Computers in Human Behavior 28 (2012) 1439–1449

Contents lists available at SciVerse ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

The impact of distractions on the usability and intention to use mobile devices for wireless data services

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ARTICLE INFO

Article history:
Available online 4 April 2012

Keywords:
Mobile
Usability
Distraction
Expectancy-confirmation theory
Satisfaction
Adoption

ABSTRACT

Mobile technology has quickly become ingrained in society due to the flexibility of anywhere/anytime usage. However, factors associated with and that impact mobility, mobile users, and mobile use of products and services are still poorly understood. For example, even though distractions are ever present during everyday use of mobile devices, the nature and extent to which user perceptions and performance are affected by their presence is unknown. An empirical study was undertaken to investigate the impact of distractions and confirmation of pre-trial expectations on usability and its subsequent effect on consumers' behavioral intention toward using a mobile device for wireless data services. Distractions were simulated in this study in the form of either user motion or environmental noise (i.e. background auditory and visual stimuli). A Structural Equation Modelling (SEM) analysis confirmed the impacts of distractions on efficiency and effectiveness, and in turn the users' satisfaction and behavioral intention to use a mobile device for wireless data services. Support was also obtained for a mediating effect of post-trial confirmation of expectations between perceived performance and satisfaction. Implications of these findings for theory, practice, and future research are outlined.

1. Introduction

Mobile devices are becoming increasingly popular, having reached over 5.3 billion mobile subscribers worldwide by the end of 2010 (ITU, 2010; PBC, 2008). Corresponding wireless data services that have emerged present an important evolution in information and communication technologies (ICTs) (Byoungsoo, Minnseok, & Ingoo, 2009). Coupled with continuous reduction in consumers' technology fears and lower adoption costs, mobile devices have become "mainstream" around the developed world. Such devices propose increased value to consumers due to "anytime/anywhere" connectivity, communication, and data services.

Although progress has been made in terms of technological innovations, many mobile subscribers are still concerned with the usability, reliability, and security of mobile applications and services (Coursaris & Hassanein, 2002). Key usability challenges include technology issues with respect to interface attributes, such as limited screen size, limited input methods, and navigation difficulties (Persson Waye, Bengtsson, Kjellberg, & Benton, 2001). Additionally, the mobile user has to share his or her attention between the task (application) and the surrounding environment. Furthermore, individual characteristics (e.g. age, culture) may be key factors in their ability and preferences to use a mobile device.

The concept of *context of use* as it relates to usability emerged out of the work of several researchers (e.g., Baker & Holding, 1993; Bevan & Macleod, 1994; Coursaris & Kripintiris, 2012; Coursaris, Swierenga, & Watrall, 2008; Lee & Benbasat, 2003; Tarasewich, 2003), who suggested that many variables beyond the immediate interface might impact usability. Although the definition of *context* may be slightly varied, the takeaway is that usability experiments need to consider various contextual factors (Liu & Li, 2011). In particular when assessing the usability of mobile devices and services, the following factors should be considered (adapted from Hassanein & Head, 2003):

- User (e.g. prior relevant/computing experience, age, education, culture, motion).
- Environment (e.g. lighting, noise, visual distractions of other objects or people).
- Task (e.g. complexity, interactivity).
- Technology (e.g. interface design, input/output modes, device size, weight).

The results of such contextual usability studies should guide the design of mobile devices and services resulting in better user

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http://dx.doi.org/10.1016/j.chb.2012.03.006

satisfaction and consequently higher rates of adoption for such devices and services. Adherence to a rigorous research design would constrain most studies to the investigation of only one (or slightly more) of the aforementioned factors, e.g. user motion. Even though user motion is only one attribute of a potential human–computer interaction (HCI), its inherently dynamic effects on other HCI attributes (e.g. input mode) augment a user's experience significantly from that of a desktop-based system use. With user motion comes the exposure to constantly changing visual and auditory stimuli. These stimuli effectively become distractions as users interact with mobile devices and their performance and experience with the services may be impacted significantly. Designing mobile interfaces and services should be informed so that they afford users greater capacity in this respect. Thus, this burgeoning research domain is guided by the need to explore the characteristics of mobility, develop new design principles for mobile systems, propose novel mobile usability evaluation techniques, and consequently to obtain a better understanding of, hence, improve mobile use (Biela, Grilib, & Gruhna, 2010; Heoa, Hamb, Parkc, Song, & Yoond, 2009).

