

Facilitating day-to-day life management of older people with Alzheimer's disease: A revelatory single-case study on the acceptability of the AMELIS interactive calendar

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Background Technologies such as smartphones and tablets can help people with Alzheimer's disease (AD) overcome their daily challenges. **Objective** The AMELIS interactive calendar, specifically designed to facilitate daily management, is a technology whose acceptability must be further documented for this clientele and their caregivers. A qualitative, descriptive single-case study was therefore conducted with an older woman with mild AD and her caregiver to document the acceptability of AMELIS. **Methods** Ten learning sessions were performed using Sohlberg and Mateer's method (1989), errorless learning and multi-layer approach. Data collection comprised pre- and post-intervention interviews with the participant and her caregiver, logbooks and experimenter's summaries. A thematic analysis was conducted and Technology Acceptance Model (TAM) was used to structure the presentation of the results. **Results** This study revealed that the acceptability of AMELIS was favorable, mainly because the tool was reported as useful by the participant and her caregiver. The large touchscreen and the personalized learning method also influenced their attitude towards the use of the tool. **Conclusion** Thus, AMELIS is an innovative technology that has the potential to be accepted by older people with AD and their families. Features of this technology and learning strategies used in this case study may help clinicians, designers and researchers introduce assistive technologies to this clientele.

Keywords: Alzheimer's disease, older people, technology, calendar, acceptability

INTRODUCTION

Alzheimer's disease (AD) is a neurodegenerative disease characterized by progressive impairment of cognitive function (Ergis & Eusop-Roussel, 2008; Alzheimer Society of Canada, 2018). Episodic memory, a cognitive function which supports remembering of past events and plays an important role in prospective memory, is particularly affected in the early stages of AD (Ergis & Eusop-Roussel, 2008). Prospective memory makes it possible to remember intentions, i.e. actions to be performed in the future (e.g. remembering to take bedtime medication; Ergis & Eusop-Roussel, 2008; Smith, Della Sala, Logie, & Maylor, 2000). In addition, temporal orientation is also altered (Grewal, 1995). For example, ability to recall the day's date is quickly affected (Topo et al., 2007), in parallel with the evaluation time flow (El Haj & Kapogiannis, 2016). Thereby, these cognitive difficulties may have a significant impact on elders' autonomy (Topo et al., 2007) and increase the burden of their caregivers (Stillmunkés et al., 2015).

However, it is possible to compensate for these cognitive deficits by acquiring new skills. Indeed, procedural memory, which is responsible for memory encoding, storage and retrieval of procedures required for the performance of motor actions, is preserved in people with AD (van Halteren-van Tilborg, Scherder & Hulstijn, 2007). In other words, procedural memory makes it possible to perform tasks (e.g. morning routine) automatically. Cognitive interventions such as vanishing cues, spaced retrieval, and errorless learning are thus frequently used in people with AD because they take into consideration episodic memory impairment and use only procedural memory to encode new learning (Bier et al., 2008).

This remaining learning capacity can be used in clinical interventions to introduce tools that help older people with AD stay at home. A large variety of technologies has been developed for this purpose during the last years (Ienca et al., 2017; Lynn et al., 2017), ranging from security-focused surveillance systems (e.g. GPS) to tools supporting daily organization (e.g. touchscreen tools). However, the use of these technologies is currently limited (Wessels, Dijcks, Soede, Gelderblom & De Witte, 2003; Ienca et al., 2017), and the perception of their usefulness varies among caregivers, who either see technology as a factor decreasing or increasing their burden (Holthe, Jentoft, Arntzen & Thorsen, 2017). Poor technology use is partly due to a lack of acceptability by the person with AD (Lynn et al., 2017); the health professionals' reluctance to integrate technologies into care and their lack of awareness about assistive technologies available (Ienca et al., 2017); and an insufficient support for the person with AD and his caregivers by profession-

als during the implementation of the technology (Holthe et al., 2017). Thus, the main recommendations presented in the scientific literature concerning the use of technology among individuals with cognitive deficits include a personalized approach (Lynn et al., 2017; Ienca et al., 2017), commitment of caregivers (Lynn et al., 2017; Holthe et al., 2017), as well as training and support (i.e. providing information, instructions, encouragement, using learning methods, etc.) for the person with AD and his caregivers (Holthe et al., 2017; Imbeault, Langlois, Bocti, Gagnon & Bier, 2016; Imbeault, Gagnon et al., 2016; Imbeault et al., 2014). Assistive technologies must also be simple and readily acceptable (Holthe et al., 2017).

A key concept for the successful deployment of an assistive technology is acceptance (Chaurasia et al., 2016). Acceptance is defined as "the perception that a given treatment, service, practice, or innovation is agreeable, palatable, or satisfactory" (Proctor et al., 2011). Acceptance is influenced by many factors and plays an important role in the process of technology integration into everyday life (Renaud & Van Biljon, 2008). The Technology Acceptance Model (TAM) of Davis, Bagozzi & Warshaw (1989) can be used to document the acceptance of a new technology, through measures taken after the person has used the technology for a short period of time. The concepts of the TAM include:

- External variables: They contextualize the use of technology and include various factors (e.g. sociodemographic data, training, user support from caregivers or professionals, etc.) that influence the perceived ease of use and usefulness (Davis et al., 1989; Lee, Kozar & Larsen, 2003; Renaud & Van Biljon, 2008).
- Perceived ease of use: This concept corresponds to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989).
- Perceived usefulness: This concept is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989).
- Attitude toward use: This concept refers to the affect of a person associated with the use of a technology (Davis, 1986), including positive or negative feelings (Davis et al., 1989). In other words, it is a person's desire to use a technology (Malhotra & Galletta, 1999). The TAM assumes that the perceived ease of use and usefulness are the defining beliefs of a person's attitude toward technology (Davis et al., 1989).
- Behavioral intention to use: This concept corresponds to a person's intention to carry out behaviors he or she believes will impact positively on his or her affect and/or improve his or her daily performance (Davis et al., 1989).

