Qualitative Investigation of Multi-Device Notifications

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Abstract
Users are confronted with more and more notifications in their lives. Multiple device types in the users' environment use visual, tactile and auditory cues to inform them about messages, events, and updates. All these devices differ in the used modalities to inform the users and in the offered configuration options for these modalities. Prior work investigated the distracting effects of notifications and how people interact with notifications. However, related work often only focuses on one platform at a time. Instead, we use interviews to investigate how users experience and deal with notifications generated by their different devices in their everyday lives. Our results show that users developed strategies to deal with notifications on their devices such as disabling (or not enabling) notifications, uninstalling applications, using do-not-disturb functionality, muting devices or even putting devices away. Only few users change the notification settings on their devices. As a consequence, the default settings selected by the device manufactures can drastically change how notifications are affecting users.

Author Keywords
Notifications; Multi-Device; Mobile; Interruptions

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

Background

Users are confronted with more and more notifications in their daily lives. Notifications are a popular method to engage users and inform them proactively, e.g., about new messages, events, or updates. Notifications use visual, tactile and auditory cues to gain the users' attention. However, notifications are no longer limited to single devices. With smartphones becoming ubiquitous and new kinds of connected devices entering our everyday lives and homes, notifications follow the users throughout the day. For instance, email notifications were once limited to desktop computers. Today, many kinds of devices can alert about incoming emails, from laptops, smartphones, smartwatches, fitness trackers, and tablet computers. In the future Internet of Things (IoT) devices like smart light bulbs [5], intelligent speakers, and pervasive displays will also notify the users. All these devices differ in their modalities used to notify users but also in the modalities users can react to notifications. However, even for devices of the same type, implementation-specific differences determine how users experience these notifications. For instance, in the mobile operating system, Android notifications are designed as opt-out while on iOS they are opt-in.

A body of related work already investigated notifications on single devices. Notifications on desktop computers tend to provide a passive awareness of incoming information rather than prompting users to change their current primary tasks [4]. However, especially in the work context notifications cause negative effects such as disruptions and interruptions [2, 3]. The type of the primary task, its complexity, its duration, the length and number of interruptions influence the perceived difficulty of continuing a task after an interruption [3]. Also, perceiving notifications during fast, stimulus-driven tasks lead to more distractions than during slower, more effortful semantic-based tasks [2]. When notifications are turned off on desktop computers, some users can increase the performance of their primary tasks; however other users interrupt themselves to check for information manually [4]. On their smartphones, users receive mainly notifications about messages, people, and events [9]. In 2014, participants in an in-situ study received on their smartphones on average more than 60 notifications per day [7]. Furthermore, they attended incoming notifications within minutes – even if their phones were in silent mode. Weber et al. found that users underestimated notifications that they received on their smartphones and implemented a dashboard to enable reflection about received notifications [14]. An investigation of smartwatch usage revealed that smartwatches are used briefly and frequently during the day [11]. Users value that they can quickly check the information on their smartwatches at a glance without being considered as rude in social interactions as well as the opportunity to decide at a glance if there is a need to interrupt their current primary tasks. Furthermore, smartwatches offer less disrupting access to incoming notifications than smartphones [1, 8, 11]. Similar to notifications on smartphones, users also interact more with notifications about communication with other people [10, 11] and calendar events [10] on smartwatches.

While a truly large body investigated notifications on individual devices, little is known about notifications in multi-device environments. Weber found that there is a need for a mechanism to coordinate the distribution of notifications across the user's devices [12]. Such a mechanism has to take multiple factors into account such as when a notification should be optimally delivered and which of the user's device(s) should display the notification. Weber et al. investigated notifications on smartphones, smartwatches, tablets and desktop computers and found that users prefer receiving notifications on their smartphones [13]. However,

factors such as the proximity to the devices, whether the devices are currently used and the users' current location influence if the users want to receive notifications on their devices. Regarding when notifications should be optimally delivered, Okoshi et al. developed Attelia II – a system that delivers notifications at identified breakpoints based on the user's multi-device usages and the user's physical activities [6]. The results of the evaluation of Attelia II revealed that delivering notifications at breakpoints in multi-device environments reduces the perceived workload of the user.

