# “You, me & TV” - Fighting Social Isolation of Seniors with Facebook, TV and Multimodality

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**Abstract**

Social isolation, common in old age, leads to a decrease of both physical and psychological skills and consequently to a decreased quality of life and even to a higher mortality risk. Social Network Services (SNSs), like Facebook, have the potential to increase the amount of online and offline social interactions of seniors. However, because of the huge diversity of characteristics of this user group, the lack of inclusive design principles concerning existing SNSs, and the inappropriate ways of interaction available, seniors still resist adopting these services. In this paper, we present a longitudinal study of the use of “You, me & TV”, a TV-based multimodal Facebook prototype enhanced with TV shows sharing functionalities, a new feature for sharing printed photos, and multiple interaction modalities – remote control, voice and gestures. Results indicate that participants accepted the prototype, rated it highly in terms of usability, and that it improved their interaction with relatives, increasing both online and offline interactions. This was particularly visible for participants that were not Facebook users before the study. We also provide relevant conclusions about the use of adaptation and personalization concepts, and the way they were received among participants.

*Keywords:* Older adults, Facebook, TV, multimodality, adaptation, social interaction

## 1. Introduction

Social isolation, commonly resulting from low quantity and quality of contact with others, is a pressing concern for seniors. The aging process raises issues such as cognitive impairments and motor disabilities that impair one’s ability to socialize. This leads to the worsening of seniors’ health condition, resulting in an increased mortality risk for older adults (Age, 2010; Alaoui and Lewkowicz, 2013). Technology can play an important role by increasing the ability of seniors to participate in social interactions (Age, 2010; Alaoui and Lewkowicz, 2013). However, the elderly are quite resistant to adopting new technologies (Karahasanović et al., 2009; Baecker et al., 2014;

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Lindley et al., 2009; Judge et al., 2011), which hinders the introduction of services that could improve their social life. The same factors that impact their ability to socialize also affect the way seniors interact with technology, further increasing resistance to adoption of these technologies (Newell et al., 2003).

Online social network services (SNSs) allow users to create and share digital content with other network users. These services have the ability to bring seniors closer to their relatives, making them a desirable tool for this user group (Harley et al., 2014; Baecker et al., 2014; Cornejo et al., 2013) Facebook, as the most popular SNS (pop, 2015), constitutes the ideal vehicle for this use. With seniors' family and friends already using this service, Facebook becomes an attractive medium for enticing seniors to engage in an online presence, as long as it can be done in an accessible manner. However, there are several issues and limitations that must be overcome in order to make it a reality. The main ones are design complexity (Cornejo et al., 2013; Baecker et al., 2014; Lindley, 2012; Hope et al., 2014; Norval et al., 2014), privacy issues (Gomes et al., 2014; Gibson et al., 2010; Norval et al., 2014; Hope et al., 2014; Waycott et al., 2013; Baecker et al., 2014), preconceptions about its use (Harley et al., 2014; Hope et al., 2014) and the inability to use and learn technology used for SNS access (Xie et al., 2012; Michailidou et al., 2015).

In order to increase the likelihood of seniors using technology that contributes to lower their social isolation, we propose implementing an accessible interface for Facebook based on technology well known by the elderly, such as television. TV is the technology most used by the elderly (Bobeth et al., 2012). This contributes to the idea that TV can be used as vehicle for seniors to access content available on SNSs. Additionally, to deal with age related disabilities and differences when interacting with technology, we argue that these social applications should resort to multimodal and adaptive interaction.

To validate our proposal we developed a prototype of a multimodal, adaptive interface for Facebook on TV. This prototype was informed by a set of design recommendations targeting social networks in different platforms (Coelho et al., 2015). The prototype allows seniors to access shared media content on Facebook about their relatives and close friends. Two features not immediately available on Facebook's standard interface were made available through our prototype. The first feature takes advantage of the platform, and the importance TV has on the life of seniors: sharing on the user's Facebook stream what TV content is being watched. The second feature is the ability to share to the Facebook stream digital copies of printed photos that the senior owns. Users can interact with the prototype using a remote controller (RC), speech and gestures. All modalities can be used interchangeably. Users could personalize lists of family and friends, as well as the application's menu. Alternatively, adaptation mechanisms can replace the personalization operations.

To understand seniors' acceptance of such an application, as well as the impact it could have on their social life, we conducted a longitudinal study with three seniors, where the prototype was deployed in their homes for a period of at least three weeks with each senior. The deployed system logged user's interaction, allowing us to measure the frequency of use of the system and of each of its features. Additionally, we conducted weekly checkpoints with the study participants that focused on their experience with the use of the prototype and the impact it had on their social activities.

The paper main contributions are the Facebook-based TV prototype and the findings from the longitudinal study conducted. Results show that seniors enjoyed the concept of having a TV-based SNS that allows them to be closer to their family. They found TV to be easier to use than personal computers, and this has lead them to use the TV to engage in social tasks. As a consequence it was possible to observe an increase in social interactions. This applies to both online and offline social interactions, with both types increasing as a result of the use of the prototype. We also found that multimodality and adaptation increased the accessibility of the application, allowing users to perform the tasks in an easier way.

In this paper, we start by presenting related work on the use of SNSs by older adults, and what advantages TV can contribute to the elderly. We also summarize past research on what multimodal and adaptive interfaces can bring to the older population. Next, we describe in detail the prototype. The description of the "You, me & TV" prototype is divided in three main areas: main functionalities, multimodal architecture, personalization and adaptation module. After this we present the methodology we followed in the user study, and a detailed analysis of the findings. We end the paper with the main conclusions and future work.

## 2. Related Work

### *2.1. Older Adults and Social Network Services*

It has been shown that the most obvious motive to join a SNS like Facebook is the need for integration and social isolation: older adults are typically more isolated than younger segments of the population ((Sorensen and Skouby, 2008)). It is essential for them to find a basis for conversation and social interaction by connecting with family, friends, and society, and gaining insight into the circumstances of others ((Lehtinen et al., 2009; Gibson et al., 2010)). Technology in the form of SNS could be an important vehicle to improve social skills in older adults and consequently mitigate social isolation in this population: SNS adoption has been associated with increases in social well-being, longevity and mental and physical heath ((Newell et al., 2003; Gibson et al., 2010; Alaoui and Lewkowicz, 2013; Karahasanović et al., 2009)).

Research has focused on two distinct groups of SNSs that take older adults into consideration, SNSs exclusively designed for older adults, like iYomu and Saga Zone, and SNSs which also draw thinking in other age groups. The first group tended to expire shortly after being launched as they tend to exclude older adults family and close friends, which are the main reason for older adults to adopt SNS in the first place (Gibson et al., 2010). Regarding the second group, several solutions have been proposed recently which indicated that privacy and usability issues are fundamental to tackle when designing for older adults inclusion: Tlatoque (Cornejo et al., 2013) was a multitouch based system which made use of ambient artifacts to collect Facebook content and present it to older adults which use resulted in increases in both online and offline interactions. Gomes et al. (2014) and Norval et al. (2014) both developed new Facebook prototypes and compared them with the native or simplified versions of Facebook. While the first showed that focusing on family functions and on filtering mechanisms increases acceptance, the second showed that a SNS designed based on certain older

adults requirements can also increase usability, reduce effort and save time. Finally, both Hope et al. (2014) and Harley et al. (2014) focused on the necessity of SNS to focus on the role of communication with family members and foster offline communication. The first showed the importance of affording expressions of thoughtfulness and tangible value functionalities like "letter writing" to accomplish that. While the second suggested the inclusion of "sharing rooms" dedicated to family members or anonymous sharing, and functionalities related with connecting with the local community face-to-face.

