

Mobile Users Are More Vigilant Than Situated Users

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Abstract. With the rapid growth of mobile device usage, daily life offers much empirical evidence that users frequently and persistently interact with mobile devices while doing other things. These users might be highly engaged within a mobile experience or unfulfilled by their real world experience; but significantly, their frequent usage could also be a form of vigilant behavior. This research seeks to understand whether or not mobile usage leads to an increased prevalence of user vigilance, first by establishing criteria that can be used to determine if a specific session of use is vigilant, and then applying these criteria to analyze observed sessions of use for two distinct cohorts: mobile users and situated users. In the analysis, it was found that everyday vigilant usage scenarios are fairly prevalent, and also that mobile users were 3 times more vigilant than situated users. These initial findings need further validation, but may prove significant to interaction design: optimizing a software interface to better support vigilant usage requires an opposing set of considerations when compared to traditional consumer product design. These design considerations are discussed, in addition to the limitations of the study, and guidance for future work.

Keywords: Mobile, User Interface Design, Vigilance, Attention.

1 Introduction

Vigilance is a state of watchfulness, the compulsion for which maps directly to the perceived consequence of missing out on possible observations. Most prior research into vigilance in the realm of HCI has focused exclusively on situated (terminal, desktop PC or laptop PC) usage with specific tasks that involve watchfulness, in order to understand the physiological impact of a sustained vigilance state when interacting with machines [5],[7],[9]. The key findings of this work have been how exhaustion and attention decline affect usage – and consequently performance – for sustained vigilance tasks such as radar operation [5], anesthesia monitoring and operation [18], and intrusion detection [15].

This narrow focus seems to imply that vigilant scenarios only exist within a small subset of human-computer interactions, namely, situated tasks performed by trained professionals or operators. However, a broader survey of scholarship into attention among people and mammals suggests that vigilance is more general – it is a context-specific state that often coincides with other tasks or distractors [4], [12], [13], [19]. For example, a grazing animal must balance two tasks that are necessary for survival: intermittently eating and watching vigilantly for any approaching predators [4]. Or, a rushing commuter, who is navigating, must also be watchful while crossing the

street. Now, imagine this commuter has a mobile phone in his pocket, buzzing for attention. Would he wait until he exited the crosswalk before checking to see who had texted? If he thought the message was important, he might not. In our interactions with computers, just as with our interactions in the physical world, vigilance is inclusive of, but is not limited to, specific and situated tasks [10]. After all, the true measure of vigilance is not that usage is sustained, but that attention is sustained. In the day-to-day reality of an average consumer, like the commuter in the crosswalk, HCI vigilance scenarios may frequently and intermittently overlap their other activities.

But how prevalent are these vigilant scenarios, really? And are mobile devices, with their nagging, their beeping, and their omnipresence, creating more vigilance scenarios than earlier technologies did? This research seeks to answer these questions. Background is provided on prior research into vigilance, how it is supported by technology, as well as prior scholarship into mobile and social media usage. A specific study is then described, detailing goals, criteria used for determining if a particular session of use is vigilant or not, participants, and methodology. A quantitative analysis of the study findings is presented, followed by a qualitative analysis of user interviews. A discussion of design considerations is subsequently provided. Finally, key achievements and future work are described in the conclusion.

2 Background

2.1 Why Does Vigilance Occur?

The instinctual basis for entering into a vigilant state is the preservation of self or society [3]. It's easy to see how this applies to a radar operator huddled over the radar screen in a WW2 aircraft. But it's a little more difficult to see how vigilance might relate to everyday device usage by normal users. To understand everyday vigilance, consider a common example: the social networking behaviors of teenagers.

For many teens, social network usage is associated with self-preservation because their interactions within that system are a basis for socialization and, partially, the formation and preservation of their identity, their sense of self [16]. In developing these social interactions, a teenager must break her natural methods for real-time communication into the discrete unidirectional communiques that these technologies enable: things like messages, status updates, and photo uploads. These communiques are signals that the teen uses for social encoding, impression management, and identity performance [1-2]. In so doing, the teen extrapolates socialization from her natural and immediate embodied experience, and pushes it into exogenous, serialized and persistent media that she must then watch over. This phenomenon could be described as a serialization of socialization, and the resultant compulsion to be watchful forces the teenager to be vigilant.

