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Assistive Technology Abandonment: Research Realities and Potentials

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Abstract. Abandonment of assistive technologies (ATs) is a serious problem – rates of abandonment can be high, 78% has been reported for hearing aids. The paper argues for the importance of studying the abandonment of ATs by collecting real-time data about the use and non-use of ATs in the lived experience of their users. In the AART-BC Project, we are studying the use and abandonment of mobility ATs including wheelchairs, walkers and prostheses. We present two apps, ESMMobilityAT and ProbMobilityAT to facilitate the collection of real-time data about mobility AT use and problems encountered with these ATs. ESMMobilityAT is based on the experience sampling method (ESM) and asks mobility AT users to answer a short questionnaire about their AT use seven times a day. ProbMobilityAT allows mobility AT users to report problems with their AT when they occur. The apps have been successfully piloted on Android and IOS smartphones, although a number of problems with deployment have been highlighted. They will now be used in a field study with mobility AT uses and can be adapted for other AT domains.

Keywords: Assistive technology abandonment, mobility assistive technology, experience sampling method (ESM), apps for measuring assistive technology use, ESMMobilityAT app, ProbMobilityAT app.

1 Introduction

Although assistive technology (AT) can have a profound positive impact on the daily life of people with disabilities, many initially adopted devices and systems are unfortunately abandoned. An estimated 13 million AT devices are used in North America alone [7] and there are more than eleven million people with disabilities in the United Kingdom, many of whom depend on AT [22]. Studies have reported abandonment rates of up to 78% for hearing aids [10, 16]. Causes for abandonment have many dimensions [10, 14]. For example, AT abandonment may start with the improper fit of a device to a user and to the tasks the user wishes to undertake [17]. If the AT is something that needs to be worn (e.g. a hearing aid), sat in (e.g. a wheelchair) or held (e.g. a joystick to control a computer) and does not physically fit the user's body or is not comfortable for long-term use, it may well be abandoned even though it meets the particular user's needs. If the AT does not enable the performance of the tasks, or all the tasks, that the user wants to do and cannot (easily) do without an AT, there is also a likelihood of abandonment.

Studies of causes of abandonment have noted that changes in the needs of users are an important predictor for abandonment [11, 13]. Such changes can be permanent (e.g. a progressively worsening sight condition, such as macular degeneration), temporary (e.g. an increased tremor in Parkinson's disease which can be addressed with altered medication) or fluctuating (e.g. increased problems with spelling by people with dyslexia when tired or stressed). Such changes might be accommodated by technology that is easier to adjust to the changing needs of the user or their situation. Difficulties in configuring and modifying the settings of an AT will often lead to abandonment [6]. Compounding the problems of abandonment is the fact that this AT is often needed rather than wanted. AT is not about more easily and effectively doing a task; it is often about doing or not doing the task at all. There is also a positive type of abandonment, which is not using a device or system because the need for it no longer exists or because a better device has become available. For example, blind people have used dedicated devices for detecting the colour of objects for some time (e.g. the Colorino [15], or the Cobolt Talking Colour Detector [1], these were particularly useful for knowing what colour clothes one might wear. But these dedicated devices have now been replaced by apps for a smartphone (e.g. ColorID [5] or aidColors [2] for iPhones, Color Grab for Android phones [9]. This "good" type of abandonment of AT is interesting, but not in the scope of the current paper.

1.1 Scope of problem and existing research

Critical to the successful introduction and adoption of AT is initially choosing the correct device or system [12]. This is a complex and multidimensional process, requiring both knowledge of available systems and knowledge of the wishes, needs and abilities of the intended user. There are numerous frameworks to aid AT professionals in making this selection [17, 19]. However, in many cases, validation of the correct choice consists merely of the absence of abandonment. And, if abandonment does occur, only a narrative record of the process of abandonment is typically documented, sometimes long after the actual event.

A study by Phillips and Zhao reported that a "change in needs of the user" showed the strongest association with abandonment [11]. Thus, those ATs that cannot accommodate the changing requirements of users were most likely to be abandoned. It follows (and is confirmed by interviews with several AT experts: Bodine, 2003; Kintsch, 2002) that an obstacle to AT retention is difficulty in reconfiguring the device. A survey of abandonment causes by Galvin and Donnell [3] lists "changes in consumer functional abilities or activities" as a critical component of AT abandonment. A study by Scherer and Galvin [18] states that one of the major causes for AT mismatch (and consequently abandonment) is the myth that "a user's assistive technology requirements need to be assessed just once". On-going re-assessment and adjustment to changing needs is the appropriate response. A source for research on the other dimensions of AT abandonment, and the development of outcome metrics to evaluate adoption success is the ATOMS project at the University of Milwaukee in the USA [12].