AMELIS interactive calendar

- Actual use: This concept refers to the “actual direct usage” of a technology by the person in his or her context (Davis, 1986). Actual use is predicted by the behavioral intention to use a technology (Davis et al., 1989).

This study is a continuation of the research done by Adelise (2017), who designed AMELIS (Alzheimer MEmoire et Llens Sociaux, i.e. Alzheimer Memory and Social Links), an interactive calendar displayed on an 18.4” tablet that aims to empower people with AD. AMELIS was designed to compensate episodic memory disorders in AD; it indicates past, present, and future events. In addition, audible and visual reminders signal that an activity must be performed (e.g. taking medication, going to a physician’s appointment). AMELIS can also support temporal orientation by displaying the current date (Adelise, 2017). By designing a tool dedicated solely to the electronic calendar, AMELIS reflects the paper calendar as an object with the singular purpose of managing everyday life. Thus, AMELIS was designed to be as close as possible to the traditional calendar used by older people (Adelise, 2017). It is of a similar size, available anytime and can be moved to different places in the living environment. To facilitate the use of this technology by older people with AD, Adelise (2017) applied the concept of learnability (i.e. the ease of learning) to AMELIS. More specifically, Adelise (2017) presented a framework to design an assistive technology that involves the identification of facilitators that need to be included and barriers that should be eliminated to ease the learning process and use of this technology in people with AD.

However, acceptance by older people who used AMELIS was not addressed in the previous study. Thus, the objective of the present revelatory single-case study was to explore the acceptability of AMELIS interactive calendar with an older person with AD during eight weeks of learning and use.

METHODS

Description of AMELIS

The AMELIS calendar is based on the visual aspect of a paper calendar which is an artefact often used by older people at home. AMELIS used a familiarity-based design approach (Turner, 2006) in order to stay close to the previous experience of this population with the real world. As stated by Leonardi, Menecozzi, Not, Piansi, and Zancanaro (2008), a technology product “that embodies meanings and practices already known by older people and does not force them to “adapt” to new paradigms” is preferable. The home screen is divided into two sections (*Figure 1*). The left section includes a grid of the month. Icons may be present in the boxes, indicating that an activity is planned for that day. The right section includes an image that changes every month and can be customized by the user like a paper calendar. Date, time, and outside weather are displayed at the top of the screen. By pressing on a daily box, the user can consult the activities registered for that day. This information will be displayed on the right screen, instead of the image. To add new activities, a simplified interface helps to register the essential information: title, date, time, category of the activity and location. The user may use shortcuts to add his/



Figure 1. The AMELIS interactive calendar

her most common activities. The user can also modify or delete an already registered activity similarly to a paper calendar. The AMELIS calendar has a multi-layer interface design that supports gradual learning of features (Adelise, 2017). The multi-layer approach allows the user to learn how to use an application which starts with an interface reduced to a few features. Then, the user progresses at his/her own pace towards more complex interfaces (Shneiderman, 2003). The first layer of AMELIS presents information without any interaction between the user and the calendar. It allows the user to locate himself in time and to be informed of activities scheduled in AMELIS (Table 1). In the second layer, the user can interact with the touch calendar to view more detailed information related to the list of activities for a given day by pressing on icons, navigating between months, and validating activity reminder notifications (Table 1). Features in the third layer are more complex to master but they provide the user with greater autonomy for the management of his activities. These features include the addition, modification or deletion of activities (Table 1).

This study was conducted with an improved version of Adelise's AMELIS calendar (2017). First, the aesthetics and design of AMELIS have been improved with a more modern feeling and an appearance which is more similar to that of a real calendar. Another new feature is that every icon and graphic is customizable. Finally, the new application focuses on its calendar features and streamlines them in a simplified manner (e.g. few buttons and fewer steps to achieve goals).

Study design

A qualitative descriptive revelatory single-case study (Yin, 2014) was conducted to explore the acceptability of the AMELIS interactive calendar for an older person with mild AD. The design comprised an intervention that included the personalization and learning of AMELIS by the older adult, as well as an exploration of its acceptability. The single-case study design is suitable for studies that aim to explore in depth a contemporary phenomenon within its real-life context when the two are closely intertwined (Yin, 2014). According to Yin (2014), a revelatory case is a situation that was previously inaccessible to researchers. Given that this is a new version of AMELIS which has not been marketed and integrated into clinical practice, the research team had the opportunity to study the phenomenon of acceptability with a new technology, without the influence of opinions communicated by other users (blind). This design focuses on theoretical generalization to further inform future research and clinical use of AMELIS. Lessons learned from this case could also guide the design and

learning of similar technologies to support their acceptability. To enhance possibilities of generalisation, transparency will be achieved by a detailed description of the case, its context, data collection as well as the methods chosen (Crowe et al., 2011). According to Yin (1999), case studies should rely on an operational framework "to define what is to be studied as well as the topics or questions that might have to be covered". Thus, an existing theoretical framework, the TAM, was used to support the qualitative data analysis from this case study.

