Obtaining Experiential Data on Assistive Technology Device Abandonment

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Abstract. There have been few studies of abandonment of Assistive Technology, typically based on surveys and best practices expertise. This paper describes the application of classic experience sampling techniques to gather timely information about mobility aiding assistive technology in day-to-day use especially with respect to causes of abandonment. The paper describes the technical understructure of the system, which uses smartphones to gather, and web services to store, data. Also described is the setup and branching of the question set presented on the smartphone. Beyond details of use of the assistive technology, the system collects a verified scale of responses to determine the emotional affect of the participant. Sampling is taken several times during the day by actively pushing a set of questions that are tailored to the users technology and responses. There is also provision for the participant to push the information to the system when desired.

Keywords: Assistive technology · Abandonment · Mobility aids · Experience sampling

1 Introduction

While assistive technology (AT) can have a profound positive impact on the daily life of persons with disabilities, many initially adopted devices and systems are unfortunately abandoned. An estimated 13 million AT devices are used in North America alone [1] and more than eleven million people with an impairment in the United Kingdom, many of whom depend on AT [2]. Studies have reported abandonment rates that range from 8% for life saving devices to 78% for hearing aids [3–6]. Difficulties in configuring and modifying configurations in AT often lead to abandonment[1] [7]. Causes for abandonment have many dimensions [4, 8]. Drivers of AT abandonment start with improper fit of device to the user and to the user's intended tasks [9]. If the AT does not physically fit the user's body or does not enable the performance of tasks that the user wants to do and cannot without an AT, there is little hope of successful adoption. Studies of causes of abandonment have noted that changes in the needs of the user are a good predictor for

[1] There is another kind of abandonment, which is not using the system or device because the need no longer exists. This "good" abandonment of AT is not in the purview of the current study.

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abandonment [10, 11]; such changes might be accommodated by technology that is easier to re-configure to the new needs of the user or situation.

ATs can be divided into three categories: (1) those that work out of the box such as adapted door knobs or pencil grips; (2) those that need initial configuration with possibly minor adjustment over time (i.e. wheelchairs, adapted mice and keyboards for the computer); and (3) those that need initial configuration and subsequent re-configuration (i.e. Augmentative and Alternative Communication (AAC) devices and computationally based prompters). This paper addresses adoption and abandonment of the second type of AT and from this, implications for the other two types.

2 Assistive Technology: Adoption and Abandonment

Critical to the successful introduction and adoption of AT to a user is choosing the correct device or system [12]. This is a complex and multidimensional task requiring both formal knowledge of available systems and personal knowledge of the intended user. There are numerous frameworks to aid the AT professional in making this selection [9, 13], however, in many cases, validation of the correct choice consists merely of the absence of abandonment, and 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 [10]. Thus, those ATs that cannot accommodate the changing requirements of users were most likely to be abandoned. It then follows logically (and is confirmed by interviews with several AT experts [14, 15]) that an obstacle to AT retention is difficulty in reconfiguring the device. A survey of abandonment causes lists “changes in consumer functional abilities or activities” as a critical component of AT abandonment [16]. A study by Galvin and Scherer states that one of the major causes for AT mismatch (and thus abandonment) is the myth that “a user’s assistive technology requirements need to be assessed just once” [17]; 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 evaluated adoption success is the ATOMS project at the University of Milwaukee, in the USA [12].

3 Understanding the Use of Assistive Technology for Mobility

In the United Kingdom, mobility issues affect 6% of 16–44 year olds and up to 55% of 75+ year olds; upper limb functional limitations are also highly prevalent in, for example, populations with stroke or Rheumatoid Arthritis [18]. Thus, a large proportion of the population will require AT and/or rehabilitation programmes (RP) at some time during their life-course. Prescriptions for AT vary from a simple orthosis or walking stick to expensive and complex high-end wheelchairs for active spinal injury patients. Prescriptions for RP, following a stroke or traumatic brain injury, may include regular stretching, or functional task practice. Surprisingly, considering the high resource implications, technology is not widely in use to understand in real-time detail how AT is being used in users' daily lives and how they adhere to their RP. There are very few studies comparing self-reported use of AT with objective measures of use, but in other domains it is well established that self-reporting is subject to significant bias and recall errors [19] and therefore from self-report we cannot know accurately how ATs are being used and what problems users encounter. Further, despite the well-established benefits of rehabilitation therapy, we know little about adherence to RP regimes, which is also assessed by self-reporting [20]. As was pointed out by Hoffmann et al. [21], there is an urgent need for more accurate monitoring of medical interventions and processes; as without knowing what people actually do, it is difficult to understand the effectiveness of any intervention.

