



## Predicting which type of push notification content motivates users to engage in a self-monitoring app

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### ABSTRACT

Despite the unprecedented access to self-monitoring health apps, lack of optimal user engagement remains a significant challenge. Push notification prompts with contextually tailored messages offers a promising strategy to improve engagement. To increase the efficacy of push-notifications on engaging individuals with health apps, greater attention to the modifiable components of push notifications that influence responsiveness is needed. This study examines the effect of message content and frequency of push notifications, along with past app usage on responding to notifications within 24 h, and engaging with self-monitoring in JOOL Health smartphone app. Mixed models were applied on a de-identified data set of 18,000 contextually tailored push notifications sent by JOOL Health App to 1414 participants. The content in sent messages on behavioural topics were mapped into either tailored suggestions or tailored insights. Our findings suggest that push notifications with tailored suggestions were more effective overall in encouraging self-monitoring, but amongst frequent app users, push-notifications containing insights was associated with greater self-monitoring. People who were not using the app as frequently were less likely to respond to a prompt. This study suggests that push-notification content does have an impact on subsequent use of key app features, and app developers should consider what content is likely to work best for who, and under what circumstances. Secondary data-analysis of commercial apps presents a unique opportunity to elucidate and optimize health behaviors.

### 1. Introduction

Self-monitoring is a demonstrated effective behavior change strategy across an array and scope of domains (Michie et al., 2009; Hartmann-Boyce et al., 2014; French et al., 2014; Olander et al., 2013). Evidently when individuals increase monitoring frequency, their outcomes improve substantially. For example, overweight subjects who monitored diet frequently achieved significant weight loss (Carter et al., 2017). Similarly, individuals with depression increased their emotional self-awareness and subsequently reduced depressive symptoms by increasing rate of monitoring from one to six times a day (Kauer et al., 2012).

In recent years, partly driven by the convergence of demands for accessible resources and high rates of mobile phone ownership, several smartphone apps have emerged in marketplace as solutions to disseminate self-monitoring resources rapidly to populations (Carter et al., 2017; Carroll et al., 2017; Rahman et al., 2017). Smartphones are

ubiquitous, relatively small and convenient for people to carry as they go about their daily lives. As a result, compared to traditional paper-based approaches, apps can prompt individuals to monitor at most opportune moments as they go about their daily lives, as well as provide contextually tailored feedback in the moment. From a public health perspective, apps have improved access to self-monitoring resources, as evident by an unprecedented number of monitoring apps now available on app stores (Hingle and Patrick, 2016; Zhao et al., 2016).

However, the lack of optimal user engagement with apps remains a significant challenge, with a significant proportion of app users disengaging from repeat use (<https://www.digitaltrends.com/mobile/16-percent-of-mobile-userstry-out-a-buggy-app-more-than-twice/>, n.d.). Automatically capturing data using passive sensing approaches can mitigate disengagement to some extent (Kim et al., 2016), however automated approaches are not yet advanced enough to reliably capture entire breadth of monitoring parameters. Furthermore, benefits of active participation in self-monitoring process are evident (Harkin et al.,

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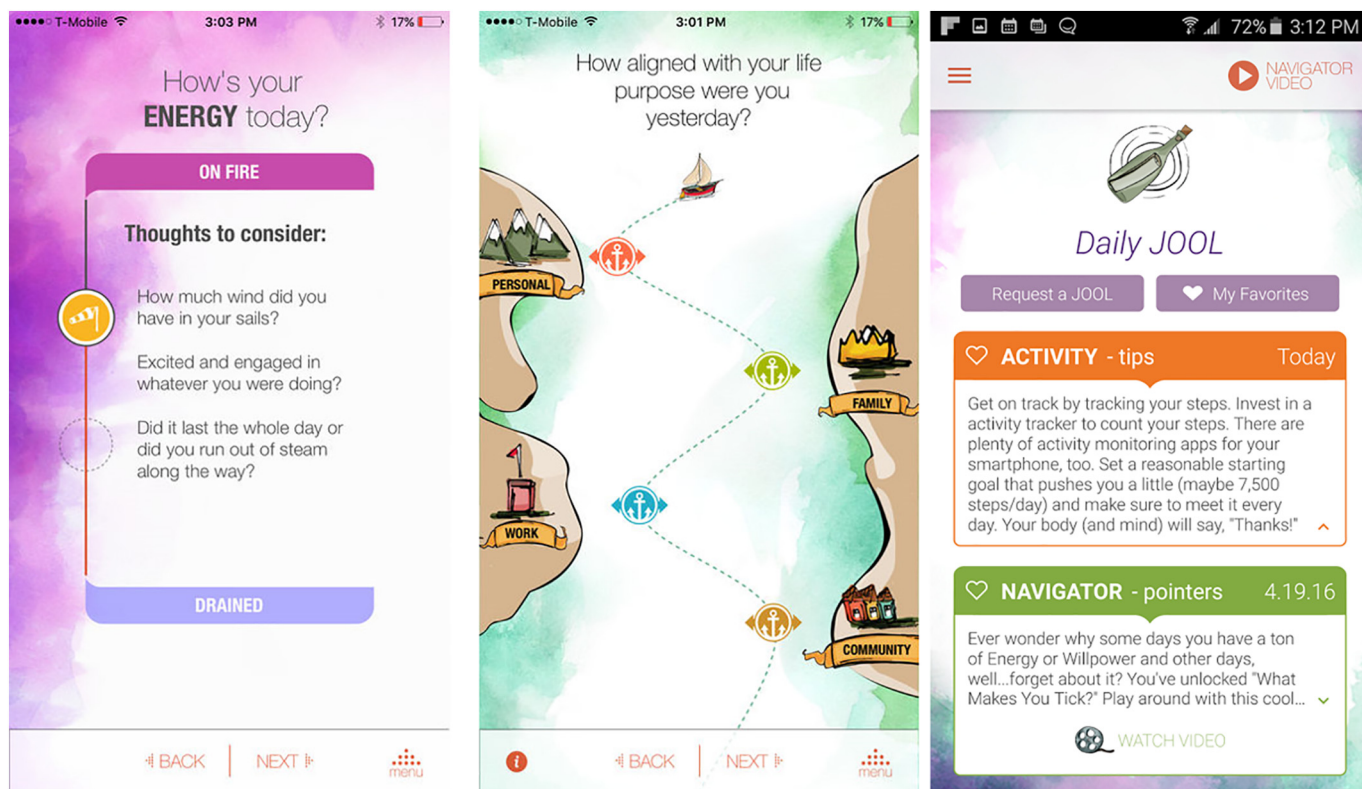


