NotiModes – An Investigation of Notification Delay Modes and their Effects on Smartphone Users

Romina Poguntke
romina.poguntke@vis.uni-stuttgart.de
University of Stuttgart
Stuttgart, Germany

Christina Schneegass
christina.schneegass@ifi.lmu.de
LMU Munich
Munich, Germany

Lucas Van der Vekens
lvekens@yahoo.de
University of Stuttgart
Stuttgart, Germany

Rufat Rzayev
rufat.rzayev@sprachlit.uni-regensburg.de
University of Regensburg
Regensburg, Germany

Jonas Auda
Stefan Schneegass
firstname.lastname@uni-due.de
University of Duisburg-Essen
Essen, Germany

Albrecht Schmidt
albrecht.schmidt@ifi.lmu.de
LMU Munich
Munich, Germany

ABSTRACT

Despite the extensive analysis of the consequences of interruptions caused by smartphone notifications, research on the effects on users has so far been sparse. Therefore, in this work we (1) explore concepts on preventing interruptions elicited by notification delay in a focus group; (2) implement a smartphone application manipulating the notification delay in three distinct ways varying in the degree of user-control; (3) evaluate all three concepts with 13 users in a four-week field trial. We thereby gather qualitative feedback in 52 semi-structured interviews, one per participant after each mode and an additional control week. The results show that through the intensive preoccupation with their notification management, users reflect critically about advantages and disadvantages of their continuous reachability. Based on the results from the focus group and field trial, we derive four design implications summarizing the users' experiences and suggestions on notification delay mechanisms.

CCS CONCEPTS

• **Human-centered computing** → *User studies*; *Smartphones*.

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KEYWORDS

Notifications; interruptions; user experience; qualitative and quantitative study

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1 INTRODUCTION & BACKGROUND

The advent of smartphones allowing more than just calling has marked an important milestone in digital communication technology. Internet surfing, social media, and the huge number of apps have, at the same time, led to a continuous increase of notifications [10, 13]. These can become disruptive when the device is ringing all day or interrupts the user in specific situations such as social gatherings or moments of focus. Apart from the negative social consequences, interruptions can lead to stress and anxiety [15] and can reduce our attention span and learning capacities [4]. To prevent such negative effects, notification management has been subject to extensive research (e.g., [2, 3, 14]).

Prior work examined approaches trying to determine opportune moments to present notification when they are least interrupting [9] and to delay or prevent them [12]. In *Attelia*, a breakpoint-based notifications management system [5–8], users' interaction with the mobile device and their activity through fitness trackers are monitored to estimate when the user switches to a different task. Further, rule-based systems enable users to specify rules themselves and adjust certain parameters (e.g., time and keywords triggering a rule) [16]. An evaluation revealed that users desire fine-grained control over notifications and that their acceptance is related to the time of the day [1]. To find out more about the disruptiveness of individual notifications, Sahami et al. assessed the perception of notifications and found that their disruptiveness is closely linked to their perceived importance. For example, notifications containing information about people or events were considered more important than others [13]. Thus, simply disabling all mobile notifications is no suitable option [11, 12] since notification receivers may fear not meeting social expectations or missing out on information.

While notification management has been evaluated from a technological and performance perspective, this work focuses on the user experience of different notification delay modes, their effects on users' habits and daily life, and the user's reflection when comparing different degrees of control. In this work, we present three notification delay mechanisms originating from a focus group ($N = 7$), which we evaluated in a four-week in-the-wild study ($N = 13$). We performed 52 in-depth interviews with our participants after using each mode including an additional control week tackling the following research questions:

RQ 1 What is the subjective user experience for each mode?
RQ 2 Which degree of user control for managing notification delay is favored by the user?
RQ 3 What is the effect of different notification delay modes on the users' daily life?

From the results answering these questions and based on the gained insights from the study, we derive four design implications for notification delay mechanisms emphasizing the importance of customization and adaptation options.

2 FOCUS GROUP - NOTIFICATION HANDLING

For the implementation of our notification delay modes, we conducted a focus group to explore how users deal with interruptions and where they see potential for improvement.

Participants & Procedure

Seven smartphone users ($M = 21.86$, $SD = 2.9$ years; 6 male, 1 female) participated in our 70 minutes-focus group session. All reported to frequently use applications generating notifications, including messengers, social media, and others. Before we collected demographic data, we explained the purpose of the focus group, and participants signed a consent form. Afterwards, we inquired how many notifications the participants received per day and from which applications. We collected feedback on the perceived importance and annoyance of those, in particular, whether the participants experienced interruptions and how they cope with them. We discussed existing solutions and how they could be improved. Finally, we thanked the participants for their time and offered sweets as compensation.