The mark of success in the selection and use of AT, and in particular AT for mobility, is the long-term adoption of the technology for day-to-day use. To understand the process of successful adoption, it is also necessary to study the process of abandonment [4]. To understand both use and abandonment of ATs, including mobility ATs, requires an approach [23] that goes beyond retrospective data collection such as surveys and interviews. We believe that gathering real-time data about AT use and problems with the use of AT, over reasonably long periods of time (e.g. weeks or months) will allow us to develop a far deeper understanding of people's lived experience with their ATs, and what factors lead to successful adoption or abandonment. This understanding can then lead to the development of guidelines to support the design and selection of ATs.

2 Studying AT use and abandonment: The Combined Sensor and Experience Sample Method (ESM) Approach in the AART-BC Project

The Adaptive Assistive Rehabilitative Technology – Beyond the Clinic (AART-BC) Project is investigating how to provide health professionals such as occupational therapists and physiotherapists with better information about their patients' use of mobility ATs such as wheelchairs, walkers, and lower limb prostheses. There is currently little data about what AT users do with their mobility aids in their day-to-day lives ("beyond the clinic" where they can be observed by their therapists). Without this information, it is difficult to understand lived experience with ATs, their use and abandonment. This research involves collecting two types of real-time data from mobility AT users: sensor data which objectively tracks their use of the mobility AT, and data about the perceptions of their mobility AT, their mood, fatigue and any problems they are having with the mobility AT. In this paper we will concentrate on the second type of data and how it can be collected.

In the AART-BC project we are exploring the use of the Experience Sampling Method (ESM) developed by Csikszentmihalyi [8] as a way of gathering immediate information about people's lived experience with their mobility AT. This method sends a very short questionnaire to participants at seven pseudo-random times during the day to collect information about their current mobility AT use. In Csikszentmihalyi's original work he used pagers to alert participants to the need to complete a paper questionnaire, now we use an app (ESMMobilityAT) deployed on smartphones to both alert participants and deliver the questionnaire. Participants can answer the questions very quickly via their phone. Each questionnaire should take no more than two minutes to answer. The questions are always the same, so participants become familiar with them, and include mainly multiple choice and Likert item responses to make answering quick and easy (Fig. 1 shows the smartphone questionnaire screens for these two types of questions).

