

# The Role of Personality-Tailored Notifications in Mobile-Based Behavior Change Intervention

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## Abstract

Mobile phones are ubiquitous, equipped with always-on connectivity and a range of sensors, and are carried by their owners at virtually all times, which renders them an attractive platform for delivering timely and relevant content. One type of such a content is information supporting positive behavior change. Indeed, phones have been proposed as a vessel for motivational messages for more than a decade now. Yet, little is known about the importance of personality-based adaptation of the message content in order to facilitate the behavioral change. In this paper we describe our preliminary investigation of the persuasiveness of mobile notifications delivered within a real-world behavior change intervention mobile app. Unlike the clear cut findings observed in other domains, we discover a rather nuanced relationship between the personalization and persuasiveness that calls for further exploration at the individual participant level.

## Keywords

Persuasive technologies, personalization, dBCI, mobile sensing

## 1. Introduction

With more than three billion active users, always-on connectivity, and the fact that they are carried by their owners at all times, mobile phones represent the most direct ubiquitous information delivery platform in the world. The pervasiveness and the tight user-device bond have recently been recognized and harnessed by digital behavior change intervention (dBCI) applications [1]. These applications aim to facilitate positive behavioral change in their users, and to date have targeted domains as diverse as weight loss, stress and depression, substance abuse, and even facilitating green behavior. With more than 1.3 billion people worldwide affected by depression, obesity, and type-2 diabetes, and with the effects of the ongoing COVID-19 pandemics on mental health yet to be assessed, the development of digital tools allowing mass behavior-based treatment of preventable diseases is of key importance. The increasing cost of face-to-face behavioral therapies, the lack of qualified health workers, and diminishing national healthcare budgets further exemplify the need for a low-cost ubiquitous dBCI delivery method.

Mobile phone's push notifications are a particularly powerful instrument allowing a sender to initiate interaction with a recipient in an asynchronous manner. Notifications are highly valuable in the mobile dBCI realm, where they allow timely behavior guidance dissemination,


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nudging, and experience sampling. Nevertheless, little is known about the effectiveness of such remote asynchronous messages. Past research, outside the scope of dBCI, demonstrates that the perception of mobile notifications, as well as a user's reaction to a notification, depend on numerous factors, including the message timing, the content of the message, and the relationship between the sender and the receiver [2]. In the field of dBCI, outside of a few studies on the role of the notification timing and content [3, 4], mobile notifications remain rather underexplored. Whether push notifications can be used as a viable vector for delivering dBCI information, and in particular, whether the framing of the persuasive dBCI content can be successfully adapted to individual personalities via mobile notifications is yet to be explored.

In this poster we present a study of the efficiency of personality-adapted mobile notifications for behavior change elicitation in a mobile dBCI app, basing our tailoring on the Big Five personality traits [5]. We designed a life-coaching mobile app, distributed it to 27 participants, and over two weeks monitored users' reactions to mobile notifications, their attitudes towards the notifications, as measured via the experience sampling method, and their compliance with the pre-set behavior change goals. Our findings indicate that in the domain of mobile dBCIs message personalization does not exhibit clear benefits observed in other domains [6].

## 2. Methods and Materials

We design an Android application that enables users to set *goals* and define *tasks* relating to those goals. The application then aims to motivate the users with *messages*, related to the above tasks, delivered via push notifications, which are the key intervention element of our study. According to the best practices in persuasive app design, we also include visualizations indicating the percentage of tasks completed and use gamification, in the form of virtual coins, to further motivate the users.

Within the scope of the Fogg's Behavior Model [7], push notification messages in our app serve as sparks, i.e. prompts that motivate. We construct them to belong to one of the two groups – *tailored* (TN) and *non-tailored* (NTN) notification messages. The TN were adapted according to the dominant dimension of a user's personality determined via an in-app Big Five 10-question personality test (BFI-10) [5] revealing an individual's personality traits consisting of *openness* to experience, *conscientiousness*, *extraversion*, *agreeableness*, and *neuroticism*.

We constructed the TN messages in advance and arranged them into five categories – one for each personality dimension. The content of messages in each category was crafted according to the method presented by Hirsh et al. that boosts the persuasive appeal by framing a message according to the recipient's dominant personality dimension [6]. Thus, rewards and social attention were emphasized for extravert users; communal goals and interpersonal harmony for agreeable users; order and efficiency for conscientious users; uncertainty, danger and threats for neurotic users; and finally, with open users, messages emphasized creativity, innovation and intellectual stimulation.

User experience was measured with the experience sampling method (ESM) [8]. In our study ESM was interval-contingent and based on fixed time intervals – each day around 8 PM, users were prompted to complete an in-app questionnaire. The questionnaire included the motivational messages delivered on that day, together with the accompanying task names. The

users then had to rate their perceived motivation induced by each of the messages by answering: “The message motivated me for pursuing my goals” using a Likert scale (1 – completely disagree, to 5 – completely agree).

We recruited 27 volunteers (15 male, 11 female, 1 other) through our personal contacts, which allowed us to have an in-person conversation with each individual and give them instructions regarding registration and usage of the app. Afterwards, each user completed an in-app personality test from which the percentiles of personality dimensions of a particular user were found. Means and standard deviations used for the percentile computation were taken from a larger study that included a representative sample from culturally similar population [9]. The personality dimension, for which the user was in the highest percentile, was then determined as the most dominant and used for TN. The users used the app to create goals and tasks related to those goals. After creation, our app randomly assigns either TN or NTN to the task, so that approximately half of the tasks would be accompanied with each of the message groups.

### 3. Research Hypotheses and Data Overview

Our hypotheses are presented in Table 1.

