

Attentional Costs of Different Notification Types

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Abstract. A user can set privacy barriers so that you only see that someone sent you a message but not the actual message or you can see a partial message, users can set various sounds and combinations of vibrate and sound...it can be overwhelming to have so many choices. This study aims to better understand how a notification is presented to the user impacts their desire to switch tasks, more specifically to see if the user seeing a preview message is more compelling versus not seeing the message at all. By learning the how behind text based notification through observational methods coupled with the previous research based on our mental and emotional needs for connection the greater understanding and framework for engaging users with disruptions can be grown beyond the basic ways of catching the user's attention but making thoughtful and intentionally decisions to better shape future interactions engaging with distracting media. . . .

Keywords: human-computer-interaction, notification, attention, distraction, smart-phones

1 Introduction

Multitasking is a part of everyday life in this day and age. People of all ages are continuously immersed in technology and the different stimuli they produce. It is no surprise to find that our productivity and efficiency decreases the more we multitask between our connected devices. The question arises then, why? Why do people knowingly switch between a multitude of tasks even though they know it will take them more time to be done with the task to begin with? Research has been done looking at this question across a wide range of ages from middle school students to college students. One study done by BJ Fogg from Stanford University on behavioral models for persuasive design looked at the underlying core reasons for why we multitask and the key elements in creating behavior changes (Fogg,2009). Fogg found these key elements to rooted in our carnal nature of pain versus pleasure and that these attributes could be mapped to three variables that needed to all come together to effectively create a switch case: the users motivation, their ability to do the task new task and the trigger of the new task (Fogg,2009).

Another study done which delved deeper into not only why we connect but how the deeper mental and emotional needs of connecting with people via social media impact our productivity habits. The study conducted by Larry D.

Rosen, L. Mark Carrier and Nancy A. Cheever at California State University observed 263 students ranging in age from middle school to college students in their homes to access their study habits and how technology and social media fit in (Rosen, et al.,2013). This study found that the creation of technology breaks would satisfy students needs for the short and long term cognitive emotional rewards instead to balance the cost of decreased learning through traditional media driven multitasking habits (Rosen, et al.,2013).

Both these studies shed a great deal of light on how multitasking and turning to technology is deeply ingrained in our habits and gives us a sense of pleasure or reprieve when we turn to it to respond to a text message, look at a post someone liked of ours or to view a photo someone just snapped you. A key element of these multitasking distractions that these studies leave out is how the notification is being presented to the user. Today there are a multitude of ways that the user can set a text message notification to appear to the user. A user can set privacy barriers so that you only see that someone sent you a message but not the actual message or you can see a partial message, users can set various sounds and combinations of vibrate and sound...it can be overwhelming to have so many choices. This study aims to better understand how a notification is presented to the user impacts their desire to switch tasks, more specifically to see if the user seeing a preview message is more compelling versus not seeing the message at all. By learning the how behind text based notification through observational methods coupled with the previous research based on our mental and emotional needs for connection the greater understanding and framework for engaging users with disruptions can be grown beyond the basic ways of catching the user's attention but making thoughtful and intentionally decisions to better shape future interactions engaging with distracting media.

In this study we conducted a user study to analyze distractibility, impulse control and comprehension with varied notification types. In the study, the participant goes through a series of short readings with one question after each reading. During the reading segments the participant is interrupted with text messages from unknown numbers with everyday content. The evaluation will be based on participants pre and post experiment survey, number of correct answers and if they opened/responded to the messages. The implications of our habits being manipulated based on notification type will inform future implementation of control options.

We need to look at the applications and culturally formed habits they help us make. We can see through the Network Effect (Arrington, 2008) that many habits are formed through the applications we use. We see features across different platforms like Netflix, youtube and hulu auto play the next video to hook viewers into the needing the self control to stop once their content has started. We see this through continuous scrolling in our social media apps and how we can fall down a click-hole stalking someone on instagram or on a webpage, jumping from hyper link to hyperlink. Information is so abundantly at our fingertips and it pulls users back in through push notifications. The hook pulling us back in can

be seen best through social media applications and texting, as this plays on our cognitive and emotional needs to connect with one another.

1.1 Related Work

In this section, we will consider the supporting research which suggests that the study of different stimuli and their impact on user comprehension, attention/distraction, impulse and emotional state can be applied to the question at hand.

