Effects of Visual Enhancements and Delivery Time on Receptivity of Mobile Push Notifications

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ABSTRACT

Using real-world logs from 6,866 users who received relevant smartphone notifications we show that visual elements in the notification influence its receptivity. Users responded significantly more to notifications that included an image or an icon compared to standard notifications and to notifications including an action button compared to those not including such button. In addition, timing of the notifications also had a significant effect on receptivity, with lower click rates during the morning hours and higher rates during the afternoon and evening hours.

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KEYWORDS

Push notifications; mobile HCI; receptivity; visual design; delivery time; experimentation; click through rate.

1 INTRODUCTION

A notification is a visual cue, or auditory signal, generated by an application or service that relays information to a user outside of the current focus of attention [1]. With the fast growth of mobile devices development and mobile applications, push notifications have become increasingly popular [2]. Push notifications distribute information to potential users and have become an important way to improve the quality of communication among people. Rather than forcing users to manually check whether new information is available, notifications instead push the new information to users, resulting in faster and increased awareness.

Previous studies showed that push-notifications increase engagement with the app and improve user retention rates [3]. Push notifications provide added value to both users and businesses. Users can receive convenient updates in real-time and businesses can communicate directly with users and encourage them to use the app via specific call-to-action messaging.

We adopt the view that receptivity of notifications encompasses users' reaction to an interruption and their subjective experience of it [4]. For instance, users might quickly respond to a notification when they are idle, but they can still get annoyed because of the content of the notification. Previous studies [4-6] have shown that the users' receptivity to a notification and their response time are affected by (1) content factors including interest, entertainment, relevance and priority (high/low); (2) contextual factors that describe the individual's context at the moment of the interruption, like the current activity; (3) social factors including emotional state and social pressure, social engagement of the user and sender-recipient relationship; (4) timing of the notification. In this paper we focus on a study that tested the effects of yet another factor – the visual design of the notification.

2 STUDY OBJECTIVES

Computer-based interruptions have been studied extensively, yet research on push notifications as a type of interruptions is still wanting, especially concerning the effects of the visual aspect of the notification on users' receptivity. Previous research on push notifications suffer from two main limitations. First, today's push notifications can include new visual elements that were not available before, such as pictures, icons, links and action buttons, whose effects on users has yet to be studied. Studying the effects of visual elements in notification design is important due to the primacy of the visual system in human cognition (e.g., [7]) and research findings that suggest that visual cues and pictures increase attention and recall of information[8, 9].

Second, most research in the area of notification was conducted in artificial settings (e.g., with simulated mobile apps and artificial content), mainly to test interruption effects and not engagement with apps.

To mitigate these shortcomings our study is focused on the effects of the notifications' visual design on users' receptivity and we do so within a real-world setting, in which a productivity app interrupts users with relevant content.

