Multimodal Interaction in a Personal Life Assistant for the Elderly

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ABSTRACT
Over the years, people raise their children and watch them as they make their adult lives away from home. Because of that, and the advancing of the age, senior citizens lose contact and intimacy with their loved ones, as physical presence might not be possible. Also, because of physical impairments that may arrive, the seniors may experience some difficulties in communicating and interacting.

Thus, a research called PAELife (Personal Assistant for the Elderly Life) was created, and it aims to fight isolation and exclusion, helping seniors have a full life. Our personal contribution to this project is related to the display of the activity of the users’ contacts, so that they notice which friends are contacting them more and which ones do not contact much. To achieve that, we built two sets of prototypes - low-fidelity and functional - that display contacts’ activity from different sources (email, social networks, etc.) and performed user tests, in order to identify the best alternatives and understand if the seniors could perceive contacts’ activity. The tests’ feedback allowed us to understand, for example, that the length of the activity bars is better perceived than the areas and that the use of transparency should be avoided. Considering this, it was possible to implement a final solution that matched all the requirements collected. Finally, a user testing session took place, to test the finalized system - with fictitious and real data - demonstrating the validity of our solution while allowing us to make some final decisions.

Author Keywords
Social Networks; Contacts; Activity; Senior Citizens; Communication.

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces – Graphical user interfaces (GUI), User-centered design.

INTRODUCTION
As time goes by, people tend to become and feel lonely, especially if no family members and/or friends are often around [13, 16]. As children grow up and move out, so does most of the communication with them. This happens especially to senior citizens - who are the people with over 60 years old and, also, the ones who need more medical care and are hospitalized more often [15] -, who no longer need to support and take care of anyone. Because of this, they adopt a lifestyle that allows them to stay at home and not going out as much as before [6]. As a result, they tend to have less communication and lose intimacy with their loved ones.

In order to best understand how those limitations can impact the daily basis of the seniors, West et al. studied how function and visual impairment are the most problematic [14] and figured out that those limitations can actually promote dependent living. As a result, seniors tend to abandon social living and interaction. Other studies [2, 12] stated that these kind of limitations are often associated with the decline of quality life and the capability to be with other people.

Nonetheless, technology helps us communicate in many ways, and many people nowadays are already embracing those technologies and making a continuous, effective use of them to narrow the emotional distance between them and their family and friends, that often live apart [10, 11]. As so, technology has proven to be very useful, as it might help in fight isolation and exclusion and can break time-space barriers, which would not be possible without its use. However, senior citizens may have trouble using the kind of technologies described before. When growing up, they had not them around, so they are not used to them. Also, they are commonly resistant to change their lifestyles [6], mainly when it comes to technological aspects, as they appeared late in their lives. We wonder if we can help seniors overcome these time-space barriers, using technology to do so. Even if we could do it, there is a possibility that it would not work, because of the existent gap between seniors and technology; we are going to try to reduce it. Despite that, we believe that these changes would be acceptable to these users, because they might help them become closer to their loved ones.

Taking all this into account, the PAELife project has the goal of preventing and fighting isolation, exclusion and loneliness, promoting new ways of enhancing interaction so that the seniors can experience a more social and fulfilling life. Part of the problems to solve, and the focus of the research described in this paper, is to successfully tackle the remote availability issue, so that users can know how often is a certain person available for online conversation, or has
initiated that conversation in a number of different channels. Finding out an effective and efficient way to convey that information led us to study some alternatives, first with low-fidelity prototypes and then, with functional prototypes embodying the lessons from the first study. Our analysis of those studies allowed us to find a suitable solution, as well as a set of design guidelines that could help and guide the creation of similar applications.

**RELATED WORK**

We will introduce some examples of tools and technologies that addressed the contacts’ activity problem, also focusing on some guidelines on how to design and build interfaces for seniors.

**Organizing and Displaying Contacts’ Activity**

Ozenc and Farnham [9] studied and explored some natural ways of displaying visual representations of groups of people. In the study are represented common lists, pie charts, timelines, geomaps and treemaps. This work compared these ways of organizing and displaying groups of people, giving us an interesting overview of some of the most used representations.