Fig. 1. JOOLHealth App - monitoring and feedback messages.

2016). As a result devising strategies that promote users to actively engage with self-monitoring in apps is of significant importance.

Prompting, via a variety of modes, including telephone calls, emails, text messages and via app push-notifications is a promising strategy to encourage and sustain repeat use (Alkhalidi et al., 2016). Within mobile apps, push-notifications are the most commonly implemented, and also the most direct engagement strategy, appearing as a brief message at programmed times on the screen. When touched, notifications open up the programmed page within the apps. While there is evidence that the use of these techniques can lead to increased app usage, findings have been inconsistent across studies, with some studies reporting null-findings and others indicating that prompts are often ignored (Alkhalidi et al., 2016; Morrison et al., 2017; Freyne et al., 2017). This is perhaps not surprising, given the large number of push notifications that users can be exposed to in a single day (Pielot et al., 2014), and the current lack of understanding about which aspects of notifications enhance or undermine responses to prompts.

To increase the efficacy of push-notifications for encouraging desired app usage, greater attention to the modifiable components of push notifications that may influence responsiveness is needed. Based on previous research, this is likely to include notification content (Schulze and Groh, 2016; Fischer et al., 2010; Mehrotra et al., 2015). Research from internet interventions indicates that sending messages with content tailored to user's characteristics is an effective strategy to persuasively motivate users (Neff and Fry, 2009; Webb et al., 2010). This is because tailored content is perceived as more personally relevant, which is a key motivator for processing information attentively (Kreuter et al., 1999). This technique is referred to as content tailoring. With mobile monitoring apps, there are increased opportunities to employ “deep content tailoring”, which involves not only tailoring messages based on fixed characteristics (e.g., gender), but incorporating context specific information based on previously reported data and engagement. In self-monitoring apps, notifications employing deep content tailoring usually include either information on progress and insights from self-monitored data, or suggestions based on previously collected

data aimed at shaping user's knowledge. Although both tailored *insights* and *suggestions* are commonly used, it is unknown which motivates users the most to respond to notifications, and furthermore to engage in monitoring activity.

1.1. Aims of this study

To date, studies investigating how prompts affect engagement have not incorporated methodologies to investigate outcomes at the level of an individual prompt (Alkhalidi et al., 2016). As a result, it is not possible to investigate how potentially optimizable factors, such as the content offered in the prompt, or contextual factors such as past usage of the app, affect users immediate engagement in response to a prompt. This study, which analyses data from a popular mobile well-being app, contributes towards addressing these gaps in knowledge.

Using a de-identified data set of 18,053 push notifications sent by JOOL Health App, through a randomization protocol, this study investigates how the odds of interacting with the app within 24 h after receiving a push notification is affected by a) content in push notification (*tailored suggestions or tailored insights*) b) usage of the app, and c) interaction between usage and content. It is hoped that our findings will provide useful information to app developers interested in optimizing push-notifications to enhance engagement with important app features that require some user input.

2. Methods

2.1. JOOL Health App push notification protocol

JOOL Health Inc. offers digital workplace wellbeing and behavioural change intervention to companies in the US. The intervention, delivered through a mobile app, encompasses self-monitoring and health messaging. Individuals monitor daily 10 different parameters – sleep, presence, activity, creativity, eating, energy, willpower along with perceived alignment with community, work and personal purposes

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