Studying and Tackling Temporal Challenges in Mobile HCI

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Abstract

In this paper, I present the idea of receptivity as a broader concept than interruptibility alongside empirical studies of receptivity to interruptions on mobile devices in naturalistic settings, and a methodology based around experience-sampling in order to inform and motivate the development of concepts and models for system design that respond to issues of receptivity in general and temporal challenges such as timing and episodic engagement in particular.

Keywords

Receptivity, Interruptibility, Mobile HCI, Context, Time, Experience-Sampling Method, ESM, Interruptions

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Human Factors.

Introduction

As people on the move engage with interactive, mobile experiences, social networks, real-time services, location-based services, and pervasive games, mobile Human-Computer Interaction (HCI) is increasingly

characterized by fragmentation across media, time and space. Human attention is a sparse resource when being mobile – technologic interaction on the move is temporally limited to short episodes [9]. Mobility is also characterised by an ever-changing user context, which makes it hard to predict, for example, recurrent interactions; the user's location and involvement with the world change constantly. Nevertheless, Increasingly capable handheld devices evolve to personal communication hubs, obediently forwarding incoming information in real time usually with audible notification. Effectively interrupting us anywhere, anytime usually with no consideration of our context.

It is still a core challenge in context-aware computing to provide the user with the right type of information at the right time [7].

Problems and Objectives

With mobile experiences becoming increasingly long-term; and social networks shifting towards real-time services accompanied by a second coming of information push technologies, new ways of context-aware information delivery may ease some of the burden of the inevitable interruptions: for example by interrupting at times and with content for which people are predicted to be more receptive.

We see *receptivity* as being a broader concept than interruptibility, as it anticipates a user's overall reaction to an interruption, which encompasses the experience of the actual interruption. After all, people may be receptive to an interruptive message if the content justifies the interruption, e.g. "It's a girl!". This is in line with the *relational perspective* [5] that calls for consideration of the interruption itself as part of the context. We conducted a study [4] to understand more

about the aspects of receptivity: How does the content of the interruption and the time of delivery impact receptivity to pushed information on mobile devices? Since much information delivered to us is less urgent and timely, the timing of its delivery becomes more important. But what is good timing? In studies of interruptions, timing has been operationalised in terms of the individual's position in the primary cognitive task [1] and it was found that opportune moments for interruptions lie at the breakpoint between phases of cognitive task processing. A core challenge of this work is to translate this finding to system design for *mobile* HCI. The translation is difficult, as the primary task – the user's current involvement – cannot be easily predicted in uncontrolled naturalistic settings. For mobile settings, it was shown that the transition phases between physical activities may also constitute good moments for interruption [7]. Yet, the feasibility of such concepts may be limited as it relies on sensors that participants have to wear on their bodies.

Methodology

In HCI, we have long emphasised the importance of the subjective viewpoint on experience, stressed individual differences in perception and action, and embraced the notions of situated action [10] or embodied interaction [2]. However, there is a disparity in the methods used to study the subjective experience. On the one hand, ethnographic procedures focus on the overt action; the covert inner experience remains opaque to purely observational techniques. On the other hand, we often apply nomothetic quantitative techniques such as comparing different treatments to groups of people to derive rules that apply for populations. Idiographic approaches that focus on the individual level often remain qualitative and questionable in representativity

Who
The sender.
What is my relationship to the sender?
- Trust, credibility, hierarchy, power, intentions etc.

Says what
The content of the message.
How do I relate to the content?
- Interest, relevance, importance, urgency, actionability, etc.

In which channel
What are the characteristics and affordances of the channel?
- SMS and email can be tended to later, phone calls act as summons etc.

To whom
The recipient.
- What am I engaged with at the moment?

When
Timing of the interruption.
- Is now a good moment for an interruption?

Where
The physical location of the interrupted.
- Where am I, who else is here?

How
Manner and style of content, presentation of interruption
- How is something said, how is it presented?

With what effect
- How does it make me feel? What do I do now? E.g. take note, act, respond etc.

figure 1. An adaptation of Lasswell's formula [8] to guide studies of mobile interruptions.

and validity. Methodologically, a promising compromise to study the subjective experience idiographically and still achieve representative and valid results may be the Experience-Sampling Method (ESM), an *in situ* method designed to overcome shortcomings of post-hoc techniques. Its goal is to gauge the quality of experience by prompting participants to complete short questionnaires during their current experience over longer periods of time [6]. Their founders have described ESM as a "systematic phenomenology" as it makes idiographic data available for statistical reasoning [6]. Furthermore, by conducting an idiographic study with several participants, salient characteristics might emerge across the collection of participants. Thus, ESM is a method with which nomothetic insight can be achieved through a series of idiographic descriptions of subjective experiences. Another merit of ESM is that in addition to self-reports it can be tuned to also collect behavioural data unobtrusively, such as time-stamped log data or even physiological data. This is especially interesting in the context of mobile HCI, as it enables the collection of behavioural usage data, e.g. in order to enhance an application with machine learning, or to evaluate a certain mobile application by instrumenting it, or to conduct studies to inform the design of future systems. Key to the research presented here is that in addition to self-reports about the experience, behavioural data is collected and analyzed to discover where information from the self-reports is represented in the behavioural logs describing system use. Thus, self-reports are a vehicle and technique to empirically test assumptions about behaviour, e.g. if longer response times represent lower receptivity or to test hypothesised good moments for interruptions. The ESM is invaluable in this work both for HCI-centred research

questions and for the purpose of testing new system designs empirically.