Selection of participant

The participant was recruited via a preexisting list of potential participants who had taken part in previous DOMUS laboratory projects (Domotique et informatique mobile à l'Université de Sherbrooke, i.e. Domotic and Mobile Computing of Sherbrooke University) and confirmed in the consent form their interest in participating in other projects. DOMUS is a research laboratory in the field of computing and home automation; its research team designed the AMELIS calendar. The following inclusion criteria were used: (1) to be over 60 years old; (2) to have been diagnosed with mild AD, according to NINCDS-ADRDA criteria and based on the results of the Modified Mini-Mental State Examination (3MS; Teng & Chui, 1987); (3) to use a paper calendar regularly at home as a daily organization strategy; (4) to live at home; and (5) to have a caregiver available to participate in the study. Exclusion criteria were: (1) pathology of the central nervous system other than AD (e.g. stroke, traumatic brain injury); (2) severe medical condition (e.g. renal failure); (3) psychiatric diagnosis (e.g. major depressive disorder, psychosis); or (4) sensory deficit (e.g. visual or hearing loss) that may interfere with learning and use of the AMELIS calendar. There were no inclusion or exclusion criteria for the caregiver.

This study has been approved by the Research Ethics Committee of the CIUSSS Estrie-CHUS. The written consent of the participant and her caregiver was obtained.

Intervention

Personalization

Prior to the beginning of the intervention, a personalization of AMELIS was carried out to facilitate the use of AMELIS. A semi-structured initial interview, based on the Canadian Occupational Performance Measure (COPM, Law et al., 2014), was conducted at home with the participant in the presence of the caregiver (daughter). The purpose of this interview was to document the participant's characteristics (e.g. diagnosis), environment (e.g. social network) and life habits (e.g. description of a typical day, medication sched-

Table 1. Teaching protocol for AMELIS features and multilayer approach

Layers	Features to master	Stages of Sohlberg & Mateer
1. No interaction features enabled	<p>The person must be able to:</p> <ul style="list-style-type: none"> Find the date of the day in written format (top) Find the date of the day in the grid (black box) Find the month consulted Find the weather Find the time Find the icon indicating an activity / Know that an activity is planned for a given day 	<p>Acquisition – Errorless method and vanishing cues</p> <p>Examples of questions:</p> <ul style="list-style-type: none"> Which day box indicates today's day? Where do we see the current month? Where do we see the weather? Where is the time indicated on the calendar? <p>Application – Role plays</p> <p>Examples:</p> <ul style="list-style-type: none"> What date are we today? When is the next time you have an activity? I don't have my watch; can you tell me what time it is? You would like to dress to go outside. How could you know the temperature without looking outside? <p>Adaptation – Real-life situations</p> <p>Examples:</p> <ul style="list-style-type: none"> Ask the daughter to call and ask her mother if she is available on Monday, July 16th at 11 am. When taking a break or before leaving, ask her: "How are you going to dress? Is it cold outside?" Look if she is referring to the calendar to answer.
2. Activation of agenda viewing	<p>The person must be able to:</p> <ul style="list-style-type: none"> Maintain the acquired skills of layer 1 View the activities of the day Navigate between months Know that the return to the home screen is done automatically after 2 minutes Read the reminder, close the activity reminder, and do the requested activity. 	<p>Acquisition – Errorless method, vanishing cues, and spaced retrieval</p> <p>Examples of questions:</p> <ul style="list-style-type: none"> Show me how to view the activities planned today. Show me how to see the next month. Show me how to return to the home screen. Show me how to close a reminder when it rings. <p>Application – Role plays</p> <p>Examples:</p> <ul style="list-style-type: none"> "We are going to do a role play in which I will pretend to call you." Experimenter picks up the phone. "Hello Mrs, I'm calling you to schedule our next appointment for the learning of AMELIS. Are you available on Monday, July 16th at 10 am?" I would like to know if you are available on the first day of next month. <p>Adaptation – Real-life situations</p> <p>Examples:</p> <ul style="list-style-type: none"> Experimenter adds an activity on Monday, September 16th before the learning session. At the end of the session, he says to the participant "I would like to schedule our next meeting. Are you available on Monday, September 16th?" Experimenter looks if the participant notices that she already has an activity that day. Experimenter adds a reminder (e.g. go drink a glass of water) that will ring during the learning session. When the reminder rings, the experimenter notes if the participants read the notification, closes it and does the requested activity.
3. Managing activities	<p>The person must be able to:</p> <ul style="list-style-type: none"> Maintain the acquired skills of layer 1 and 2 Add an activity Delete an activity 	<p>Stages of Sohlberg & Mateer were not built because the participant did not make it to layer 3.</p>

ule). Habits more specifically in connection with the use of the paper calendar (e.g. appointment management) were of interest. During this first meeting, the calendar was personalized: the participant chose the icons and images of the AMELIS interface that were most significant for her from a bank of preselected images.

Learning of AMELIS

The teaching of AMELIS was done at the participant's home to limit generalization difficulties that typically arise in people with AD (van Halteren-van Tilborg et al., 2007) and to facilitate the use of the technology in her daily life. Ten learning sessions of 45 to 75 minutes each were conducted according to the participant's abili-

ties (e.g. level of fatigue, cognitive availability for learning, etc.) over a month. The presence of the caregiver during the learning sessions was not required. The intervention was inspired by the Sohlberg & Mateer (1989) learning method demonstrated to be effective with older adults with cognitive deficits (Imbeault et al., 2014; Imbeault, Langlois et al., 2016).