Arrington, Michael. "Most iPhone Apps Are Failing To Leverage The Network Effect." This article discusses how most applications are unaffiliated with an established website, which means they need to be able to build a sustainable business on the iPhone alone unless they're just there for fun. Already we're seeing applications that are effectively identical to others. Without a compelling existing brand or a really innovative product with protectable intellectual property (some of the games fall into this category), the only chance these apps have for long term success is to start thinking about ways to have users interact with each other in order to build network value. Apple and Google turned the mobile industry on its head by creating vibrant product ecosystems encompassing devices, content and on-line services. The battle of ecosystems, however, is still far from being decided. The expansion of the experience ecosystems across screens, shifting the battleground from smartphones to tablets and finally the living room

Cengage Learning. (2014). Transitioning to a More Digitally Focused Course Experience focused on surveying students and college faculty from two and four year colleges to look at the technology landscape as it is and discuss what students need. Learning how the abuse of technology by fellow classmates impacts the room dynamic and what the best classroom strategies are for engagement. Cengage Learning found that 60% percent of the distractions can be attributed to texting and 59% to social media. 41% of students believe that the misbehavior is primarily due to boredom while 31% blame the instructor for not being engaging. The instructors lack of technology literacy impacts the ability to adopt technology easily in the classroom but Cengage found that combining Online discussion forums, simulations and podcast/video lectures to be the top 3 digital ways to boost engagement.

BJ Fogg, A behavior model for persuasive design from Stanford University presents a new model for understanding human behavior. The FBM model requires the user to be 1) sufficiently motivated, 2) have the ability to perform the task/behavior and 3) be triggered to perform the task/behavior. All three of these factors need to be triggered according to the FBM model to follow through with the task. Fogg asserts that the Factors in the Behavior Model boil down to the notion of pain versus pleasure in terms of motivation and ability. Ability is defined by the scarcest resource that the user is willing to give up at that moment in time-be it focus, time, etc. Fogg goes on into further detail of the different combinations of motivations, triggers and ability to determine how to create persuasive design.

Foroughi, C., Werner, N., Barragn, D., & Boehm-Davis, D. (2015). Interruptions Disrupt Reading Comprehension discusses user's ability to comprehend and synthesize information across passages. Through a study where users are given a passage at a time and in between passages are given a task, such as a math problem set and then at the end followed up with yes or no questions. The findings found that the participants who answered the math questions correctly the most did not retain the most comprehension of the passages.

Grinter, R., & Eldridge, M. (n.d.). Y do tngrs luv 2 txt msg? looks at teenagers motivations towards using mobile phones to communicate and their practices. Grinter and Eldridge studied five girls and five boys between 15 and 16 years of age. The students self logged their texting habits (date, time, location, who and what was said, etc). The study found in terms of frequency more girls sent text messages, 3.3 messages on average to 2.5 for boys and 20% of the messages were used for chatting/gossip whereas 26% used for coordinating plans with friends. The study found that the ease of use, convenience and cheapness of texting made it easily adoptable but the evolution of language was seen as a problem. Some messages were hard to decrypt due to shorthand and that this becomes very exclusive as the language is not seamless and universal which leads to misreading messages that can lead to unintended scenarios.

Oakhill, J., Hartt, J., & Samols, D. (2005). Levels of Comprehension Monitoring and Working Memory in Good and Poor Comprehenders delves into how comprehension models dont account well for good comprehenders versus poor. This study looks at how and if error detection versus memory in text based readings are a better indicator towards better or poorer comprehension. The study dealt with spotting the accuracy of adjacent sentences and memory comprehension in pairing sentences.

Porath, S. (2011). Text Messaging and Teenagers: A Review of the Literature This literature review examines the limited amount of research on the practice of text messaging for adolescents and young adults (ages 11-21), focusing on the motivation, means, and methods of text messaging. In addition, it considers how adults have successfully engaged text messaging to access and inform youth about health-related issues. The findings are that through dialogue there needs to be a teaching of better choices such as disconnecting (turning off) from the teenagers devices, specifically during sleep hours as an example.

Rosen, L., Carrier, L., & Cheever, N. (2013). Facebook and texting made me do it: Media induced task switching while studying. This study found three key issues surround the impact of task switching: (1) primary task completion, (2) secondary (interruptive) task completion, and (3) resumption lag. The underlying reason for task switching is primarily cognitive needs at the time rather than short-term emotional needs or long-term needs but that the driving force behind multitasking is emotional rewards gained even at the cost of learning. The study conducted research by observing students ranging from middle school to college age in their natural studying environment for 15 minutes at observed details such as how many web browsers were open, texting, social media, music and their relevancy towards the studying the user was doing. After observation

the participant answered survey questions regarding their uses of technology and how they were as a students. Results ranged but the take away is that the students who were able to finish a task or get to a point where the information was not as important before task switching were the best balanced as students and media users.

