

On the Impact of Context-Aware Notifications on Exercising

NEGAR HAGHBIN, Gina Cody School of Engineering and Computer Science, Concordia University, Canada
MARTA KERSTEN-OERTEL, Department of Computer Science and Software Engineering PERFORM Centre,
Concordia University, Canada

Mobile push notifications are a common means to send messages from a mobile application to the user's device. These messages can have different purposes and may be received at any time of the day in different modalities on a smart device. In this work we seek to answer how to make the most of push notifications in fitness and health applications, while avoiding negative reactions. After an exploratory survey on push notifications, we designed and developed an iOS fitness application with the ability to send daily context-aware notifications based on: (1) a user's location, (2) current activity level and (3) at a pre-defined time. The fitness app utilizes reminders with the purpose of motivating users to do their daily workouts. A small preliminary user study showed that even though reminder notifications can help to direct users attention to doing a workout, the user does not necessarily follow through with the workout.

CCS Concepts: • **Human-centered computing** → **Ubiquitous and mobile computing design and evaluation methods**.

Additional Key Words and Phrases: Push Notifications; Reminders; Fitness Application; Context-aware Notifications; Motivation

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1 INTRODUCTION

Mobile push notifications are a common means to send messages from a mobile application to a user's device. Since the emergence of push technology in the mid 1990s, the use and impact of notifications on anxiety and stress, and social engagement has been studied.

Push notifications have different purposes, including reminders, promotional messages, and social media notifications. On average, smartphone users receive 63.5 notifications per day [8]. These messages can be silent or use different modalities such as haptic, visual (i.e. LED on phone) and aural, or a combination of these. Different contexts, types of messages, and timings demand different modalities. Previous studies have shown that on average a notification is 12x more likely to be attended to immediately if it uses one of these modalities [7].

One of the most powerful types of mobile push notifications are reminders. These can be particularly helpful in the health context by reminding users to take their medications[1], follow a specific dietary routine[5], or support daily activities[3]. While reminder notifications themselves may not contain much information, they can persist in a user's mind[4] and encourage them to interact with the app in the future. According to Bidargaddi *et al.*[2], sending reminder push notifications is associated with greater engagement with self-monitoring apps and can remind users to record their behaviors and feelings daily. While push notifications can have many advantages, if they are poorly timed, they

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can have disadvantages such as causing distraction, redundant stress and anxiety[4, 8]. Although, there has been much research focused on exploring the negative effects of push notifications, there has been little exploring how to utilize the advantages of push notifications for fitness and physical health. Specifically, to the best of our knowledge no studies have looked at the impact of context-aware push notifications (i.e. based on the user’s current context, e.g. location, activity, etc.) on motivating users to exercise.

In this work, we explore the use of push notifications for motivating users to be active. We hypothesized that context-aware push notifications would positively impact users by getting them to perform an exercise routine. To verify the hypothesis we developed a custom iOS workout mobile application with the ability to send various types of push notifications. A short week-long preliminary study was then done with five participants to explore how different context-aware notifications impacted the users’ fitness regimes.

2 USER SURVEY

We developed a questionnaire probing people’s use and perceptions of push notifications. The questionnaire was created using Google Forms ¹ and was sent out using social media and emails. The goal of the questionnaire was to answer the following research questions: *Which modality (visual, aural, haptic) is the most appropriate for a given notification in a given context?* and *When is the ideal time and where is the ideal device to receive a specific type of notification?* The questionnaire consisted of approximately 40 questions targeting 3 different contexts: (1) work-related push notifications (e.g. calendar reminders), (2) home-related push notifications (e.g. smart alarm system notifications), and (3) reminder notifications in the specific context of fitness and healthcare purposes. For each scenario the questions targeted three main issues: (1) *what device* notifications should be received on (e.g. smartphone, smart speaker, watch), (2) *which modality* should notifications have (e.g. text, voice, vibration, combination), (3) *when* is the ideal time to receive a notification?