In this paper, we investigate how users cope with the notifications on different devices in their everyday lives. Therefore, we conduct interviews and investigate especially strategies developed by the users to deal with unwanted notifications on their different devices. Furthermore, we are interested in how users use the offered configuration options for notifications on their devices. Our results show that users developed similar strategies to deal with unwanted notifications on their different devices. Furthermore, few users are changing the notification settings on their devices.

Interviews

We conducted a qualitative study with 16 participants to investigate how participants experience and deal with notifications from different device types. We, therefore, invited the participants to our lab and conducted semi-structured interviews. When the participants arrived, we asked them to fill out a consent form and asked them to provide demographic data. For the interviews, one researcher lead the interview, another researcher took notes, and a third researcher supervised the procedure. The interviews were structured into two parts. In the first part, we asked the participants about their experience of notifications in general. In the second part of the interview, we asked them about their experience depending on the different device types.

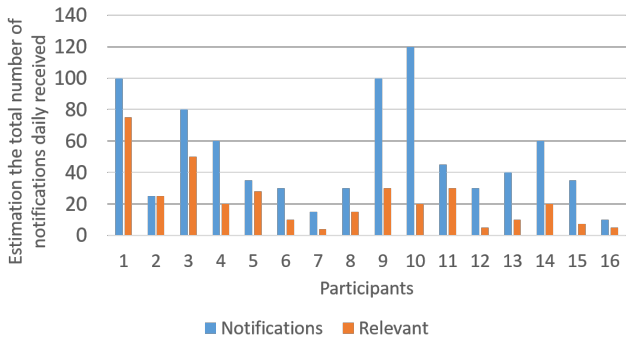

Figure 1: Number of all and relevant notifications daily received by the participants on their devices. All values are estimations.

Participants

In total, we interviewed 16 people (8 female, 8 male) that were aged between 16 and 60 years ($M = 30.94, SD = 15.11$). Participants had diverse backgrounds; none had a computer science background. Six participants were students of various subjects, four employees, two high school students, two retirees, and two trainees.

Part 1: General Questions

For the general questions about notifications, we asked the participants on which devices they receive notifications in their daily lives as well as how many notifications they receive from this devices on a daily basis. All participants owned a smartphone as well as a laptop or desktop computer. Furthermore, six participants owned a gaming console, five a tablet computer, three a smart TV, three a TV set-top box, three an ebook reader, two a smart car, and two a fitness tracker. One participant also owned a traditional mobile phone. Our participants estimated that they receive from 10 to 120 notifications per day ($M = 51.56, SD = 32.65$). All estimations are shown in Fig-

ure 1. We further asked the participants to estimate how many notifications they consider relevant. Here, the answers ranged from 4 to 75 relevant notifications per day ($M = 22.66, SD = 18.94$). Only P2 stated that she considers all notifications that she receives relevant.

We investigated how our participants experience different kinds of notifications. Eleven participants noted that they consider notifications as useful when they are related to communication. Notifications about calendar events, reminders and alarms were mentioned as useful by four participants. In contrast, system- and security-related notifications were only found useful by two participants. Furthermore, P4 stated that news notifications are relevant. Two participants stated that the usefulness depends on the content of the notifications itself and not on the category. Another two participants mentioned that they consider all notifications are useful.