Stothart, C., Mitchum, A., & Yehnert, C. (2015). The attentional cost of receiving a cell phone notification argues that while it is well documented interacting with a mobile phone is associated with poorer performance on concurrently performed tasks because limited attentional resources must be shared between tasks, the knowledge of the notifications themselves hold a lot of weight in our performance. Although these notifications are generally short in duration, they can prompt task-irrelevant thoughts, or mind wandering, which has been shown to damage task performance. We found that cellular phone notifications alone significantly disrupted performance on an attention-demanding task, even when participants did not directly interact with a mobile device during the task. Stothart, et al. claim that the magnitude of observed distraction is comparable to the users who actively use their mobile phone during tasks.

Strayer, D., Watson, J., & Drews, F. (2011). Cognitive Distraction While Multitasking in the Automobile discusses the different ways in conceptualizing the different distraction points while multitasking and driving. This study illuminates the differences between cell phone usage versus human interaction with a passenger and how the two distraction differ greatly. The study took a cognitive neuroscience approach to driver distraction and the study of driving. The study found that the gauge for multitasking is too obscure but we are unable to test multitasking ability, aka supertaskers as a culture are illusioned that people have this superior multitasking ability versus the inattention blindness that multitaskers blame on driving issues.

2 Methods

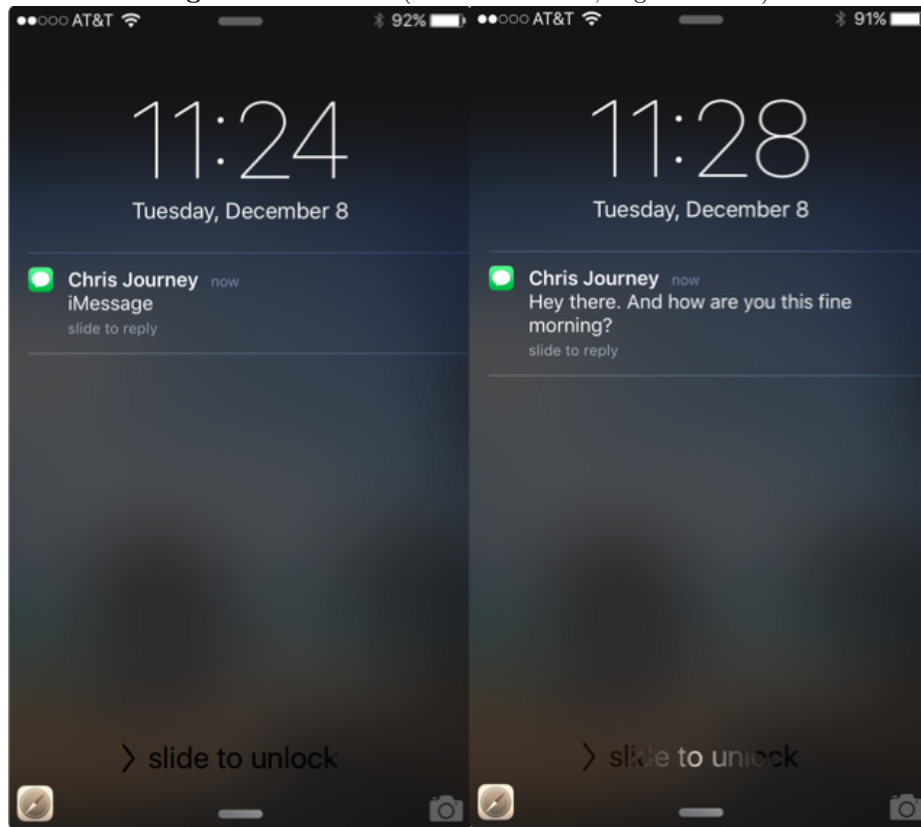
We conducted a user study to analyze distractibility, impulse control and comprehension with varied notification types. To conduct the user study minimal materials were required. We used a survey service, Survey Monkey to house the pre-test survey, user study, post test survey and debriefing. For sending unknown text messages a combination of Google Voice numbers and the app Private Testing was used. To mirror the users screen, TightVNC services were installed on the testing laptop and access through examiners machine. Users took the study alone in a collaboration room within the schools library. The examiner was in a room out of sight from the participant.

Readings and questions were sourced from SAT English sections and middle through high school reading comprehension lesson plans.

In the study, the participant went through a series of short readings with one question after each reading. The participants computer screen was mirrored so the examiner could time sending a text message during the reading portion of the user study, rather than while the participant answered questions. In Figure

1 you can see what the lock screen of the user's phone might have looked like depending upon which test group they were in. On the left, the test group was the No Preview group, the user just saw who they received the message from and no other information. The right-hand image shows the second test group, the Preview group. In the second group users received information on who the sender of the message was and a preview of the message on the lock screen.

