Relevant Fade-in Notifications Attract Attention

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RUNNING HEAD: Relevant Notifications

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Abstract

Notifications within graphical displays, such as software updates and virus warnings, are often flashed-on demanding the user's attention. These notifications occur regardless of relevance to the task being performed. This can interrupt the user from their task creating frustration and ultimately diminishing the user experience of the interface. Previous research has explored *when* notifications should appear. We by contrast, examine how notifications can be designed to notify users of new information without demanding attention unnecessarily. Participants were instructed to divide their attention between a primary and secondary task. Information associated with the secondary task was presented either with or without flashing, and it was related or unrelated to the primary information. We found that notifications that faded on screen and were related to the primary task attracted more attention than the other notifications.

Relevant Fade-in Notifications Attract Attention

Notifications, such as program updates and virus warnings, present new information to users within a computer's interface. Unfortunately, the common way notifications are presented captures the user's attention regardless of relevance to the user's primary task [1]. This frustrates and distracts the user, diminishing the user experience of the interface [4]. Human-Computer Interaction (HCI) researchers have attempted to predict *when* notifications should be presented. We focus on *how* notifications should be presented. We do this by examining the user's visual attention system to design a notification that more naturally improves the user's experience.

Understanding how to present notifications to users is critical. According to Iqbal and Bailey (2008), users are presented with notifications an average of eight times an hour. Notifications occur at a high frequency because it results in near instant communication with the user about potentially time critical information. Additionally, notifications help alert users to information located in the periphery of the interface and act as a reminder for events. Unfortunately, notifications can have a negative impact on: time to complete primary task, error rates, affective state, and decision making ability [1, 7, 8]. These negative effects do not facilitate the user's goals or the usability of the interface. As computers become more ubiquitous, they should become invisible to users by supporting their task goals and not becoming a distraction [19]. Within the use of multiple interfaces and notifications associated with each there is an increased probability of distraction.

One method for decreasing the negative effects of notifications is to examine when they should be presented. This method is based on the theoretical foundation that notifications would have lower interruption costs if presented at moments of lower mental work load, or breakpoints [1, 6, 12]. Breakpoints are moments of transitions between two observable, meaningful units of task execution reflecting transitions in perception or action [6]. When a user is working on a document, then switches tasks to check their email, the moment between the two tasks (where the user is focused on neither task) is the breakpoint.

In order to locate breakpoints, statistical models and complex algorithms have been developed to identify, or predict, when breakpoints will occur. However, statistical models cannot identify the user's task context [7]. Therefore, the highest accuracy for correctly predicting a user's breakpoint was only 64%, with a majority of models making predictions between 2% and 40% accuracy [7]. This approach also takes considerable time to employ as a model must be developed for each user.

Although breakpoint predictive methods are improving their success rate remains considerably low. Further, the major limitation of this work is the ignorance of the context surrounding a user's breakpoints. Just because a user is between tasks does not imply they want to embark on another unrelated task. Imagine you are working on a manuscript and have just completed the method section. This is a break point. Although you have completed one section you are in a hurry to finish the results section before your coauthor leaves town. So, you start analyzing the data with a statistical software package. Between these tasks you receive a notification asking if you would like to update your operating system. No, of course you would not. We suggest a more natural design solution that allows the user's attention system to determine what ought to be selected instead of using a complex model.

A relevant area of research has examined [5, 11] the effects of animated notifications (fade, ticker, and blast) on a user's primary task. It has been shown that animated notifications with strong transient signals (sudden changes in intensity; e.g., flashing) capture attention. But, other researchers suggest that only memorability of the flashing banner's content is decreased while a user is processing a mental workload and attention is not captured more than a static banner [2]. However, other research recommends designers employ flash notifications over fade for certain processing [17]. There is still debate about whether flash notifications attract more attention than their fade versions. Further, the current literature does not provide an explanation for why fade notifications are preferable.

