wait." The static display, sequential dots, and constant-feedback bar dialogues were similar to those used in Experiment 1, except that the sequential dot display included four dots rather than three.

The variable-rate progress bar was identical to the constant-rate one with the following modifications. Although the bar filled at the same overall average rate, it paused four times (determined at random for each trial) for a time period equal to 8%, 10% 12%, or 14% of the total time in that condition (e.g., the 10% pause in the 30-s condition would be 3 s). There was always a period equal to at least 10% of the total duration between pauses.

After each trial, participants were queried about how reasonable they thought the wait time was on a scale from 1 (*very reasonable*) to 7 (*not reasonable at all*). Following that, participants estimated the number of seconds the feedback dialog had remained on the screen by moving a slider on a scale from 0 s to 120 s.

In addition, participants were presented with two additional questions. The first asked them to rate on a scale from 1 (*very bad*) to 7 (*very good*) the overall experience of selecting and downloading the movie. The second asked whether they thought the amount of time they had to wait for the trailer to download would be "worth it" on a scale from 1 (*definitely not worth it*) to 7 (*definitely worth it*). After

TABLE 2: Mean Ratings for Experiment 2

Duration	Dots	Fixed Progress	Random Progress	Static	Mean ratings (SD) for all durations
Mean judged reasonableness					
30 s	4.32 (1.15)	5.96 (0.91)	5.07 (1.09)	5.28 (0.64)	5.16 (1.09)
40 s	4.02 (0.93)	5.57 (0.81)	4.54 (1.03)	5.25 (0.58)	4.84 (1.03)
50 s	3.93 (1.23)	5.18 (0.67)	4.11 (0.86)	5.04 (0.63)	4.56 (1.02)
60 s	3.59 (1.29)	4.61 (0.76)	4.00 (1.27)	4.21 (0.96)	4.10 (1.13)
Mean (SD) rating for all durations	3.96 (1.16)	5.53 (0.92)	4.53 (1.17)	5.06 (0.89)	
Mean duration estimates					
30 s	37.82 (15.75)	33.32 (14.31)	41.11 (14.94)	40.57 (16.31)	38.20 (15.33)
40 s	44.04 (14.81)	44.95 (18.62)	49.43 (15.90)	52.68 (26.13)	47.78 (18.87)
50 s	54.07 (10.91)	52.48 (18.78)	56.54 (15.58)	58.46 (15.73)	55.39 (15.25)
60 s	59.46 (11.69)	60.77 (17.89)	65.54 (20.47)	67.14 (16.81)	63.23 (16.72)
Mean (SD) duration estimate for all durations	48.85 (13.29)	47.88 (17.40)	53.16 (16.72)	54.71 (18.75)	
Mean "worth it" ratings					
30 s	4.98 (1.51)	6.18 (0.91)	5.18 (0.91)	5.68 (0.61)	5.51 (0.99)
40 s	4.91 (1.22)	5.75 (0.73)	4.96 (0.95)	5.29 (0.78)	5.23 (0.92)
50 s	4.57 (1.73)	5.75 (0.91)	4.61 (1.47)	4.96 (0.75)	4.97 (1.22)
60 s	4.68 (1.55)	5.57 (0.98)	4.54 (1.31)	5.11 (1.07)	4.98 (1.23)
Mean (SD) rating for all durations	4.79 (1.50)	5.81 (0.88)	4.82 (1.16)	5.26 (0.80)	
Mean experience ratings					
30 s	4.77 (1.35)	6.05 (0.99)	4.68 (1.01)	5.43 (.068)	5.23 (0.85)
40 s	4.71 (1.38)	5.61 (1.02)	4.46 (1.08)	5.00 (0.98)	4.95 (1.12)
50 s	4.29 (1.50)	5.23 (1.01)	4.07 (1.19)	4.79 (0.73)	4.59 (1.11)
60 s	4.32 (1.58)	5.16 (1.00)	3.96 (1.35)	4.57 (1.16)	4.50 (1.27)
Mean (SD) rating for all durations	4.52 (1.45)	5.51 (1.01)	4.29 (1.16)	4.95 (0.73)	