In addition, our participants reported that they consider notifications as disturbing when they receive them at night (6 participants) and at work/university/school (5 participants). Also, our participants mentioned that receiving notifications is also disturbing in inappropriate situations such as during meetings and appointments (3), when generally being busy (2), while they are talking to others (1), when other people are around them (1), while driving (1), during sport (1) or even while being in a bad mood (1). Furthermore, participants disliked notifications that are mainly used as ads, for example when lesser-used apps try to grab their attention to keep them in the loop (3). Three participants stated their dislike of 'spammy' notifications, and two other participants mentioned spammy messages (e.g., group chats from instant messaging). Notifications from games and update notifications were disliked by two participants each. Further, two participants disliked notifications that are delivered with sounds, and one participant mentioned that visual notifications are sometimes unwanted. One participant disliked the fact that in some cases notifications cannot be disabled. Other participants disliked receiving duplicate notifications.

Part 2: Device-Specific Questions
In the second part of the interview, we asked the participants specifically about their usage of their devices and how they cope with notifications on their devices.

Smartphone: Thirteen participants owned an Android-based smartphone, and the other three participants owned Apple iPhones. We asked the participants to estimate their daily smartphone usage, which resulted in an estimated average usage time of 3.61 hours ($SD = 2.82$) per day. For Android smartphones, the participants estimated that they receive from 5 to 80 notifications ($M = 36.15, SD = 16.67$) per day. They considered 3 to 50 notifications ($M = 14.54, SD = 5.77$) as relevant. Ten participants stated that they check incoming notifications immediately or within a short time span. Only three participants mentioned that they silent their phones (2) or put their phone away (1) and check the received notifications manually from time to time. P15 explained that he checks notifications displayed on the lock-screen and attends to them if the content is interesting for him. Furthermore, four participants reported that they keep notifications in the notification center to attend or answer them later. Two participants stated that they dismiss received notifications immediately to keep the notification center clean. However, P12 noted that he attends the content of dismissed notifications later to react to them. If an app triggers mainly notifications that are experienced as unwanted, five participants stated that they dismiss these unwanted notifications without changing the notification settings (i.e., they neither deactivate notifications for this app nor uninstall the application). P12 explained that he

is aware that Android offers the opportunity to disable the notifications for specific apps, but he is not using this opportunity as dismissing them is less effort. However, five participants mentioned that they remove the permission for such apps to trigger notifications. Furthermore, four participants using Android reported that they uninstall such an application directly. After we explained how to revoke the notification permission for apps on Android, three participants reinstalled apps and disabled notifications for them. Regarding iPhones, the participants estimated to receive 20 to 50 notifications ($M = 36.67, SD = 15.27$) per day of which 20 to 30 notifications $M = 26.67, SD = 5.77$) are relevant. All iPhone users stated that they are attending incoming notifications not immediately but as soon as possible. Similar to the Android users, one participant using iOS mentioned to dismiss notifications from an app that generates unwanted notifications instead of changing the notification settings. Another participant mentioned that she revokes the notification permission for such an app and one participant uninstalls such applications.

PC: All participants owned a desktop computer or laptop with a running a version of Microsoft Windows. Participants estimated spending 1 - 12 hours per day in front of the PC ($M = 4.91, SD = 3.49$). Besides, participants estimated that they receive between 0 and 40 notifications ($M = 15.16, SD = 11.69$) per day. From this number of notifications, our participants estimated between 0 and 25 notifications ($M = 5,72, SD = 6,42$) as relevant. Three participants considered all notifications received on their desktop computers or laptops as useful. Twelve participants mentioned that they perceive such notifications but usually do not attend to them if they see no need to react on notifications; e.g., about available updates or WiFI connections. Nine participants stated that they attend only to notifications generated by specific applications, e.g., by mail, calendar, or instant messaging applications. Four participants stated that they dismiss notification without reading their content. Regarding unwanted notifications, six participants reported that they ignore them until the disappear automatically, eight participants reported that they dismiss unwanted notifications, and two participants uninstall applications generating unwanted notifications. None of the participants changed the default settings.