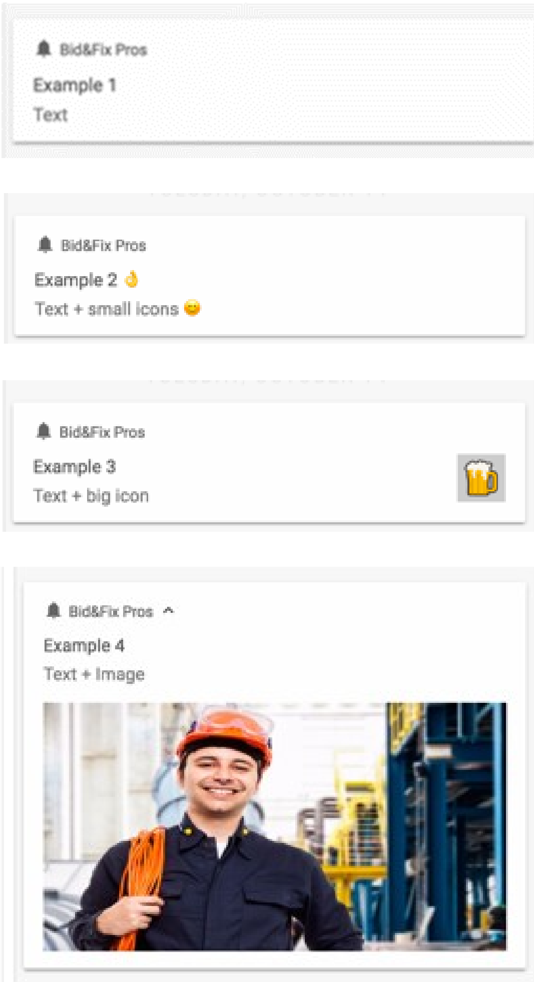

Figure 1: Mockup visual manipulations of smartphone notifications, top to bottom: Text-only (baseline), text + icon, text + large icon, text + image.

3 METHOD

We conducted an in-situ field study of user's reaction to pre-designed push notifications in natural settings. The experiment took place in the US market, on a mobile app. The app connects between thousands of local service providers (plumbers, electricians, etc.) and the customers who needs their services. The app supports maintenance, scheduling and bidding activities and sends thousands of daily notifications to its users.

3.1 Participants

The study involved a group of 6,866 local service providers. The baseline click-through rate of that group was 17.6%. About seventy percent of the app's subscribers were Android users and 30% were iOS users. Twenty-five percent of the users signed up for the app within three months before the study's commenced, while the rest were more experienced users of the app.

3.2 Variables

We collected both objective and subjective data. Objective data included logs of users' reactions to the notifications they received from the app during the study period. Objective user reactions (i.e., dependent variables) were (1) click-through rate (whether or not they clicked the notification), and (2) response time following reception of the notification. The data was monitored using advanced push notifications tools like 'One-signal,' 'Pushwoosh' and 'Firebase notifications.' For the subjective data, we conducted a short daily survey, in which a subset of our participants (108 users who serve as the service's test pool) responded to 3 items about the notifications they received on that day. Due to space limitations, the results of the questionnaire are not presented in this paper.

3.2 Experimental Factors and Manipulations

The study included manipulations of three factors as described below:

(a) *Visuals.* The baseline notification included text only. This factor was manipulated by adding three additional conditions. In each condition, the baseline was augmented by one element: a small icon, a large icon, or an image (see mockup designs in Fig. 1).

(b) Ostensibly, action buttons make it easier for users to interact with the app and take immediate action from a notification (e.g., 'open the app', 'more information', etc.). This factor had two conditions – present (e.g., Fig. 2) or absent (e.g., all examples in Fig.1). While some recommend the inclusion of action buttons to a notification (e.g., [10]), Google's design standards discourage developers from including action buttons that duplicate the behavior of tapping on the notification body [11].

(c) *Sending time.* According to Google's research, mobile usage is spread quite evenly throughout the day [12]. However, others suggest that usage peaks during the evening hours (e.g., [13]). During our study, notifications were sent immediately following a triggering event as they would be in real life. To test sending time effects on users' reactions, we divided the sending time to three categories: Morning (7am–12pm), Afternoon (12pm–5pm), and Evening (5pm–10pm) – all local times.

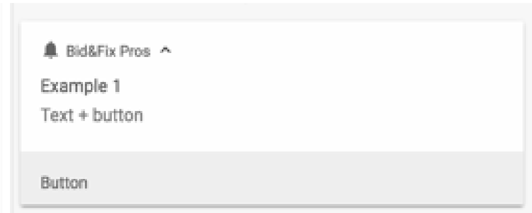

Figure 2: The text-only notification design, augmented by an action button (at the bottom of the notification).