Note. Reasonableness of the wait was rated on a scale from 1 (*very reasonable*) to 7 (*not reasonable at all*). Duration estimates were selected from a range from 1 s to 120 s. Whether the wait was "worth it" was rated on a scale from 1 (*definitely not worth it*) to 7 (*definitely worth it*). Mean experience was rated on a scale from 1 (*very bad*) to 7 (*very good*). Standard deviations are in parentheses.

completion, participants were debriefed and dismissed. The entire experiment took approximately 15 min.

Results and Discussion

Means and standard deviations for Experiment 2 are presented in Table 2. All post hoc contrasts use a least significant difference adjustment.

Reasonableness. As in Experiment 1, participants judged short waiting periods to be more reasonable than long ones, $F(3, 50) = 41.36$, $MSE = 0.33$, $p < .001$. There also was a main effect of dialog type, $F(3, 52) = 8.04$, $MSE = 2.66$, $p < .001$. Post hoc contrasts indicated that reasonableness ratings were higher in the fixed-progress bar condition ($M = 5.53$, $SD = 0.92$) than in the sequential dots condition ($M = 3.96$, $SD = 1.16$), $t(26) = 4.42$, $p < .001$, and the variable-rate progress bar condition ($M = 4.52$, $SD = 1.17$), $t(26) = 2.93$, $p < .005$. Reasonableness ratings in the fixed condition, however, were not significantly different from those in the static condition.

Similar to the constant-rate progress bar, participants in the static condition ($M = 5.06$, $SD = .89$) judged waiting periods to be more reasonable than those in the variable-rate progress bar, $t(26) = 2.06$, $p < .05$, and sequential dots conditions, $t(26) = 3.56$, $p < .001$. Reasonableness ratings for the variable-rate progress bar were not significantly different from those for the sequential dots.

Duration estimates. Participants estimated longer times for longer durations, $F(3, 52) = 68.70$, $MSE = 93.03$, $p < .001$, but as in Experiment 1, there was no main effect for dialog styles, nor was there an interaction between dialog style and duration. Interestingly, whereas participants tended to underestimate longer durations in Experiment 1, this time they tended to overestimate all durations. Two factors may account for this difference. First, the experiments involved two different tasks. In Experiment 1, participants were ordering movies to be delivered by mail; in Experiment 2, they were downloading movies to their computers. Participants might very well expect that downloading movies would take longer than ordering them for delivery. Indeed, previous research (Jacko et al., 2000) has found that what people expect during a wait and what they receive after the wait can influence their evaluations of the wait.

A second possibility is that the difference may be the result of a more realistic simulation in Experiment 2. That is, making the Web-based nature of the downloading more realistic may have caused participants to adjust their expectations of how long a download would require.

Experience. Not surprisingly, participants judged shorter waits more positively than longer ones, $F(3, 52) = 56.88$, $MSE = 0.317$, $p < .001$. Furthermore, a main effect of dialog type, $F(3, 52) = 3.58$, $MSE = 4.49$, $p < .02$, and post hoc contrasts indicated that the constant-rate progress bar provided a better experience ($M = 5.51$, $SD = 1.01$) than either the variable-rate progress bar ($M = 4.29$, $SD = 1.16$), $t(26) = 2.47$, or sequential dots ($M = 4.52$, $SD = 1.45$), $t(26) = 3.04$. No other comparisons were significant.

Worth it. Participants judged the waiting period to be more worth it for shorter than for longer durations, $F(3, 52) = 9.35$, $MSE = 0.39$, $p < .001$. Furthermore, a main effect of dialog, $F(3, 52) = 3.22$, $MSE = 4.00$, $p < .030$, and post hoc contrasts indicated that people in the constant-rate progress bar condition ($M = 5.81$, $SD = 0.88$) were more likely to judge that the trailer would be worth the wait than were people in the variable-rate progress bar ($M = 4.82$, $SD = 1.16$), $t(26) = 2.62$, $p < .05$, or sequential dots ($M = 4.79$, $SD = 1.50$), $t(26) = 2.72$, $p < .01$, conditions. No other comparisons were significant.

