Knock, knock! who's there? Putting the user in control of managing interruptions ☆

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ABSTRACT

The abundance of communication technology, such as the omnipresence of cell phones, has not only increased our ability to reach people anytime anywhere, but also the likelihood of being interrupted. As a result, there is value in understanding how to design technology so that gains are realized from desired interruptions, while the losses from unwanted interruptions are minimized. This paper presents the findings of two complementary field studies, one quantitative and the other qualitative, exploring how the provision of additional incoming cell phone call information impacts people's interruption decision making. These studies were enabled by, *Telling Calls*, a research application built to enable users to provide and receive information such as what the call is about and the caller's circumstances. The qualitative study showed how the additional call information helps people make informed call handling decisions and acts as an aid to effective conversation. The quantitative study elucidated these findings and showed that reducing the uncertainty about the nature of an incoming call improves people's ability to predict the value of an interruption. By combining these diverse research approaches: (1) theory instantiation through tool building; (2) context-aware surveys; and (3) semi-structured interviews, we were able to gain unique insights into the nature of interruption management in the wild, and related design implications.

1. Introduction

In today's multi-tasking and socially connected world, interruptions are inevitable. As a result, researchers are continually on a quest to understand how to help people better manage their interruptions. Most work in interruption management has focused on gaining an understanding of how interruptions affect one's task performance (Adamczyk and Bailey, 2004; Avrahami and Hudson, 2006; Bailey et al., 2001; Iqbal and Bailey, 2005) and how to reduce their negative effects (Fogarty et al., 2005), inspired by theories of attention and cognition (Broadbent, 1958; James, 1890; Johnston and Heinz, 1978; Kahneman, 1973; Treisman, 1960). These theories and insights were primarily based on laboratory studies, where subjects were asked to attend to an interruption, or new information, while engaged in a task within the experimental setting (Eysenck and Keane, 2002; Allport, 1980). In this paper we show how an examination of responses to real world interruptions, using a more diverse set of methods, necessitates a more nuanced account of interruption management.

Interruption may impact one's task performance, but that does not necessarily follow that this impact will determine how one handles these interruptions. People are not passive recipients of interruptions such as incoming phone calls, instead they actively interpret them, and then make decisions about if they should be engaged with or avoided. Even though our understanding of interruption-effects from laboratory studies has been complimented by observational workplace studies, the nature of these studies inherently narrows the "context" of the interruption in terms of factors such as the task, location, interruption type, interruption source (González and Mark, 2004; O'Conaill and Frohlich, 1995; Perlow, 1999; Rouncefield et al., 1994; Fogarty et al., 2005). For example, Altmann and Trafton (2007) showed in a laboratory experiment that response time in a task dropped steadily in the first 15 seconds of the recovery process from an interruption, during which time people seem to incrementally bring back the necessary cognitive resources required to resume the complicated interrupted task. The findings suggest that we should perhaps focus on the designing technologies that aid in the recovery process. However in

the real world it may be equally if not more important to aid interruption response decision making process in the first place. Such an understanding of how people desire to manage their interruptions can only come from exploring people's interruption response behavior based on their dynamically changing social and work roles spanning across various social and work environments where technology makes people reachable anytime and anywhere.

In this paper, we present new and expanded findings from two field studies into interruption response decision-making behavior (Grandhi et al., 2011). We show how an examination of people's behavior in-situ provides insights into people's natural responses to interruptions that were lacking in prior laboratory and workplace studies. The rest of the paper is organized as follows. We briefly summarize previous research in interruption management to situate the theoretical and methodological approach we take to understanding people's interruption response decision making. We then present the design and implementation of *Telling Calls*, an interruption response management research application for cell phones used in the field studies. The two field studies are then presented followed by discussion of the utility of the field study approach to understanding interruption response behavior and deriving design implications for interruption response decision making tools.

2. Background and theoretical approach

Historically, the majority of interruption research has focused on the nature of interruption impact and how that varies with factors such as the time of interruption (Perlow, 1999; Bailey et al., 2001; Adamczyk and Bailey, 2004; Iqbal and Bailey, 2005); the frequency, length and similarity of an interruption to the main task (Gillie and Broadbent, 1989; McFarlane and Latorella, 2002); complexity of an interrupting task as well as the interrupted task (Gillie and Broadbent, 1989); social and workplace norms, expectations and culture (González and Mark, 2004; Hudson et al., 2002; Perlow, 1999); interdependencies of work patterns (O'Conaill and Frohlich, 1995; Perlow, 1999). These studies have generally been viewed as providing support for the *Interruption Impact Reduction Paradigm* (Grandhi and Jones, 2010), the notion that given interruptions have a negative effect under certain conditions, interruption management should focus on reducing the negative impacts of interruptions on those being interrupted.