"You, me & TV" takes advantages of the requirements found in these studies that could influence seniors to adopt and use SNSs applications. Further, it includes a new concept of TV shared content that will allow users to share what they are seeing in television as well as the capability of taking pictures of old photos and sharing them with relatives. Finally, none of the aforementioned studies attempted to evaluate this context of interaction in a longitudinal way like it is done for this prototype.

### *2.2. Multimodal Television and Older Adults*

Television, by being available to older adults on a daily basis like no other technology, has the potential to enable or simplify participation and inclusion in their surrounding private and professional communities. Therefore, older adults could make use of TV-based services to communicate with family and close friends and that way tackle problems related with social isolation (Karahasanović et al., 2009; Bobeth et al., 2012). However, they still face problems when interacting with SmartTVs. These problems are usually associated with age-related disabilities (Lindley et al., 2009), complexity of Electronic Program Guides (EPGs) (Epelde et al., 2011), or the lack of accessible TV-based user interfaces (Coelho et al., 2011).

In recent years, research has been focusing on how these problems can be bypassed or taken into account. Almost all solutions proposed involve the provision of multimodal features keeping the remote controller as the main interaction modality though: Karahasanovic et al. (Karahasanović et al., 2009) showed a TV with additional features takes less time to turn on and connect and is much simpler to work on than a traditional TV. Ocean Blue Software Nexus TV (obs, 2010) supported speech interaction to enable EPG and menus navigation compensating poor vision and low reading ability. The Photostroller (Gaver et al., 2011) by simulating a portable TV where older adults could visualize a photo slideshow showed older adults would be interested in interacting socially with a TV and that a remote control could be suficient if the UI is accessible enough. The GUIDE project (Coelho et al., 2013) indicated remote control should be kept the default modality of interaction but together with voice and gestures could enhance accessibility by providing different ways of fitting distinct older adults characteristics. Finally Bobeth et al. (Bobeth et al., 2014) used a Nutrition Tracker and a Photo Brower applications to show that combining Tablet interaction with TV is appreciated by both young and older adults, and that while the remote controller could be used for linear tasks, gestures should be used only for accomplishing very limited interaction.

All this research showed that the provision of new alternative ways of interacting with TV-based systems can work as a bridge for the adoption of more complex applications. Services like Facebook, by running on top of a multimodal TV, could help older

adults keep in contact with the world. "You, me & TV" is a multimodal TV-based application that bases itself on these studies offering several modalities (gestures, voice and RC) so that older adults can achieve social tasks like seeing and commenting photos of their relatives. Additionally, it hybrids with TV functionalities, making possible, for example, for older adults to share what they are seeing on TV.

### *2.3. Adaptive Interfaces and Older Adults*

Personalization provides mechanisms for users to configure certain features of applications like font size, audio volume, etc. On the other hand, adaptation provides automatic mechanisms that change the user interface. With these concepts applications can perceive the real context of interaction and older adults can benefit of a better user experience.

Examples of adaptation features have been present in recent research (and usually go hand-in-hand with multimodal mechanisms) focusing on color schemes, font size, UI modifications, and user preferences. Elderis (ELDERIS, 2013) and OBS Nexus Tv (obs, 2010) were based on Set-Top Boxes that could to deliver services for entertainment, education, video communication and content sharing for older adults. Both provided speech and RC interaction and basic means of adaptation, in terms of changing menu color schemes and increase or decrease the font size. While the first was not able to adapt to the user or integrate further UI components, in the latter this modifications were always manual and thus worked more like a personalization mechanism. MyUI (Peissner et al., 2012) adapted their UIs to an evolving individual user model based on empirical patterns of design and context characteristics. However, adaptation was done through modifications of the UI which were normally rejected by TV based application developers making hard the transition to a real-life context. finally the GUIDE platform (Coelho et al., 2013) implemented both personalization and adaptation. Personalization was based on the development of a user profile by running an initialization application which would gather a set of user preferences and provide modality tutorials. Adaptation was based on the data collected and allowed the modification of UI depending on that user profile in three distinct manners, from resizing components, to adjusting objects position, to replacing colors and objects.

"You, me & TV" is build from the demonstrated necessity of focusing on adaptation features when designing TV-based applications for older adults. In this application we implemented and tested both personalization and adaptation concepts in real usage contexts for an extended period of time. None of the mentioned studies performed an evaluation like this.

## 3. "You, me & TV" – a TV-based Facebook prototype for older adults

Coelho et al.'s analysis (Coelho et al., 2015) presents the results of a study identifying the most desired features in a SNS for this age group. Following those recommendations, we developed a prototype for a TV-based Facebook application aiming to meet the needs of seniors regarding both content and interaction. Interaction-wise the prototype tries to retain some of the look and feel of Facebook, while abiding to interaction design recommendations targeting senior users (Lindley, 2012; Lehtinen et al., 2009;

Gibson et al., 2010; Cornejo et al., 2013; Hope et al., 2014; Norval et al., 2014) and TV applications (Karahasanović et al., 2009; Gaver et al., 2011; Coelho et al., 2011, 2013). Content-wise, given that the relevant content is mostly the one produced by family members and close friends (Lindley, 2012; Judge et al., 2011; Gibson et al., 2010; Xie et al., 2012; Cornejo et al., 2013; Hope et al., 2014), the prototype integrates directly with the Facebook SNS through the Facebook's Graph API. This also supports the prototype's publishing features, endowing the user with the ability to produce and consume content.

### *3.1. Main Functionalities*

The "You, me & TV" prototype (Figure 1) focuses on three main features: user feed, managing groups of friends, photo viewing and sharing. The news feed allows seniors to see what their family and friends are publishing in Facebook. It is also in the news feed that users are able to publish content for their family and friends to see. The self-generated content will also be displayed in the news feed, together with likes and comments that family members and friends input on this content, providing a single place for the senior to overview her or his social interactions. Relative to the standard Facebook applications, "You, me & TV" allows its users to publish two new types of content: the TV show that the senior is currently watching and digital copies of printed photos the senior owns. Additionally the prototype also makes possible for users to like a content (the like button when toggled would say "I don't like" for the ability of canceling the like) or to see all comments or make a new comment on the content.