Ratings of reasonableness, user experience, and whether the wait was worth it were higher when the feedback on the screen required less attention, consistent with attentional gate theory. Feedback containing multiple frequent stops and starts, or many discrete events, was judged less favorably. To examine how this unpredictability influences user preference, a third experiment was conducted.

EXPERIMENT 3

As Experiment 2 demonstrated that more attention to temporal information (i.e., variable-rate progress bar vs. constant-rate progress bar) reduced judged reasonableness, it is of primary interest to investigate how such variability influences user preference. User preference was not collected in Experiment 2, as feedback display was run as a between-groups variable. Including user preference in such a design would have required each participant to wait for, and make judgments about, 32 total downloads, which obviously might raise issues such as participant fatigue and other carryover effects. However, as user preference is still critical for those who design such interfaces, this third experiment simply examined user preference in relation to different feedback displays.

Method

Participants. Participants were 20 students at a large public university in the southwestern United States, who took part in this experiment for course credit. None of the participants had engaged in either Experiment 1 or Experiment 2.

Procedure. The materials and procedure were identical to Experiment 2 except that the experimental design was within subjects, and participants did not make any judgments after each trial. Instead, after all trials were completed, participants were shown an example of each of the feedback methods. Participants were then asked to rank order the four feedback methods according to preference.

Results and Discussion

Preference data are in the form of ranks, so lower scores indicate greater preference. These data were analyzed using a repeated-measures Friedman's ANOVA for rank data. The analysis indicates that some dialog types were clearly preferred, $\chi^2(3) = 41.04$, $p < .001$. Post hoc analyses using a Wilcoxon signed rank test showed that participants preferred the constant-rate progress bar ($M = 1.29$, $SD = 0.62$) to the variable-rate progress bar ($M = 2.1$, $SD = 0.55$), $Z(1) = 2.73$, $p < .01$, sequential dots ($M = 3.14$, $SD = 0.64$), $Z(1) = 3.93$, $p < .001$, and static wait dialog ($M = 3.57$, $SD = 0.76$), $Z(1) = 3.99$, $p < .001$.

Additionally, participants preferred the variable-rate progress bar to both the sequential dots, $Z(1) = 3.51$, $p < .001$, and the static wait dialogs, $Z(1) = 3.73$, $p < .001$. There was no significant difference between the static dialog and the sequential dots. These data demonstrate that people prefer cumulative progress feedback to simple movement on the screen or even a static dialog, providing further evidence that preference depends on keeping the user informed.

GENERAL DISCUSSION

This research employed a simulated movie database to investigate the effects of various feedback displays on user preference, apparent waiting time, reasonableness of waiting, user experience ratings, and impressions of whether the waiting time was worth it. The displays were a static wait dialog, sequential dots, a constant-rate progress bar, and a variable-rate progress bar.

Intuition suggests that across all dependent variables, feedback with more information would be received more favorably than feedback with less information. On the other hand, a competing theory, the attentional gate theory of prospective timing (Block & Zakay, 1996; Zakay & Block, 1997), suggests that feedback with many discrete, attention-getting events would yield less favorable results. Specifically, displays that emphasize change may increase arousal or focus attention on temporal information, thus making durations seem longer. Displays that minimize changes should have the opposite effect.

In Experiment 1, durations were judged to be more reasonable for a static display than for a sequential dots display, whereas the feedback bar performed similar to the static display. On the other hand, users overwhelmingly preferred the progress bar to both the static and the dynamic displays. Experiment 2 demonstrated that introducing variability into the progress bar reduced ratings of reasonableness and user experience, suggesting that focusing user attention on the display makes the experience less favorable. In Experiment 3, participants rank ordered the feedback methods according to preference. Interestingly, the methods preferred were not identical to the estimates of reasonableness, user experience, and whether the wait was worth it. In fact, participants preferred the constant-rate progress bars to variable-rate progress bars, followed by the sequential dots and the static wait.