This method includes three stages: acquisition, application, and adaptation (*Table 1*). Each stage has a specific learning objective: Stage 1) Learning the calendar features (acquisition phase): As recommended by Sohlberg, Ehlhardt & Kennedy (2005), a combination of errorless learning, vanishing cues, and spaced retrieval methods was used to facilitate feature learning. The goal of this phase was to keep the number of errors made by the participant at a minimum level (errorless learning). To achieve this goal, the experimenter first showed the participant how to do the task (e.g. locate the date of the day on the screen), and then simple instructions were tested with the participant (e.g. "Show me the date of the day"; *Table 1*). If a mistake was about to occur, the experimenter would instantly indicate the right action and ask the participant to try again (Sohlberg et al., 2005). The experimenter followed this pattern with all the features of a layer while carefully reducing cues (vanishing cues) and ensuring rehearsal of information at increasing intervals of time and during several sessions (spaced retrieval).

When the participant successfully completed 80% of instructions, she could move to the next objective, Stage 2) Learning "how" and "under what circumstances" to use the calendar (application phase; *Table 1*). This step was achieved through role plays, and performed during several sessions during which the proposed situations were potentially real and required the use of the calendar. For example, a feature to view information about a fictitious appointment was used.

Once again, a success in 80% of role-play scenarios led the participant to the final step, Stage 3) Using AMELIS in real-life situations (adaptation phase; e.g. the AMELIS calendar was used to recall a real meeting with the research team; *Table 1*). The teaching phase integrated AMELIS features according to the multi-layer principle (Adelise, 2017). Thus, the features were activated as the participant mastered AMELIS. Each layer included the three phases of Sohlberg and Mateer (1989), which had to be completed successfully to move on to the next layer.

Data collection method

Using the TAM to structure the qualitative methods, the data collection aimed to explore the following aspects (themes) of acceptability:

- External variables that influence the perceived ease of use and usefulness
- Observed and reported ease of use
- Observed and reported usefulness
- Observed attitude toward use
- Behavioral intention to use
- Actual use

To ensure an in-depth understanding of the acceptability phenomenon as well as the internal validity of the study (triangulation), qualitative data was collected from several sources (Yin, 1999): logbooks were completed by telephone with the participant and her caregiver, summaries of each learning sessions were written by the experimenter, and interviews were conducted with the participant and her caregiver.

Logbooks

The logbooks aimed to explore the usefulness of AMELIS in everyday life. Logbook questions were based on the French Multifactorial Memory Questionnaire (MMQ; Fort, Adoul, Holl, Kadour & Gana, 2004) and the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith et al., 2000). Two logbooks (pre-intervention, post-intervention) were produced using a checklist comprising several questions (Appendix I). The pre-intervention logbook was completed by the experimenter (sixth author, M.Sc. student in occupational therapy) before the training with AMELIS. Data was collected through telephone interviews with the participant that took place during the five days preceding the training session. The participant answered questions related to daily difficulties; this information was used to identify situations in which AMELIS could provide support. The purpose of the post-intervention logbook was to report everyday situations in which AMELIS had helped, failed to help or could not have helped. Given the fact that the participant had a poor awareness of her difficulties, the post-intervention logbook was filled during phone interviews; the first interview was carried out with the participant, but the following five interviews (five consecutive days) were conducted with her caregiver.

Experimenter's summaries

The experimenter kept a summary of each learning session. These clinical notes included a brief review of how things went with the calendar since the last teaching session (e.g. difficulties encountered), observations (e.g. reactions, level of fatigue, cognitive availability), progress of learning (strengths vs challenges), apprehensions (e.g. fears or anxiety), and comments from the participant and her caregiver. The experimenter wrote 12 summaries (including one meeting for the initial interview, one meeting for the personalization of icons and 10 learning sessions) holding on 22 pages.

Final interviews

One month after the end of the 10 learning sessions, two interviews based on the concepts of the TAM model were conducted by a MSc student in occupational therapy (eighth author): the first interview was carried out with the participant and her caregiver at the participant's home and the second one was a phone interview with the caregiver only. The purpose of these interviews was to document the acceptability of the AMELIS interactive calendar and the impact of its integration on day-to-day management. The eighth author used semi-structured interview guides (Appendix II), developed by two MSc students in occupational therapy (first and fifth authors) which had been validated by an occupational therapist (third author). The interviewer summed up or quoted the answers (two pages for the participant, four pages for the caregiver) on a computer.

