Assessing the Relationship between Technical Affinity, Stress and Notifications on Smartphones

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Abstract
Smartphones have become an indispensable part of everyday life. By this time, push notifications are at the core of many apps, proactively pushing new content to users. These notifications may raise awareness, but also have the downside of being disruptive. In this paper we present a laboratory study investigating users' attitudes towards notifications and how they deal with notification settings on their smartphones. Permission requests for sending push notifications on iOS don't inform the user about the nature of notifications of this app, leaving the user to make a rather uninformed choice on whether to accept or deny. We show that requests including explanations are significantly more likely to be accepted. Our results further indicate that apart from being disruptive, notifications may create stress due to information overload. Notification settings, once assigned a preset, are rarely changed, although not necessarily matching the favored one.

Author Keywords
Smartphones; Notifications; Apps; User Study; Human Factors

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction

Push notifications on smartphones proactively inform users about a variety of events, utilizing visual pop-ups, app icon badges or audio-tactile cues. Particularly for social networking applications, notifications are a core feature to inform users about incoming messages. With the ever rising number of apps available from mobile application stores, the number of apps making use of this channel increases.

Considering the two major smartphone operating systems, Android and iOS, Android users automatically 'opt-in' to receiving push notifications when downloading an app, while users with a device running iOS may choose to receive push notifications by 'opting-in' when prompted. However, this prompt doesn't allow for making an informed choice, as the permission request looks the same (except for the app's name) for every app (see Fig. 1) and doesn't give provide information on what kind of notifications the user has to expect when opting in.

It has been shown that notifications vary in their level of importance [9] and although they are designed to make users aware of events, they may be disruptive [3] and even worse, annoying. This in turn could ultimately lead to uninstalling an app.

In this paper, we present results of a laboratory study investigating how users deal with notification settings on their smartphones. The core contribution of this work includes: an investigation of (1) the relationship between push notification characteristics and settings, personality traits, technical affinity and technostress, and (2) added explanations in push notification permission requests.

Related Work

Notifications in desktop environments have been studied extensively in the past (e.g. [3, 2]), concluding that notifications can often be disruptive, but also valuable. In contrast to notifications on desktop PCs, notifications on smartphones are likely to be delivered when one is not interacting with the device.

In a field study with 10 participants, Mashadi and colleagues [5] found that participants were more likely to attend to a notification when actively using the phone. Although users did not always attend to notifications immediately, the visual cue was found to be helpful in reminding them at a later point in time. Oulasvirta and colleagues [6] identified a checking habit introduced by mobile devices: a "brief, repetitive inspection of dynamic content quickly accessible on the device". This may as well include checking for missed notifications from social networking apps due to social pressure [7]. Simultaneously handling multiple streams of information with mobile phones has also resulted in communication and information overload [8]. In a study with 325 participants, Lee et al.[4] found a significant relationship between compulsive smartphone usage and technostress, i.e. stress caused by information and communication overload.

Shirazi and colleagues [9] argue that the nature of notifications is disruptive and that notifications vary in their level of importance. Important ones were found to be about people and events and although important, they do not necessarily cause immediate attention. System notifications were found to be rather unimportant. In order to specify which notifications are important, users would like to have more fine-grained controls over notification settings [5].

Before actually receiving push notifications, users have to

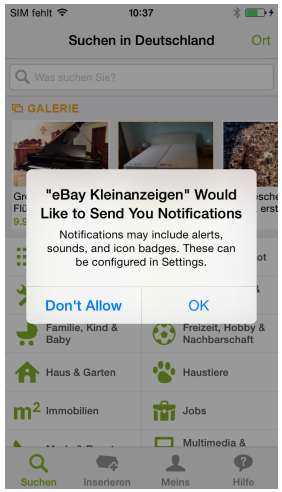

Figure 1: Default request (*eBay Kleinanzeigen*)

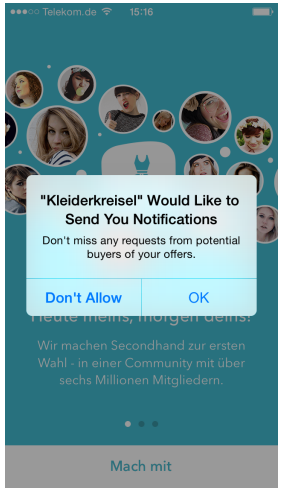

Figure 2: Custom request (*Kleiderkreisel*)

opt in on devices running Apple's iOS. For permission requests covering privacy related data (e.g. address book or location) it has been shown that added explanations made users accepting these kind of permission requests more often than those without [11]. However, the option of adding purpose strings to permission requests is not available to push notifications as of iOS8.

Methodology

50 German-speaking individuals (25 female) between the age of 18 to 46 (M=27.6) took part in the laboratory study. They had diverse fields of employment, while their educational level was above average for Germany [10].