Tablets: Five participants owned tablets. Two Android-based tablets (Android 4.3 and 5.1) and three Apple iPads (iOS 9.3.1). Participants estimated to use their tablets between 15 and 120 minutes per day ($M = 51, SD = 41.89$). All participants mentioned that they receive few notifications and of little importance. On the Android tablets, both participants estimated to receive 2 and 20 notifications per day, of which 0 and 1 notifications (M=0.50, SD=0.71) are relevant. They mention that most notifications are from games or duplicate email notifications that are already received on other devices. unwanted notifications are mostly tolerated and sometimes dismissed. No Android tablet user changed the default settings. One iPad user estimated to receive 10 notifications and the other two iPad users mentioned that the amount is similar to smartphone notifications since they are synced. P14 mentioned that most notifications are from the Mail app since he did not grant the permission to most other apps. However, he ignores mail notifications most of the time. He also did not change the default settings but disables the Wi-Fi connection at night.

Smart TVs: Two participants enhance their TV with an Apple TV. Both participants stated that they only use the Apple TV on weekends, with estimated usage time of 2 hours. The only notifications shown are about system updates.

Gaming consoles: Four participants owned gaming consoles. Two participants owned a Sony PlayStation 3 and

two a PlayStation 4. They estimated a daily usage time between 10 and 120 minutes ($M = 47.50, SD = 49.24$). Participants estimated that they receive between 0.5 and 10 notifications per day ($M = 4.38, SD = 4.19$). Notifications are typically about low battery warnings for the controller, online/offline status changes, and system updates. The participants mentioned that they ignore all notifications except the low battery warnings.

Ebook reader: Only one participant shared her experience with an ebook reader. She estimated a daily usage of 1.5 hours. The only notifications she receives from her ebook reader are warnings about low battery, which she described as useful and typically acts upon immediately.

Discussion

People are surrounded by notifications from different types of devices. The smartphone is the primary notification device for all our participants. The smartphone always turned on and always being with the users means that users can be reached all the time. We heard subtle differences in how the participants describe their dealing with notifications. For instance, Android users mentioned disabling the permission to allow notifications while participants with iPhones mentioned not granting the permission in the first place. Since notifications are often used to engage users, it is to expect that more and more apps make use of notifications on their diverse devices. Our investigation of how users deal with notification showed that fewer users configure their notification settings or are aware of the configuration options. Therefore, the default configuration of notification settings is an essential challenge for the diverse device types supporting notifications as well as for future notification management systems. Making notifications opt-in instead of opt-out might be a useful first step to manage the increasing number of notifications. Even if users are aware of the offered notification settings, some are not changing their settings for individual apps since this is perceived as more effort than dismissing unwanted notifications. Thus, future devices supporting notifications should also offer options to change the notification settings with less effort.

Conclusion

In this paper, we reported on a qualitative study where we investigated how users perceive and deal with incoming notifications on multiple device types in their daily lives. The discussions with the participants highlighted how more and more devices in the environment could notify the users. The smartphone and the PC were the predominant types of devices in the study, as all participants owned them. One participant owned nine different types of devices that are notifying him. On average, participants estimated that they receive 51.56 ($SD = 32.65$) notifications per day. Strategies to reduce distracting effects of notifications include, disabling (or not enabling) notifications, uninstalling applications, using do-not-disturb functionality, muting devices or even putting devices in other rooms. However, few users are configuring the notification settings of their devices nowadays – even if they are aware of the offered options such as revoking the permission to generate notifications for certain apps. With more and more devices notifying the users it is necessary to avoid overloading users with notifications. Decisions taken by device manufacturers can drastically change how notifications affect users, e.g., when comparing the opt-out approach of Android with the opt-in approach of iOS. Manually configuration of notifications on all devices might not be feasible in the future anymore, considering the increase of notifications and devices. This will especially become true with the Internet of Things (IoT). Therefore, identifying the right default notification settings for the different device types is an essential challenge for the device manufacturers in the future.

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