According to Coelho et at. (Coelho et al., 2015), photo viewing and sharing are particularly interesting and motivating for this target group. Accordingly, as aforementioned, we included in the prototype a feature that allows seniors to share with their contacts the old printed photos they so much treasure. While designing this feature we decided for a solution that favored interaction simplicity over the quality of the final digital artifact to share, thus deciding against complex scanning mechanisms. The final implementation makes use of the Microsoft Kinect's connected to the prototype. The user presents the printed photo to the Kinect's camera, and a snapshot is taken after a small period has elapsed. This snapshot, after confirmation by the user, is posted to the user's Facebook stream, prompting social interaction with family and friends.

The feature supporting the user to post the TV show being watched to the Facebook stream is not completely integrated with the TV set in this version of the prototype. The current prototype runs on a PC connected to a TV set that works only as a display. This means that the prototype is not aware of what channel the user is watching. This requires extra effort from the user that must stop watching TV, switch to the prototype application and select the channel that was being watched (the prototype collects from a Web service the shows that are being broadcasted in the different channels, freeing the user from having to specify the show). A final version of this application would allow the user to post this info directly from the TV set.

Another important feature presented in Coelho et al.'s study (Coelho et al., 2015) is the distinction made by seniors between family and friends. Consequently, we decided to separate them into two sub-groups. This is implemented in the prototype by having two entries in the main menu, one for each group: the family and friends. The same study (Coelho et al., 2015) reported that seniors also desire to be able to specify smaller

sub-groups. The prototype supports this recommendation by allowing the user to create new sub-groups of the family and friends groups, and name them as desired (e.g. "grandsons" or "reading club"). It is possible to add and remove friends and family to and from these sub-groups.

### *3.2. Multimodal architecture*

Taking into account the different needs and characteristics that characterize the members of this user group, we decided from the early stages of design to support multimodal interaction. Given the TV interaction context, users can interact with the prototype using a remote control (RC) in addition to speech commands and gestures.

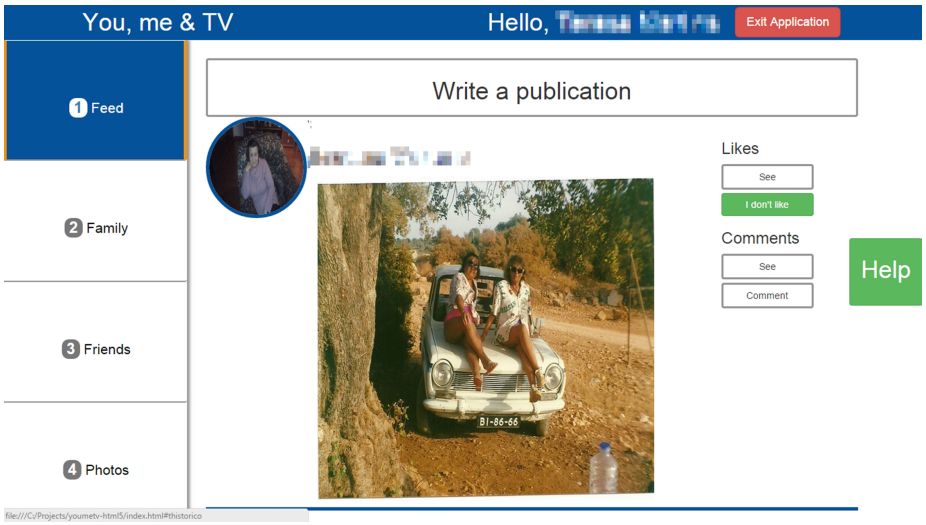
To interact with the application using the RC users mainly employ the arrow keys (up, down, left and right) to control what element is selected on screen. Additionally, there are four main buttons on RC: Confirmation, Back, Help and Personalization. The Confirmation button allows users to confirm the execution of a task or make a selection. For example, if users want to select one of the options within a publication of the feed (e.g. like) they must use the keys to select the desired publication and then click the Confirmation button to access the different options of this publication. The Back button allows users to return to the previous functionality. The Help button allows users to access a modal box with contextual help. The Personalization button will be explained later in this section.

Regarding gesture interaction, we used the mouse cursor metaphor recommended by Bobeth et al (Bobeth et al., 2012). With this metaphor, hand movement maps to the movement of a cursor on the application. Selection is done by the hand closing action. Hand tracking and gesture recognition was implemented through a dedicated application that uses the Kinect SDK v1.8 and communicates events to the Facebook-based prototype.

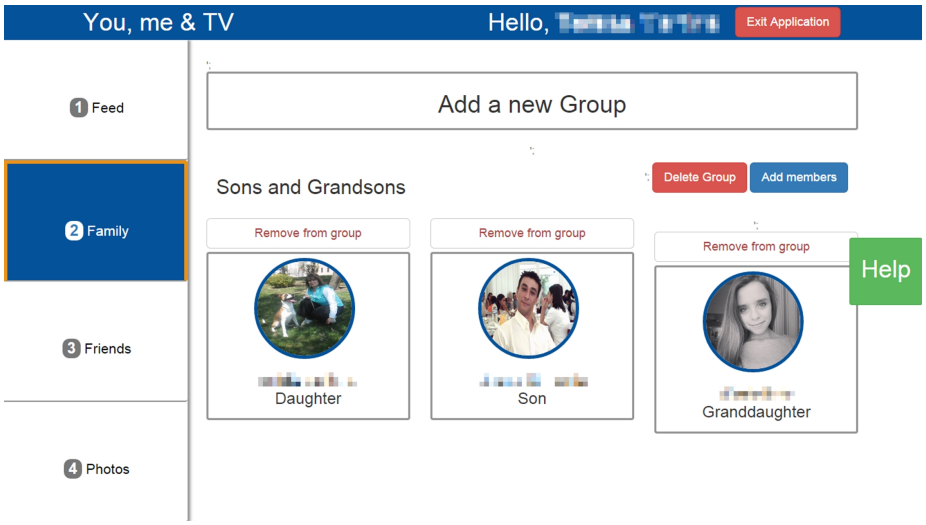
Finally, the voice modality can be divided into two modes: voice commands and dictation mode. Voice commands have been implemented using the "annyang" (ann, 2015) framework that allows command definition in Web applications and recognition of voice commands. To prevent unwanted command recognition, in its initial state the application only recognizes the keyword "Speech". Thus, any voice instruction must be preceded by this statement. Dictation mode has been implemented using the Web Speech HTML5 API (Shires, 2013) and allows users to write by speech. This mode only works when the element in focus is a text box.