Participants were recruited using a university participant database, notices on bill-boards in supermarkets, and an advertisement in a free local classifieds website. Owning an Apple iPhone with iOS 8.x was a prerequisite for participation, which was compensated with €10. 25 participants were longterm iPhone users owning an iPhone for more than two years, while 10 owned their device for less than six month.

The study took approximately an hour to complete and was divided into four parts:

Part I: Questionnaires
Firstly, participants were asked to fill out questionnaires covering

(a) demographic data

(b) technical affinity (*TA-EG* [1])

(c) technostress: smartphone-adapted version of [8] with a total of 12 items including the dimensions

(1) techno-overload: higher workload due to smartphone technology

(2) techno-invasion: invasive effect of smartphones, where users can be reached anytime and feel the need to be constantly connected

(3) techno-complexity: complexity of smartphone technology leads users to feel inadequate with regard to their skills

Part II: Interview
In a personal interview, participants were asked for their most used apps, apps they liked most, those that they find particularly bad or annoying. Furthermore, we asked for what they do in order to not being disturbed (phone features) and occasions they use these features in. Additionally, participants answered questions regarding their behavior in dealing with push notifications.

Part III: Permission requests
The third part consisted of a questionnaire including 14 apps of the top *Top 50* free App Store apps (as of February 2015) from seven app categories (namely *games*, *health*, *lifestyle*, *music*, *photo & video*, *social networks*, *weather*) where apps of a single group provided similar functionality (cf. Fig. 1 and 2 for two apps of the *lifestyle* category offering classifieds). For each app a screenshot with a pop-up requesting allowance for sending push notifications was presented. Seven screenshots (one of each category) contained the standard request shown in Fig. 1, the other seven an adapted one explaining the nature of push notifications (see Fig. 2). Messages are listed in Table 1. The order of apps was randomized and the assignment of default/custom requests to apps were swapped for half of the participants (gender balanced).

For each app, the participant was asked a) whether she used this app before, b) whether she would accept this request (5-point Likert scale with 1 = *very unlikely* and 5

= *very likely*), and c) for an explanation of her choice (free text). Responses to c) were later categorized by two independent researchers. Upon finishing, the participant was asked whether something (i.e. non-default requests) in the screenshots attracted her attention.

Default	**Message**
	Notifications may include alerts, sounds, and icon badges. These can be configured in Settings.
Custom App Category	
Games	*You'll receive game challenges via push notification!*
Health	*Stay tuned! We'll help you sticking to your training goals.*
Lifestyle	*Don't miss any requests from potential buyers of your offers.*
Music	*There is a new release of your favorite artist? We'll inform you immediately.*
Photo & Video	*Receive news of subscribed persons and channels instantly via push notifications.*
Social Networks	*Via push notifications you will be informed about new messages from friends.*
Weather	*Weather alerts are directly sent to your smartphone via push notifications.*

Table 1: Default and custom messages for push notification requests

Part IV: Notification settings
Participants brought their personal iPhone and we recorded notification settings from the participant's device for every app that had previously asked for the permission to send push notifications. The recording was done using a screen mirroring software and later transcribed.

Results

Participants used their smartphone for a variety of occasions, ranging from the smartphone as a pure mobile phone (i.e. for making phone calls and SMS) to a toolbox for photography. This is also shown in the number of third-party apps installed, ranging from merely two to 145 (Mdn=38.5).

Notification settings
Evaluating the transcribed recordings of participant's smartphone notification settings, we found that on average 72% of all third-party apps installed requested the permission to send push notifications (min 33%, max 100%). 77.6% of these were given permission to do so. Here, we cannot report whether users denied the actual permission request, or switched off the push notifications at a later point in time.

Overall, notification settings (i.e. badge, sound and alert style) were changed for 14.4% of all apps. Sound (10.1%) was the most modified setting, followed by badge (6.7%) and alert style (6%). To an extreme, one participant reported that she never enables push notifications because of annoying sounds/vibrations.

Asked for the frequency of notification settings changes, 18 (36%) participants stated that they never changed a setting. 21 (42%) rarely changed settings and 10 (20%) indicated that they sometimes change notification settings. Here, the most common change was to turn off notifications for reasons of relevance and disturbance due to too many notifications.

App categories requesting push notification permission most often (which doesn't necessarily relate to the number of apps installed from this category) were *social networking* (16.3%), *games* (11.1%), *lifestyle* (10.5%)

and *travel* (8.5%). An analysis of variance (ANOVA) further examined the relation between app category and enabled/disabled push notifications. The assumption of homogeneity of variance was violated; therefore, the Welch F-ratio is reported. We found a statistically significant difference between app categories, $F(19,117.84)=7.896$, $p<.001$. As homogeneity could not be assumed, a Games-Howell post hoc test was used. With regard to most requesting categories, it indicated significant differences between *social networking* ($M=.88$, $SD=.33$) and *games* ($M=.51$, $SD=.50$), and *social networking* and *travel* ($M=.60$, $SD=.49$). However, the *lifestyle* category ($M=.71$, $SD=.45$) did not significantly differ from the aforementioned. Interestingly, the *entertainment* category showed significant differences to eight other categories. All significant differences between app categories are listed in Table 2.