2.2 How is Vigilance Supported?

Certainly, an active social network user might spend a few hours a day logged into the system on her laptop, monitoring things. This usage is not entirely vigilant, but the interface employs a number of visual and audible alerts to direct the user's attention to something that they might need to see. The user will watch for these alerts, in case

she needs to respond to something. This is an everyday example of vigilance, occurring in a situated usage scenario.

Now consider mobile devices, which have quickly become a primary means of communication as we move through our daily physical lives [6], [11]. An active social networker will not stop monitoring the network when she closes her laptop; rather, she will use her mobile device to monitor things. However, the nature of her engagement with the device is quite different. By design, mobile devices must be held, carried, and tended to. While the average user engages with their mobile device for about an hour each day, this usage is broken up into numerous one-minute sessions [14]. Like the desktop experience, mobile devices employ notifications and alerts to capture attention. But with mobile devices, those alerts often pull the user's attention away from the physical world, and into the mediated world. This is less often the case with a situated user, who is already engaged in the mediated. As such, the growth of mobile devices and their utility as a communication tool has brought rise to a form of vigilance that spans intermittent sessions of device usage. In this form of vigilance, a state of watchfulness over the mediated experience is sustained and balanced within the physical world, via endogenous and exogenous cues [10].

In the everyday case of social networking, vigilant usage scenarios have emerged as a result of the inextricable role that technology plays in the establishment and maintenance of the self. Mobile devices enable this vigilance to persist as networkers navigate the physical world, pushing them into a state of divided attention. And yet, vigilant scenarios appear to be much more ubiquitous than a teenager constantly checking her social network. As Sherry Turkle notes: "It is the more mundane examples of attention sharing that change the fabric of daily life. Parents check e-mail as they push strollers. Children and parents text during family dinners." This is neither boredom, nor simple device addiction – it is a compulsion invoked by the perceived importance of socialization. She further explains, "Although we can't keep up with [our mobile device], we feel responsible for it. It is, after all, our life." [16].

3 Study

3.1 Study Goals

This research seeks to demonstrate that mobile usage leads to increased user vigilance, first by establishing criteria that can be used to analyze whether or not a usage session is associated with vigilance, and then applying these criteria to observed sessions of use for two distinct cohorts: mobile users and situated (terminal-based, laptop or desktop) users. Both cohorts were comprised of participants who were actively communicating through social networks and other mediated channels like text messages and emails. It is important to note that sustained usage was not assumed to be a criterion for vigilance. The vigilance tasks could be of any duration or relative complexity.

3.2 Criteria for Vigilance in a Session of Use

Because of the diversity of users and their relationship to computing devices and software, it is difficult to describe any general usage scenario as categorically vigilant or not. For a user who is deeply engaged in a social network, monitoring that network

might become an important aspect of socialization - important enough to trigger vigilant attention. However, a casual user of that same social network may feel no need to monitor things – their usage may be entirely non-vigilant. In order to observe the prevalence of vigilance among day-to-day computer usage scenarios, we must establish a set of criteria against which an individual observed session of use can be evaluated as vigilant or not. For this study, the following criteria were used:

1. **High Task Importance.** First, the importance of completing the associated task must be recognized by the user as being higher than average. This follows the simple logic that self-preservation is important; if a task is associated with self-preservation, then it must also be important. In this study, users were asked to rank the importance of individual usage scenarios directly, and their ranking of task importance was performed antecedent to task completion. As such, one limitation of this study is that it did not necessarily capture false alarms, scenarios where users thought something might have been important and took action to engage with their device, but ultimately decided the task was not important [8]. In this study, participants may not have described false alarms as important, although vigilant attention may have invoked their session of use.
2. **Endogenous or Exogenous Cueing.** Secondly, the scenario must have been invoked by an exogenous or endogenous cue. In other words: the user was either responding to some type of alert or notification, or the user had experienced a desire to check for some form of update or response. This criteria differentiated vigilance tasks from planned tasks (like work or homework), direct inquiries (like research and web browsing), and boredom activities (like playing games or surfing the internet). As vigilance is a state of sustained watchfulness over potentially intermittent sessions of use, cues are essentially the events that invoked the user's engagement with the device. Exogenous cues are those that are specifically designed to capture the user's attention: a smartphone buzzing when you receive a text message, or your email client displaying a visual alert when you receive a new email on your laptop [20]. Endogenous cues are invoked by the mind of the user and manifest as the compulsion to direct attention to the device; for example, checking to see if you'd received a response to an email you sent, after having been away from the computer [20]. Or, looking to see how many responses you received to an update that you posted in a social network.
3. **Dire Consequences for Failure to Complete Task.** The user should perceive that failure to complete the associated task would have dire consequences. This follows the logic that if you do something out of self-preservation, then you believe that you would be harmed in some way if you failed to do the task. Along with the other criteria, this helps establish that the task is associated with a scenario of sufficient gravity to validate vigilance. In order to capture this criterion, users were asked to speculate what would have happened if they had not done the task, and if their failure to perform the task would have created any problems for them.