4 Beyond Surveys: Experience Sampling

The mark of success in the selection and use of AT, and in particular AT for mobility, is the long-term adoption of the system for day-to-day use. To understand the process of adoption, it is also necessary to study the process of abandonment [22].

This requires an approach [23] that goes beyond only retrospective surveys, even beyond open-ended interviews. We believe that by gathering real-time AT performance data combined with experience sampling [24, 25] over long periods of time (e.g. weeks or months) meaningful conclusions can be drawn and the creation of design and selection guidelines can be developed.

There is currently little experiential data of what the AT user does outside the clinic with their mobility aid, and a dearth of data about how the user interacts with their AT on a daily basis. Without this information it is difficult to truly understand the lived experience with ATs.

In his theory of optimal flow Csikszentmihalyi and Larson [26] developed the experience sampling method (ESM). There are three types of ESM:

- Timing-based – a request for information is sent to the participant, at a number of random times during the day (but within an agreed time span, for example between 8am and 10pm)
- Event-based – participant records information when a specific event happens, this may be "pull" (generated by the system, e.g. the system realizes the participant has left their residence) or "push" (initiated by the participant, e.g. when they encounter a problem with their AT)
- Interval-based – participant records data in pre-set intervals, agreed with the participant (e.g. every hour or after every trip outside their residence)

The data collected may be psychological (e.g. mood, stress level) or about actions (e.g. attempting to enter a bus when using a wheelchair) or context (e.g. rain is making the surface too slippery for my walker). The ESM has been widely used to study many aspects of life, and there is a sound body of work existing to base extensions [24].

In the case of AART-BC this work both event contingent and signal contingent approaches are used, polling the user for actions and mental state as well as allowing the user to initiate data collection. Initial work has been taken to support the expansion of the system to sensor (on the user and mobility aid) driven push event contingent modes.

5 Using the Experience Sampling Method with Users of Mobility Aids

As part of the AART-BC Project[2] we are developing an app to collect ESM data with users of mobility aids, using both timing-based and event-based types of data collection. A smartphone application has been developed which will also integrate with data which can be collected from sensors on the mobility aid to provide detailed objective data about the use of the aid. We believe that this is the first use of experience sampling to study AT use and abandonment.

5.1 Conceptual Design of the ESM App

There were two parts to the design, (1) adapting an existing ESM smartphone system for mobility aid user in both timing-based and event-based modes and (2) developing appropriate questions to support data about AT use and problems.

Set-up: When the user receives the app, they do an initial setup with the help of a researcher. They will enter an ID (to ensure anonymity), and make a selection of the mobility aids that they are currently using from a list provided (see Fig. 1). They will

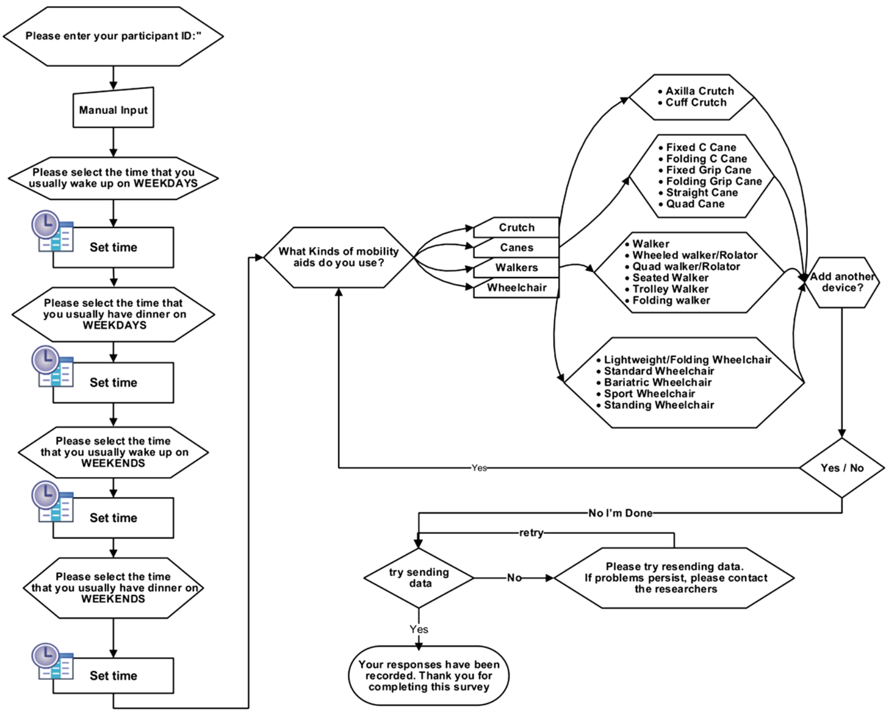

Fig. 1. Workflow of set up of ESM app

[2] http://www.aartbc.org/.

also enter the earliest time of the day that they wish to receive a request for information and the latest time of day they wish to receive a request (Fig. 2). The times of day will be used when the system generates random times to ask the user about their activities and use of mobility aids.