In this study, we applied a human-centered design approach. This approach focuses on taking advantage of the user's natural abilities by considering the role of attention in the user's visual experience. Attention is the selection of information for processing resulting from limited cognitive resources [3]. This limitation results from working memory's limited capacity to store and manipulate information; attention can only select a small number of items to attend to at any given time. Attention is controlled by a combination of goal and stimulus directed cognitive processes [16, 20]. Goal directed processing is guided by a user's intentions and conscious effort usually towards a specific target. Stimulus directed processing refers to the guidance of attention by visually saliency and semantically relevant features. Thus, attention is oriented voluntarily through goal driven processing and reflexively through stimulus driven processing [13].

Understanding how attention is directed and oriented allows us to identify why notifications demand attention. Notifications are presented with strong transient signals associated with the rapid appearance of new objects. This visual onset causes an exogenous orienting of attention, which demands attention and disrupts goal driven processing. Even if these signals are placed within the periphery of the users' visual attention, where notifications are often located, they still demand the users' attention [10]. Removing transient signals from notifications should minimize unwanted orienting [17]. However, when the transient signal is removed, it is possible that relevant notifications will be missed. There is no reason to believe that they will not; in this case. The notification's relatedness to the task may increase the notifications signal strength by way of priming.

Attention can be automatically oriented to relevant notifications as a by-product of priming. This is accomplished when the user's current thoughts and primary task are semantically related to the notifications. According to [9], priming occurs when "one stimulus, the prime stimulus, affects the processing of another stimulus, the test stimulus" (p.46). This change in processing results in attention becoming involuntarily driven to the notification. It is import to highlight that this orienting has a positive effect on the user experience as relevant information is noticed and irrelevant information may be allowed to go unnoticed.

Given previous research, we predict that if notifications are presented with strong transient signals (flash) then attention will be reflexively oriented to them. This will occur at a cost to the primary task regardless of the relationship between the notification and the primary task. However, if notifications are presented without transient signals (e.g. they fade onto the screen); attention will not be reflexively oriented to unrelated notifications but will be voluntarily orientated to related notifications. This allows for related notifications to facilitate near instant communication while unrelated notifications will not interfere with the user's primary task.

To test these hypotheses a dual-task paradigm was employed. The relationship between the primary and secondary task was manipulated; the two tasks could either be related or unrelated to each other. The second task will present critical information either with or without a transient signal. Accuracy will be analyzed to see if relevance or the presence of transient signal affects the primary task, which is of main importance.

Method

Participants

The university institutional review board approved the experimental procedures. Thirty undergraduates participated in exchange for course credit in an introductory psychology course. Each participant had normal or corrected to normal vision.

Stimuli and Apparatus

The experiment was presented on a Dell Pentium 4 Windows XP machine with a 17 inch monitor. One-hundred twenty-eight semantically related word pairs were extracted from the University of South Florida's word association norms [14]. On each trial, a word would appear in the center of the screen along with a second word approximately five degrees to the lower right with a bar underneath it. Both words were presented in size 22 Courier New font. Responses were collected via a PS/2 keyboard. This study was created and executed within E-Prime presentation software (Psychology Software Tools, Inc., www.pstnet.com).

Procedure

Participants were asked to complete two tasks. The primary task was to determine if the first word was singular or plural by pressing keys labeled 'S' or 'P', 'z' and 'x' keys respectively. The secondary task was to press the 'SPACEBAR' if the second word was a vehicle. Instructions were given verbally and displayed on the computer screen. Participants were told the list of potential vehicle words they would see and were asked to respond as quickly and accurately as possible. Participants completed ten practice trials before continuing with the experimental trials and were encouraged to ask questions.

Stimuli consisted of one-hundred twenty-eight semantically related word pairs divided into three word lists: normal, vehicle, and buffer. The normal list contained 96 word pairs and was used to measure primary task performance. The vehicle list contained eight word pairs with only the second word being a vehicle: *car*, *truck*, *boat*, *ship*, *train*, *airplane*, *helicopter*, and *motorcycle*. Each vehicle word pair was repeated resulting in 16 vehicle word pairs. The buffer list contained 16 word pairs and immediately followed a vehicle trial. The buffer word pairs were included to prevent words from the vehicle trials from directly affecting (via priming) a normal word pair trial.