For this study, any observed session of use that met the first two criteria – that the task was important to the user, and that some form of endogenous or exogenous cue invoked the task – was considered to be a vigilance scenario. A subset of these vigilance scenarios was then further analyzed to determine if it met the third criterion: that there would be dire consequences for the users if they failed to complete the task.

3.3 Study Participants

Two user groups were established and their device usage was monitored for vigilance. One user group was comprised of situated users, and the other group was comprised of mobile users. Users who were interested in taking part in the study filled out a brief application form that focused upon their relationship with their computing devices. In order to be selected to serve as a participant in the study, applicants need to meet the following criteria:

- They must own or have access to a mobile device or a computer.
- The user must have a profile on at least one social network.
- That profile must have been created at least 6 months ago.
- The user must check on the status of his or her social network at least once a day.
- The user must have completed an initial 20 minute interview over the phone.

Based upon these criteria, applicants were screened and 8 participants were selected for each of the two user groups, resulting in a total of 16 participants. (Figure 1)

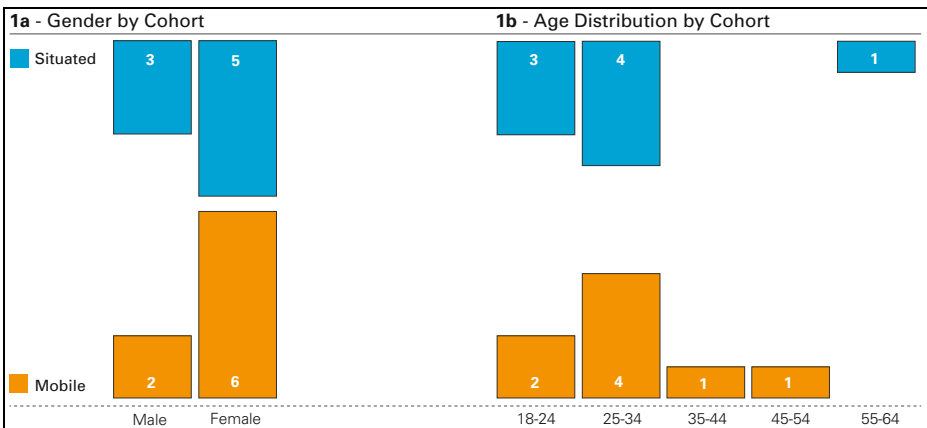


Fig. 1. Gender and Age Distribution by Cohort

3.4 Study Methodology

The study consisted of two distinct phases. The first phase was a phone interview within which users were asked to describe their technology usage patterns and their relationship to their devices. Users were asked to describe their social network engagement in some detail, including the reasons that they typically access their network. They were also asked about other prevalent modes of communication: email and text messages.

The second phase of this research, which commenced immediately upon completion of the interview portion, was a longitudinal study. Participants were asked to maintain a daily journal, where they described a specific session of use that occurred on that day, using an online journal form. This component of the study lasted for approximately two weeks, until each participant completed 14 journal entries. If a participant missed a journal entry on any particular day, he simply resumed on the

following day. The test moderator emailed each participant every day with a reminder and link to the daily journal form. The email was sent at random times of day over the course of the study, and all 7 days of the week were included in the study.

The journal entries were concise - up to 6 questions, and designed to take approximately one minute to complete. Each entry was focused upon a single session of device usage. The order of response options was randomized for all multiple choice questions. Over the course of the study, a set of core questions persisted for all 14 entries, and a number of questions were introduced for a fewer number of entries, resulting in 3 distinct journal entry types, as shown in Figure 2. This created an element of diversity into the participant’s experience, but also enabled the collection of additional data points without making the daily journals too long.

