Opportune Moments for the Multi-Stage Notification Responding Process: A Preliminary Investigation

Chung-Chiao, Chang*
National Yang Ming Chiao Tung University
Hsinchu, Taiwan
sean831004.cs07@nycu.edu.tw

Meng-Hsin, Wu*
University of Toronto
Toronto, Ontario, Canada
menghsin.wu@mail.utoronto.ca

Yu-Jen, Lee
National Yang Ming Chiao Tung University
Hsinchu, Taiwan
lee.cs09@nycu.edu.tw

Xi-Jing, Chang
National Yang Ming Chiao Tung University
Hsinchu, Taiwan
siliconcrystal.c@nycu.edu.tw

Yung-Ju, Chang†
National Yang Ming Chiao Tung University
Hsinchu, Taiwan
armuro@cs.nctu.edu.tw

ABSTRACT

Notifications are advantageous to users, but they could cause interruptions when appearing at inopportune moments. Research has suggested that multiple stages are possibly involved in the notification responding process, including the phone generating an alert, the user roughly glancing it, engaging with it, and acting on it. Nevertheless, how users' perceived opportune moment for each stage correlates with each other remains unclear. Using experience sampling method, we show that users' perceived opportune moment for each stages differed. This result needs further in-depth investigation into the precisely defined opportune moment for each stages and its underlying key factors.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in ubiquitous and mobile computing**.

KEYWORDS

Mobile notifications; mobile receptivity; opportune moment; interruptibility; ESM

ACM Reference Format:
Chung-Chiao, Chang, Meng-Hsin, Wu, Yu-Jen, Lee, Xi-Jing, Chang, and Yung-Ju, Chang. 2021. Opportune Moments for the Multi-Stage Notification Responding Process: A Preliminary Investigation. In *Adjunct Proceedings of the 2021 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2021 ACM International Symposium on Wearable Computers (UbiComp-ISWC '21 Adjunct), September 21–26, 2021, Virtual, USA.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3460418.3479278

*Both authors contributed equally to this research.
†Corresponding author.

UbiComp-ISWC '21 Adjunct, September 21–26, 2021, Virtual, USA

1 INTRODUCTION

While notifications offer users instant access to needed information, they can be troublesome on some occasions. For example, overwhelming notifications that carry undesirable information can cause stress [9]. Prior research has shown that smartphone users prefer to see notifications from certain sources [1] and people[3]. Beyond preference, research has shown that notifications delivered at inopportune moments, such as when concentrating on a complex task at hand[4], are considered disruptive. Prior research thus has sought to identify *opportune moments* for sending notifications. However, the main body of research has been investigating opportune moments either from a general sense or with a primary focus on the responding action on the delivered content[5, 7]; little research distinguishes users' perceived opportune moment for different stages involved in the process of responding notifications, commonly considered to include at least noticing the alert, attending, and responding [1, 2], with other works further separating attending into two stages: focusing and reading [6]. Given that research has identified factors associated with one of these stages, users' perception of the opportune moment for these individual stages is also likely to vary. Nevertheless, the existing literature lacks the understanding of: 1) how the overall opportune moment for notifications and for each of these stages correlate with each other respectively, 2) what differences exist in the set of factors that influence the perceived opportune moment for each of the stages. We conducted an experience sampling study (ESM) with 74 smartphone users using a research app we built. The app generated ESM questionnaires that asked participants about their perception of the opportune moment for each stages.

2 STUDY METHOD

Initially 78 participants were recruited for two weeks, out of which 4 participants withdrew from the study. The remaining 74 participants (male = 31 and female = 43) were aged between 20 to 55.

We collect data through the Minuku app, which delivers a questionnaire when a notification occurs. Participants are free to decide whether to complete the questionnaire or to ignore it. The buffer time between each questionnaire is 60 minutes. In the questionnaire, participants assessed how opportune the moment was for

each of the four stages for the sampled notification: 1) generating an alert (Alert), 2) glancing the notification (Glance), 3) tapping into the notification to engage with the notified content (Engage), and 4) acting upon the notified content (Act) as well as the overall opportuneness of that notification, all five factors assessed through a seven-level Likert scale. The questionnaire contained a total of 20 factors, which are all found to be influential on at least one stage in prior studies. Participants assessed the status of each factor, as well as the impact they thought the factor had on their assessment of how opportune the moment was for each stage. ESM questionnaires were delivered within a 14-hour window via notifications, at most eight times per day, and will be removed if they were not responded by the participant within 30 minutes. Participants received cash compensation of $300 TWD (approximately $10 USD) and $20 TWD for each completed questionnaire.

3 RESULTS

We received 326,560 phone notifications and 5,451 ESM responses. The analyzed data is 5,080 ESM responses after data cleaning. Among these responses, participants' average ratings of the opportuneness for each stage and the overall were 0.003 (Alert), 0.164 (Glance), -0.131 (Engage), -0.193 (Act), and -0.101 (Overall). Generally, participants assessed the sampled moments as more opportune to glance notifications than the other interactions. Below is the results of our first research question: how do the overall opportune moment for notifications and the opportune moments for each stages correlate with each other respectively?