Results & Insights

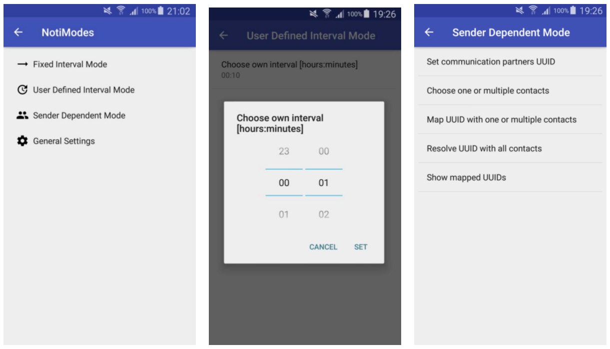
Our participants estimated that each of them received approximately 100 notifications on average per day, primarily from social messaging apps. Besides the annoying character of notifications, all participants agreed that notifications were also useful for presenting important information at a glance. One user said, "*It is important to know if something happens. In case one does not use the smartphone at this moment, and there is a message, it could be a problem* [if it is an emergency]". Notifications have been perceived as annoying in many situations, for example, when the participants played mobile games or when they wanted to work or study. All participants agreed that receiving multiple notifications can affect productivity with three participants admitting: "*One is distracted immediately and takes a look*". Reflecting upon approaches on how to prevent interruptions by unwanted notifications, the participants named several ideas. These include an *Emergency Mode*, during which only urgent messages can be sent, an *Occupation Mode* displaying the current status of a chat partner, or applying keyword filtering to classify urgent messages (e.g., "emergency", "now" etc.). Existing solutions like the "Do-not-disturb" or flight mode, disabling all connections, were largely described as "*not desirable*". The participants agreed on that notifications can be annoying and that they might have negative consequences. Since participants were hesitant to disable all communication completely, our approach focuses on notification delay. Additionally, the discussions tackled aspects like prioritizing notifications and sender responsibility. Inspired by the focus group session outcome, we implemented the Android Application *NotiModes* (see Figure 1), providing three different notification delay modes.

3 NOTIMODES ANDROID APPLICATION

We developed the application *NotiModes* (for Android versions 5.0.1. or higher) communicating with a complementary Node.js server to enable the following notification delay modes: *Fixed Interval (FI)* (no notifications for a fixed duration of 59 minutes which is not adjustable), *User-Defined Interval (UDI)* (users could set a preferred interval for the delay, default is 10 minutes), and *Sender Dependent (SD)* (no notifications delivered for a fixed interval of 59 minutes which is not adjustable; for communication applications the sender of a message was asked whether he/she wants to send a message right away or not, thus, deciding on the delay).

The app uses Android's Notification Listener Service API [1] to access notifications. After explicitly confirming the data collection and granting the app permission to access notifications at the first launch, the main view of the application

[1]developer.android.com/reference/android/service/notification/NotificationListenerService.html, last accessed Jan 2nd, 2020



(a) (b) (c)

Figure 1: Three notification delay modes of the *NotiModes* application in the main view (a); interval length settings that could be adjusted in the *User-Defined Interval (UDI)* Mode (b); menu for matching UUIDs to contacts allowing the *Sender Dependent (SD)* to grant a message's sender responsibility when a message would be sent (c).

is shown. The app blocks notifications including their visual, auditory, and tactile signaling. Incoming calls, however, are indicated through short vibration. All notifications received are stored transiently locally on the smartphone during the delay and removed from the notification bar and lock screen.

We logged the following information locally on the device using an SQLite database server: (1) general information on the device (e.g., Android Version), (2) notification metadata (i.e., applications used and timestamps), (3) UUID of communication partner for *SD Mode*, and (4) the user settings for each mode.

4 USER STUDY

In a four-week field evaluation, thirteen participants used all three modes of notification delay following a within-subject study design. A control condition without delay complemented the three modes. For one week each mode was presented in randomized order according to a Latin square.

Participants, Procedure & Analysis

As a requirement for this study, participants had to be smartphone users and sign up as a pair of two, since a chat partner was needed for the *SD Mode* for matching them using UUIDs. Before the study, all participants received a detailed instruction manual on the installation of *NotiModes* including information on the notification delay manipulation functionality and privacy preservation. After receiving the signed consent form, we gave participants access to the *NotiModes* app and asked them to fill in a short demographic questionnaire. Before using the *SD Mode*, each participant had to enter the assigned UUID for his/her study partner. After successful installation, the first (randomized) mode was activated automatically and ran for one week before switching to the next mode. We compensated each participant with 40 Euros. We initially recruited 35 participants. However, 18 users discontinued their participation during the study process, stating to feel too restricted in their communication opportunities. We will discuss this insight in the limitation section. We furthermore excluded four participants due to technical issues resulting in a final sample size of 13 users (seven female, six male; aged 18-52, $M = 23.31$, $SD = 8.41$).

The semi-structured interviews (on average 9.32 minutes; performed in person or via Skype by three interviewers; audio-recorded and transcribed) tackled the following six aspects: (a) advantages and (b) disadvantages of the specific mode, (c) willingness to use the mode on a personal device in the future, (d) effects of the mode on participants' daily routine, (e) opinions on the overall concept of the modes, and (f) potential improvements. For the *UDI Mode* and *SD Mode* we asked additional questions regarding the individual settings the users chose. For the interview analysis, we applied an open-coding process with two researchers deriving 16 codes according to our leading questions. We compared the individual code assignments and discussed all discrepancies until a consensus was reached. Through a final discussion, we deduced the key findings presented in the following.

