Effects of Activity Breakpoints on Mobile Crowdsourcing Task Performance

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ABSTRACT

Mobile phones have become a new means of accessing and executing crowdsourcing tasks in a variety of situations. Yet, while it is commonly assumed that people are likely to perform these tasks during activity breakpoints, it remains unclear whether different types of such breakpoints affect the likelihood that crowdsourcing tasks will be performed. To explore this question, we classified breakpoints into five types, according to phone users' preceding, current, and upcoming activities, and conducted a six-week experience sampling method study of 30 users' breakpoint-type-specific crowdsourcing-task performance behavior. We found that these participants tended to engage in crowdsourcing tasks when they were at breakpoints between two different activities, rather than within an activity, and also when breakpoints were long. Additionally, the higher the complexity of their previous activity, the lower the crowdsourcing-task execution rate. However, high complexity of the post-crowdsourcing task activity had no obvious impact on execution rate.

CCS CONCEPTS

Human-centered computing → Empirical studies in ubiquitous and mobile computing

KEYWORDS

Mobile crowdsourcing; breakpoints; interruptibility; mobile notifications; mobile receptivity; task performance; ESM

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1 INTRODUCTION

In recent years, to improve the services they provide, an increasing number of companies have sought to collect large amounts of data from their customers. For example, Waze[1], a GPS navigation application, is an information-sharing platform that offers user-submitted travel times and routes. To collect larger amounts of crowd data from people's day-to-day activities, crowdsourcing tasks have begun to be issued and processed on smartphones, allowing users to perform these tasks almost anywhere and at any time. Some services even actively seek to expand the amount of time their users spend contributing data to them: e.g., navigation apps that prompt their users with real-time traffic-notification questions. However, whether people will actually contribute data under such conditions largely depends on their availability in the moment [9]. Researchers have begun to investigate users' openness to notifications [8], including how best to identify opportune moments for their answering of questionnaires [7] or performance of mobile crowdsourcing tasks [2]. Breakpoints, which are defined as the time intervals between two adjacent tasks, have been identified as likely opportune moments for receiving notifications. For instance, Okoshi et al. [4,5,6] detected breakpoints using a combination of physical sensing and user-interface events, and reported that this approach resulted in less user frustration and lower workload perception. Inspired by their physical-based breakpoint-detection of transitions between two different physical activities (e.g., from sitting to standing or vice versa) [1], the present paper proceeds from an assumption that different combinations of consecutive activities may have different effects on the likelihood that a person will perform mobile-crowdsourcing tasks. Specifically, Adamczyk et al. [1] argued that users' availability at breakpoints within the same activity [3] might be different from their availability when they were at breakpoints between two different activities; but this question has hitherto been underexplored.

To facilitate such exploration, we classified breakpoints into five categories according to mobile phone users' previous, current, and next activities. These were 1) during the same activity, 2) between two different activities, 3) preceded by but not followed by an activity, 4) not preceded by but followed by an activity,

[1] Waze is a GPS navigation software app owned by Google and provides turn-by-turn navigation information and user-submitted travel times and route details, while downloading location-dependent information over a mobile telephone network.

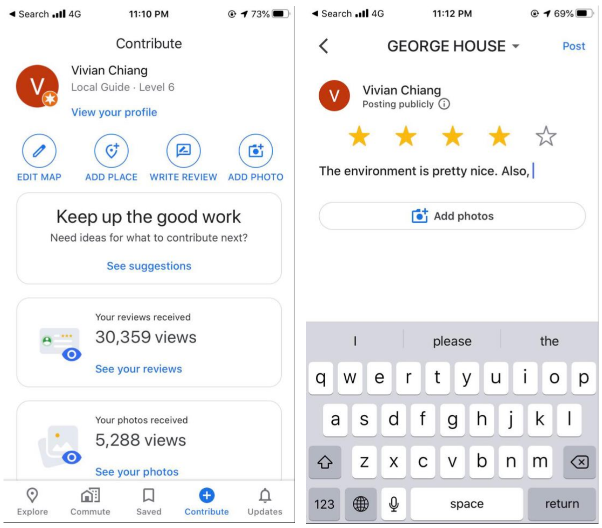

Figure 1a. The mobile-crowdsourcing tasks *Review and rating* on Local Guides

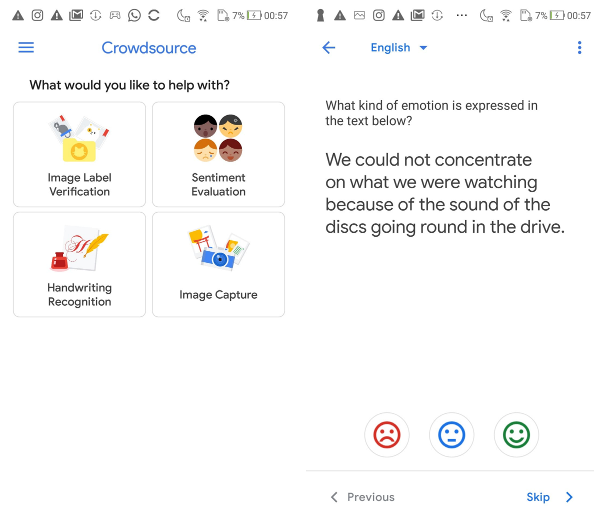

Figure 1b. The mobile-crowdsourcing task *Sentiment evaluation* on Google Crowdsource

and 5) neither preceded by nor followed by an activity. Each preceding, current, and upcoming activity was further characterized according to its complexity, perceived physical effort, perceived mental effort, and perceived attention required.