Fig. 1. The condition (Left: No Preview, Right:Preview).



Participants were evaluated on pre and post user study survey data, the number of correct answers to passage questions and if they opened/responded to the text messages. In the pre-test survey the users were asked about how comfortable they were with technology, how they spent their time outside of classes and social awkwardness. Post test survey asked users about their phone usage and how the user felt about how much time they used their phone during the day. The post test survey also acted as a gauge for how many text messages they received and how it made them feel.

The participants were Connecticut College students, from a diverse set of backgrounds and majors. The students were recruited through word of mouth and group emails to different classes and social groups.

The data from the surveys and user study were analyzed through SPSS analysis software. Statistical tests such as the Chi Square Test (for distribution), One-Way ANOVA tests using Tukey for Post-Hoc analysis, T-Test for statistical data and cross-tab correlation tests.

3 User Study

The user study was comprised of 3 parts: pre test survey, reading comprehension test and a post test survey. The students, now to be referred to as participants, began the study as they entered into the collaboration rooms on the second floor of Shain Library and read over the consent form. They were then asked a series of questions about their phone settings to be placed in to the appropriate test group.

Once this was complete, the participant was left alone in the room to complete the experiment while the examiner sat in a nearby room, out of sight. The examiner was able to watch the participants screen through TightVNC services to monitor how quickly the participant was reading through the passages. This allowed for better timing for sending text message interruptions.

As the participant answered the pre-test survey, the examiner set up the distraction text messages across the different platforms and devices. Pictured in Figure 2 and 3 are examples of the reading and question part of the user study. After the third reading and question section, the participant would receive their first distraction notification. Users' each received four messages over the course of the study and self identified the text messages, how they handled them and how distracted they felt by them during the post test survey. Over the remaining 7 passages at points of their 5th, 7th and 9th passage the user would receive the remaining messages.

Fig. 2. Example Reading Section.

CS User Research 2015-2016

Passage 5

Rust is the common name for iron oxide, a compound that forms on iron and iron alloys that are exposed to oxygen and moisture. Although iron seems solid, its surface is covered with microscopic holes and cracks. When water is introduced into these cracks, it begins the process of forming iron oxide. The water molecules separate into hydrogen and oxygen atoms. The hydrogen atoms combine with the carbon dioxide present in the air to form carbonic acid. This acid begins to dissolve the iron, exposing even more of the metal to water. The oxygen atoms from the water molecules then bond with the dissolved iron, forming iron oxide. The additional chemical compounds in salt water and acid rain can cause rust to form even more quickly.

Prev Next

Fig. 3. The following page, example question.

CS User Research 2015-2016

Passage 5 Question

17. According to the passage, carbonic acid...

- is the scientific name for rust
- forms when hydrogen atoms combine with water
- is found in acid rain, but not in salt water
- is present in the air
- dissolves iron

Prev Next

After the user pressed 'next' they were unable to press the 'prev' button to go back and review the text they had just read. Through this we were testing comprehension and retention of information.

After the user finished the 10 reading and answer questions they would be prompted to fill out the post-test survey where they went into how many texts they received, how they handled them, and how distracted they were by them. After those questions the user was prompted with more pointed questions about their feelings on how they connected. The user was then prompted with debriefing information, disclosing that their screens were being monitored. Once the post test and debriefing the users were free to leave and carry on with their day.

4 Results

The results of this study are not ground breaking or conclusive but we can find trends that are reaching statistical significance. This gives us a path to follow as developers and designers, as well as grounds for future studies.

In figure 4 we can see the participants reading comprehension scoring based on their condition. The control group which received no text messages received the highest scoring rate of 65% correct answers versus the Message Preview which scored 6% lower, at 59%. The No Preview group did only a mere 1% better. Here the results are not statistically significant but we can see a trend towards the text message preview being more distracting to users overall.

Figures, 5 through 7 break down three main text message handling modalities and how each test group handled them. It is seen to be statistically significant that the Text Message Preview group would check their lock screen the most out of all three test groups. This can most clearly be seen through figure 5.

Fig. 4. Scores based on condition.