Adopting the *Interruption Impact Reduction Paradigm* perspective leads to focusing on factors within the interruptee's 'local context' that cause negative impacts, namely: (1) **Cognitive context:** which is all aspects that encompass the interruptee's cognitive level of involvement in tasks (Arroyo and Selker, 2011; McFarlane and Latorella, 2002; Perlow, 1999; Zijlstra et al., 1999); and (2) **Social context:** which is all aspects that encompass the interruptee's immediate environment, as understood in a social sense, such as the place the individual is in, people present within that place, and the social nature of the activity in that place (Fogarty et al., 2005; Ho and Intille, 2005; Janssen et al., 2014; Marti and Schmandt, 2005). With such a focus, researchers and designers working within the Interruption Impact Reduction *Paradigm* have concentrated their efforts on strategies that prevent, dissuade, or present an interruption in the least intrusive manner possible. A number of simple related design features have been implemented in commercial systems including setting alerts to muting them on phones, emails and instant messaging. More sophisticated features have been explored through proof-of-concept systems focused on preventing or postponing of interruptions until an opportune time such as *Bayesphone* (Horvitz et al., 2005); *Disruption Manager* (Arroyo and Selker, 2011) or *Negotiator* (Wiberg and Whittaker, 2005), *Live Addressbook* (Milewski and Smith, 2000), *Lilsys* (Begole et al., 2004) and *Calls Calm* (Pedersen, 2001). Other studies have found value in enabling tacit or explicit

negotiation between interrupters and interruptees as a way to dissuade unwanted interruptions using presence or awareness features (Nardi, 1996; Woodruff and Aoki, 2003; De Guzman et al., 2007; Avrahami et al., 2007). Many commercial applications have also focused on minimizing the burden of fully engaging in the interruption by enabling automatic or user controlled text/voice responses to missed or ignored phone calls/ instant messages inspired by proof of concept systems such as *Taming the Ring* (Nelson et al., 2002) and *Quiet Calls* (Pering, 2002), instant messaging. Together these systems and studies show how people can manage their interruptions by exclusively focusing on reducing the negative impacts they can cause on people's local context.

In contrast to the *Interruption Impact Reduction Paradigm*, the *Interruption Evaluation Paradigm* focuses on the utility brought by an interruption (Milewski, 2006; Dabbish and Baker, 2003; Szóstek and Markopoulos, 2006; Grandhi and Jones, 2010). Researchers working from this perspective do not focus solely on factors of social or cognitive context that are local to the person being interrupted, but also on factors related to who the interruption is from and under what the circumstances is the person interrupting. Those interrupted are understood to engage in a cost vs. benefit evaluation of interruption in a broader context. Thus from the *interruption evaluation paradigm's* perspective the goal of interruption management is to optimize one's ability to evaluate the utility of engaging in interruption. The role of technology should then be to aid evaluation and the decision making process of whether to engage in or ignore the interruptions. Since one is aware of their own social and cognitive contexts, the required information for interruption evaluation is outside of the local context that is termed as the **Relational Context**: this encompasses information on who the interruption is from, what the interruption is about, under what circumstances is the interrupter interrupting, and the nature of the relationship between the interrupter and interruptee including their historic interaction patterns defined by the nuances of their relationship (Grandhi and Jones, 2010).

The majority of interruption management design strategies adopt the *Interruption Impact Reduction Paradigm* even though the *Interruption Evaluation Paradigm* makes intuitive sense. Furthermore, research has shown that individuals seek relational context information to evaluate the value of an interruption such as urgency tags in emails, call screening for who the caller is, call content, urgency via an answering machine (Milewski, 2006), importance as relayed by administrative assistants (Dabbish and Baker, 2003; Szóstek and Markopoulos, 2006). Yet there is limited research on understanding what relational context information users specifically desire during various technology mediated interpersonal interruptions and how it can be used to support their response decision making.

In this research we adopt the *Interruption Evaluation Paradigm* to explore how people's interruption response decision making in everyday interpersonal communication is influenced by social, cognitive and relational contexts. The work presented in this paper builds on our previous work (Grandhi and Jones, 2010, Grandhi et al., 2011) where we developed the theoretical framework of interpersonal interruption response management that proposes that when presented with an interruption, people try to predict the value (PIV) of an interruption and in the process try to reduce the uncertainty of any unknown relevant information. Given people are aware of their own cognitive and social context they seek to reduce uncertainty about the unknown relational context such what the interruption is about, who and under what circumstances is one interrupting them to predict the value of the interruption. If the predicted value of interruption is positive they will engage in the interruption and if it is negative they will refrain from engaging in the interruption. The key constructs of this theoretical framework were validated by two studies (Grandhi and Jones, 2010, Grandhi et al., 2009) that not only confirmed the