3 RESULTS: USER SURVEY

We had 105 participants answer the survey (42.9% female, 56.2% male, aged 18 to more than 65 years old, mean=30.81 years). Participants had diverse backgrounds but since the majority (39%) came from engineering and computer science backgrounds, their practical knowledge of technology was generally more than good (75.8%). About half of the participants (48.6%) had an iOS mobile device, and 51.4% were Android users. Just over a quarter (29 participants) owned a smart watch which was used mostly for checking time (82.1%), heart rate monitoring (60.7%), activity monitoring (57.1%), and push notifications (57.1%)

Regarding push notifications, the majority of participants (65.7%) tend to customize the notifications that they want to receive from apps and disable those that they don’t. Since in previous works it has been shown that non-tech-savvy users usually do not configure their notification settings[9], this might be a result of the fact that the majority of participants were from a tech-related background. About one fifth of participants (21%) do not customize push notifications but rather use the default settings.

Based on the survey, the two most popular types of notifications are reminders (78.1%), and social media notifications (55.2%).

Although the questionnaire surveyed push notifications in three different contexts, here we focus on the results of the fitness and health questions. However, the interested viewer is directed to the full results².

¹<https://forms.gle/J1FuBcPqQGf8Pwbj8>

²<http://bit.ly/2tdooH0>

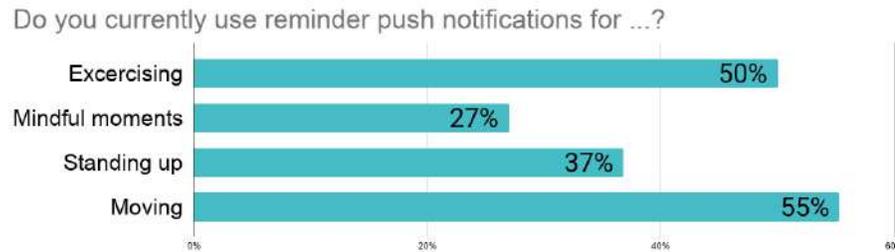


Fig. 1. User's current usage of reminder push notifications related to fitness and well-being out of 38 responses.

3.1 Push notifications for fitness and health

We found that 36.2% of our participants currently use push notifications for health and fitness tracking. Of them, 50% use push notifications to remind them to exercise (Figure 1). The majority of participants, prefer to receive notifications related to fitness either on their mobile device (60.5%) or smartwatch (60.5%). This matches former study results on multi-device notifications. Since as smartphone is typically turned on and reachable most of the time, it's usually the primary notification device for people[9]. This reason applies for smartwatches too. In contrast, a very small number of participants favour push notifications on their tablet (2.6%) or smart speaker (2.6%). This can be because of the fact that these devices are not easy to carry around and are less reachable for people. Regarding the type of notification, among different modalities (text, voice, vibration and voice, vibration and text, voice and text, tone and text) the top two were text (60.5%), and vibration and text (60.5%). The least popular ones were found to be vibration and voice (47.3% did not like this modality), and voice (44.7% did not like this modality). We might be able to connect this to the fact that privacy was found to be very important (52.4%) or important (32.4%) to the participants and having voice notifications does not comply with private notifications.

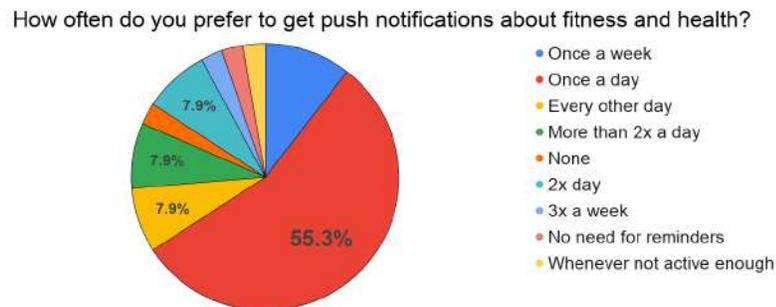


Fig. 2. The ideal quantity to receive push notifications related to fitness and well-being.