The main purpose of this study [3] was to display the users’ activity so that it would become a way of stimulating users’ participation. The authors created IntroText, a new way of displaying the users’ activity on a community. This interface is based on multiple actions, as it captures all the interactions that can be performed on a certain online community. Based on those indicators, sentences are formed to let the users know how active a certain contact is. “[Username] is a loyal visitor” and “[Username] eventually shows up” are just a couple of examples of how the activity can be showed.

Another widget is called ‘Babble’ [4] and it provides cues about the presence and activity in an online conversation. The ‘Babble’ is a circumference that contains a circle on the center of it and several other colored, smaller circumferences - dots - (each one of the latter representing a contact). The proximity of the dots to that centered circle is a representation of how recently the contact has spoken to the user, which means that the closest a dot is to the center of the ‘Babble’, the most recently that contact has talked to the user. This way, each user can see what are the most active contacts, and what are the contacts that have not been talking much.

Morikawa and Aizawa [7] propose a system to facilitate awareness of peoples’ contactability and online presence. The framework proposed by this study tries to display the contacts in an innovative way, including a new way to let the users know that a certain contact is actually available for chatting. In the solution proposed by the authors, the contact’s avatar is what the user sees. The pictures are displayed in front of a colored background, which indicates the current status of that contact. On top of that, the avatars have their own opacity, whether its owner is in front of the computer or not. If an avatar is opaque, it means that its owner is sitting in front of the computer. As time passes, and if the user leaves its position, the avatar starts to fade out and becomes more transparent. This approach the problem of the transparency of the avatars, that may not be very noticeable by the senior users, who tend to see fewer details and lose visual perceptive, with the ageing process.

**Designing for Seniors**

There are a few guidelines that developers should take into consideration when designing for seniors. Sizes should be larger than usual, as seniors have difficulty in perceiving small details. Colors are a key point and should be used in as much contrast as possible [8]. Low saturation levels and transparency are to be avoided, but very bright colors might also fatigue the eyes [5], so balance is required. Background patterns should be avoided as well. Also, there is a need to make distinguished and important elements highlighted and visible, but without animations and distracting constituents [5]. These few guidelines are important concepts that are proven to be helpful when designing for seniors and that should be taken into consideration to help seniors take the best advantage of the interface.

**LOW-FIDELITY PROTOTYPES**

The contacts’ activity visualization development was processed in several steps, in order to correctly identify the users’ needs and build the visualization prototypes incrementally.

The first set of prototypes was made based on some of the implications described in the previous section. They incorporate all the features we want to include in the final prototype – general activity, specific activity regarding the different sources and the indication of new/direct messages from each source – but each of those features is specified alone, not only to not overwhelm the users, but also to understand exactly what the users expect from each feature and if they make sense, which would not be possible if they were all displayed together.

For the general activity, we proposed two different visualizations, which are presented in Figure 1 and 2. Figure 1 shows the activity apart by increasing or decreasing the sizes of the avatars, as the activity is higher or lower, respectively; Figure 2, instead, changes the transparency of the pictures, in a way that pictures with lower transparency are the ones that have the highest amount of activity. This makes sense because higher transparency makes pictures less obvious, which is an indicator that the contact is not around much.
Regarding the activity from the sources, we designed seven different ways of displaying this information. The first two, represented by Figures 3 and 4 only differ in the shape of the avatars. The first one has a squared representation, as it is the most used and the rounded one was also an alternative because it has the possibility of containing more sources, even tough that is not happening in the current phase of this project.

Figures 5a and 5b show another way of visualizing the activity from the sources, that is similar to the one showed in Figure 3 and that are represented on the next two figures. The approach on Figure 5a is similar to the one on Figure 3, but with the bars condensed in only one place, and horizontally. This approach was conceived because it is cleaner than the one on Figure 3. Figure 5b is also a similar alternative, but with the bars on the middle, instead of around the avatar. This approach was created because it is simpler to compare the activity from sources this way.

The three remaining options are very similar between them, as they differ only in the shape of the representation of each source, and are represented on Figures 6a, 6b and 6c.