### *3.3. Adaptation and Personalization interface*

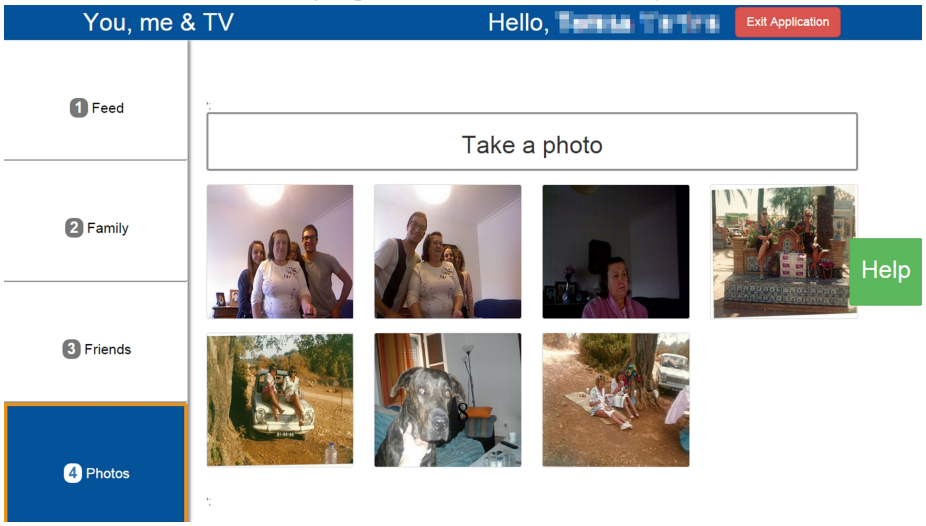
The deployed prototype also explores the concepts of adaptation and personalization. The aim was to understand what characteristics of each concept are more beneficial in the context of an application for the elderly. Adaptation and personalization mechanisms were applied to two features: the order of the elements in the main menu, and the order of the elements of the family and friends groups and sub-groups. Regarding automatic adaptation, the order of the elements was adjusted based on the number of accesses made by the user. For example, elements included in the main menu appear in the order they are most commonly used. Thus, the most used features appear in the top of the menu. With respect to the order of family members and friends the same principle was applied – the most popular elements appear in the first place.




(a) The user feed




(b) A group with 3 members of user family.




(c) Pictures that user took with Kinect camera.

Figure 1: "You, me & TV" user interface

| User | Age | Gender | Family (on Facebook) | Friends (on Facebook) | Duration | Facebook user | Lives with | Retired |
|---|---|---|---|---|---|---|---|---|
| U1 | 65 years | Female | 6 | 4 | 6 weeks | No | Alone | Yes |
| U2 | 67 years | Male | 12 | 7 | 3 weeks | Yes | Wife and stepson | No |
| U3 | 73 years | Female | 8 | 3 | 3 weeks | No | Husband | Yes |

Table 1: Participants description

The personalization concept has been applied to the same features. For a user to personalize the order of the elements in the different groups or the order of features in the main menu, the element to be reordered must receive the focus using the arrow keys in the RC, followed by a press in the Personalization button. After that a message is presented to the user, asking for the new position of the element. Personalization options always took priority over adaptation options.

## 4. Methodology

The overall goal of the prototype is to improve the quantity and quality of social interactions of their senior users. To be able to assess this goal we conducted a longitudinal study, where we deployed the prototype in the homes of the participants. A longitudinal study was chosen because we needed to find out the impact the prototype has over a period of time, thus giving us insights into its acceptance, frequency of use, more used features and the overall potential improvements in the social life of seniors.

### *4.1. Participants*

We planned to have the prototype deployed in the homes of four seniors for a period of three weeks each. All participants were selected via convenience sampling. However, one participant requested to keep the prototype running after the three weeks period ended. We agreed to the request, and since we had no access to further hardware for prototype deployment, we ended up with three participants. Table 1 shows the profiles of the seniors who participated in the study. The table also shows the number of family members and close friends who also contributed by "friending" the senior participant and placing content in their native Facebook streams.

As seen in Table 1, two of three participants were not Facebook users previously to this study. However, U2 uses Facebook on a daily basis. We assisted the participants who were not Facebook users in creating their accounts and inviting their relatives.

### *4.2. Procedure*

The study started with the installation of the system in the participants' homes. Firstly the system was introduced and an explanation of all features and modalities that could be used was given. All features were available during all weeks, with the exception of adaptation and personalization features. These features were used separately because they could cause incoherent results when used together. U1 and U3 used personalization in the first half of the study and adaptation in the second half. U2 used these features in reverse order. All accesses to the different features were logged and the findings gathered through the analysis of these logs are presented in the next section.

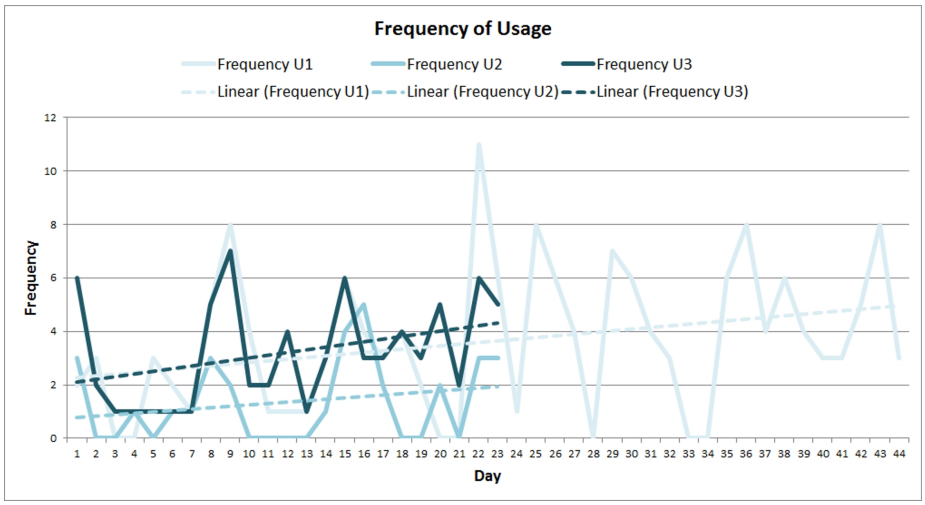



Figure 2: Frequency of use of U1, U2 and U3

We also collected qualitative data, through weekly checkpoints with the study participants. In these weekly checkpoints we visited the participants' home and discussed about their opinions of the system and difficulties they faced. Additionally, we administered two surveys to measure their experience with the system: the System Usability Scale (SUS) (Brooke, 1996) and the User Experience Questionnaire (UEQ) (Cota et al., 2014). SUS calculates a score of the application's usability. The average SUS score is 68. Thus, a SUS score above 68 would be considered above average. UEQ measures the user experience through six different scales that evaluate quality of design (stimulation and novelty) and quality of use (dependability, perspicuity, efficiency and attractiveness). U2 and U3 answered these questionnaires every week while U1 answered it every two weeks, for a total of three samples for each participant.

## 5. Results

Overall, older adults received our prototype well. Since the first days, all participants and their relatives showed willingness to use the application. Their experience improved as they kept using the prototype. In the following sections we discuss different aspects of the overall experience.

### *5.1. Older adults acceptance*

In this section, we address acceptance and use of the prototype. We base our discussion on the frequency of use of the system and individual features, complemented with opinions collected during the study.

