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Towards the acceptance of care robots by senior users

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ABSTRACT

The acceptance and usability of robots by their final users differs from the acceptance of other types of technological innovations, and these differences are even more accentuated in the case of Social Assistive Robotics intended for the senior people. In addition, it has to be taken into account that a robotic system that has only been tested with regular users may not meet older users' expectations. For that reason, it becomes necessary to involve the said users in the design and testing process. On the other hand, in the robotics field, it is common practice to try and reuse robotic designs and implementations in different scenarios. However, in the particular case of social robotics, many developed services and robot behaviors do not translate well between domains or even subdomains. In the present paper, we present the results of the first interaction experiments between the humanoid robot Sacarino and two groups of users: middle-aged users under lab conditions and senior users in a care facility. Sacarino is a humanoid mobile robotic platform initially designed to provide information and accompany guests in a hotel. With the current experiments, we aim to explore the extent to which the results obtained in a hotel environment can be extrapolated to the assistive environment and if a robotic system intended for senior people can operate properly in real conditions, having only been tested with regular users.

CCS CONCEPTS

• Human-centered computing; **• Ubiquitous and mobile computing**; **• Empirical studies in ubiquitous and mobile computing**;

KEYWORDS

human-robot interaction, interface design, social robotics, care robots for the older people

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1 INTRODUCTION

Assistive Robotics (AR), which has led to Social Assistive Robotics (SAR), merges activities traditionally developed in social robotics with those that belong to the healthcare and assistance field. These technologies are of great interest, since different studies have shown that the use of social robots in the care setting can have therapeutic benefits for all types of dependent patients, in areas ranging from autism [4] to post-stroke rehabilitation, or dependent persons suffering from dementia [5].

In that sense, the gradual aging of the population poses challenges to the long-term policies of the different countries, especially in the provision of health services and care for the older persons. The growing demand for care services from an aging population requires that multiple actors in society work together to explore how to overcome the challenges ahead. Thus, one of the initiatives explored is the deployment of social robots for the care of the seniors at home or in care facilities. For example, the works of Wada and Shibata [1] using the robot Paro in care facilities show how the robot strengthened social bonds among residents, in addition to the fact that most residents established moderate or strong links with the robot. On the other hand, Sabelli et al. [3] used the robot Robovie in a teleoperated way, making him act as a conversation partner with senior people, conducting interviews with them using simple dialogues. The analysis of the results of the interviews, together with the data obtained through direct observation, indicated that the robot had a good reception among the older persons.

It should be noted that the acceptance of robots by the users differs from the acceptance of other types of technological innovations [14].

This generates several challenges when facing the transition from a robot (or any other device) developed in the laboratory to its target domain, even if the robot is designed with a specific end user in mind. Due to the separation between the research environment and the end user environment, special care must be taken to ensure that a robotic development adequately meets the needs of its final users, especially if those users are somehow dependent. Therefore, it is imperative for the development of assistive technologies, to involve the end user in the design and evaluations [6]. These end-user assessments, along with their appropriate metrics, can provide

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the basis for initiating the transition from pilot development in the lab to the final product in the care setting.

With these considerations in mind, and with the ultimate goal of developing a new robotic platform intended for the care of the older persons, in this article we describe interactive experiences of the robot Sacarino with senior participants of the 'Centro Sociosanitario Hermanas Hospitalarias', Palencia (Spain). Sacarino is a humanoid mobile robotic platform (Figure 1) initially designed to provide information and accompany guests in a hotel [15]. Proxemic studies have successfully been performed with the robotic platform [16], and it has been validated over a two-year period in a process of successive refinements [17].

2 THE CARE ENVIRONMENT

We argue that the lessons learned and the knowledge acquired during the development and validation of the Sacarino robot could serve as a basis for the development of a new robotic platform for the healthcare environment [15][16][17]. However, with the change of environment (from the hotel to the care facilities), there are great differences both from the end user and the robot point of view in terms of the type of interaction and services that the robot should offer, communication channels, design of interfaces, etc. For these reasons, the need to reconsider the services offered along with the design of the interface and functionalities arises. Consequently, it is necessary to perform new validations and experiments like the one proposed in this article that can serve as feedback in the development of a new robot oriented to this new environment.

There exist various works that describe the guidelines and evaluation metrics for the transfer of robotic developments from the laboratory scope to real scenarios [7]. However, in the case of social robotics, most of the metrics employed do not translate well between domains or even subdomains [6]. For this reason, in our particular case, the results obtained in the hotel sector may not be applicable in the healthcare area, even using the same robotic platform, even though there are expected to be certain similarities. The main differences considered a priori between the two scenarios are described below.