Where notifications are concerned, the representations with glow, saturation change and numbers are very used nowadays, which is why we opted to create them in these first prototypes. The representation of the small dots was created because it could be simpler for seniors to count the dots. We designed four alternatives that are presented in the next four figures.
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social networks and other technologies disabling female session.
the number of interviewees was not 2013.
The first session was by the users.
these feedback with the requirements specified we could
seniors.
To find out what could be the best way of displaying the contacts’ activity, we performed preliminary user tests with seniors and evaluated the results of those tests. This way, we could compare the results that came from actual user feedback with the requirements specified before. Also, these tests are a way to engage seniors in the design of the framework, which increases the chances of its acceptance by the users.

Protocol for User Testing
To find out what could be the best way of displaying the contacts’ activity, we performed preliminary user tests with seniors and evaluated the results of those tests. This way, we could compare the results that came from actual user feedback with the requirements specified before. Also, these tests are a way to engage seniors in the design of the framework, which increases the chances of its acceptance by the users.

The first session was made in the beginning of December 2013 and a second one took place in February 2014, as the number of interviewees was not enough with only one session. We interviewed 20 people, 13 of whom were female, from 60 to 96 years old without cognitive disabilities and with none to low knowledge of computers, social networks and other technologies or tools. Each test was performed individually and before its start, the users were asked to sign a consent form, were they declared to understand the context of the tests and that it was anonymous and cost-free. After that, the questionnaire was performed and answered and the total amount of time spent with each person did not exceed 15 minutes.

The survey was divided into four categories: general information about the user, the users’ perception about the general level of activity, their perception about the activity from each source and their perception about the notification system. These questions represented everything we needed to know from the users, in order to understand what prototypes we should use and which ones clearly do not work for seniors.

Results
To understand which alternatives the users preferred, we applied a non-parametric chi-square test, where we determined that, for each set of alternatives, the expected result for each alternative is the total amount of users over the number of alternatives on that set (all things being equal, if there is no preference, then the same proportion of users should choose each of the alternatives). There were also a few questions where we just needed to perceive if the users understood the concept. The information gathered by those questions was analyzed differently, in a more qualitative way.

We did not find statistically significant differences between the two alternatives to represent the general contact’s activity (p=0,371). However, and even though the result was not statistically significant, the preferred alternative was the one represented on Figure 1, as 60% of the users found it slightly easier to understand. Also, and taking into account the visual impairments seniors might have, the alternative represented by Figure 2 could present higher difficulties in being perceived, which was actually verified in the tests.

When analyzing the information about the perception of the users regarding the different sources of activity, we based our questions in the comparison of the different approaches. Firstly, we compared the representations on Figures 3 and 4. Although the chi-square test did not reveal statistically significant differences (p=0,655), we understood the users took much longer in analyzing the rounded representation. As it is known, in the information visualization field, humans are better in analyzing straight lengths than rounded ones. Also, the squared representation is more appropriate to be implemented in the general solution of the project, as the rest of the interface is based on squares. Then, we analyzed the comparison between the visualization represented on Figure 3 and on Figure 5a. The differences were not also significant (p=0,655) but the users were confused about Figure 5a, as they did not understand where each bar started (if all from the beginning or if each one represented the total length). Then we analyzed the information collected regarding Figures 3 and 6a. Differences were statistically significant (p=0,025) which showed a preference for Figure 6a. Similarly to this last one, where Figures 6a, 6b and 6c were compared, the chi-
square test showed us a clear preference (p=0.004) for Figure 6a. Finally, in the comparison of Figures 3 and 5b, the result was not significant again (p=0.655), but Figure 5b revealed to be hard to understand as the bars covered a relatively large part of the avatar.

Regarding the notification system, the analysis of the results was much simpler, as the great amount of the users was almost unanimous in the understanding of the alternatives. Less than 10% of the users were able to understand (or see) the notifications on Figures 7 and 9. Also, only 25% of the users could perceive the notifications on Figure 8. The only approach that was well received by the users was the one represented by Figure 10, which got a percentage of understanding of 65%. Even though the results about Figure 10 were not very high, we observed that the people with no access whatsoever to computers and technology were the ones that had more difficulty in understanding the last approach.

Conclusions
Regarding the general level of activity, we opted to choose the representation on Figure 1. Even though the result of the test was not significant, Figure 2 could impose a problem in the correct understanding and analysis, since it changes the transparency of the pictures.