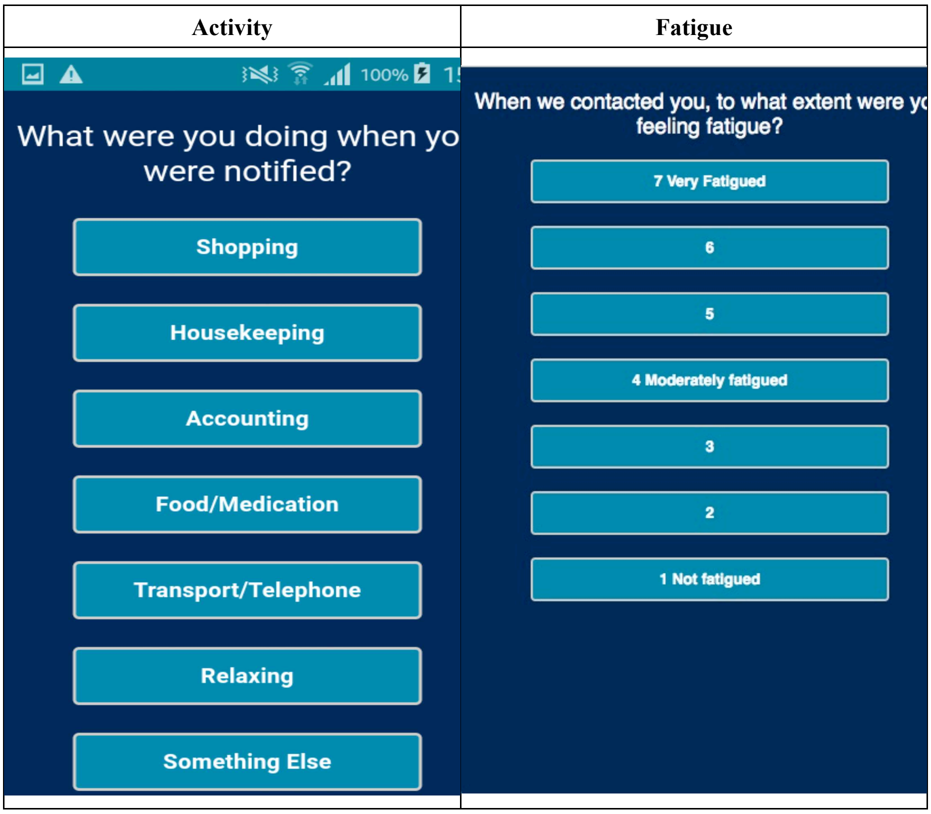

Fig 1. Questionnaire screens for mobility AT users from the ESMMobilityAT app.

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Participants can select what time in the morning requests to answer the questionnaire start and what time in the evening they should finish, to suit their personal schedules. Requests should be no less than one hour apart, but are sent at random

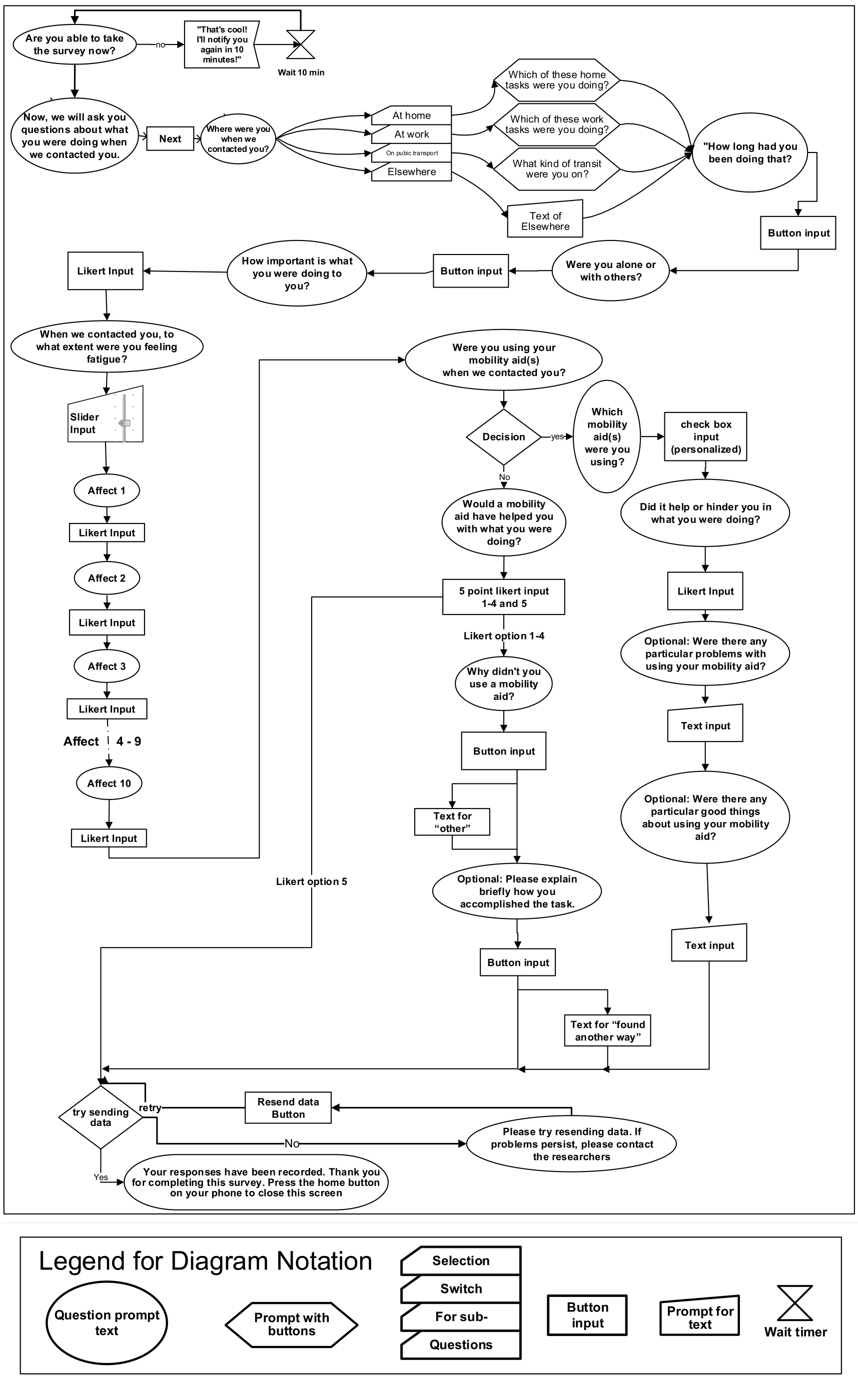

Fig. 2. Questions and logic of the AART-BC ESM questionnaire for studying mobility ATs.