In terms of the quantity of push notifications, we found that 55.3% of the participants prefer to receive push notifications concerning fitness once a day (Figure 2). The ideal times to receive push notifications related to fitness and well being were: "When I have not been active enough" (63.2%), "In the morning before I start my day" (47.4%) and "In the evening, if I have not been active enough" (34.2%), see Figure 3. On a scale of 1 to 5, (5 being most useful), most



Fig. 3. The ideal times to receive push notifications related to fitness and well-being.

participants replied 4 to push notifications being useful in staying motivated. Lastly, we found that the majority of participants (63.2%) prefer short notifications with only the title of the notification and no details.

4 PRELIMINARY USER STUDY

In order to study mobile phone users preferences for fitness notifications, and the impact of these notifications on motivating users to exercise, we conducted a one-week small preliminary study with 5 participants. The study involved users downloading and using a custom designed fitness application, with specific push notification reminders based on the results of our survey.

4.1 Participants

For the study, 5 participants (all male, age 18 to 34) were recruited who had iOS smartphones. Two participants had full-time jobs, two were students, and one was unemployed. The field of study/work for all participants was technology related.

4.2 Pre-test Questionnaire

At first a consent form was sent to all those who were interested in joining the study. Once those people had read the consent form and agreed to take part in the study, they were asked to complete the pre-test questionnaire. This questionnaire collected information such as demographic data, questions about the participant's preference of push notifications specifically in the context of fitness and health, as well as, their current use of fitness apps.

4.3 5 mins Fitness App

The implemented workout application was built for iOS devices and it is made to look and feel similar to two of the most downloaded fitness apps available in the App Store: 7 Minute Workout: Fitness App (8.4k download and 4.7 stars) and Workout for Women (31k downloads and 4.7 stars). All of the workouts are inspired by DAREBEE workout routines, a free global fitness resource(Figure 4).

The first time the user opens the app, the user is asked to give the app permission to send notifications and track the user's location. After giving the authorization, it will set three types of default notifications, based on the results gathered from our survey. The first type is scheduled for a specific time that is set by user. By default, this time is set to 8:00 A.M., which is compatible with the second most popular choice from the questionnaire: "In the morning, before I



Fig. 4. Screenshots of 5 mins

start my day". Further, if the user has not been active enough the day before, the content of these notifications will be more encouraging next day, e.g. "Today is a new day!".

The second type of notification is based on the user's location. We assume that users will use the app for working out mainly in locations that they do not have access to special equipment e.g. their home. Hence, for location-based notifications the app saves the location of the user each time that they start a workout routine from the app. Consequently, it is able to find the most frequent chosen location for using the app to workout and set a notification for that location. Furthermore, the user is able to modify the amount of time that is needed to pass after entering that location for the notification to be sent.

The third type of the notifications is determined by the user's activity. Based on the survey results (Figure 3), the most ideal time to receive a notification as a reminder for working out, is "When I have not been active enough" and the third most ideal time is "In the evening, if I have not been active enough". So the default time that we chose for this reminder, is 8:00 p.m. After tapping on this notification, the user will be sent to activity history of the app. They will then be able to see their progress for that day and their total history over time and compare different sections with each other. This type of notification will be disabled if the user has done 2 minutes of each type of workout for that day.

According to our questionnaire results, the majority of people prefer short notifications with only a title and no details, thus we designed short notifications that are clear, yet comprehensive. Example notifications are shown in Figure 4.

4.4 Post-study Process

The post-study process consisted of three parts: sending screenshots from the app, filling out an online questionnaire, and having an interview. In the post-study questionnaire and interview we targeted participants' reaction to the push notifications and their perception of the push notifications. In addition, they were asked about any changes in their workout routines that might have resulted from the reminder notifications and any further suggestions for improving usability of the app.