For each trial, a fixation cross (+) appeared at the center of the screen for 1000msec. After 1000msec, the fixation cross was replaced by the first word. After 200msec, the second word would “fade” onto the screen for 1380msec to ensure consistency across conditions. In the fade conditions, a bar located underneath the second word would fade on the screen. In the flash condition, a bar located underneath the second word would flash on the screen. Using a bar to either fade or flash on allowed the second word to remain constant across display conditions while manipulating transient signal strength.

Results

The experimental design was a 2 (related type: related, unrelated) X 2 (display type: flash, fade) resulting in a fully crossed factorial, within subject design. All statistical tests used an alpha level of .05. Accuracy on the primary task was the dependent measure. Data from two participants’ were excluded from analyses due to their mean accuracy being below 50%. This left 28 participants for analysis.

A 2 (related type: related, unrelated) x 2 (display type: flash, fade) within subject ANOVA was used to analyze the data. The display type x related type effect was significant, $F(1, 27) = 8.53$ $p = 0.007$.

A paired sample *t*-test was used to investigate the interaction. As illustrated in Figure 1, only the fade related condition ($M = 0.763$, $SD = 0.11$) differed from the other conditions: flash related ($M = 0.86$, $SD = 0.09$), flash unrelated ($M = 0.85$, $SD = 0.07$), and fade unrelated ($M = 0.83$, $SD = 0.09$), $p < 0.05$.

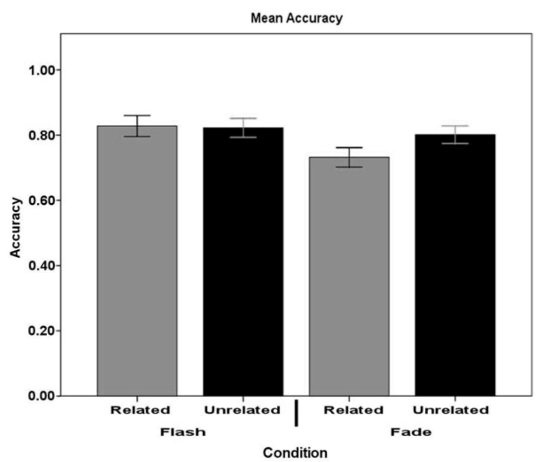

Figure 1. Mean accuracy of primary task by condition with standard error bars (+/-2)

Discussion

Our results suggest that related semantics draw attention in a visual display. In the present task that means attention was drawn to the second word at a cost to the primary task. It is difficult to disregard relevant information. Stolz (1996), provides an explanation for cost to the primary task by suggesting that if attention is oriented to a semantically related word, there is a delay in disengagement. These results support our hypothesis that if transient signals are removed from notifications, users will not miss potentially critical notifications. However, the results also indicate when a transient signal (flash) is used the relatedness effect disappears. Based on the current literature, the flash related condition ought to reflect the same attentional cost as the fade related condition. Interestingly, this was not the case. It appears that a flashing bar prevented attention from fully encapsulating the second word. Thus, attention was able to quickly disengage from the second word preventing harm to the primary task's performance. Further, we found that the fade unrelated and flash unrelated conditions are statistically indistinguishable. This does not support our hypothesis that notifications will have less cost to the primary task, if transient signals are removed. Thus, our results do not support [17] recommendations, but do provide evidence that [2] animated banners may not demand more attention than their static versions. In addition, our findings support the conclusion that search times for a target may actually decreased in the presence of an irrelevant flashing distractor [15].

We believe our approach and findings provide justification for the use of fade notifications recommended by previous research [5, 11]. Due to the lack of a difference between fade and flash notifications, we recommend fade notifications as they avoid many of the negative effects associated with flashing notifications. Although more research is required to determine whether flashing notifications actually negatively impact primary task performance. In some design instances flashing may improve primary task performance by allowing quicker disengagement from the notification. Importantly, we have demonstrated that if transient signals are removed, relevant information will not be missed by participants.

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