We were able to discard the rounded representation and the one represented on Figure 5a, as they would not be well incorporated in the rest of the system or were not very obvious. Although there was a preference for the representation on Figure 6a, we decided to implement the one on Figure 3 as well, as it was preferred when compared to other approaches. The representations on Figures 6b and 6c were also discarded, as there was a clear preference by Figure 6a, reinforcing the decision to choose it. Finally, and even though we could also choose the representation on Figure 5b, we decided not to, because most of the picture would be covered by the bars and the picture’s transparency changes could be a problem for the seniors vision. Thus, we decided to implement only, for the next study, the alternatives from Figures 3 and 6a.

Figure 10 was the only one that had a proper level of acceptance and was the only one the users could see and understand correctly, which made it the one to implement.

FUNCTIONAL PROTOTYPES
The first functional prototypes are the result of the tests and feedback collected from the users that was obtained in the low fidelity prototypes’ test session. By analyzing the conclusions from the first tests, we were able to understand what were the options that can best fit the users’ needs and interests. In these first functional prototypes we decided to maintain the several types of visualization separated, but incorporated the notifications in the sources’ visualization, as there was only one preferred option for that element. Also, we produced a prototype that gathers all the alternatives combined, in order to understand if it is perceptible by the users.

Regarding the general level of activity, we implemented the preferred alternative, as it can be seen in Figure 11.

![Figure 11. Functional representation of the general level of activity by the size of the avatars.](image)

As far as the representations for the different sources are concerned (with notifications), we implemented the two alternatives described before. Both alternatives are represented in Figures 12 and 13 and both of them have the notification system.

![Figure 12. Functional representation of the activity from sources in bars (with notifications).](image)

![Figure 13. Functional representation of the activity from sources in squares (with notifications).](image)
Finally, we merged these alternatives and created a single view that maps what we are trying to create from the beginning. As before, there is an alternative with bars and another with squares, represented in Figures 14 and 15, respectively.

These first functional prototypes display information created by us that represent the contacts’ activity in the several sources. Each contact is fictitious and its information represents a few activities a person can perform on each source: number of posts on Facebook, number of tweets, number of friend requests, emails sent to the user, missed Skype calls and others. Each of these elements helps composing the length of each bar and, together, they compose the size of the avatar in the alternatives where that happens.

To perceive if the visualization with many contacts was still understandable for users, we decided to create four distinct scenarios: the first one with 20 contacts — a relatively low number of contacts, which is likely the case of most seniors — and just a few contacts that are highly active; a second one with also 20 contacts, but with contacts that have a more uniform level of activity; a third one with 100 contacts, similar in activity as the first one; and a final scenario with 200 contacts, as it is the average number of Facebook friends per user. By creating these different scenarios, we are able to test each alternative with each scenario, making it possible for us to understand if the visualization was not reliant to a small number of contacts. Also, it proved that the packing algorithm worked correctly and appropriately with a high number of contacts.

Protocol for User Testing

After performing the preliminary user tests with seniors and evaluating the results of those tests, we came up with the implementations described before. With these intermediate prototypes complete, we also needed to do another session of user testing, in order to understand if these representations made sense and are well perceived by the users, and also, to make a final inquiry on which of the two alternatives for the activity in sources is better, so we are able to choose a final one.

This session took place in April 2014 where we were able to interview 15 people, 9 of those were female and 6 were male, from 68 to 90 years old without cognitive disabilities and with none to low knowledge of computers, social networks and other technologies or tools, which are roughly the same characteristics of the participants of the preliminary user tests. Each test was performed individually and we made sure to the users that their participation was anonymous and cost-free. The questions were made and answered and the total amount of time spent with each person did not exceed 15 minutes.

The survey was divided into six categories: general information about the user, the users’ perception about the general level of activity, their perception about the activity from each source, their perception about the notification system, perception about the total amount of activity (general and sources) and a few conceptual questions regarding actual tasks that can be performed using our solution. These questions focused on the perception of the activity of the users and were meant for us to know if the prototypes chosen previously are working correctly and are well adapted for the users’ needs.

Results

In these tests’ results, we decided to adopt the same method we used in the low-fidelity prototypes’ tests. We applied a chi-square test to analyze the preferred options when we asked for comparisons and analyzed the general understanding in each alternative.