#### *5.1.1. General usage of the system*

U1 was the most active user of our system. She said that she wanted to use the application everyday. Figure 2 illustrates this statement. As it is possible to see, U1

used the application almost everyday. In the 44 days she had the prototype available to her, she used the application 159 times and only in 7 days she did not use the "You, me & TV" prototype. She averaged 3.6 uses per day. No pattern correlating non-usage with the weekday was found (the prototype was not used on one Monday, one Tuesday, one Wednesday, two Thursdays and two Fridays). In general, she really appreciated our system because it allows her to interact more with her relatives. She said: "many times, after I use the application, I call my relatives and talk with them about the photos that I saw in "You, me & TV"".

U2 made a limited use of our system (Figure 2). He used the application only 34 times in 23 days, averaging 1.34 uses per day. In the checkpoint meetings he said that he was already accustomed to use Facebook on his personal computer and he did not see advantages in using it on a TV-based application. However, he was the user that made most use of the different modalities, in particular, voice and gestures. He enjoyed these modalities and the fact that they were always available for all features.

Finally, U3 made a growing use of the application, especially because the number of shared photos between her and her family also increased (Figure 2). She accessed the prototype 74 times in 23 days with an average of 3.2 uses per day.

*5.1.2. System Usage*

Since the first week, participants felt the system was quite beneficial to their lives as they could see what family members did daily (if they publish it on Facebook). On every checkpoint, participants indicated that features such as sharing printed photos and viewing family photos are the most important ones in this application.

As expected, family was the major reason for adopting "You, me & TV". In total, we recorded 42 accesses to family member profiles compared to only 12 to friend profiles. This reflects the fact that the participants' social networks were composed mainly by their family members, with less friends.

Another important feature in this system was the ability to share what the user was watching on TV. In the weekly checkpoint discussions, we learned that the usage of this feature could have been considerably higher if the integration with the TV set was full, instead of requiring the user to change between TV and prototype application. Still, they showed enough interest in this functionality to use it, even with the required effort. They also contributed a suggestion of having a button on the RC that automatically shares with family members what they were watching on TV.

Participants appreciated the features that allow fast content sharing with their relatives. U1 stated: "Sometimes I can not call my family and they often are unable to call me but with this application I can always know what they are doing and can easily show them what I'm doing". In the context of being able to somehow communicate proximity with family members, the ability to "like posts" in the news-feed was appreciated. In fact, she indicated that it is easier to select a button to like one post, than to write a comment in that post. We observed that content sharing motivated seniors to establish contact with their relatives. U1 indicated that she reestablished contact with an aunt who she had not seen for a long time. This fact is representative of the potential of our prototype to increase relations between seniors and their relatives. The importance of photos, consuming family content, but also of creating content can be seen as

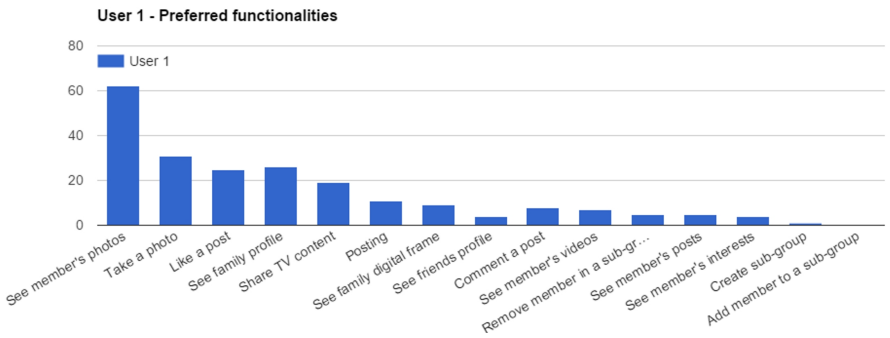



Figure 3: Feature usage by U1

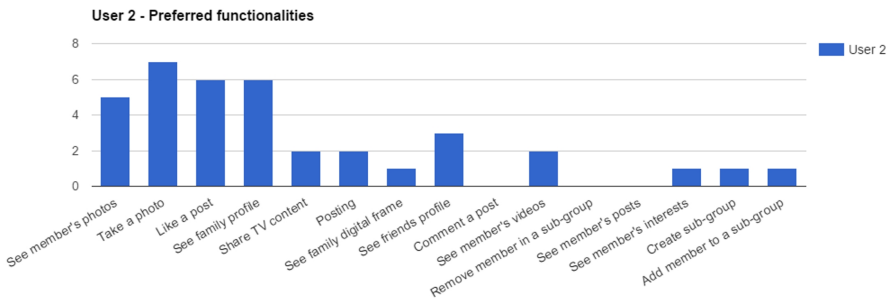



Figure 4: Feature usage by U2

main functionalities preferred in Figure 3, where the number of times each feature was used by U1 is presented.

Figure 4 shows feature usage for U2. This participant made a limited use of "You, me & TV". However, he indicated appreciating the sharing printed photos feature because "sharing pictures on Facebook is really difficult and through this application it is easier".

U3 focused particularly in photos (Figure 5), both the taking photo and sharing it with the family feature and the ability to see the photos of her relatives. She used the application as a photo sharing system: "I used the application to share old printed photos with my family. They also send me old photographs and this allowed me to revive old times." In three weeks, U3 shared forty-three photos with her family.

### *5.1.3. Interactions with others*

We looked into how SNSs could increase social interactions between seniors and their relatives by measuring the number of sharing actions – liking posts, posting, commenting, sharing TV content, sharing printed photos – that seniors performed in "You, me & TV" and observing their evolution over time for each participant.

U1 interacted 83 times (averaging 1.89 interactions per day) with his/her family members. The evolution of these interactions can be seen in Figure 6. We can see