- The kind of interaction in the hotel was impersonal and of short duration since the hotel guests are generally just passing by. The required services are focused on providing information (room location, weather, news, information of places of interest, schedules of the hotel restaurants, menus, etc.). On the other hand, the interaction with senior users involves a much more personal treatment and should focus on trying to establish a continuous and adapted relationship for each user.
- In the case of the care facilities, services should focus on entertainment and attendance, but it is important to promote and strengthen the relationship between the user and the robot.
- These differences should also be reflected in the design of the robot screen interface. While in the hotel the interface was fixed without considering aspects related to accessibility, in the case of the care facility, a configurable interface design that covers the wide range of possible age-related user disabilities is needed.

Taking the above into account, the present pilot study intends to explore the following research questions:

- To what extent can the results obtained in the hotel sector be extrapolated to the care facility?
- In terms of usability for the seniors, can web and mobile application design recommendations be extended to the robotic field?
- To what degree can a robotic system designed for older people operate properly in real conditions, having only been tested with regular users?
- What kind of services should an assistant robot offer and how can the limitations in communication that may arise be overcome?

3 EXPERIMENTAL SETUP

Sacarino (Figure 1) can interact with the users and to move around the hotel dependencies. From the interaction point of view, it has the ability to use different communication channels: conversational agent, speech recognition and synthesis, gestural ability through the movement of arms and neck as well as through a set of LEDs located in eyes and mouth, and also showing and receiving information by means of a touch screen located in his torso (Figure 1). Even though the robot has proven to be fully operative, hardware and software modifications were needed in order to accommodate the robot for the new experiment.

3.1 Hardware adaptation

From a hardware point of view, the main modification from the configuration used in the hotel has been to include the Android operating system. The use of an Android operating system allows us greater versatility for the graphical interface shown on the touch screen, ease of interface programming and better integration of resources (google voice recognition and more applications).

It should be taken into account that, as shown in [8], when a robot performs body gestures the comfort distance of the users increases, causing them to position themselves away from the robot in order to avoid physical contact. For this reason, the robot arm movements have been disabled so that senior users are not intimidated when it comes to interacting with the touch screen.

3.2 Screen interface adaptation

From the software point of view, the original design of the interface on the screen also required certain changes since the size of the letters, colors, or the amount of information shown was not suitable for use by senior users as shown in Figure 2. For the new screen interface, we have followed the indications of [9] and [10] for the design of applications oriented to the senior users.

3.3 WOZ Dialog Control

Both the voice recognition and synthesis are based on Google services provided by Android. However, for this experiment, a Wizard of OZ approach was employed, in which the researcher can remotely validate the response chosen by the conversational agent or Chatbot or select an alternative answer. This methodology was chosen to minimize the effects of possible errors in the speech

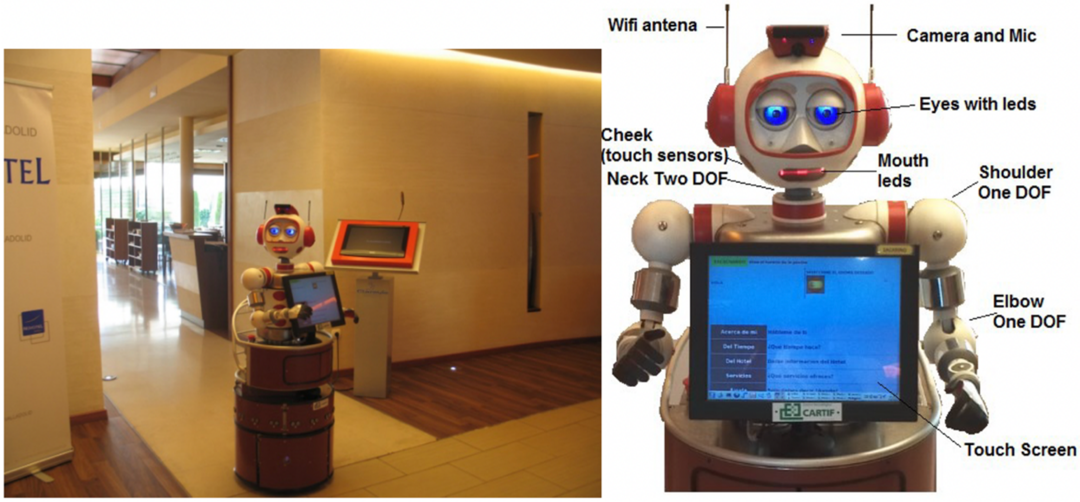

Figure 1: Top image, Sacarino at the hotel. Bottom image, robot's components for interaction purposes.