		Question Sets			Topic Areas
		Over the course of the study, questions were rotated three times:			
		Set 1 Days 1-5 (80 entries)	Set 2 Days 6-10 (80 entries)	Set 3 Days 11-14 (64 entries)	
Number of Questions	1				Watchfulness Did user feel a need to be watchful this day?
	2				Dire consequences Problems if task not completed?
	2				Session details Length of session Task switching
	3				Vigilance criteria Task description Task importance Task invocation

Fig. 2. Journal Types: Question Distribution by Topic Area

4 Qualitative Analysis

A number of observations were made regarding the usage of mobile and situated devices during the participant interviews.

4.1 Separation Anxiety for Mobile Users

Many mobile users described a feeling of anxiety when without their phones. Several described that the last time they had left home without their phone, they immediately returned home to retrieve it. One user noted that she’d “feel lost” without it, because it lets her know what’s going on around her. Another user described feeling “kind of scared” when she’d lost her mobile phone. A student recalled the time she’d broken her mobile: she immediately stopped studying for her exam and went to get the phone replaced. Another user summarized the experience of being without her phone: “it is

the worst. I feel like I am not connected to the world. You feel lost.” In describing the importance of his device, a young professional made a profound observation about his mobile phone: “when not at my desk, it’s my only form of communication.”

Situated users had less separation anxiety. One desktop user described frustration and boredom when a hurricane had knocked out Internet connectivity. Computers were also associated with livelihood for some situated users. As one participant noted: “[My computer] is critical. I have to have it. It is how I make my living.”

4.2 Habituated Usage Patterns

A number of mobile users also revealed different aspects of how they had become habituated to use their devices. One user reported that he would often pull out his smartphone, unlock it, and then look at the screen, but forget why he even pulled it out of his pocket. Another participant indicated that she had to expend effort to avoid use her mobile phone in front of other people. As she describes: “it’s not difficult, but I have to think about it”. Another form of habituation involved the use of notifications to know when to open the device. One participant described that she “trusts the notifications” to tell her if and when she needs to check on the device, and would habitually open the device if a notification was received.

4.3 Suppressing Social Networks

Active social networkers employed a few workarounds to suppress the service in their everyday life. One participant refused to install the Facebook app on her mobile phone and instead used the Facebook.com website, because the website couldn’t invoke alerts or notifications through the phone. For her, avoiding the app was a way to suppress the service, because otherwise she’d be distracted by, and compelled to respond to the alerts. For another user, suppressing Facebook was done in a more extreme fashion: she would temporarily deactivate the service when she had to write a paper or during exam week – “because [Facebook is] counterproductive.”

5 Quantitative Analysis

A total of 224 journal entries were recorded: 14 entries for each of the 16 participants. Each journal entry described a single session of device usage for the day the entry was submitted; as such, the journal captured user descriptions of 224 distinct sessions of use. It is important to note that users were not directly asked if they were being vigilant or not; rather, they were asked a number of questions related to the type of tasks they were doing, the relative importance of these tasks, and what events prompted their session of use. The responses within each journal entry were then analyzed according to the vigilance criteria in order to determine whether the corresponding session of use appeared to be vigilant or not. The two test groups were then compared. For the mobile group, 43.8% of the recorded sessions were vigilant. For the situated group, 14.3% of the recorded sessions were vigilant – see Figure 3. Thus, it was

observed that mobile users are about 3 times more likely to be vigilant than situated users.

Users were also asked to speculate about the consequences if they had not completed the tasks involved. This was accomplished through a pair of questions that were together included in 144 of the 224 journal entries, the first asking if failure to complete the task would have been a problem, the other asking for speculation about what would have happened if they'd failed to complete the task. Users associated negative or dire consequences with failure to complete their task for 95.2% of the vigilant sessions captured, shown in Figure 3b. This high correlation validates that the usage sessions were vigilant.