Technical affinity and technostress
Running a correlation analysis, we found that the number of push notification enabled apps is correlated to technostress overload (Pearson's $r(48)=0.29$, $p=.023$). In the same line we found that a negative attitude towards technology is strongly correlated to technostress overload (Pearson's $r(48)=0.42$, $p=.002$) and also correlated to technostress complexity (Pearson's $r(48)=0.26$, $p=.034$).

Good vs. bad push notifications
When asked for what a good push notification would look like, participants agreed that it should a) be relevant and b) have a clear message (that doesn't just prompt the user to open the app). 19 users stated that they already uninstalled an app because of receiving too many or irrelevant push notifications.

Explanations in push notification permission requests
Half of the participants stated that they did not see a difference in any of the screenshots. This was often reasoned by paying no attention to the details of the request, as they are always the same. We ran a Mann-Whitney's U test to evaluate the difference in the responses of our 5-Likert scale question for likelihood of request acceptance. We found that participants who identified custom requests were statistically significantly more likely to accept requests ($U = -4.21$, $p < .001$).

A Wilcoxon test was conducted to evaluate whether users who identified different request types were more likely to accept a request that contained an explanation compared to a default one. The results indicated a significant difference, $Z=-2.44$, $p=.007$. Customized requests were accepted more often compared to the default requests. For participants who did not identify custom requests no difference was found.

Discussion & Conclusion

In this paper we reported results of a laboratory study on push notifications with 50 participants.

We found that participants rarely make use of notification settings, which is partly explained by some participants ignoring content of permission requests where hints on how to find settings are given (Fig. 1). Differences in enabled/disabled push notifications among categories suggest that notifications are valued most for social networking apps (e.g. messengers), in line with findings of [9].

We found a significant effect of added explanations to push notification requests on request acceptance, although half of the participants missed the difference between standard and custom requests. This is consistent with

App Category I	App Category II	App Category I	App Category II
Business (M=.80, SD=.41)	Entertainment**	Music (M=.58 , SD=.50)	Social Networking**
Entertainment (M=.29, SD=.46)	Business** Finance** Lifestyle** Navigation** Productivity** Social Networking** Sports** Travel*	News (M=.58 , SD=.50)	Social Networking*
		Photo & Video (M=.53, SD=.50)	Social Networking**
		Productivity (M=.76 , SD=.43)	Entertainment** Games*
		Social Networking (M=.88 , SD=.33)	Entertainment** Games** Music** News* Photo & Video** Travel** Utilities*
Finance (M=.75, SD=.44)	Entertainment**	Sports (M=.81 , SD=.40)	Entertainment**
Games (M=.51, SD=.50)	Navigation* Productivity** Social Networking**	Travel (M=.60 , SD=.49)	Entertainment* Social Networking**
Lifestyle (M=.71, SD=.45)	Entertainment**		
Navigation (M=.81, SD=.40)	Entertainment** Games*	Utilities (M=.53 , SD=.51)	Social Networking*

Table 2: App categories that show a statistically significant difference for enabled/disabled push notifications at * $p < .05$ or ** $p < .001$

findings of [11], investigating privacy related requests. It would be interesting to run this part of the study again "in the wild", i.e. using an app available from the App Store. Not identifying custom requests may be caused by users only reading the first few lines of the request and then acting upon prior experiences (e.g. thinking of an app sending unsolicited messages). Capturing the timespan between showing the request and acceptance/denial in a real app might give a hint in this direction.

The seemingly mismatch between users asking for fine-grained controls over notification settings [5] and not using them might indicate that there is room for improvement. Here, it would be interesting to relocate notification settings to the permission request and see if users would a) make use of the settings when directly provided, b) be more likely to accept a request and c) are in the end more satisfied with the app altogether. This would also provide a visual cue that could make the custom request less likely to be overlooked.

Notifications on smartphones often provide valuable information and are able to raise awareness. However, it has been shown that notifications can often be disturbing and also can be a contributor to creating technostress. Currently, users are not empowered to make informed

choices on whether or not they would like to receive push notifications by an app. Once opted in, default notification settings remain mostly untouched, although this may not be the favored modality. In the worst case, an app is uninstalled because of push notifications. We showed that requests containing a hint on what the user has to expect from notifications by this app are more likely to be accepted.

Limitations

This study was performed in a laboratory setting with a limited number of 50 participants. In Part III: Permission requests participants were asked to respond to push notification permission requests. As they did not select the presented apps on their own (as they would when installing an app from an app store) and didn't actually install them on their private smartphone, the likelihood for accepting requests may be shifted in one direction.

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