Data analysis

To explore the acceptability of AMELIS by the participant and her daughter, a thematic analysis of the data collected in logbooks, experimenter's summaries, and interviews was conducted using the Miles, Huberman and Saldaña (2014) approach. First, a member of the team (first author, MSc student in occupational therapy) read line-by-line the logbooks, experimenter's summaries, and interviews to immerse herself in the data. Then, using an inductive process, she assigned a conceptual code to each meaningful segment of text related to acceptability. Second, another team member (fourth author, MSc student in occupational therapy) read the data and validated the coding list - i.e. verified if the conceptual codes assigned reflected the meaning of the segments of text. First and fourth authors then met to discuss their interpretations and to find a common agreement on all of the codes. Third, to better structure our analysis of the acceptability, the codes were classified deductively according to TAM themes shown previously. For example, the code "difficulty to use the tactile screen" was classified under "Observed and reported ease of use". Fourth, for each TAM themes, the first and fourth authors clustered the codes into more general themes. For example, the codes "weight of the tablet" and "size of the screen" were clustered into the theme "hardware". Fifth, to consider the plausibility of competing interpretations, a second round of validation of the codes and themes was conducted by the experimenter (eighth author; MSc student in occupational therapy) and an expert researcher of the use of technologies by older people with cognitive difficulties (last author). Themes and codes of each TAM themes were then organized as a checklist matrix to facilitate their visualization and achieve a higher-level analysis. For example, the matrix helped to identify the similar and different per-

ceptions of the participant and her daughter regarding the ease of use and usefulness. We used Microsoft Word and Excel software to assist with coding and presenting the data into a matrix. To ensure trustworthiness and rigor of the qualitative analysis, members of the team met regularly and had critical discussions.

RESULTS

In order to organize this section, results describing the acceptability of AMELIS will be presented according to TAM themes used in our analysis (Table 2).

Participant

The participant was a 78-year-old woman diagnosed with a mild neurocognitive disorder due to Alzheimer's disease 1 year before the study. The older woman lived alone in a house where she had lived for the last 35 years. Her two daughters lived nearby. One of them came to visit her mother every day. The older woman had an autonomy loss that affected her daily activities. She only prepared a few simple meals; the preparation of complex meals was supervised by her daughter during collective cooking groups. House cleaning was provided by a housekeeper and her social network. In addition, the participant benefited from several compensatory strategies to facilitate her daily life. For example, she received automated calls to remind her to take her evening medication. She used a paper calendar and a fridge board where her daughter wrote the current date. In addition, a home care provider came in the morning to make sure that she took her medication.

External variables

Personal factors related to acceptability

Among the personal factors that were considered related to acceptability of AMELIS was the fact that the participant was not fully aware of her deficits. Indeed, she did not consider that she was forgetting events or that she was repeating tasks or sentences. The participant's daughter reported that her mother considered that "everything [was] OK all the time" but that her mother often repeated the same stories and forgot to measure her blood sugar level and to take her medication. In that context, the enthusiasm of the older woman to participate in the AMELIS project was mostly due to her social network (daughters).

The experimenter also observed some particularities in the participant's behavior and communication that may have impacted acceptability. The older woman's answers were always very short and open questions were necessary to obtain more complete answers. The participant also showed difficulties related to memorization and association (e.g. remembering that the AMELIS acoustic

Table 2. Summary of results describing acceptability of AMELIS by participant and caregiver

EV	PEU	A	BI	U
	Facilitating aspects			
+	<ul style="list-style-type: none"> Learning methods Lack of awareness of her deficits Large screen Tactile screen more intuitive Difficulties related to communication, memorization and association Size of writing Weight of tablet Satisfaction towards progression of learning 			
	Limiting aspects			
	<ul style="list-style-type: none"> Difficulty grasping the meaning of black box and alarm clock icon Daily reminders needed to use AMELIS Limitations of technology requiring a return to paper calendar (e.g. application bugs, power failure, etc.) Excessive screen brightness Overcome disadvantages of paper calendar Improve autonomy of the older person Equip social network Remind activities with notifications Be aware of the time of activities Consult scheduled activities 	<ul style="list-style-type: none"> Initially, fear of breaking the tablet Familiarization with the tool over time Rewarding learning Increased sense of self-efficacy 	<ul style="list-style-type: none"> Daughter wishes to continue daily use Desire to expand and manage application bugs 	<ul style="list-style-type: none"> Consults AMELIS daily to know the time of scheduled activities Still needs help to add activities

Note. EV = External variables; PEU = Observed and reported ease of use; PU = Observed and reported usefulness; A = Observed attitude toward use; BI = Behavioral intention to use the interactive calendar; U = Actual use.

signal meant that an action had to be done).

Learning methods

Learning methods were also considered as factors that may have impacted acceptability. Both participant and daughter agreed that the frequency and duration of learning sessions were adequate to promote good feature learning. It should be noted that the intervention was stopped at the adaptation phase of the second layer because of the gap between the participant's abilities and the skills required to learn the third layer. The team members as well as the participant and her network agreed to end the learning sessions at this point because a plateau had been reached. The participant's daughter appreciated that the experimenter has adjusted the duration and content of learning sessions according to the participant's energy level. She also noted that learning methods were useful for the tactile ability (i.e. to press the tablet with the pulp of the finger and not with the nail). In addition, the participant was satisfied with her progress in learning the features of AMELIS. She did not notice any particular challenge. The family was also pleasantly surprised by the level of familiarization with the tablet reached by their mother: "The results are better than we thought. She got used to the tool even though she was initially reluctant" (daughter, final interview).

Observed and reported ease of use

Elements associated with the hardware and interface of AMELIS facilitated its use. Regarding hardware, the participant stated that she initially found that the screen was large, but became accustomed to it over time. Concerning the interface, the touchscreen emerged as an element that was initially difficult to understand for the participant, but then turned out to be facilitative. According to the daughter, the touchscreen was beneficial because it was more intuitive. Both mother and daughter reported that the characters were large enough to allow the older woman to read the information on the tablet properly.