We conducted a six-week experience sampling method (ESM) study with 30 users to investigate their crowdsourcing-task performance at different breakpoints. We found that the participants were more willing to perform mobile-crowdsourcing tasks at the breakpoints between two different activities than those between two phases of the same activity. They were also less likely to perform such tasks during long breakpoints, i.e., moments that were neither immediately preceded by nor immediately followed by any other activity. In addition, we found that the complexity of preceding vs. upcoming activities had differential impacts on the likelihood that a crowdsourcing task would be performed.

2. METHODOLOGY

2.1 Crowdsourcing Tasks

Mobile Crowdsourcing App

Unlike previous studies, in which researchers designed crowdsourcing tasks of their own, we leveraged existing tasks offered by two of Google's apps. The first was Local Guides[2] (Fig. 1a), a built-in crowdsourcing platform within Google Maps, which encourages people to contribute their location information. Local Guides incorporates various mobile-crowdsourcing tasks, including Reviews, Ratings, Photos, and Q&A. The second was Google Crowdsource[3] (Fig. 1b): a standalone platform that encourages its users to contribute data to help Google provide better services. Its crowdsourcing tasks include Image Label Verification, Image Captioning, and Handwriting Recognition.

2.2 Research Instrument

We developed an Android research app (See Figure 2) which allows users to review contribution, refer study description, submit data and fill out ESM questionnaire. Our system is capable of detecting precisely when the participants performed crowdsourcing tasks on both Local Guides and Google Crowdsource. Upon detection, our app prompted the users to record their screens to capture the task-execution process in detail. Our system utilizes the Accessibility Service in Android to read the screen content and users' interaction, as a means of detecting whether they entered either of the focal crowdsourcing apps to perform mobile-crowdsourcing tasks. The Accessibility Service detects possible pages in the target apps via specific keywords (e.g., contribution, helpful, missing, translation) indicative of a high probability that mobile-crowdsourcing tasks are being conducted.

Due to the Accessibility Service's limited ability to acquire the content of the two crowdsourcing apps' entire screens, our research app also adopted screen recording as an alternative method for obtaining the whole process of crowdsourcing tasks. Specifically, once the Accessibility Service detects a possible mobile-crowdsourcing event, a recording notification is issued to invite the relevant participant to record her/his upcoming task. The participant then clicks "Start recording" to record that task. The user can either stop the recording manually, or automatically by closing the relevant app.

After the user finishes each crowdsourcing task, the research app prompts her/him to answer an ESM questionnaire about the activity context in the moment, including its complexity,

[2] Local Guides was launched by Google to garner user contributions to Google Maps, and provides its contributors with various perks and benefits for this work.

[3] Crowdsource is a crowdsourcing platform developed by Google, intended to improve a host of Google services via user-facing training of various algorithms.

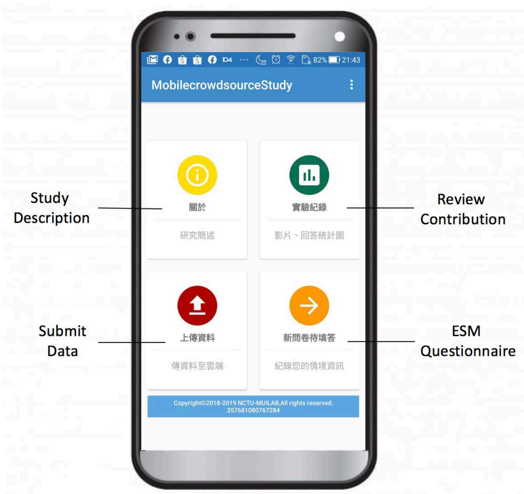

Figure 2. Research Application, (a) Study Description, (b) Review Contribution, (c) Submit Data, (d) ESM Questionnaire

perceived physical effort, perceived mental effort, and perceived attention required. The research app also logs the background phone-sensor data, including app usage, notifications received, transportation mode, and connectivity.

2.2.1 Reminders

To mimic the reminder systems of Local Guides and Google Crowdsource, our research app sends its users notifications asking them to perform mobile-crowdsourcing tasks randomly throughout the day, at intervals of between 90 minutes and 2 hours. To mitigate users' sense that such reminders are interruptive, however, our collecting tool does not send a reminder notification if a genuine reminder from either of the target crowdsourcing apps has been sent within the previous hour. Users' behavior is also taken into consideration. That is, once a participant has finished a crowdsourcing task, the system will automatically cancel the next reminder that it would otherwise have sent. Reminders can be dismissed, either by the users if they are not available to perform crowdsourcing tasks, or by the research app itself, if no user response has been received within 30 minutes.