ESM questionnaire: at seven scattered times during the period during the day when the user has stated they are open to receiving a request for information, the ESM system generates a short questionnaire and the app asks the user whether they are available to answer it. The user has the possibility to decline the request, and the system will ask again in 10 min time. If the request is declined a second time, the data collection point is abandoned, and the system waits for the next randomly generated time.

When the user accepts the request, three short sets of questions are asked. With a little practice, the aim is that the questions should take no more than two minutes to answer. The first set of questions addresses the activities and context of the user immediately prior to the request for information. Questions include: Where were you?, what were you doing?, and how important was what you were doing when you were contacted?

The second set of questions addresses the use of any mobility aids. If the user responds that they were using an aid, they are asked if the aid was helpful in what they were trying to achieve, and any good or bad aspects in using the aid. If they were not using a mobility aid, they are asked whether an aid would have been helpful, why they did not use one and how they achieve their goal.

The third set of questions assesses the user's mood, they are asked to complete a short form of the PANAS Scale of mood [27] the PANAS-10 [28] to classify mood.

Problem notification option: at any time, if the participant encounters a problem or a good experience with their mobility aid that they wish to report, a set of questions similar to the first and second sets described above appear for the participant to complete.

5.2 Implementation

The experience sampling application is based on the open-source smartphone library (http://www.experiencesampler.com/), which can be used with both Android and iOS devices as well as being displayed in a browser. The library facilitates both time-based and push-event methods of request.

The questionnaire can branch or skip questions depending on the responses provided by the participant as they are completing the ESM questionnaire (see Sect. 5). For example, questions relating to the effectiveness of a particular mobility aid will not be asked if the participant indicates that they have not used a mobility aid. Skipping these questions reduces the time that the participant needs to complete the questions. This type of question branching can also be triggered by events detected by the phone. This might mean detecting that a participant has not left their home for a long period of time, or that the ambient light level is below a certain threshold.

Figures 3 and 4 illustrate and the flow diagram (Fig. 6) showing the sequence and branching of the questions presented to the participants.