The participant experienced difficulties with some elements of AMELIS related to the interface and software. Understanding the meaning of icons or their location could cause problems. In this case, the daughter reported some learning challenges that had not been overcome by the participant at the end of the 10 sessions. For example, it was difficult for the participant to understand that the black box corresponded to the current day. Instead, she thought that the black box indicated the experimenter visit. She also had difficulty grasping the meaning of the alarm clock icon appearing in a day box. This icon had been chosen by the participant herself to notify her that an activity was scheduled on that day.

Despite this, she often associated the alarm clock icon with an outing while it was sometimes intended to remind her of an event (e.g. a family party). She also believed at one point in the experiment that the hands of the clock represented the approximate time of the planned activity, although the icon never changed. In addition, some application's bugs impacted negatively on the ease of use. The application closed by itself, leaving only the tablet home screen displayed. Although it happened only a few times, the participant became worried and contacted her daughter for help. A last element that suggests that AMELIS was not very easy to use is that the older woman still needed help and reminders to use AMELIS daily at the end of the intervention, according to interviews with the participant and her caregiver. This case demonstrates the need to use reminders in order to integrate memory support tools in everyday life of people with AD.

Observed and reported usefulness

According to the participant and daughter, AMELIS has been useful on a daily basis. Among other things, it allowed the older woman to consult her planned activities and to know the time of an activity or an event. The activity reminders (alarms and notifications) also helped the woman to remember a visit (e.g. housekeeper, home care provider, etc.) or an activity (e.g. to get the woolen clothes to unravel them).

The daughter also noted several other benefits associated with the use of AMELIS, especially with regard to her mother's social network. AMELIS has been used by the social network as a means of communication. Both daughters could record activities on the calendar that the other could consult. Even the home care provider contributed to the integration of AMELIS on a daily basis by entering her next visits to the calendar. The information was then more accurate than before and the older woman relied on it. Indeed, the daughter mentioned that, prior to her participation in this research project, the participant did not write down correctly the dates of her activities on her paper calendar. Moreover, the daughter believed that AMELIS had improved her mother's participation to the management of her schedule, since she felt that it was now easier for her to consult the information related to her planned activities.

Observed attitude toward use

The attitude toward the use of AMELIS changed over the course of the study; at the beginning, the participant was afraid to break the tablet, but then learned how to control it. She needed to be reassured: "When I ask her how the week went, she replied that she is still afraid to break the tablet" (experimenter, meeting summary). The

participant reported that the tablet was expensive and that it did not belong to her. She also mentioned that she did not know much about technology, which fueled her fear of breaking the tablet. The participant's daughter reported that her mother was reluctant to use the tablet at first, but that she became accustomed to the tool. The daughter noted various positive changes since the integration of AMELIS. For example, she stated that her mother felt more skilled over time and that "learning was rewarding" (daughter, final interview). The daughter also reported that her mother could find what was expected during the day, and this increased her sense of control.

Behavioral intention to use the interactive calendar

The participant did not make any comments in this regard. However, a positive intent to continue using AMELIS emerged from the final interview with her daughter. She even expressed her interest in extending its use to other activities (e.g. for taking medication or meals, measuring blood sugar levels).

Actual use of the interactive calendar

When the learning sessions ended, the participant was able to use some features of AMELIS by herself but needed help for others. For example, she used AMELIS to consult the timeframe of the various activities that had been scheduled (collective cooking sessions, morning visits of the homecare provider, birthdays, activities with her daughter or siblings, medical appointments, etc.). However, she needed help from her social network to add activities. Also, when the screen stopped displaying the information after a certain time (due to some bugs in the application), the participant called her daughter to know what to do.

DISCUSSION

The purpose of this study was to explore the acceptability of the AMELIS interactive calendar for an elderly person with AD. Qualitative analysis of logbooks, summaries of learning sessions, and interviews revealed factors that facilitated or limited acceptability. Three main factors emerged: (1) The importance of perceived usefulness by caregivers; (2) The ease of use and usefulness of the tablet's characteristics; and (3) The adaptation of learning methods by the experimenter.

Results suggest that perceived usefulness by caregivers is a favorable factor for the acceptance of AMELIS. Other studies reported that involvement and support of caregivers influence the elder's use of technology (Evans & Collier, 2017; Holthe et al., 2017; Imbeault et al., 2016; Lindqvist, Nygård et Borell, 2013; Middlemass, Vos & Siriwardena, 2017; Peek et al., 2016). In this study, relatives showed a positive attitude from the very

beginning of the process. Their involvement was all the more important as the participant herself was not always aware of her cognitive deficits. This poor degree of insight may have minimized her perception of the usefulness of the tablet at the outset of the intervention, because she could not see how AMELIS was going to assist her. Furthermore, the positive attitude of the entourage was reinforced during the study as they benefited from the use of AMELIS. First, relatives were able to know more accurately which activities had been scheduled. Second, AMELIS facilitated communication between them. Caregivers even considered to continue the use of this technology at the end of the pilot project to support other activities such as medication intake.