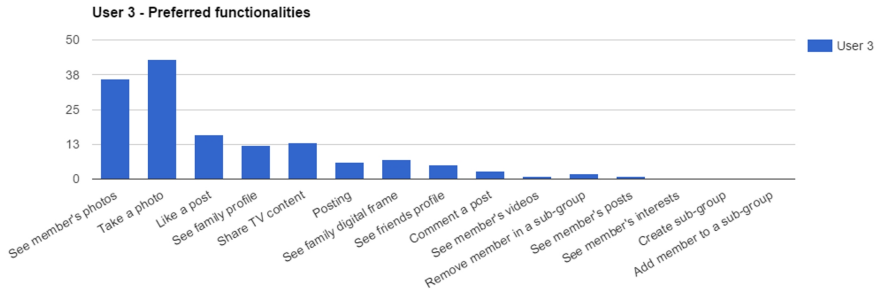



Figure 5: Feature usage by U3

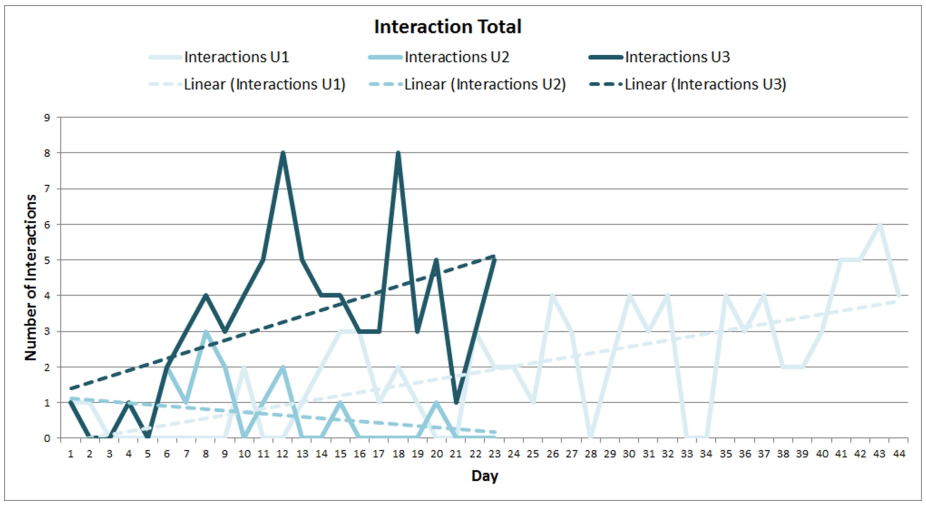



Figure 6: Social interactions of U1, U2 and U3

that the number of interactions increases with time, after an initial period where the participant was not yet comfortable enough to share content.

U2 interacted only 15 times (averaging 0.65 per day) and growth was somewhat contrary to the one observed in U1 (Figure 6). However, the data for this participant must be labeled as inconclusive, since he was already an assiduous user of Facebook and he continued to use the Facebook native application during the study period, establishing interactions that we could not account for.

U3 was the participant with the greatest number of interactions with others (Figure 6). She engaged in 75 interactions in total (an average of 3.26 interactions per day). Like participant U1, U3 showed a tendency to increase interactions over time.

### *5.2. Multimodality importance*

Regarding the modality most used in the study, we could verify that the RC is the principal way participants used to interact with the prototype. Additionally, this was the only modality for which they did not require assistance. They felt comfortable

| Task / Modality | RC | Voice | Gestures |
|---|---|---|---|
| ***Total Percentage*** | ***77.31%*** | ***7.98%*** | ***14.71%*** |
| ***Content production*** | ***77%*** | ***17%*** | ***6%*** |
| Posting | 39% | 61% | 0% |
| Comment a post | 45% | 55% | 0% |
| Like a post | 64% | 26% | 10% |
| Take a photo | 88% | 4% | 8% |
| Share TV content | 100% | 0% | 0% |
| ***Content visualization*** | ***76%*** | ***0%*** | ***34%*** |
| See family digital frame | 100% | 0% | 0% |
| See family profile | 68% | 0% | 32% |
| See friends profile | 58% | 0% | 42% |
| See member's photos | 75% | 0% | 25% |
| See member's videos | 100% | 0% | 0% |
| See member's interests | 100% | 0% | 0% |
| ***Group management*** | ***80%*** | ***0%*** | ***20%*** |
| Create a subgroup | 100% | 0% | 0% |
| Add member to subgroup | 100% | 0% | 0% |
| Remove member from subgroup | 71% | 0% | 29% |

Table 2: Usage of different modalities relative to specific tasks.

interacting with a television based application using the same device they always have used to interact with the TV set. However, we found that there was interest among the participants to try new modalities, especially for features that were not so easy to use with RC, like writing a post. In fact, we can state that the participants did not appreciate using the RC to write posts, given that it was a very time consuming process. As a consequence we witnessed an increase of posts written by voice over time. U2 found that "by speaking it is much easier to write on television." Gestures were also used, especially to select large buttons, such as buttons representing family members and friends. However, participants considered it a little difficult to use, given that they already exhibit slight hand tremors which caused the on-screen cursor to jump considerably.

Table 2 presents the overall distribution of modalities used for each feature, across the three participants. As aforementioned, it is clear that the RC was used for most interactions. However, it is informative to look at what the other modalities were most used for. Speech commands emerge as a valid alternative for producing textual content. In fact, its overall usage surpassed the use of the RC to write posts and comments. Albeit much lower, it also has a non negligible use for liking posts. Gestures, on the other hand, had more use for content viewing tasks, including accessing profiles of friends and family members and accessing photos posted by the members of the participants' social network. Overall, results indicate that voice is more useful in content producing tasks, while gestures are more appropriate for content browsing tasks.

### *5.3. Benefits of personalization and adaptation*

The concepts of adaptation and personalization elicited different reactions from the participants. Personalization was perceived as very complex, which caused some discomfort. U1 stated "it is a feature that will not be missed." U2 indicated that "he did not feel that its use would cause the application to become simpler to use." U3 considered personalization a feature for advanced users. She stated: "you might think that this is a good feature if you know how to use it. I don't see benefits in using it."

In what concerns the concept of adaptation, the opinions were more positive, in particular regarding the adaptation of the order by which friends and relatives are listed. U1 said: "I have more interest in seeing pictures of my grandchildren and my children and I like that they automatically appear first." U3 had the same opinion, adding the following regarding the adaptation of the order of entries in the main menu: "I use the application to view photos of my family and for taking and sharing pictures with them, so I like that the first two menu options are my family and my photos. Best of all is that I did not have to do anything to change that." However, U2 alerted us for the fact that sometimes the menu changed without him being aware. This lead him to occasionally select the wrong menu option. However, at the end of the trial he recognized that it was a feature that had plenty of benefits especially because it made it faster to perform a certain action.

### *5.4. Usability and User Experience*

As mentioned, in each checkpoint participants filled out both SUS and UEQ questionnaires. We now discuss these results.

U1 was the participant that better classified our prototype in terms of usability and user experience. The usability level, as measured by SUS, was consistently rated high and increased at each checkpoint (Figure 7). UEQ scores remained constantly high throughout the checkpoints with a single exception: dependability (Figure 8). This was expected given that the deployed system was a prototype, and thus not completely robust and stable. Another factor that contributed to the low dependability score is the participant's perception regarding the security of Internet applications, as can be seen in her statement: "sharing personal photos on the Internet is a little insecure".

U2 was the participant who worst classified our system in terms of usability and user experience. In the first checkpoint he gave a high usability level as measured by SUS (Figure 7) but the following checkpoints' results were substantially worse. This could represent his valuation of "You, me & TV"'s usability decreasing after the initial novelty weared off. This is particularly evident in this participant, since he continued using Facebook's native application, which has a higher level of usability than our prototype. However, it is important to observe that only checkpoint number 2 presented a SUS score marginally below 68 points, which is the average SUS score. UEQ scores reflect the same tendency (Figure 8). Only the novelty score maintained a higher value throughout the study, reflecting the participant's opinion about the novelty that speech and gestures brought to the interaction with Facebook. Finally, the attractiveness score, albeit decreasing in each checkpoint, was always in the positive range of the UEQ scale, meaning that the overall experience of this participant was still positive.