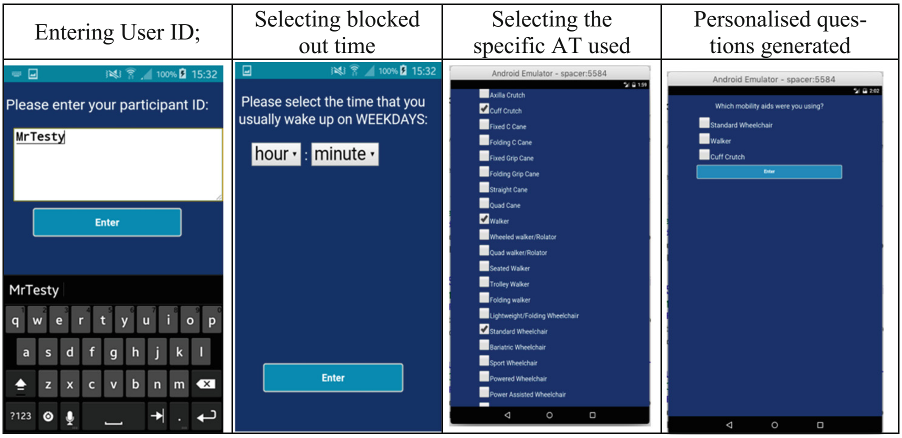

Fig. 2. Set-up of the AART-BC ESM app

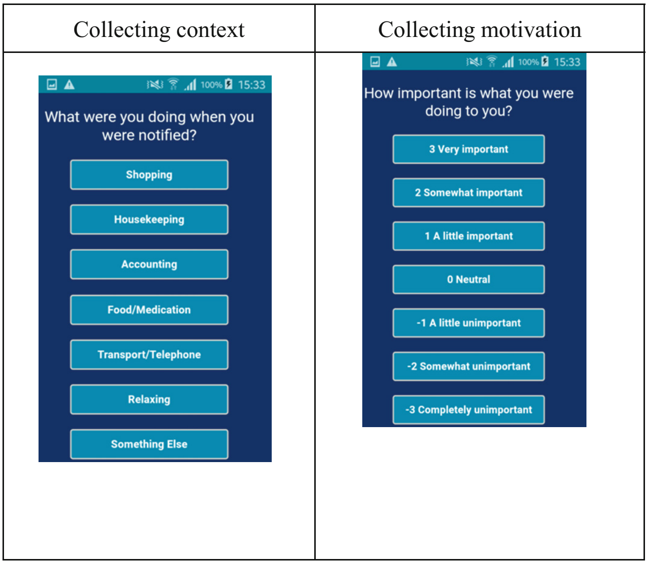

Fig. 3. Collecting context and motivation

5.3 System Outputs

At the end of each scheduled questionnaire, information is sent to a server for processing and storage (see Fig. 5 right). However, it is also possible for participants to send information at any time. This may occur because the participant is having a problem and wants to highlight the event for a future visit to a clinician, or it may be for a more positive reason, such as showing that they have completed a specific task or found their device to be particularly useful.

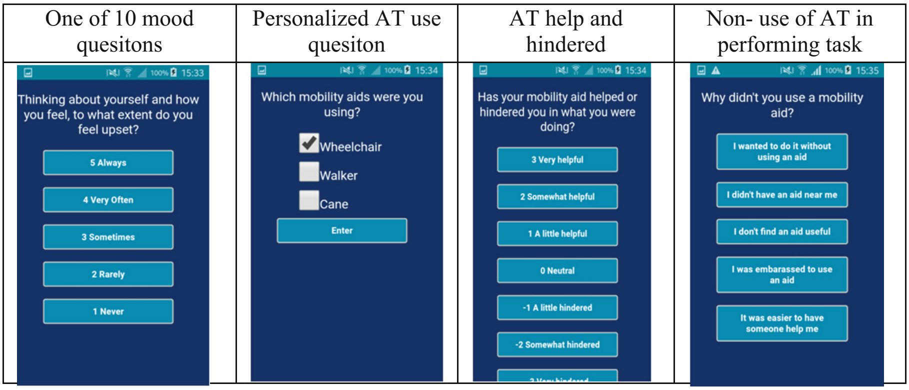

Fig. 4. Mood and AT use questions (left); mobility aid questions (right)

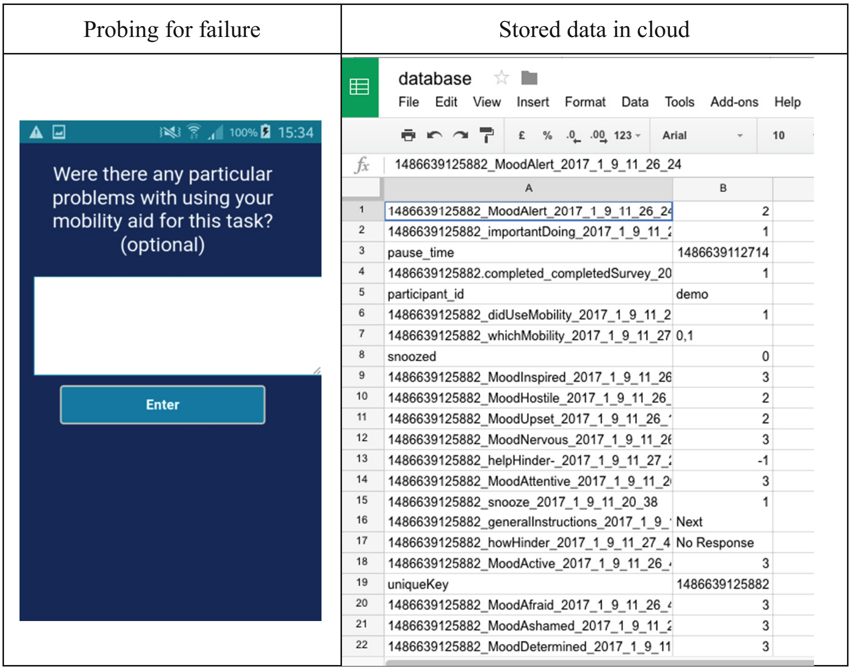

Fig. 5. Probing for failure and data in cloud

The data collected by the app can be summarized and presented to clinicians during a scheduled appointment, and can be correlated with other external sensors in the participant's home. In an ideal configuration, the ESM application can use the output from external sensors to trigger a questionnaire, and tailor the questions appropriately. While this is an attractive prospect, consideration must be given to the additional power that this type of constant polling requires.