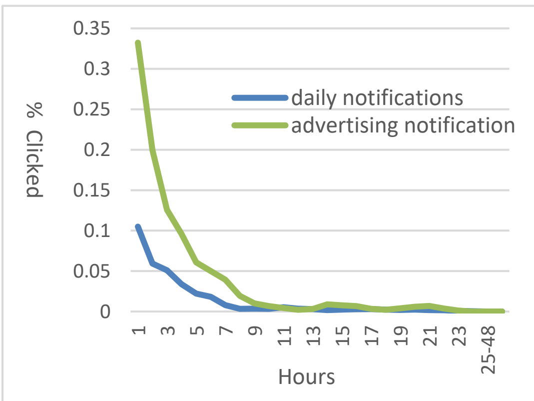

Figure 3: CTR as a function of number of hours since the notification was sent.

3.3 Procedure

The 6,866 participants received a total of 57,666 push notifications over a period of 15 working days. Two types of notifications were sent: (1) 32,249 work-related notifications were sent as part of daily work-related transactions, (2) 25,417 promotional notification were sent (once every week to each user). The notifications were manipulated randomly as described above.

At the end of each day, an online survey was administered to the 108 participants who belonged to the application's test pool. The survey presented each of the notifications that they received on that day as a reminder and asked them to respond to the 3-item questionnaire.

4 RESULTS AND DISCUSSION

As mentioned above, space precludes the presentation of the questionnaire results. Similarly, there is not enough room to present and discuss some aspects of users' response to the notification (e.g. weekly aspects of users' responses or responses during the first hour since receiving the notification). Hence, we concentrate here on presenting the overall patterns of those responses.

The overall click-through rate (CTR) of the notifications was 35.26%. Figure 3 shows CTR as a function of number of hours since the notification was sent. The figure suggests a concentration of clicks during the first few hours and a long tail afterwards.

4.1 Effects of the Experimental Factors

We conducted a mixed-effect binary logistic regression to analyze the effects of notification design (4 levels), action button (present/absent) and timing (3 time categories) on CTR, with notification type (work-related vs. promotional) as a control variable. The three experimental factors and the control were modelled as fixed effects while users were modeled as a random effect. The analysis yielded significant main effects of all the fixed factors. In addition, there were significant interactions of Time × Design and Design × Button (see Table 1).

CTR for text-only notifications (17.8%) was very close to the app's baseline figure of 17.6%. Post-hoc pairwise comparisons (all significant at $p<.001$) showed that rate to be significantly lower relative to all other design conditions. CTR was significantly higher for notifications with image (48.9%) relative to all other designs. In addition, large icons were associated with higher CTR (42.5%) than small icons (21.6%).

The addition of a button to notifications improved CRT to 42% compared to the no-button baseline (35%). While the positive effect of the added button on CRT is consistent across design levels, the significant Design x Button interaction effect indicates that this effect is stronger for the notification with image design relative to the other designs, as can be seen in Figure 4.

Pairwise comparisons following the Design × Button interaction indicate that while for each of the designs clicks are significantly higher for notifications with action button than for notifications without an action button, these differences were less pronounced for the text-only design relative to the other three designs.

Table 1: Fixed effect (df2= 57,641)

SOURCE	F	DF1	SIG.
Time	113.87	2	.000
Design	1,213.09	3	.000
Button	124.59	1	.000
Notification Type	15.88	1	.000
Time × Design	25.38	6	.000
Time × Button	0.31	2	.736
Design × button	8.72	3	.000
Time × Design × Button	1.01	6	.419

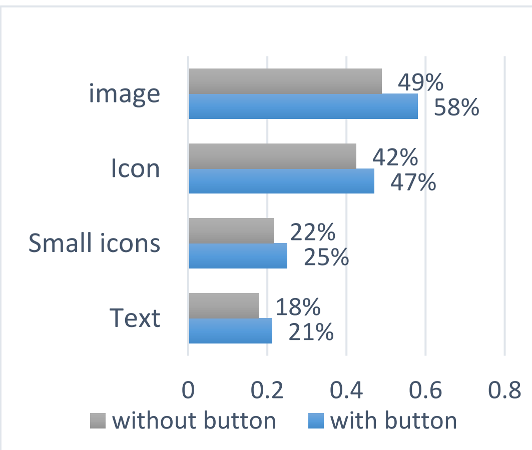

Figure 4: Click-through rate as a function of notification design.