This paper explores the impact of context on the usability of mobile devices. Specifically, the paper empirically investigates the impact of distractions as well as the post-trial confirmation of users' initial expectations of performance on the usability and the subsequent effect on consumers' behavioral intention to use a mobile device for wireless data services. Distractions are ever present during everyday use of mobile devices, yet the nature and extent to which user perceptions and performance are affected by their presence remains unknown. Similarly, the relationship between pre-trial expectations from and post-trial perceptions of usability has received limited attention in the context of wireless data services. This study will contribute to theory through an extension of usability theory, by considering cognition and by additionally testing the applicability of the Expectancy-Confirmation Theory (EDT) in explaining a mobile user's evaluative process of usability. Furthermore, this study contributes to practice by providing a better understanding of contextual usability factors that influence consumer adoption of mobile devices and wireless data services and hence can inform improved design of these devices and services.

2. Theoretical development and research model

Distractions are stimuli that are irrelevant to a subject's primary task, and can come in different forms (Sanders, Baron, & Moore, 1978), for instance, external stimuli—such as changing light (visual) conditions, the sudden introduction of music (auditory) sounds—or an internal thought process. Consequently, a distraction may affect an individual's performance with a primary task due to attentional conflict, i.e. the individual's tendency, desire or obligation to allocate attention to various competing inputs (Baron, 1986; Nicholson, Parboteeah, Nicholson, & Valacich, 2005; Sanders et al., 1978).

Attending to more than one stimulus at a time requires greater mental activity on the part of an individual's working memory (Sweller, 1988, 1994), which is commonly referred to as cognitive load. Increased cognitive load may affect performance negatively by reducing the individual's attentional control, accuracy, working memory, and retrieval efficiency (Eysenck, 1984; Lavie, 2010). As a result, individuals exposed to distractions may omit procedural steps, forget to complete tasks, and take unbeneficial shortcuts (Latino, 2008, p. 10). Yet, such effects have rarely been examined in the human–computer interaction literature, and even less in the context of mobile computing and usability. Nonetheless, the effect of distractions in the use of mobile devices may have substantial consequences, ranging from short-term inconveniences (e.g. annoyance) to life-threatening situations (e.g. driving accidents).

In order to analyse the role of distractions, researchers need to pay close attention at the dyadic inverse relationship that exists between methodological rigour and relevance of findings (Lindroth, Nilsson, & Rasmussen, 2001). It can be argued that the more natural the experimental setting, the more relevant and applicable the study's results will be. However, typically, usability studies are performed in controlled laboratory settings where external variables (e.g. distractions), are absent (Kallinen, 2004) in an attempt to uphold a rigorous methodology. By omitting distractions, however, such studies exclude factors that would typically be present in a real-world setting and therefore the external validity of these findings is limited.

2.1. Distractions and performance

The aforementioned limitation in excluding distractions from contextual usability studies arises mainly from the observation that distractions negatively affect information processing and performance (Baker & Holding, 1993; Sörqvist, 2010). Both short-term memory (also known as working memory) and attention span are subject to cognitive constraints (Baddeley, 1986). Nicholson et al. (2005) describe cognitive load as "the total amount of mental activity imposed on the working memory at an instance in time" (note: for a comprehensive review of cognitive load, refer to (Hollender, Hofmann, Deneke, & Schmitz, 2010). Any single distraction adds to the total cognitive stimuli (i.e. load) thereby reducing one's capacity to process information efficiently (Miller, 1956) and effectively and, hence, potentially one's overall performance.

Extensive literature focuses on auditory and visual distractions and their impact on performance. In this respect, it has been shown that a quiet environment results in higher efficiency, while the presence of irrelevant sound lowers mental efficiency and performance due to the obligatory cognitive process of organizing unattended information (Hughes & Jones, 2003). It is interesting to note that both noise and music hinder performance (Persson Waye et al., 2001; Stansfeld, Haines, & Brown, 2000), but music has been shown to have a more substantial negative impact on performance compared to noise (Umemura, Honda, & Kikuchi, 1992). Additionally, increased variability of background noise results in lower performance (Hughes & Jones, 2003).

Research has also shown that visual distractions may elicit different responses from the brain than auditory distractions, yet, the negative impact on performance remains. In fact, studies have shown that it may be more difficult to return to one's thoughts and task after certain visual rather than auditory distractions (Berti & Schroger, 2001).

Another previously explored source of distraction is motion. Ljungberg, Neely, and Lundstrom (2004) study supports the argument that the combination of a subject's motion (e.g. walking) with the presence of any other auditory or visual distraction would impact the subject's performance negatively, as they would have an additive effect on cognitive load. Although there is a substantial body of literature on the negative effect of various forms of distractions on performance (Baker & Holding, 1993), no studies have yet explored the role of distractions in the context of wireless data services.

Yet, based on the discussion of previous findings regarding the negative effect of auditory, visual and motion-related distractions, it can be inferred that the greater the level of each of these types of distraction, the more adverse its impact on performance. Hence, the following hypotheses are proposed:

H1a. *Exposing users to higher levels of distractions will negatively influence their perceived efficiency of a mobile device for wireless data services.*