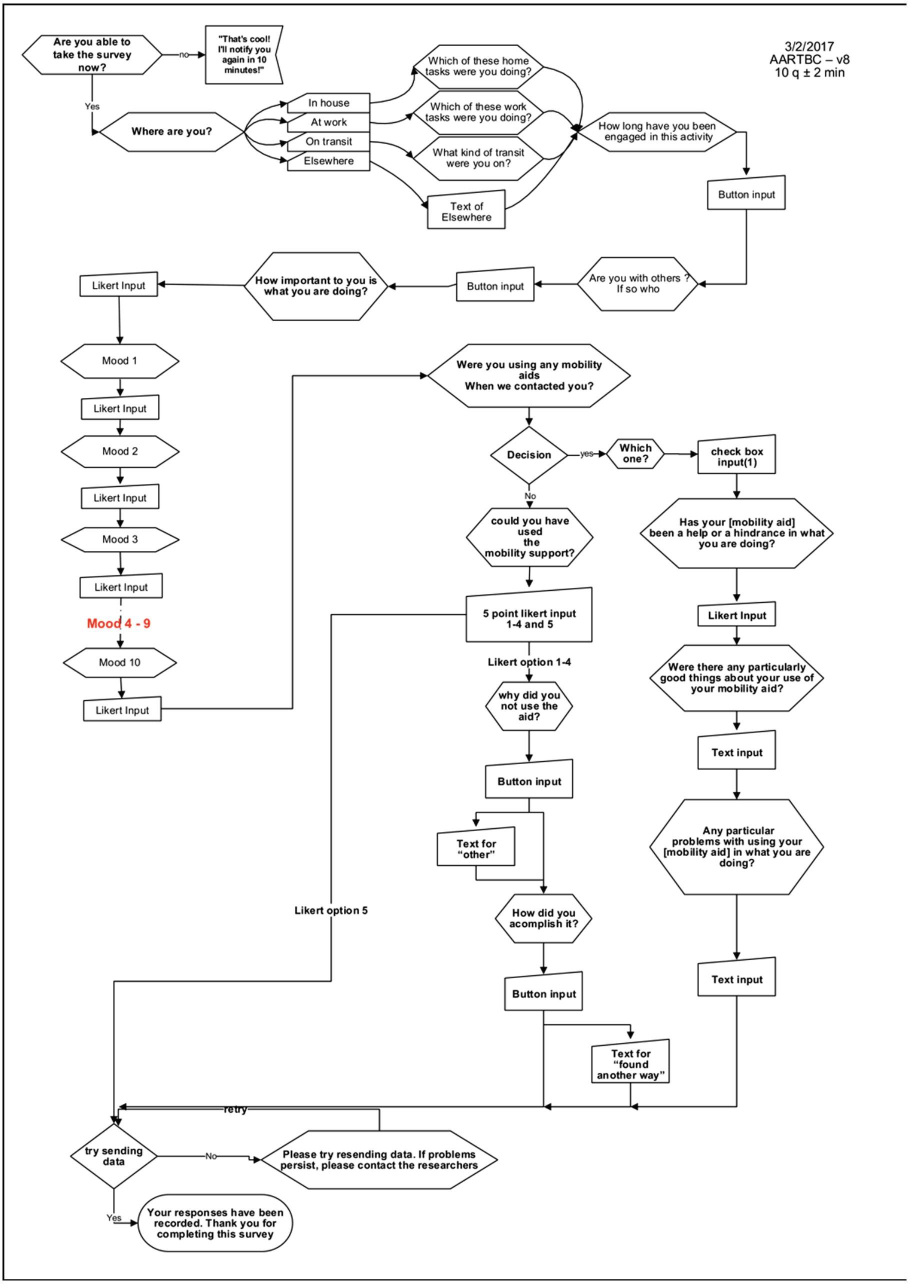

Fig. 6. AART-BC ESM question flow

6 Next Steps for the AART-BC ESM App

The AART-BC ESM app has been implemented for the Android platform and will now be implemented for the iOS platform. It has been subjected to extensive stress testing and has been shown to be extremely robust. The next step is to use it in the field. A study with users of a range of mobility aids, including wheelchairs, walkers and prosthetic limbs will be asked to use the app for a period of a month, to collect in-depth data about their use of their aids, their problems and challenges and their successes with their mobility aids. This data will provide a rich source of information about the use of mobility aids in the daily lives of people with physical disabilities and insights into their lived experience. This information will help understand the high rates of AT abandonment in this area. The ESM app could also be easily adapted to study other types of AT use, particularly those with high abandonment rates.

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