Results

Through the 52 interviews we received genuine feedback on the user experience and the perceived effects for each mode. We will refer to the participants grouped as pairs, i.e., P3a was paired with P3b in our study.

RQ 1 - Subjective User Experience. During the *UDI Mode*, participants perceived receiving notifications in a bundle after a certain amount of time (P4a, P6c) as positive. They liked to define the time span themselves as in contrast to the *FI Mode* (P2b, P3a, P3c, P12a). During the *FI Mode*, participants claimed they wanted to see notifications on messages from friends and family instantly (P11a, P2a, P3b) because they feared to miss important messages (P4a, P4b, P3b), especially when something urgent comes up (P3b, P12b). In the *SD Mode* participants(P1a, P3a, P3b, P3c) appreciated receiving urgent messages and having different notification patterns for messaging apps in general (P4a). In the *UDI Mode*, participants were missing the opportunity to end the mode and access their messages before the time elapsed (P3c, P3b, P2b). P12a criticised the high number of notifications at the end of one interval, feeling "[...] *it was a bit too much when it all came at once*". However, this view was not shared by all participants. Thus, for example P1a mentioned that in the *SD Mode* he/she got used to not receiving notifications in time and P12a adds that texting becomes "*more relaxed*" when not

Part.	Adjustm.	Min	Max
P1a	4	0	10
P2a	8	1	421
P2b	2	120	180
P3a	1	30	30
P3c	3	60	240

Table 1: Number of adjustments of the notification delay (in minutes) for the *UDI Mode*. This table reports the data for all participants who adjusted the default delay of ten minutes. The columns *Min* and *Max* depict the lowest and highest chosen deferral time.

expecting an immediate answer. Accordingly, users reported to be more aware of how they deal with notifications.

RQ 2 - User Control. As depicted in Table 1, five participants adjusted the notification delay time in the *UDI Mode* according to their needs. Concerning the degree of control, users preferred a combination of different modes. Having a certain interval of delay but the option to define exceptions based on certain apps or people, especially for messaging apps (P6c, P3c), would be favourable. This combination would grant the user a sufficient amount of control to avoid distractions while still being contactable in emergencies.

RQ3 - Effect on Daily Life. For each mode, about half of the participants felt an influence of using *NotiModes* on their daily life (six participants in the *UDI Mode*, six in the *SD Mode*, seven in the *FI Mode*). Those who reported an effect of the modes on their daily life stated positive remarks for their routines exclusively. P2a and P11a perceived having fewer notifications of lower priority as positive. P12a and P3a claimed that the *FI Mode* also decreases the checking habit throughout the day, especially when compared to the *SD Mode* (P3a). Further, the *UDI Mode* helped to leave the phone on the side for some time (P12a) and made it easier to concentrate (P3c). Participants felt less distracted (P12a, P12b) and interrupted (P11a) in the *UDI Mode*, stating that they enjoyed the delay in communication because "[...] *there would be no need to reply right now because messages are not coming in real-time anyway*" (P12a). Consequently, users reported an increased awareness when actively adjusting their notification delaying intervals.

Limitations & Future Work

After the start of the study, 18 of the 35 initially recruited participants resigned from the study. Participants stated feeling too restricted, especially due to a lack of responsiveness in text-based messaging services. Participants reported that the modes severely affected their role within their social network. We are aware that despite conducting the user study in the field and on a 4-week basis, the results need to be validated on a larger scale with more participants. However, we believe that the observation that participants were fearing social exclusion due to canalized reachability provides considerable insights for the design of notification delay mechanisms.

5 DESIGN IMPLICATIONS

We derive four design implications comprising the users' experiences and reflections upon notification delay:

Allow Customization of Delay Intervals. Users preferred to set their intervals to individually fit their specific needs. Pre-defined modes varying in interval length according to activities were suggested (e.g., study 2h, sleep 7h).

Allow Different Delays for Different Apps. Participants appreciated the delay of certain notifications (e.g., gaming apps), but hesitated to delay messages. Hence, individual delay intervals for different apps were preferred.

Provide Filters to Classify Notifications. In line with the focus group suggestion, participants were keen on automated classification of messages by keyword filtering to improve the *SD Mode* (e.g., "hospital").

Allow Exceptions. While current solutions (e.g., 'Do-not-disturb' mode) block every potential disruption, participants rather wished for a feature to define exceptions. These exceptions can target contacts or contexts in which notifications would be patched through even when a delay mode is active.

6 CONCLUSION

Our work presents an investigation of the effects on users when dealing with different notification delay modes. We implemented the Android application *NotiModes* providing three notification delay techniques varying in user-control. Our findings show that individual preferences for notification delay depending on the subjective need to be reachable at any time. We observed that actively managing one's notifications increases the awareness for reachability. From the rich feedback we received on the improvement of notification delay, we derived four design implications. Those implications reflect important considerations for the design of notification delay mechanism, which can improve the acceptance of novel approaches aiming to prevent interruptions through notification delay.

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