**Table 1**

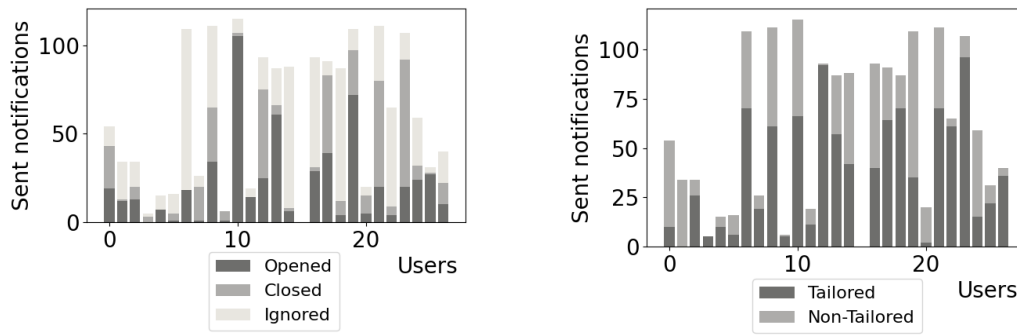
Hypotheses and outcome (1 – Confirmed; 0 – Rejected) from our analysis.

Hypothesis	Outcome
H1: The average scores from the app’s evening questionnaire for TN and NTN differ within different groups of users (e.g. different dominant personality dimensions).	0
H2: The ratios of finished tasks with pre-defined deadlines differ depending on whether the tasks are accompanied by TN or NTN.	0
H3: The ratios of finished tasks without considering pre-defined deadlines differ depending on whether the tasks are accompanied by TN or NTN.	0

The distribution of reactions to notifications delivered can be seen on Figure 1a with the proportion of TN delivered to users seen on Figure 1b. As observed in the figures, the users did not contribute equally, which was related to a few challenges we faced during data collection – not all users had the same interest in the app usage, some of users went on unplanned vacations, and some of the users had unplanned personal obligations. This was taken into account during the data analysis by constraining the analysis of perceived motivation to tasks with answered questionnaires.

### 4. Results

The hypotheses we laid out in Section 3 target different aspects of persuasiveness and its perception. Here we investigate how the perceived motivation and the task completion differ depending on whether a user had received a TN or a NTN. Table 1 summarizes the hypotheses outcomes. We evaluate the actual perceived motivation of persuasive messages by assessing our H1, opposed to exploring the potential of persuasive message only through storyboard scenarios,



**Figure 1:** Notification action and tailored/non-tailored notification distribution.

as was done in previous studies [6]. We code the 5-step Likert scale answers about the message motivational power to a 1 to 5 interval and perform the  $t$ -test over the per-user average ratings of the two groups of messages in our dataset – TN and NTN. With the application of Bonferroni Correction, the  $p$ -value produced from tests should fall below .004 for statistically significant differences to be detected. The analysis of the whole dataset implies almost no difference between the ratings of TN and NTN, with TN ( $M = 3.71$ ,  $SD = 1.1$ ) being scored slightly higher than NTN ( $M = 3.66$ ,  $SD = 1.1$ ),  $t(39) = 0.1$ ,  $p = .898$ . We then divide the data according to the users' demographic and psychographic characteristics, and re-run the analysis. Of all the bisections, the most notable difference was found among the neurotic individuals, with TN ( $M = 3.9$ ,  $SD = 0.7$ ) favored a little over NTN ( $M = 3.5$ ,  $SD = 1.0$ ),  $t(13) = 0.8$ ,  $p = .448$ , which further increased when every individual measurement of scores (instead of a per-person average) for TN ( $M = 4.15$ ,  $SD = 1.12$ ) and NTN ( $M = 3.9$ ,  $SD = 1.3$ ) was considered. The differences indicated subtle preference for TN, however they were not statistically significant,  $t(284) = 1.8$ ,  $p = .071$ . A user's perception of whether a message is persuasive need not correspond to the actual reaction to the message. Indeed, it could be possible that a user actually completes a task despite a nudging message not being welcomed. Thus we examine the impact of motivational messages on the completion of a task that the message relates to. With examination of H2 we find that the proportion of completed tasks was higher in the group of tasks that received TN ( $M = 38.2$ ,  $SD = 33.2$ ) than in the group that received NTN ( $M = 34.6$ ,  $SD = 32.6$ ), however the difference is not significant,  $t(44) = 0.4$ ,  $p = .719$ . Comparing the proportion of tasks completed regardless of the pre-defined deadline there was almost no difference, with 78.61% of tasks accompanied with TN completed and 80.45% of tasks accompanied with NTN completed, leading us to a conclusion that H3 should be rejected.

## 5. Discussion and Conclusions

In this work we aimed to confirm that messages, personalized to personality traits, motivate users more than non-tailored ones to achieve a desired behavior. A positive finding would indicate that perceived persuasiveness from personality-tailored messaging in static domains holds true when persuading people to take action in a mobile domain.

Users were first analyzed as a single group, but no significant differences were observed. The users, on average, completed the largest proportion of tasks with the pre-defined deadline and when receiving a TN (followed by NTN and no notification). Messages had a similar average scores, although we observed larger differences between TN and NTN when only active users (received 40 or more notifications) were considered. Overall, however, we found that tailoring messages on the dominant Big Five personality trait of a user does not significantly change neither the perception of the message, nor the outcome of the intervention when compared to a non-tailored message, therefore rejecting hypotheses 1–3.

The results of our study may break the myth of personalization being the panacea in the area of persuasive technologies. Nevertheless, we believe that a more in-depth examination of users' motivation for the actual behavioral change, which would involve the analysis of both the content as well as the form in which the intervention is communicated, would likely point to the actual avenues where message personalization could prove beneficial.

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