U3 also classified positively our prototype. The SUS score lowered from the first to the second checkpoint, but increased in the final checkpoint to a final score above

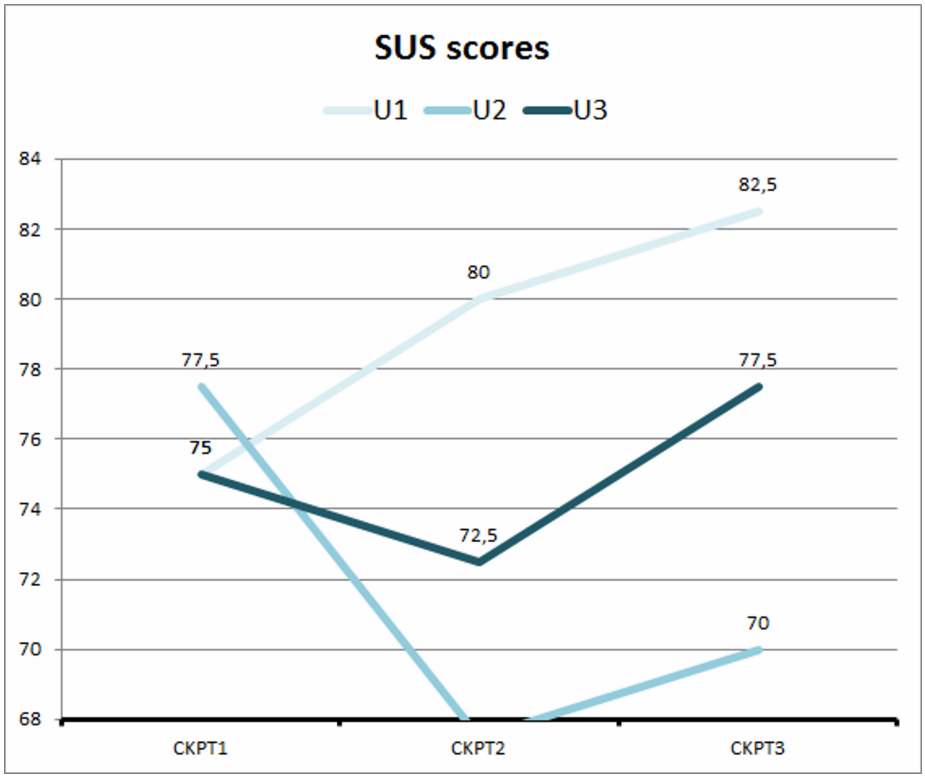



Figure 7: Evolution of SUS scores for U1, U2 and U3

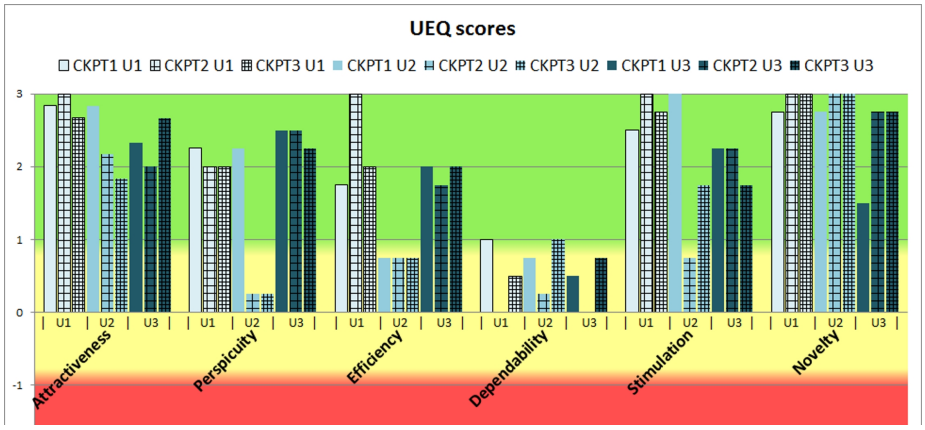



Figure 8: Evolution of UEQ scores for U1, U2 and U3

77 points (Figure 7). UEQ scores remained positive and stable across the period of the study, with the same exception that had already been observed for U1, regarding the dependability score (Figure 8).

In general, results indicate that our prototype achieved high usability marks and provided participants with a great user experience, especially taking into account that it is still a prototype.

## 6. Discussion

Our study provided indications that SNSs could have a positive impact on the lives of older adults. Participants recognized that during the duration of the study they were able to become closer to their relatives, increasing the number of interactions between them, both online and offline.

In accordance to previous works (Lindley, 2012; Judge et al., 2011; Gibson et al., 2010; Xie et al., 2012; Cornejo et al., 2013; Hope et al., 2014), our findings also strongly support that SNSs that want to meet the needs of seniors should focus primarily on family interaction. In our study, accessing content and interacting with family members, even if done offline, proved to be the main reason for adopting such technology.

The content older people prefer to consume is related to their family, allowing them to know more about their relatives. The type of content that the participants in our study preferred were photographs. There were two types of preferred photographs: photos from the senior's past that provide nostalgic moments and encourages them to re-establish contact with relatives, and current photographs of family that allow seniors to know more about their relatives status and activities, especially relatives that live far away.

In terms of novelty, and when compared with the traditional Facebook interface and functionalities, the feature of our system which influenced participants the most was the one related with sharing printed photos. The ability of using the Kinect camera to capture the printed photograph and send it as a digital memoir to their relatives on the network was seen, not only as an easier way to upload a photo than the traditional one, but also allowed both seniors and relatives to revive old memories and favored reciprocity. This is mainly because by visualizing this content on the their feed, relatives of the participants also uploaded more photos, favoring a chain of interaction around this type of digital artifacts. These findings not only support previous findings related with the importance of photo content to attract older adults on the use of social technology (Baecker et al., 2014; Gaver et al., 2011; Michailidou et al., 2015; Cornejo et al., 2013; Waycott et al., 2013) but extend these notions further showing viable ways of including new photo artifacts on SNS systems based on TV.

Television is a technology that older people face with optimism and do not feel uncomfortable using, since they are already accustomed to it. In that regard, we feel our choice of using the TV as platform for deploying the access to Facebook proved to be a contributing factor to their adoption. The fact that they can share TV content with their family was also identified as a positive factor. Participants indicated that the awareness of what TV shows they are watching created new streams of conversations, which consequently lead to an increase in the number of interactions with their relatives. Another

factor that made our participants comfortable using the application was the ability to interact with using the RC. This was the modality most used by the participants. However, when participants felt that the TV remote control was not the most appropriate way to perform a specific task then they looked for new ways of interaction. This was visible when participants found the RC too cumbersome to write posts and comments and explored alternatives and eventually switched to an easier modality for that task: using speech to dictate the contents. In the end of the trial, speech was the most frequently used modality to accomplish this task. This supports ours, and others (Gaver et al., 2011; Coelho et al., 2011, 2013; Karahasanović et al., 2009), perspective that a multimodal system is paramount given its ability to provide alternative modalities for all tasks that can be carried out within the application.