Taken together, these findings suggest that judgments of reasonableness, experience, and whether the wait was worth it are consistent with the attentional gate theory of prospective timing (Zakay & Block, 1997). Static displays with no change over time, and constant-rate progress bars that change minimally and predictably, yielded the highest ratings of reasonableness, user experience, and assessments of whether the wait was worth it. Conversely, sequential dots that emphasized temporal information, with many changes, produced lower ratings of reasonableness and user experience as well as lower assessments of whether the wait was worth it. Variability, when introduced into the progress bar, had similar negative effects.

Preference, on the other hand, is consistent with the intuitive notion of keeping the user informed. Experiment 1 showed that participants clearly preferred the progress bar to the sequential dot display, and the sequential dot display to the static wait dialog. Even when variability was added to the progress bar in Experiment 3, participants still preferred progress bars to sequential dots and the static display.

What Is a Designer to Do?

Design often involves trade-offs. For example, making a product easier to learn for a novice may sometimes make it less efficient for experts. According to our results, users prefer more feedback rather than less, even though the activity on the screen makes the wait seem less reasonable. So, in one regard, the designer is left trying to determine which is more important: user preference or perceived reasonableness.

On the other hand, the data do provide some suggestion for ways to reach a middle ground between both preference and reasonableness. For example, the constant-rate progress bar performed at the top of both reasonableness and preference. It keeps users informed without increasing arousal or inducing the user to attend to temporal stimuli. As a result, it increases preference without increasing apparent duration, providing the best of both worlds. Thus, this feedback display seems the best choice when both user preference and reasonableness are concerns.

However, in cases when it is impossible to ascertain how long a process will take, as a possible option, the designer could provide a constant-rate progress bar that starts out by underestimating the progress of the computation and then quickly updates the progress at the very end. This provides the benefit of reducing the number of discrete events—the constant progress is experienced as one event, whereas the quick update is another. Furthermore, there is some evidence that fast progress at the end increases user satisfaction (Harrison et al., 2007), in accordance with peak and end effects (Fredrickson & Kahneman, 1993).

According to previous research (Meyer et al., 1996), if designers choose to employ feedback mechanisms, such as moving dots, they may be able to improve wait time reasonableness ratings by reducing the tempo of the changes, because fewer changes reduce attentional demands. Similarly, adding a small amount of movement to static screens could increase preference by assuring the user that the computation is still progressing versus showing a nonmoving, static display.

Although the current set of experiments did not evaluate additional feedback displays that are also used to fill wait times (e.g., hourglasses, clocks, rotating balls), one would expect that these different displays would also conform to the findings here and to the subsequent predictions of attentional gate theory.

This study highlights how two mechanisms account differentially for preference and waiting time reasonableness and shows how attention gate theory corresponds to the way participants experience waits. Future research might more directly explore the two mechanisms in the attentional gate model—the pacemaker, the attentional gate, or both—to see which is more critical for influencing reasonableness or preference of waiting.

Similarly, further research should focus on developing a better understanding of the effects of various tempos in updating displays. Generally, slower tempos attract less attention and yield shorter duration estimates, but does this relationship hold for all tempo rates? And at what point does a tempo seem to yield a continuous movement rather than discrete events, and how does this affect duration estimates? It would be particularly useful to determine under what conditions a feedback bar appears to be constantly updating and under which conditions the updates seem more discrete. A better understanding of this would be valuable in choosing tempos for particular display updates.

Another useful line of investigation could focus on the merits of providing a progress bar that updates slowly in the beginning and catches up quickly—all at once—at the end, thus reducing discrete events. Would this approach indeed increase perceived reasonableness compared with a variable-rate progress bar? Finally, it would be useful to explore the function of multitasking on the presentation of feedback. For example, it would be interesting to determine whether occupying one's attention with additional tasks might influence estimation of wait times, which was not explored here.

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