General	0.725	0.880	0.953	0.951
	Alert	0.754	0.689	0.685
		Glance	0.861	0.826
			Engage	0.953
				Act

Figure 1: Spearman's rank correlation coefficient(ρ) between different interactios' opportunness and general moment opportuneness. All correlations are significant at the 0.001 level.

We conducted the Spearman's rank correlation, and the results are shown in Figure 1. The results indicate that the five types of opportune moments are generally correlated with each other, with all the five correlations being at least 0.68. However, perceived opportune moments for some stages were more similar to each other than the other pairs. For example, the overall opportune moment was perceived to be the closest to the opportune moment for Engage and Act. Note that the correlation between the overall opportune moment and the opportune moment for delivering alert is 0.725, which is still correlated but noticeably lower than those for the two latter stages. Second, the opportune moment for a particular interaction tended to be opportune also for a neighbor interaction, especially the subsequent interaction. Note that, participants perceived the opportune moments for the last three stages as conceptually closer, resulting in the opportune moment for delivering alert being the most distinct stage among the four stages. Lastly, the opportune moments for the last two stages were perceived to be the closest, suggesting that from the users' perspectives, the moment suitable for engaging with notifications were most of the time also suitable for acting upon it. This finding is consistent with [8], which suggests that many users reportedly only spent time reading full messages when they were ready to respond to the message.

4 CONCLUSION

We show that the opportune moment for each stages involved in the notification responding process differed. This result needs a more precisely defined opportune moment for each stage. Our future work will identify the differences that exist in the set of factors that influence the opportune moment for each stages.

ACKNOWLEDGMENTS

This research was supported in part by the Ministry of Science and Technology, R.O.C (MOST 107-2218-E-009-030-MY3).

REFERENCES

[1] Yung-Ju Chang, Yi-Ju Chung, and Yi-Hao Shih. 2019. I Think It's Her: Investigating Smartphone Users' Speculation about Phone Notifications and Its Influence on Attendance. In *Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services*. ACM, Taipei Taiwan, 1–13. https://doi.org/10.1145/3338286.3340125

[2] Yung-Ju Chang and John C. Tang. 2015. Investigating Mobile Users' Ringer Mode Usage and Attentiveness and Responsiveness to Communication. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services*. ACM, Copenhagen Denmark, 6–15. https://doi.org/10.1145/2785830.2785852

[3] Hao-Ping Lee, Kuan-Yin Chen, Chih-Heng Lin, Chia-Yu Chen, Yu-Lin Chung, Yung-Ju Chang, and Chien-Ru Sun. 2019. Does *Who* Matter? Studying the Impact of Relationship Characteristics on Receptivity to Mobile IM Messages. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–12. https://doi.org/10.1145/3290605.3300756

[4] Abhinav Mehrotra, Veljko Pejovic, Jo Vermeulen, Robert Hendley, and Mirco Musolesi. 2016. My Phone and Me: Understanding People's Receptivity to Mobile Notifications. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, San Jose California USA, 1021–1032. https://doi.org/10.1145/2858036.2858566

[5] Martin Pielot, Bruno Cardoso, Kleomenis Katevas, Joan Serrà, Aleksandar Matic, and Nuria Oliver. 2017. Beyond Interruptibility: Predicting Opportune Moments to Engage Mobile Phone Users. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1, 3 (Sept. 2017), 1–25. https://doi.org/10.1145/3130956

[6] Liam D. Turner, Stuart M. Allen, and Roger M. Whitaker. 2015. Push or Delay? Decomposing Smartphone Notification Response Behaviour. In *Proceedings of the 6th International Workshop on Human Behavior Understanding - Volume 9277*. Springer-Verlag, Berlin, Heidelberg, 69–83. https://doi.org/10.1007/978-3-319-24195-1_6

[7] Aku Visuri, Niels van Berkel, Tadashi Okoshi, Jorge Goncalves, and Vassilis Kostakos. 2019. Understanding smartphone notifications' user interactions and content importance. *International Journal of Human-Computer Studies* 128 (2019), 72–85. https://doi.org/10.1016/j.ijhcs.2019.03.001

[8] Ting-Wei Wu, Yu-Ling Chien, Hao-Ping Lee, and Yung-Ju Chang. 2021. IM Receptivity and Presentation-type Preferences among Users of a Mobile App with Automated Receptivity-status Adjustment. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–14. https://doi.org/10.1145/3411764.3445209

[9] SungHyuk Yoon, Sang-su Lee, Jae-myung Lee, and KunPyo Lee. 2014. Understanding notification stress of smartphone messenger app. In *CHI '14 Extended Abstracts on Human Factors in Computing Systems*. ACM, Toronto Ontario Canada, 1735–1740. https://doi.org/10.1145/2559206.2581167