Prior, Current, and Future Work
Studying players in *Day of the Figurines* (DoF), a pervasive long-term SMS-based game, we found that as a consequence of their episodic patterns of interaction, frequent dis- and re-engagement, players often felt annoyed by receiving too many messages at bad times, and that the experience would benefit if the system could adapt to the player's receptivity. In order to test if temporal properties of the player's behaviour in DoF can be utilized to adapt the experience to the player we have instrumented the game with an SMS-based ESM. Self-reports collected by means of the adapted ESM revealed that levels of player engagement differ significantly in respect to behavioural data properties from the game's log files [3]. We found that the behavioural properties elapsed time and response time (the times since the player last sent and received a game message) provide a model that can be used to predict player engagement and may be utilized to adapt the experience to the player's predicted engagement unobtrusively. As a coherent guideline for the development of systematic studies of the context factors at play in the process between interruption and potential response I suggest an adaptation of Harold D. Lasswell's famous formula of communication: *Who says what in which channel to whom with what effect?* [8] For our purposes, I extend the question with *when*, *how* and *where* (see fig. 1). The individual answers to this set of questions can be related to the user's context in order to identify the relational context factors at play throughout the interruption process.

Using this guideline, we developed an ESM-based study to test the impact of the interruption content (*what*)
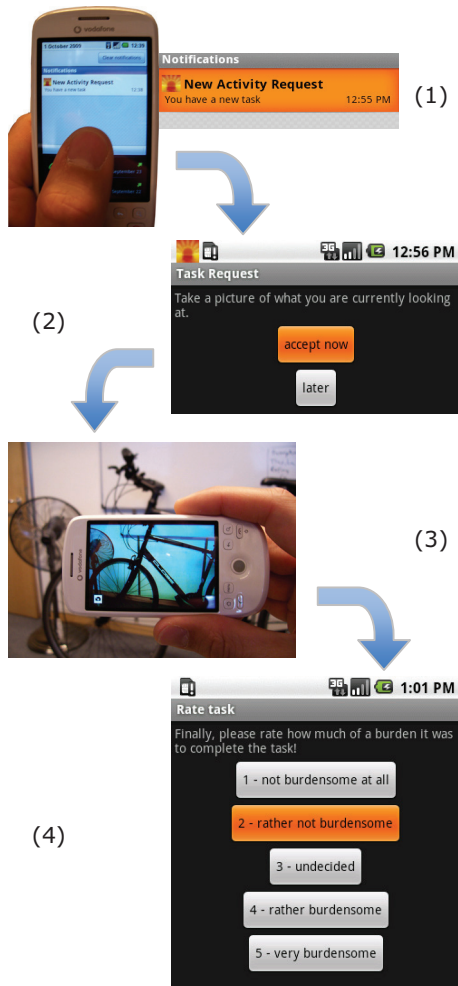
figure 2. (1) A user is interrupted at opportune and random moments with a notification. (2) On acceptance, he is presented with different tasks, for example to take a photo (3), in order to test for impact of task type on responsiveness. Finally, the user is asked to rate the burden of the task (4), a measure to control differences in perceived burden to complete the task.

and the time of delivery (*when*) on receptivity to SMS. Findings suggest that the appropriateness of an interruption is evaluated by its content rather than by its time of delivery. We also examined the underlying variables that increase the perceived quality of content and found that the factors interest, entertainment, relevance, and actionability influence people's receptivity significantly [4].

However, the fact that time of delivery proved to be an insufficient operationalisation of timing motivated the current work to search for unobtrusive ways to predict opportune moments for interruption in mobile settings. Inspiration was found in research in neuropsychology, which has found that not only are the cognitive tasks humans engage in structured into phases, but the brain structures our everyday experience into temporally bounded episodes [11]. This episodic nature of our experience suggests that breakpoints between episodes exist – transition phases in which attention shifts and which would lend themselves to provide opportune moments for interruption. Can we approximate these breakpoints in experience to test if they provide opportune moments for interruption in a mobile, naturalistic context? I argue that episodes of mobile device use themselves are framed by breaking points from the ongoing experience as the user's attention shifts to the interaction at its initiation and away from it at its end and that the breakpoints at the end of the episode represent an opportune moment for an interruption. In a study designed for Android OS (see fig. 2) participants' reaction time and self-reports at random moments and after they have completed an episode of interaction such as after a phone call will be compared. Future work will put more effort into understanding what good timing for mobile interruptions may be and at the same time explore the

potential of an information delivery concept attuned to the user's temporal context of interaction.

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