With regard to the calendar's interface, some characteristics of AMELIS contributed to its acceptability by the participant and her daughter since they were reported as easy to use. First, the size of the tablet, which at first seemed too large, facilitated the use of large buttons, requiring less dexterity, and information was easier to locate. Moreover, larger characters were easier to read, compared to more compact technologies such as AP@LZ, an organizer application for people with AD which is available on smartphones (Imbeault et al., 2011). Initially, the participant had difficulties using the touchscreen, as in other studies (Imbeault et al., 2014) but they resorbed over the course of learning sessions. This is not surprising, since touchscreen tools seem highly beneficial for people with cognitive disorders because they are intuitive and easy to use (Jodrell & Astell, 2016). Some characteristics of AMELIS which were reported as useful also had a positive impact on acceptability. The auditory (audible alarms) and visual (notifications) signals emitted by AMELIS, which popped up at the right time, represent a major advantage over the conventional calendar. Reminders allowed to overcome some of participants' memory failures (Imbeault et al., 2014; Imbeault, Langlois et al., 2016).

However, some design characteristics of AMELIS hindered acceptability. In many cases, the use of icons is a good visual support to help users understand and navigate inside a user interface. However, it represents an issue in this study as reflected in the results above. The participant had difficulties understanding the meaning of icons in AMELIS as well as how to use the icons without help. Several reasons could explain these results. Foremost, the cognitive capacities of the participant could have an impact on the understanding of the icons. As reported in the results section, the participant had difficulties with memorization and association. Asking persons with Alzheimer's disease, like our participant, to memorize symbolic rep-

resentations and make associations with functions to use AMELIS is a real challenge. With this in mind, we suggest that designers consider some alternatives to the exclusive use of icons. For instance, interpretation of text labels could be explored with this population. In addition, the customization of the icons did not emerge as a favorable element for acceptability, probably because it was not used to its full extent. First, most of the personalized icons were implemented on the third layer, which turned out to be too complex for the participant. These icons were symbols that could be used to illustrate activities being added to the schedule (e.g. puzzle pieces for a leisure activity, a cake for a birthday party, a doctor for a medical appointment, etc.). Second, the only personalized icon she interacted with was the alarm clock. As presented before, she had trouble understanding its meaning. In fact, this icon confused the participant, contrary to what was intended. It might have been helpful if, instead of the icon of the alarm clock (which was misunderstood), the icons chosen for the third layer appeared in day boxes to indicate the type of activity that was planned. Third, the sequence of customization steps needs to be optimized: should the icons be presented before the learning sessions, when users do not really understand their meaning and the impact of the personalized icons, or during the learning sessions, when they link images to functions? Could the icons be changed during learning, when it becomes obvious that the pictogram is confusing the user? Thus, the personalization that was done in this study might not be the best. Furthermore, the use of interface hierarchy had the goal to organize the functionalities of AMELIS in order to facilitate its use by people with AD. Nevertheless, the results of this study showed that the participant experienced some difficulties. Using the advanced functionalities (e.g. Adding activity) and navigating in the interface of AMELIS proved challenging despite the use of a multi-layer approach. These results are probably linked to the complexity associated with the interface hierarchy and the cognitive load that represents the navigation in the interface for an older person who has never used this type of technology before. With this in mind, we suggest that designers consider the strategies usually applied by the person in order to facilitate the use of the technology. In this case, designers could have considered the strategy used by the participant to record activities on the paper calendar.

A final facilitator for acceptability was the structure of the learning sessions (external variable). The flexible and personalized format of the interventions (in terms of duration and content)

was appreciated by the participant and daughter. Despite the challenges encountered, this strategy allowed the older woman to experience success in her apprenticeships, which appears to have enhanced her sense of self-efficacy. Indeed, the participant's daughter reported that her mother's ease with AMELIS increased over time, despite her declining health condition, and this improvement in performance seemed rewarding for her mother. Other studies also reported that the sense of capacity provided by assistive technologies is of great importance to the user (Lindqvist et al., 2013). This positive feeling of self-efficacy promotes acceptability (De Veer et al., 2015; Middlemass et al., 2017; Golant, 2017) and should be kept in mind by designers.

The main limitation of this study lies in the limited generalizability of results to all of the people with AD. People with AD form a heterogeneous group (Ergis & Eusop-Roussel, 2008). The disease progression differs from one person to another, implying various challenges during the learning of a technology. In addition, the size of the sample ($n = 1$) is also a factor that limits the generalizability of results. Furthermore, it is difficult to build a single structure for the learning process and expect repeatability and uniformity of progress in all participants, as constant adaptation is required based on the skills of each individual. However, a single-case design was relevant because AMELIS is an innovative technology which is not yet commercialized. Its acceptability had not been studied before. Thus, this study allowed us to have a preview of its potential acceptability by older people with AD and to propose theoretical generalization. It helped to better understand strengths and weaknesses

of both AMELIS and learning methods that were used. Results showed that improvements can be made in future versions in order to promote its acceptability in the population. Lessons learned from this study can be considered by other researchers or clinicians for designing and supporting the learning of a similar technology.

CONCLUSION

In conclusion, results of this study show that the unique characteristics of AMELIS and the personalized intervention may have contributed to its acceptance by a participant with AD. Her social network certainly perceived a major impact. Although this exploratory study has limitations, the use of such a tool supports the hypothesis that technologies have the potential to significantly support future generations of older people (Buettner, Yu & Burgener, 2010). Future generations will also be more familiar with technology and its use. It is therefore possible to predict that acceptability for this technology will evolve, even in old age and in people with limited learning skills. In addition, more and more assistive technologies are available (Ienca et al., 2017), which opens the door to a large number of opportunities to support home care. Further studies could examine the acceptability of a similar technology, but with younger adults with neurocognitive disorders. Finally, the project was carried out over two months, including five weeks of intervention, which does not allow to explore the full potential of daily use in the long term. There is thus a need for a subsequent study to address the acceptability and long-term use of AMELIS, an assistive technology which shows great potential to support the independence of people with AD who wish to manage their everyday life.