In the perception about the general level of activity, and as we only had one option, we asked the users if they understood the concept correctly. More than 65% of the users were able to understand the concept and make the comparison of the general activity between two contacts.

1 http://www.pewresearch.org/fact-tank/2014/02/03/6-new-facts-about-facebook/
correctly. Some of them found it confusing, as it is not a concept that is commonly used, but after a simple explanation, most of them understood it correctly.

Regarding the perception about the sources of activity, more than 90% of the users were able to perceive both approaches. However, the comparison of the activity between two contacts was well perceived in Figure 12, as 93% of the users were able to compare easily and correctly, while only 33% could identify who was most active on Twitter on Figure 13. This happened because humans are better in perceiving changes in length than changes in areas. Also, the results from the preference of the users supported the difficulties they had in analyzing the sources’ squares. The result of the chi-squared test was statistically significant (p=0.004) as the users showed a clear preference by the option with the bars.

Both alternatives from the notification system (the same approach chosen from the previous user testing, but represented inside the bar and inside a small rounded circle) were well accepted and interpreted by the users, as over 85% of them understood both alternatives. However, the chi-squared test was statistically significant, although with a lower confidence (p=0.071), which showed us a preference by the representation of the notification’s number inside the bar (Figure 12).

Finally, we asked the users about their perception about the total activity (general, from each source and with notifications), which is a representation of what the contacts’ visualization will probably look like in the final prototype. As expected, the representation with the bars was preferred to the one with the squares (test showed p=0.004, a preference for Figure 14) and the understanding was higher in the alternative with the bars – 80% - than the one with the squares – only 40%.

Conclusions
As we only had one alternative to represent the general level of activity and it was well accepted by the users, we are going to continue to use it in the final prototype. The same goes for the notification system, that was incredibly well perceived; to represent the notifications, we will choose the option that has the number of notification inside the bar, as it was the preference of the users, and it makes the matching (notification to source) more immediate.

Regarding the activity from each source, it was clear that the users had a preference for the representation with the bars, and it was also clear that this representation made the comparison of the activity of the contacts much easier. Because of all this, on the final prototype, we will implement only the representation with squares, as shown on Figure 14.

IMPLEMENTATION
This phase of the work was meant to be implemented just with real data. However, and as we were afraid that the users might not have accounts on any of our sources, we decided to maintain some fictitious data.

Also, our work was developed using a Windows Store App template, as a result of a requirement of the project. Also, as the work is integrated with other modules of the project, we had to adapt the development to maintain consistency.

Displaying Contacts
First of all, and when we started to build the first functional prototypes, we had to think about how to design our contacts’ avatar, which is represented on Figure 16. This element is the base of all the contacts, which all look the same.

![Figure 16. Contact with sources’ activity and notifications inside the bars.](image)

Packing Algorithm
After the creation of the contact element, another very important detail we had to think about was on how to pack the contacts’ on the canvas.

As the size of the avatars is not always the same (even though they are all squares they have different areas because of the different level of activity each contact may have), we needed to create a packing algorithm that packed the squares in the available empty area. To achieve this, we based our algorithm in an existent one, which tackled the problem of packing blocks into a fixed rectangle\(^2\). Our solution was based on setting the maximum height size to the computers’ screen resolution and maximum and minimum values for each avatar size. After that, we take into account the algorithm we based ourselves on, and place an avatar on the first empty space it finds. Then, and instead of horizontally dividing the empty area into two, we do it vertically, so our biggest avatars are placed on the left side on the canvas. Each new avatar is then placed in the leftmost empty area available where it fits. We do this recursively until we have no more avatars to place on the canvas.

Information Collection
When we had access to the Social Networks API, in which we could retrieve the actual information that we would be

\(^2\) [http://codeincomplete.com/posts/2011/5/7/bin_packing/]
able to use in our work, we were able to understand that we had the following information: Facebook Private Messages, Public Messages, Unread Messages and Likes; Twitter Private Messages and Public Messages; Emails Sent.

This information, stored in a text file, represented the same information that we collected from the API, which allowed us to have two similar alternatives.