Two other concepts that can be important for improving the accessibility of an interface for seniors are personalization and adaptation. Personalization was not seen as positive by our participants, since it increased the usage complexity of the application. They had to learn how to customize it before they can reap the benefits of this feature, but they were not willing to spend that effort. Adaptation was much better received by the participants, who enjoyed not having to do anything to benefit from a better user experience. By adapting the order of the menus, participants performed faster and had the feeling the system acknowledges what they are doing, making them feel more confident. The only raised issue was related with the lack of awareness of when adaptation is performed.

Perhaps the most impacting factor relative to the adoption of our prototype was the previous experience of the participants with social networks. This is clearly seen in the usage patterns exhibited by U2 on the one hand, and U1 and U3 on the other. U2 was already a Facebook user, and saw limited benefits in using the SNS via a TV set. He did point out the benefits from having additional modalities to interact with, but overall he made limited usage of the prototype during the three weeks it was available to him. U1 and U3 were not previous users of Facebook, had none to limited experience with computers, and were not enthusiastic about the prospect of learning to use one. Providing them with access to Facebook through a platform they are already familiar with, proved to be decisive for adoption. The impact on their well-being was such that one of the participants asked for retaining the prototype after her trial period ended. The results strongly suggest that, for technology inexperienced users, TV can make Facebook accessible. Results also suggest that having access to Facebook increased the quantity and quality of social interactions experienced by seniors, both online and offline. Overall, we found evidence that a solution with characteristics similar to what we have deployed can help fighting social isolation of older adults.

Finally, we would like to discuss some of the limitations that constrained our study. The main limitation is the small number of participants in the study. We had to choose between having more participants for shorter periods or less for longer periods. Given the nature of the study we were conducting, we opted for the latter. Two factors constraining the number of participants were the lack of further hardware to deploy the prototype and the fact that the Facebook API was changed at the end of April, ending our study for all purposes. Having such a small number of participants limits the generalization of our findings. It also prevents us to investigate further factors that can impact the adoption or the proposed solution. However, we still believe that these find-

ings are relevant, and supported by having observed similar behaviors in participants U1 and U3, which had in common not being Facebook users.

Other limitations strive from the incomplete integration of the prototype with the TV set and an improvable implementation of the hand tracking and gesture recognition system. The former limited a more fluid exchange of attention between the Facebook application and the TV broadcast, which might have prevented further usage of our prototype. The latter limited the usability of gestures, which might have prevented a more extensive usage of this modality, given the combination of its heightened sensitivity with participants exhibiting hand tremor.

## 7. Conclusion

Social Network Services, like Facebook, have the potential to improve the quantity and quality of the interactions between seniors and their relatives and close friends, allowing them to feel (and be) more active, and assist them in fighting social isolation. In this paper we report a longitudinal study with three senior participants focusing on how the use of "You, me & TV" – a TV-based multimodal Facebook prototype – can help older adults to be more socially active. The results indicate a potential for this system to increase both online and offline social interactions between seniors and their relatives. Providing TV based access to Facebook was a contributing factor to the adoption of the system, and the resulting opportunities for social interaction. This was a decisive factor for the participants that were not Facebook users at the beginning of the study. However, its importance was smaller for the participant that already used Facebook. The prototype supported two innovative features which were very-well received by older adults: the possibility of sharing printed photos and the support for sharing TV content. Both these features have the potential for triggering offline conversations and, in that way, help fight social isolation of its users. Additionally, participants classified the prototype very high in terms of usability. Regarding interaction preferences, although the RC is still seen as the traditional way of interaction, speech was used mainly for content production tasks while gestures were seen as a viable option for visualization purposes. Finally, while the personalization features were seen as adding complexity to the system, participants really enjoyed adaptation mechanisms because they speed the interaction and provide them with a sense that the system understands them. This study shows that TV-based Facebook provided with appropriate modalities of interaction and adaptation features can help older adults tackle social isolation. Not only by making them use Facebook-related functionalities they do not feel comfortable to use on the PC, but mainly because these online interactions result in more offline interactions and in bigger reciprocity with their relatives. Finally, the novel features implemented in this prototype, by making use of standard and available technology (a Kinect sensor or camera and a RC) are easy to replicate or integrate into real TV-based systems.

## 8. Future work

While the prototype demonstrated some capability of improving social connectedness it can still be improved in a manner of ways. Future work should focus on the

implementation of more features related with photos (seniors indicated that this could even be the only type of application content) and TV content (they recognized that this type of content can trigger various conversations among family members). It is also important to provide a direct communication feature between older adults and their relatives. The main suggestion was to use video conferencing technology, and in fact, past work has shown receptiveness for this kind of functionality (Raffle et al., 2010; Vutborg et al., 2010; Judge et al., 2011; Baecker et al., 2014). Additionally, by providing features related with video-conference and voice-calls (which are already included on Facebook) the prototype could make sure older adults are not further kept out of this service. The possibility of integrating a specific button on the RC for sharing TV content, as suggested by the participants, should also be taken into account. Additionally, and resulting from both the results on the previous experience (Coelho et al., 2015) and from several findings on past related work (Karahasanović et al., 2009; Xie et al., 2012; Cornejo et al., 2013; Hope et al., 2014) focus should also go for the implementation of a privacy settings mechanism. This should make possible for older adults to share the contents only with a specific group, sub-group or single contact. It also should drift away from the default Facebook privacy options design as these represent a barrier for this segment of the population (Gibson et al., 2010; Norval et al., 2014; Lehtinen et al., 2009). These privacy options should at the same time be more simplistic, set to more private as a default and possible to gradually expand, and fit each mode of interaction.

In terms of future experiments design, it is important to focus on three distinct factors: (1) usability measures should be combined with social engagement measures. This would help confirming the findings regarding the potential of "You, Me & TV" prototype for improving social engagement and the use of SNS features. To measure social isolation we could consider the basis of Cornwell et al. study (Cornwell and Waite, 2009) and their measures of social disconnectedness and perceived isolation. (2) we should be capable of measuring the reaction of family members on the older adult use of the SNS, including reactions on sharing TV content. This way we could verify if the potential of the prototype is also on the relatives side. And (3) in order to improve the user experience of TV-related functionalities it is important to integrate the prototype in a TV or Set-Top Box context. Additionally, some focus should also be given on the use of Facebook "jargon" such as the word "feed", as it may be replaced by other word more familiar to older adults. However its use might also contribute for older adults to better grasp the meaning of it and improve their knowledge about Facebook. This contravention should be evaluated in next experiments. In the same way, we should also evaluate the use of the word "speech" for activating speech commands, and the possibility of replacing it for a word like "Facebook". This not only could be more intuitive, but also contribute further to feelings of familiarity with the service.

Finally, and concerning adaptation and personalization features, a more extended set of mechanisms should be implemented and tested with older adults. Relevance here should go for the implementation of adaptation mechanisms to help ease pointing interaction and compensate motor impairments like tremors. The implementation of an algorithm based on gravity attraction around buttons or on the proximity of UI elements could be two distinct possible solutions.

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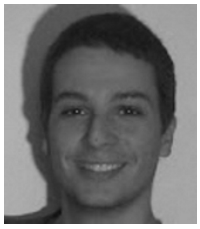

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