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APPENDIX I – CHECKLIST OF QUESTIONS FOR LOGBOOKS

Pre-intervention logbook (participant only)

(1) What are the important events that you:

(a) were afraid to forget today?

(b) forgot today?

e.g. meeting a person, visit from your daughter, appointments, etc.

(2) What are the situations/events for which you forgot something (such as an action or a tool, when to do a task, steps of a task)?

e.g. forgetting to use your glasses, warm a meal, someone's name, take your medication, eat at the right time, put on some piece of clothing, etc.

(3) Today,

(a) did you decide to do something and forgot about it a few minutes later?

(b) did you forget to do something that your daughter had just asked you to do?

(c) have you repeated the same story more than once? Or, did you realize that you were repeating the same story more than once?

(d) did you do the same task more than once without it being necessary (e.g. washing the same plate twice)?

(4) Do you remember what you did today?

Post-intervention logbook (participant and caregiver)

(1) What are the important events that you/your mother

(a) were/was afraid to forget today? Did AMELIS help you not to forget it? How?

(b) forgot today? Could AMELIS have helped?

e.g. meeting a person, visit from your daughter, appointments, etc.

(2) What are the situations/events for which you forgot something (such as an action or a tool, when to do task, steps of a task)?

e.g. forgetting to use your glasses, warm a meal, someone's name, take your medication, eat at the right time, put on some piece of clothing, etc.

(3) During the last days (to participant)/ today (caregiver)...

(a) did you/your mother decide to do something and forgot about it a few minutes later?

(b) did you/your mother forget to do something your daughter/you had just asked you/her to do?

(c) Did you/your mother repeat the same story more than once?

(d) did you/your mother do the same task more than once without it being necessary (e.g. washing the same plate twice)?

(4) To caregiver: Could your mother tell you what she did today? Did she refer to AMELIS to answer the question?

To participant: Can you tell me what you did today? Which tool could you use to answer the question?

(5) During the day, did you think about a situation for which the AMELIS calendar would have helped you/your mother?

APPENDIX II – SEMI-STRUCTURED INTERVIEW GUIDES

Interview with the participant

AMELIS calendar

(6) How did you find the interface?

(a) The icons?

(b) The images?

(c) The size of writing?

(d) Ease of use? Effectiveness?

(7) Did you like the size of the screen? Its weight?

(8) Did you appreciate the fact that the calendar is tactile?

(9) Do you have any suggestions for improvements related to the appearance of AMELIS?

Learning

(10) How was the learning of the calendar in general?

(11) What were your strengths when learning AMELIS? Are there features that you found easier to learn? Are there any that you find essential?

(12) What were your challenges when learning AMELIS? Are there any features that you found more difficult to learn? Are there features that you find useless?

(13) Was the frequency (2X/week) and duration of learning with MDG (experimenter) adequate for learning?

(14) Are you satisfied with your progress in learning the different features of AMELIS?

(15) Do you have any suggestions for improvements related to the AMELIS learning method? Life habits

(16) Have you noticed improvements in your daily life after learning/using AMELIS?

(a) For which activities/life habits?

(b) In what way?

(17) What were your challenges related to the integration of AMELIS in your daily life? (AMELIS vs paper calendar and board on refrigerator)

(18) Do you plan to continue using AMELIS in your daily life?

(a) If so, for which life habits? In what way?

(b) If not, why? What are the life habits that AMELIS cannot support?

Interview with the caregiver

AMELIS calendar

(19) How did you find the interface?

(a) The icons?

(b) The images?

(c) The size of writing?

(20) Did you like the size of the screen? Its weight?

(21) Did you appreciate the fact that the calendar is tactile? What is facilitating or not for your mother?

(22) Do you have any suggestions for improvements related to the appearance of AMELIS?

Learning

(23) How was the learning of the calendar by your mother in general?

(24) What were your mother's strengths when learning AMELIS? Have you observed any features that are easier to learn? Are there any that you find essential?

AMELIS interactive calendar

(25) What were your mother's challenges when learning AMELIS? Have you observed any features that are harder to learn? Are there features that you find useless?

(26) Was the frequency (2X/week) and duration of learning with MDG (experimenter) adequate for learning, according to you?

(27) Did you notice if your mother progressed in learning the different features of AMELIS?

(28) Do you have any suggestions for improvements related to the AMELIS learning method?

Life habits

(29) Have you noticed improvements in daily life after learning/using AMELIS?

- (a) In your mother's life? In yours?
- (b) For which activities/life habits?
- (c) In what way?

Life habits suggestions related to the participant's initial interview:

- Did you start recording her collective cooking activities in AMELIS?
- Did you start adding new types of appointments/activities that she did not record on her paper calendar before (e.g. hairdresser, water the plants)?
- Is medication management facilitated by AMELIS (dispill, blood sugar measures)?

(30) Have you observed any challenges related to the integration of AMELIS into the daily routine?

- (a) Challenges for your mother? Challenges for you?
- (b) AMELIS vs paper calendar and board on refrigerator

(31) Do you think that your mother will continue to use AMELIS in her daily life? Would you like to continue supporting your mother with the use of AMELIS?

- (a) If so, for which life habits? In what way?
- (b) If not, why? What are the life habits that AMELIS cannot support?