**Activity’s Assessment**

As the contacts may have very low activity levels, it might become tricky to analyze the activity levels on those types of contacts. As so, we decided to calculate the activity level multiplying the original activity by a factor that would change accordingly to the contacts’ level of activity. Regarding each source of activity (that is displayed in the bars around the contacts’ avatar), we used the factor in a way that is represented in Figure 17.

![Figure 17: Multiplying factor variation regarding the variation of the activity on the sources.](image)

The X-axis represents the amount of activity that a contact might have - in each source. These values were determined empirically, accordingly to the total length of the bars, and are here translated from "Very Low" to "Very High", in which "Very Low". The multiplying factor was, as well, determined empirically. This solution allows us to prevent the problem described previously, in which we might have contacts that appeared to have no activity at all.

A similar approach was used to the calculation of the general activity, which is translated by the total area of the avatar, even though the factors were quite different – also determined empirically.

**Group Visualization**

We decided to represent the groups in two different ways, and evaluate these alternatives in a later user test session.

A first approach was to display the groups in an horizontal line and the second one with a dropdown, right above the contacts, just as presented on Figures 18 and 19.

![Figure 18: Visualization of the groups in an horizontal list.](image)

**Contacts’ Activity - Friends**

The first approach seemed the best to us because it only takes one tap to change the group. However, in this alternative we had to confine the number of groups to be created. The second approach might allow a larger number of groups, but it requires two taps to change to the view of another group. As so, we decided to maintain both alternatives and let the users choose what best fit them.

**Managing Groups and Contacts**

Regarding the contacts and groups management, the users can perform several actions: create, rename and delete groups. These actions allowed the users to manage all the groups in the application. So that the users could add contacts to the groups, they could also work on that: move contact to group and remove contact from group. This way, the users could segment their contacts into several groups, easily finding them and analyzing their activity.

**Data Persistency**

In order to keep the contacts in their groups after the application is shut down, we had to find a way to maintain the groups’ data persistent. The way we stored the groups’ information in the variable was as follows:

```
{<Group's name>:<Contact-1 ID>,<Contact-2 ID>,<Contact-3 ID>,...,<Contact-n ID>}
```

This way, not only the groups are stored, but the application runs this variable and quickly finds out which contacts are in which group. We needed to implement this persistency feature, as the Social Networks API did not allow writing permissions.

**EVALUATION**

In this section we will explain all the procedures that we followed during the last user test session.

**Protocol**

We were able to interview 15 people (in homes in Lisbon), 6 of whom were male and the rest were male, from 70 to 91 years old without cognitive disabilities, that were able to see and read, and with none to low knowledge of computers, social networks and other technologies or tools. Each test was performed individually, in a room were the users could sit and interact with the device, and we made sure to the users that their participation was anonymous and cost-free. The questions were made and answered and the total amount of time spent with each person did not exceed 20 minutes.

The survey focuses on two main aspects: perception of the users about the contacts’ activity using fictitious data and their perception of the contacts’ activity regarding their own
contacts; thus, with real data. Apart from that, we included some tasks for the users to perform, that tested all the interactions in the application and debriefing questions, for qualitative study.

Results
The first two questions regarding the perception of activity when comparing two contacts had a task completion of 9/15. It is important to state that the users that could not answer those questions were some of the ones that never had any contact with technology. Also, in those questions we measured the time that the user took in answering the question and give an answer. As the first question was usually asked first, the average time to complete the answer was 28 seconds, and the second one (very similar to first) took only 18 seconds, in average, as the users already knew what to search for. So, for the first question we estimated a standard deviation of 30.76 seconds and for the second one, 22.03. Thus, for a level of confidence of 95%, the confidence interval is [7.904,48.096] for the first comparison and [3.6,32.4] for the second. The same applied to the next two questions, in which we asked the users about the contact with higher and lower level of activity. Both the tasks had 6 answers and the average times of response was within a reasonable limit.