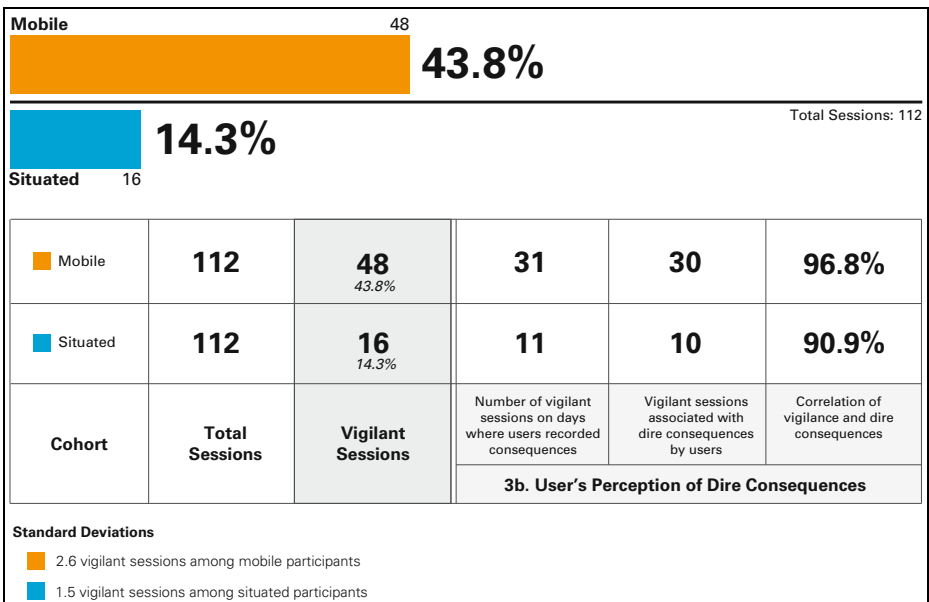


Fig. 3. Percentage of Sessions That Were Vigilant

Mobile users had a higher standard deviation of 2.6 vigilant sessions per user compared to 1.5 for the situated users, indicating greater variance in the vigilance of mobile users. One possible explanation is that mobile devices are a newer technology than laptops and PCs, and thus there may be more experimentation among mobile users. Secondly, because mobile devices are carried upon the person, they support a greater diversity of usage scenarios, whereas situated usage was more often correlated with planned work. Thirdly, there may simply be more variation among mobile users in the perceived importance of monitoring the device.

Mobile users reported that they felt the need to be watchful over their device on 78% of the days observed, while situated users felt the same need on 44% of the days observed. (See Figure 4) Watchfulness was established by directly asking users whether they felt the need to be watchful or not, each day. Measuring watchfulness was useful a number of ways. First, to account for unobserved usage sessions that may have been vigilant. Because each daily journal asked users only to describe their most

recent, or most notable session of use on a particular day, it captured only a subset of all sessions that the user actually conducted each day. Self-reported watchfulness was much more commonly observed than vigilance was: the ratio of watchfulness to vigilance was 78:43.8 (57%) for mobile users and 44:14.3 (32.5%) for situated users. This may suggest that a significant number of vigilant sessions occurred outside of the sessions described in the journal entries. Secondly, self-described watchfulness was used as a measure of quality control of the vigilance criteria: vigilant sessions should always correlate to days where the user described a need to be watchful. This was found to be the case: across both mobile and situated user groups, it was observed that 95.5% of the sessions that were found to be vigilant occurred on days where the user described a need to be watchful over his or her device.

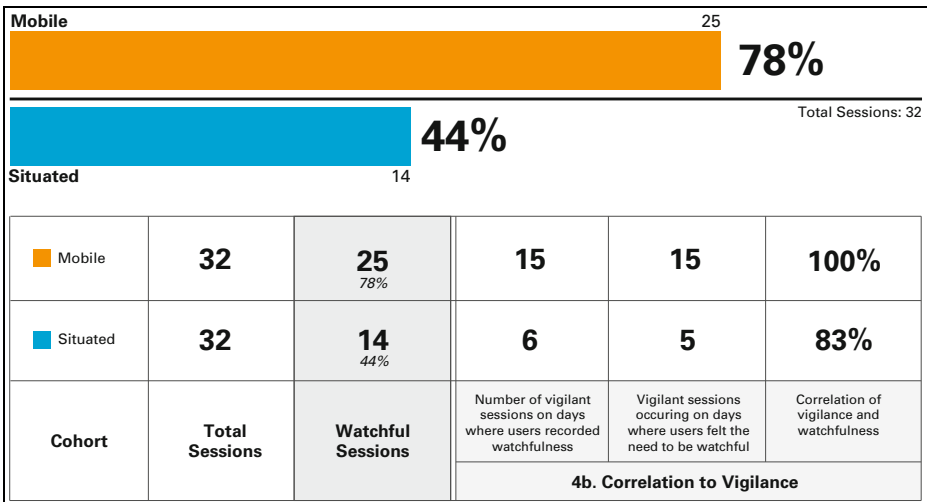


Fig. 4. Percentage of Days Where Users Felt the Need to be Watchful

6 Discussion

While more work must be done to substantiate these findings, the analyses suggest that vigilance scenarios are prevalent in everyday consumer interactions. But how effectively is vigilant use being supported by today’s consumer experiences? Users who are trying to balance device watchfulness with their physical experiences need to spend as little time interacting with the device as possible [10]. We must design for *disengagement*, and make it easy for them to put the device down. Successful designs will enable users to easily watch for signals that need their attention, quickly and efficiently enact a response, and return back to the real world with minimal interruption:

6.1 Vigilance Design Principles

- **Vigilance First.** Vigilance compelled the user to start their task, and as such, the initial interface should be optimized for vigilant use. Users should be presented

with only enough information to know if they need to take further action or not. All actions should be enabled via efficient, optimized paths within the application flow. The interface should eliminate or deemphasize all distractors (unrelated content, secondary actions, advertisements.)

- **Encourage Disengagement.** Alerts should be minimized and vigilance should be supported via the shortest possible session of use. When the vigilant task is completed, the session should terminate. Shorter sessions create less interruption and distraction from the real world experiences that the user is balancing.
- **Make Habituation Easy.** Interactions should be standardized and not novel. Users should be able to easily form habitual usage patterns that require less cognitive focus to process and perform. This also means that users may be more resistant to changes in the interface design if habituated usage patterns are disrupted.

6.2 Challenges Lay Ahead

The clear challenge with these principles is that by reducing engagement, they likely compete with the business goals and Key Performance Indicators of the company that is designing the software. Most consumer applications are designed in an effort to deepen user engagement. Vigilance requires a paradigm shift. Designers have been taught to value the attributes of an engaging user experience - immersion, focused attention, and lengthy sessions of use – often above all others. This is because a user's attention is of considerable value to most organizations that build web products. For one, the user's session can be monetized with advertisements that interrupt views or are displayed alongside content, and the more time the user spends within the product, the more opportunities there are to show him ads. Many such organizations track the length of sessions of use or the number of typical interactions that they see from users, in order to raise the amount of money they can charge for ad impressions. A site with engaged users can charge much more than a site with disengaged users.

Another challenge is that vigilance is likely not the only scenario that everyday consumer products must support. Vigilance emerges only after the software or service is used enough that the user begins to feel the need to be watchful. Outside of any moment of vigilance, the user may be more casual and exploratory, even immersed or deeply engaged. Consumer products most support both extremes.

Users also need to completely disengage at times when they expressly do not wish to be vigilant. As demonstrated by the participant who deactivated her social network in order to study for her test, suppression is a critical form of control. This may involve a different mode in the interface, or settings that suppress alerts or notifications.

7 Conclusion

This study had several limitations requiring additional research in order to validate the findings. With a small population size of 16 participants, the results are not statistically reliable. A similar study should be performed with an increased population size, increasing the total number of journal entries for analysis. With a larger population, distinct cohorts could also be defined, enabling analysis of vigilance behavior based

upon age range or other demographic criteria. Another key limitation of this work was that it relied upon self-reporting rather than instrumentation or direct observation. This reduces the quality of the data by introducing the possibility of subjectivity, biases, and errors on the part of the participant. While interviews and self-reporting will likely be useful methods for future work, other research methods like instrumented environments for observational research, instrumentation of user devices, and instrumentation of software and services would be useful quantitative methods that would help hybridize the general methodology and validate the findings. More work is needed to fully define principles that can be effectively utilized during the design process, in order to better support vigilant user scenarios. The discussed design principles should be further defined and their effectiveness evaluated. Towards this end, user studies could be used for specific interfaces, evaluating how effectively vigilance scenarios are supported through workflows or tasks presented to users.

This study suggests that vigilance is an important and common usage motivator for everyday consumers, and also that mobile devices have increased the prevalence of vigilant use. This research further supports the observation that everyday users might be quite vigilant in their device usage. Vigilance in HCI is not limited to specific situated tasks performed by trained professionals or operators; rather, vigilant use applies to a broad spectrum of tasks performed by consumers. In short, it is more important to support vigilance in a world full of mobile users. This has profound implications for software, because optimizing the interaction design of a software product to better support vigilant usage requires a different, and at times opposing, set of considerations than traditional consumer product design does.

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