Participants Scoring on Reading Comprehension Questions by Condition

<u>Condition</u>	<u>N</u>	Mean Score	Std. Deviation
No Text Message	10	6.50	1.650
Text Message No Preview	10	6.00	1.054
Text Message Preview	10	5.90	1.524
Totals	30	6.13	1.408

Fig. 5. Proportions of Users who checked their lock screen

Proportions of Checking Lock Screen on Phone by Condition				
	yes		no	
	<i>N</i>	%	<i>N</i>	%
No Text Message	0	0.0	10	33.3
Text Message No Preview	6	20.0	4	13.3
Text Message Preview	5	16.6	5	16.6

On a scale of 0-100%

Fig. 6. Proportions of Users who opened their phone.

Proportions of Opening Message on Phone by Condition				
	yes		no	
	<i>N</i>	%	<i>N</i>	%
No Text Message	0	0.0	10	33.3
Text Message No Preview	2	6.6	8	26.6
Text Message Preview	1	3.0	9	30.0

On a scale of 0-100%

Fig. 7. Proportions of Users who did not check their phone.

Proportions of Not Checking Message on Phone by Condition				
	yes		no	
	<i>N</i>	%	<i>N</i>	%
No Text Message	0	0.0	10	33.3
Text Message No Preview	1	3.0	9	30.0
Text Message Preview	1	3.0	9	30.0

On a scale of 0-100%

We can also confirm that through our study that those who self identify as socially awkward also self identify as people who turn to their phones when they feel uncomfortable in social situations. As we polled all 30 students and it was found to be statistically significant at .04 and the standard is .05.

5 Discussion

Through the findings we need to look at the study and see what could have altered the results. For one, we need to take into account the small sample size. With there being 30 participants, resulting in each sample group being 10 students per group, the pool is too small to really get significant data. Ideally, the sample size should have been in 80-140 range to yield statistically significant results. We can also take into account the setting of the user study.

The campus library was chosen for its casual yet academic environment. The location was within view of other students studying and doing their coursework, this was aimed to give the student an atmosphere where they did not feel so much pressure to not look at their phone that a classroom might impose. We chose the second floor of the library because it was a mid-range of social and studious time. Comparatively we could have chosen a more studious level of the library or an even more social level to yield different results.

The users in the condition of receiving a text message preview, actions of checking their lock screen, 16.6% in comparison to those who in the same group opened their message at a low 3% as well as the no preview group where 20% looked at their lock screen and 6.6% opened their phone to check their messages. This implies that more users are sensitive to the information displayed on their

lock screen where they can noncommittally indulge their connectivity needs, which we know from many studies mentioned above but most specifically *Facebook and texting made me do it: Media induced task switching while studying*, that the emotional and cognitive needs to connect are strong drivers which need to be satiated, especially when we are feeling stressed or displeasure towards our task at hand (2013). This is also seen in Stothart's study, *The attentional cost of receiving a cell phone notification* where just the knowledge that we have received a notification to be considered to be equally as distracting as those who act on their notifications. Since the lock screen is a gateway to these distracting, non-task oriented thoughts we can follow this thread when moving forward in designing and developing notifications in the future(2015).

When designing and developing push notifications we should bear in mind what action we want to elicit from our user. Most of the time in the promotional, marketing and advertising scheme there is little thought on how the way a notification is designed impacts the end user. The brand, company, product, etc are looking for quick acting engagement from users (Arrington,2008). For the more socially sensitive and or focus driven user apps which are more aware of what kind of actions need to be taken depending upon the content shown can change the game for distraction within technology. Larger technology companies could go out of their way to create a focus oriented mode for their smart phones, there already exists a driving mode—so why not one that targets classrooms or study time?

As we saw in the study on Facebook and text messaging, students did best when they were able to get to a point where they covered a section before checking back into their social networks-what could we as developers create that is aware of our habitual needs but also careful to coax us into better work habits(Rosen, et al.,2013). Through this knowledge from Rosen, et.al. and this study finding previews of content to be distracting, we could develop ways of displaying information within predetermined time segments or only once a user feels as though they finished a section of their work. There are many possibilities and combinations of phone manipulation that could be used. There are computer applications like, Self Control which allow the user to blacklist or whitelist websites and email clients so they can give up their control and force themselves to work without being able to indulge their connectivity needs until their predetermined time limit is up. You can turn off your machine and restart it, the clock will keep ticking and locking you out of the sites once you start the timer(Self Control,2008). Adopting this sorts of schema could result in a new habit forming culture with proper user testing.

6 Conclusion

In conclusion while the results are not statistically significant we can see trends that can be followed up in future work and give developers and designers a new way of thinking about their end user they are designing for. By taking a look at the network effect and the goals of applications as well as the greater

software used on our smart phones and their goals. By breaking the tech habits we can develop game changing applications and modalities to help us aid our socioculturally formed habits. Through further user testing and then developing of application standards, the way a notification is presented to the user can change the way we work.

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