During the experiment, a total of 13,052 notifications were sent in the morning, 21,505 notifications in the afternoon and 23,109 in the evening. Pairwise comparison showed that CTR was significantly lower ($p<.001$) for messages sent in the morning (32.7%) than those sent in the afternoon (41.8%) and evening (42.7%). The latter two categories were not statistically different from each other. The Time × Design interaction effect stemmed from higher CTR in the afternoon and evening hours for notifications that included text-only or text and small icons. However, for notifications with an image or large icon, the clicks are not significantly different for the three time categories (see the test results in Table 2). Finally, there was a weak yet significant effect of notification type: CTR for work-related notifications was 38% compared to 40% for promotional notifications.

4.2 Effects of Control Variables

A total of 38,670 notifications were sent to Android users and 18,996 were sent to iOS users. Of the notifications, 40,541 were sent to experienced users and 17,125 notifications were sent to new users. CTR was very similar (about 35%) across both operating systems and experience levels. Mann-Whitney U tests were performed, for each control variable. In both cases, the differences between the groups were not significant ($Z=1.35$, $p=.177$ for the comparison between operating systems, and $Z=.74$, $p = .46$ for the comparison between the experience groups).

5 LIMITATIONS

Our work is based on experimentation and data collection in the wild. Such studies are susceptible to issues related to lack of experimenter control and potential noisy environments. For example, we could only assume that users have read the notification when they clicked on the notification. We could not tell whether they were reading a summary of a message from the notification-bar. Second, we cannot tell whether users opened the app directly by clicking on the app icon rather than on the notification. Still, we have no reason to suspect that the rate of clicking directly on the app was affected by any of our manipulations or control variables. Third, the test pool participants answered the questionnaires at the end of the day and not immediately following reading the notification. Therefore, their answers may be tainted by the passage of time, although we do not have any concrete reason to assume that their answers were biased particularly in a certain direction. Finally, the visual elements in the notifications were not controlled for size. Hence, future research may have to consider element size as another design factor in notification receptivity.

6 CONCLUSIONS

The main contribution of this study lies in the combination of (1) using a very large sample; (2) systematically manipulating design aspects of smartphone notifications in a real world context; (3) using notifications to convey content that is highly relevant to the users. The results indicate that changes to the notification design have bearing on users' receptivity of the notifications.

Table 2: Overall test results – Time×Design
(contrast field=time, df2=57,642)

DESIGN	F	DF1	ADJ. SIG.
Text	136.17	2	.000
Small icons	53.23	2	.000
Icon	1.04	2	.352
Image	2.01	2	.134

Due to lack of space, our theoretical treatment of the subject matter is limited. Yet, there is considerable evidence from both academic research and trade literature regarding the persuasive potential of images over text-based information. Our findings are in line with this evidence.

The results suggest that app vendors may consider departure from the traditional text-only model of push notifications. However, such changes should be made cautiously. Icons and images can have a positive effect on users' receptivity when used selectively to differentiate between types of notifications (e.g., based on importance and urgency). Otherwise, wholesale adoption of icon-, or image-heavy notifications may desensitize users to such differences in a manner similar to the banner blindness (advertising avoidance) phenomenon. [e.g., 14]. In addition to the negative practical implications of abusing the use of images in smartphone notifications, we should also consider the ethical aspects of such a practice. The findings may tempt vendors and developers to adopt image-heavy notification design, which might add noise to the already cluttered smartphone environment.

Finally, our data set includes additional analyses that have not been presented here due to lack of space. These analyses include users' subjective responses to the notifications, their notification receptivity during the first hour of receiving notifications (which turned out to be the most meaningful in terms of CTR), and analyses of longitudinal data (i.e., users' response patterns over the three weeks during which the experiment was conducted). We intend to add those analyses in subsequent publications.

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