2.2.2 Experience Sampling Method

ESM is widely used to collect smartphone users' in situ experience via questionnaires. Our ESM questionnaire is sent under either of the following two circumstances: 1) when mobile-crowdsourcing tasks are detected and the users leave Google Crowdsource or Local Guides; and 2) when mobile-crowdsourcing tasks are issued by one of the target apps or a reminder is sent by the research app. Users can either respond the ESM prompt through notification or through right bottom section of the research app. To minimize self-reporting error caused by recall bias, all ESM questionnaire are dismissed after 15 minutes.

The ESM questionnaire comprises two dimensions: context, and crowdsourcing tasks. It begins with two questions, one about whether a mobile-crowdsourcing task has been completed, and the other about what type of breakpoint the user was in while completing it. Follow-up questions seeking contextual information vary, depending on the types of breakpoints users identify. For example, if the participant said that s/he had been engaged in a non-crowdsourcing-related activity, the follow-up questions would cover what that activity was, how complex it was, and its requirements for physical effort, mental effort, and attention. If the user has just finished an activity and there is an upcoming one, the follow-up questions will cover both the previous and upcoming activities. The six questions that are shown if the participant says s/he has just finished a mobile-crowdsourcing task cover the general nature of the task, whether a notification reminded the user to perform it, and task attributes including complexity, required physical/mental effort, and required attention.

2.3 Recruitment and Participants

We recruited 30 participants, all of whom were at least 18 years old and frequently used Local Guides and/or Google Crowdsource, or left comments on crowdsourcing online platforms, via advertisements posted on social-media pages. The participants included 13 students and 17 non-students, and 10 females and 20 males, aged up to 64 (M=29.2, SD=10.3). All participated in this study for at least six weeks, with some volunteering to extend this period.

2.4 Study Procedure

Every participant attended a pre-study meeting, either physically or virtually, during which the researchers helped them install the research app on their phones.

Regardless of whether they had completed a crowdsourcing task recently, the participants were encouraged to complete all ESM questionnaires within 15 minutes of receiving ESM prompts. Every two weeks, all participants were invited to partake in short, non-mandatory interviews, aimed at augmenting the researchers' contextual information about their mobile crowdsourcing tasks.

2.5 Data Analysis

We received 3,735 ESM responses, of which 2,767 reported that the user had just executed a mobile-crowdsourcing task, and 968 that s/he had not. After 13 incomplete questionnaires has been eliminated, we analyzed the remaining 3722 responses. There were 1,951 during-activity responses, 815 that were between two different activities, 334 reflecting a previous but no post activity, 269 without a previous but with a post activity, and 353 with no activity on either side.

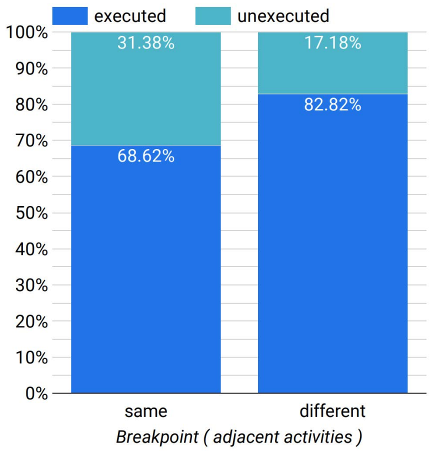

Figure 3. Number of executed/unexecuted crowdsourcing tasks by type of breakpoint, (a) adjacent activities are the same, and (b) adjacent activities are different.

3. FINDINGS

3.1 People tended to perform mobile-crowdsourcing tasks during the transition between two different activities

We received 2304 responses in consistent situations, including during the same activity, and neither preceded by nor followed by an activity. 1418 responses were in transition between two different situations, including between two different activities, preceded by but not followed by an activity, and not preceded by but followed by an activity. In Figure 3, the blue color indicates when participants executed mobile crowdsourcing tasks, while cyan shows when they did not. It can be observed from this figure that people were in consistent situations most of the time, but that they were more willing to perform mobile-crowdsourcing tasks when transitioning between two different situations.

3.2 Different impacts of preceding and upcoming activities

We found that the complexity of their previous and subsequent activities differentially affected the likelihood that the participants would perform mobile-crowdsourcing tasks. It can be seen from Figure 4 that in breakpoints between two dissimilar activities, high complexity of the preceding activity was associated with lower mobile-crowdsourcing task-execution rates. However, such execution rates remained at similar levels regardless of the complexity of subsequent activity.

4. CONCLUSION

This study's results demonstrate that people tend to perform mobile-crowdsourcing tasks between two other activities that were dissimilar to each other. Moreover, at the breakpoint between two such dissimilar activities, the complexity of preceding activity and the upcoming activity had different impacts on the likelihood of that mobile-crowdsourcing tasks would be executed. Our future work includes further analysis of

Figure 4. Variation in crowdsourcing-task execution rate, by complexity of previous and subsequent activities

the crowdsourcing tasks people chose to perform at different types of breakpoints, as well as how the choice of the tasks relates to the properties of the preceding and the upcoming activity.

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