5 RESULTS: PRELIMINARY USER STUDY

According to the pre-test questionnaire, 4 of the subjects customize their notifications and disable the rest. The participants' preference regarding push notifications is generally towards reminders (5 subjects), and update notifications (3 subjects). Their habits in terms of exercise varied from hardly ever (1 subject), 1-2 times a week (2 subjects), to 3-4 times a week (1 subject), and 5-6 times a week (1 subject). The majority of the participants (4 subjects) considered themselves as a person who is concerned about their health. However, several factors such as not having time (4 subjects), and forgetting to exercise (3 subjects) keep them from working out. None of our participants were currently using reminder push notifications for exercising and 3 of them have never used them before. The rest of the participants stopped using push notifications since they were not motivated (1 subject), they do not exercise anymore (1 subject), reminders were not as useful as they thought (1 subject), and because of poor timing of the notifications (1 subject). Unlike the survey's result, the group of participants preferred to get fitness reminders once a week (4 subjects) with more details rather than just the title (4 subjects).

5.1 Reaction to Notifications

During the study the exact time and date of the tapped notifications, start and duration of the routines were recorded. By default, if participants authorized the app for always tracking their location, they received more than 2 notifications per day. Since most of the participants (4 subjects) are more than somewhat concerned about data privacy, two users did not authorize the app to track location and three users only allowed it while they were using the app. Based on this, the participants were prompted 70 times for the week of study to begin their fitness routine. However, only 7(10%) interactions resulted from the notifications, 6 of which were unintentional and did not result in starting a workout routine.

Based on the post-test questionnaire, the majority of participants (3 subjects) believe that the notifications were motivating. This might be due to the fact that most of the participants were concerned with their health and the reminders prompt them daily to do exercises to remain healthy. The least favorite type of reminders were location-based reminders which none of the participants felt were very helpful. This might be due to the fact that participants did not give full location tracking permission to the app because most of them (4 subjects) are more than somewhat concerned about data privacy. Additionally, iOS users are encouraged to not allow the apps to track their location in the background and will be prompted to change the authorization if they do give an app the permission to always track their location.

In terms of the users' feelings after receiving a reminder at a time when they couldn't workout, 3 of them just ignored it without any negative feelings, 1 felt pressured and 3 were more motivated to do the workouts as soon as they could. It might have been useful to see if there was any connection between having their devices on silent mode and their feelings towards notifications.

Regarding the content of the push notifications, users believed that having more dynamic messages could help to not overlook them as easily. Furthermore, 3 of the participants agreed on getting more information such as links to health-related articles or steps count might be more helpful. In addition, one of the participants suggested adding daily goals to the app so that the reminder can show their daily progress and give encouragement based on it.

5.2 Time Spent Working out

Based on the interviews, for those who had a routine before using the app and did regular workouts (3 subjects), they continued to do the same during the study. However, only one of them changed their routine to comply with workouts

in the app. This result was predictable since the time it takes for most people to form a habit ranges from 18 to 254 days[6]. We also found that 4 of the participants believed that having the feature to add your own exercises can be a motivating factor.

6 DISCUSSION & CONCLUSION

The results of our work suggests that push notifications in any context requires consideration of that context's special set of characteristics in order not to create negative effects nor be ignored. Regarding the specific context of health and fitness, people tend to favour being reminded to be more active, however these reminders need to have dynamic content and be received at times that the user has not been active enough.

In terms of privacy, our results indicate that the respondents were concerned with their privacy and were not willing to give apps full authorization to collect their data in the background. This may not necessarily generalize as the majority of our participants were technologically savvy. It will be interesting to see in future work, if a similar trend exists in the general population.

In terms of limitations, our preliminary push notification fitness study had 5 male technology friendly iOS users. The results may not generalize to other segments of the population. In particular, the findings may not apply for people who are less concerned with the data gathered from their phones, who do not configure their notification settings, who use Android devices with LED notification modality, or who are not too occupied by their daily activities. Further, long term results on the impact of notifications have not been collected. At the same time our results begin to provide evidence that people do believe that push notifications which are received at the right time and on appropriate device with proper modalities can motivate them to exercise, and form new habits.

The next step of this work will be to add more control regarding customization of workouts for users and do a more extensive and longer term study, to further explore the impact of reminder push notifications on motivation and specifically exercise routine completion.

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