times within those constraints, so that participants cannot predict exactly when they will arrive. Questions ask about what the participant was doing immediately before the request arrived, whether they were using their mobility AT, whether they were having any problems with it, and if so what they were. In addition, participants are given the PANAS-SF [21], a validated short form of the PANAS scale [24] which measures positive and negative affect, what would commonly be called "mood". Finally, after consultation with occupational therapists and physiotherapists, a question about how fatigued the participant felt was added. The full set of questions and logic of the questionnaire is illustrated in Fig. 2 (apart from the PANAS-SF questions, which are given in Table 1). The questionnaire has been implemented as an app using the framework developed by Thai and Page-Gould [20]. Deployment of the applications is relatively straightforward, via an APK package for Android devices, or an IPA package for iOS devices. It is worth noting that deployment on to iOS devices requires an Enterprise developer licence that involves a paid subscription, but allows the installation of apps without using the Apple store. Apple devices also require "over the air' (OTA) installation from a custom or third party website (e.g. diawi.com) that supports IPA installations. Android deployment requires no special considerations, and the APK package can be downloaded directly or sent to the target device via email for installation.

Positive affect	Negative affect
Active	Afraid
Alert	Ashamed
Attentive	Hostile
Determined	Nervous
Inspired	Upset

Table 1. PANAS-SF questions to measure positive and negative affect.

We have also developed a second app, ProbMobilityAT, which allows participants to report any problems them are having with their mobility AT, when it occurs. This will allow for the collection of much more detailed information about problems which occur with mobility ATs. The questions used by the ProbMobilityAT app are very similar to those in ESMMobility to collect the context of the problem, but the main emphasis is on a free text description of the problem that the participant supplied (see Fig. 3).

We have extensively piloted these two apps, in a range of realistic situations of use, on a range of different IOS and Android smartphones. It emerges that there are numerous problems in deploying such apps, particularly to Android smartphones. For example, if the app is suspended when the phone is in power-saving mode, the pseudo-random notifications will not be received, or will be received later than expected. Similar problems can be found on smartphone that have battery-extending applications installed, as they can aggressively manage the running of background applications. The process of delivering notifications can become even more problematic when moving between different versions of the Android OS, as there are functional differences in the way that file paths are referenced that can cause an app to crash when it tries to access a resource file such as a custom notification sound. Many of the problems encountered are related to the diverse range of operating system versions now available on smartphone, the number of third-party plugins required to make apps function as expected, and the fact that operating systems may be updated by the user at any time. When operating systems or development tools are upgraded it can take some time for related plugins to be updated by their respective developers. Thus, at the moment, it may not be possible to deploy the app to all smartphones without considerable extra effort. However, in initial use of the apps, users have found the questionnaires easy to understand and quick to answer.

Fig. 3. Problem reporting screen in the ProbMobilityAT app.

3 Discussion

One goal of the AART-BC Project is to develop an understanding of the lived experience of mobility AT users, to further our understanding of their use and abandonment of their ATs. A further goal is to provide better information to clinicians such as occupational therapists and physiotherapists about their patients' use of their mobility ATs in their daily lives "beyond the clinic", to enable them to support their patients more effectively. But the problems of AT use and abandonment are multifaceted and complex. To address these problems both real-time and retrospective data are required. To facilitate the collection of real-time data, we have now developed two apps, ESMMobilityAT and ProbMobilityAT. The first prompts mobility AT users to answer a short questionnaire about their current activities, mobility AT use, any problems with the AT, their mood and fatigue. This questionnaire is delivered seven times a day, to sample across their lived experiences. The second app allows them to report problems with their mobility AT when they occur, meaning that immediate detail about the problems will be recorded.

Deployment of the apps has not been as simple as we anticipated and much attention needs to be paid to how different versions of the Android and IOS operating systems handle a range of issues. Initial reaction from users on the other hand has been very positive, with the questionnaires easy to understand and quick to answer. The smartphone deployed ESM method is not too intrusive for users who have found the whole experience interesting. We are now ready to use the apps in an extensive field study with mobility AT users. We are also planning to extend this approach to the other AT domains such as the use of hearing aids.

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