The first task that asked the users to create a new group had a completion of 7/15. The average time to perform the task was 62 seconds (the time in which the users were writing the name of the group were not taken into consideration), with a standard deviation of 39.48. As so, for a level of confidence of 95%, the confidence interval for this task is [32.76,91.24]. The next tasks (all of them had a task completion of 6/15) were performed without major difficulties and were all quite similar. The tasks that only required group management were performed with fewer average times than the ones that involved contacts management. The tasks about renaming and deleting groups had an average time of 54 and 51 seconds, respectively. Using the standard deviation calculated for those results - which is 33.1 and 38.2, we were able to calculate the confidence intervals of [27.52,80.48] and [20.5,81.5] for 95% of confidence. The average number of errors for these two tasks was also very low: 1.2 for the renaming of a group and 0.8 for its deleting. Once more, typing times were not considered. Finally, the results for the tasks to move and remove contacts from a group were analyzed. These revealed some higher average times in performing those tasks. These results are also explainable: the users something clicked the wrong contact when they had to choose it, which made them deselect the contact and select the right one. Also, when managing contacts, more taps are required, which undoubtedly increases the completion times.

Finally, we analyzed the results from the final task, in which the users had to visualize the contacts’ activity from another period. This task showed amazing results: all the users performed the task with 0 errors and the average completion time was 23.67 seconds and the average completion time was 23.67 seconds, which translates to a confidence interval of [13.17,34.17] for 95% of confidence.

After this, we could analyze the information that we collected from the debriefing questions and from informal conversations with the users. For the two alternatives of visualizing groups, we applied a non-parametric chi-square test. Even though the result of the test was not statistically significant (p=0.205), there was a preference for the alternative with the list, even it was by a small margin.

Regarding the debriefing questions - the ones in which the easiness of performing the tasks was evaluated, the results were satisfying: only around 12% of the users found any of the tasks difficult or very difficult.

Conclusions
This final user test sessions allowed us to choose which of the two ways of visualizing the groups we should use. Of course that we opted to eliminate the dropdown, maintaining the very first approach we implemented: the horizontal list, as the results from the user tests - even having non statistically significant results from the chi-squared test, showed a preference for the horizontal list.

Also, although the amount of users that were able to complete the tasks were roughly the same amount as the ones that could answer the first questions about the perceiving of activity, the response times were significantly high. The users struggled in opening the bottom bar, and many times they closed the application in the process of pulling the bar up. Also, they felt confused by doing operations whose context is not familiar to them, as groups creation is not a very common action. Even though the results were not very good, we were not extremely concerned: the main focus of the application is to visually show the activity of the contacts, in which many users succeeded in analyzing. The group management was an extra feature that we included in the application due to the addition of the requirements to the project and it can be used separately regarding the contacts’ visualization.

A main component of the test session could not be evaluated - the component with the real data from the users - because the users did not have accounts in which they could login and test the application. This shows us that, probably, only a very small amount of seniors will use the application due to the fact of having accounts on Gmail, Twitter or Facebook. However, and as many of the users from our session performed surprisingly well in the tasks they were asked to execute, they might have seen the benefits that the application could offer them, and as they did not struggle much, they would not feel scared to use it.

CONCLUSIONS AND FUTURE WORK
The PAELife research was created, with the main objective of fighting isolation and loneliness among seniors, promoting new ways of interaction. To achieve that, and
focusing on our own contribution, we developed an application that displays the contacts’ activity of an user, in order to allow the users to identify their active contacts easily. This way, the users will know with whom they can readily interact with, by the means of the activity analysis.

We produced a first set of prototypes that map all the features we needed to include in our system. Those features were tested with users, and the results collected showed us what were the options we clearly needed to discard and what others were good for the seniors to use.

Then, and taking into account the prototypes previously produced, we chose the alternatives that were most understandable and preferred by the users and built the first functional prototypes. This time we made a similar session of user testing, not only to choose a final representation of each element, but also to perceive if the representations chosen before were still accurate and understandable.

In the final work of this project we only had one alternative for each component. Finally, a final session of user testing was required. Apart from questioning the users about the perceptibility of the activity on the three components of the application, we asked the users some qualitative questions, and performed a debriefing questionnaire, in order to perceive and collect feedback in a way that no answer to a task could. The results of the final user test session showed us that the users could interact with the system with relative easiness.

If we could continue with the work, we would have wanted to explore more ways of visualizing the activity, regarding each source and the general activity. This would allow us to determine if there were still better solutions to display the contacts’ activity to the users. Also, it would be interesting to develop new ways of display the management groups and contacts. The most difficult action for the users was to pull up the bottom bar that displayed the available actions regarding groups and visualization of activity on other periods of time.

REFERENCES