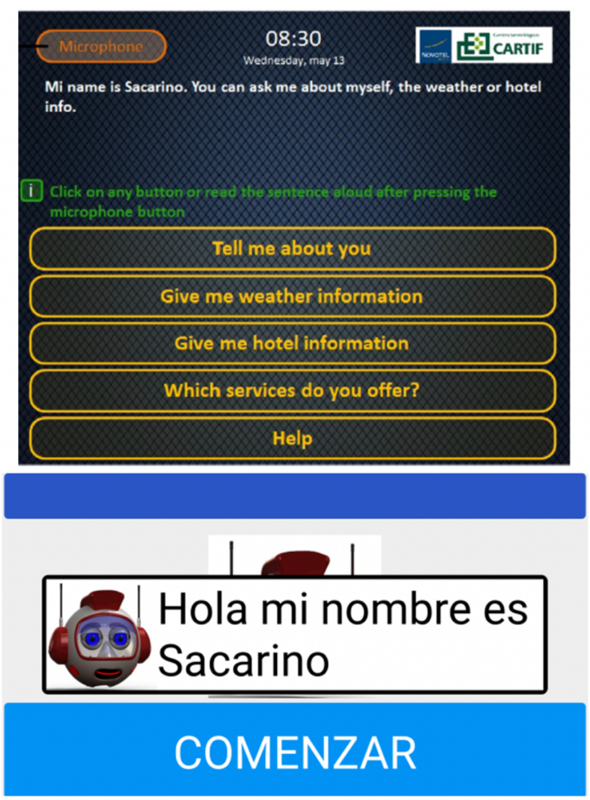

Figure 2: Interface screen used in the hotel environment (top); and new interface screen corresponding to the introduction for the experiment (bottom)

recognition, as well as to obtain guidelines for the refinement of the Chatbot rules.

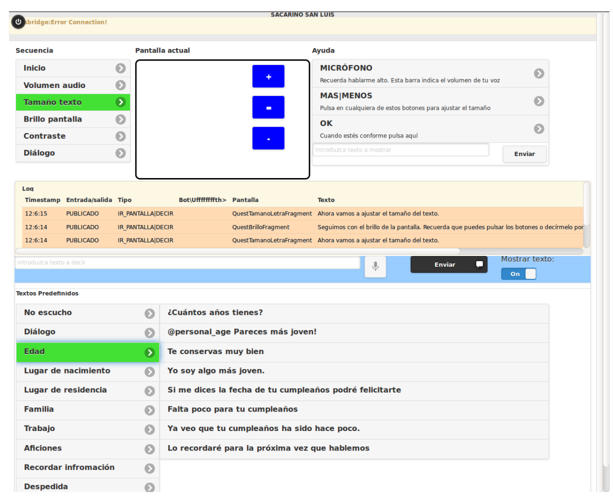

Figure 3: WOZ web control interface

A web interface has been developed to remotely control the robot using the jQuery Mobile framework that can be run on any mobile device or desktop PC. The interface is housed in the robot and can be used remotely in a bi-directional mode through an Apache web server (see Figure 3).

3.4 Population

The experiment was divided into two phases. In the first one, we tested the robot interaction skills with staff at our research center (Cartif Technological Center). In this first phase, 27 participants took part, 15 men and 12 women aged between 21 and 53 years. In the second stage, the robot was taken to the senior care facilities at the 'Centro Sociosanitario Hermanas Hospitalarias', Palencia (Spain), where the experiment was repeated for a group of 10 residents, of whom 3 were men and 7 were women aged between 75 and 88 years.

3.5 Experimental development

Before the beginning of the experiment, participants were asked to read and sign a consent form which informed them of the purpose of the experiment and notified them that the experiment would be recorded. This form was sent to the senior care facilities one week before the experiment took place there, so that it could be reviewed by a family member or patient representative if necessary.

The robot was placed in an isolated space for the experiment, so that only one participant would interact with it each time. A researcher in charge of managing the robot dialog through the WOZ interface was in an adjacent room. Before letting the participants interact with the robot, a brief explanation of the experiment was given to the participant, indicating that the interaction with the robot could be carried out both by voice or by using the touch screen. The participant was then left alone with the robot and, from this moment on, the robot was remotely commanded to make a brief presentation explaining the content and purpose of the experiment to the user, as well as the interaction possibilities available.

The experiment was divided into two phases: in the first, the robot asked the user a set of questions about their preferences regarding the interface (text size, brightness and contrast) and the volume of its voice. For each of the configurable features, a simple screen (Figure 2) with a set of buttons had been created. The robot introduced the user to each of the screens and asked him/her to adjust the desired parameter. The second part of the experiment consisted of a dialog in which the robot tried to acquire personal information about the user as well as their hobbies. During the experiment, a splash screen superimposed on the touchscreen interface showed the text being spoken by the robot (see Figure 2).

The dialog with the users was intended to obtain personal data to improve future interaction and services given: name, date of birth, birthplace, activities or hobbies, family and relatives information.

In addition to audio and video recordings, information pertaining to each interaction was stored in log files. Those logs included information such as: time at which an action occurs (screen touch, speech synthesis, etc.), input method (e.g. voice, touch), screen change, voice synthesis, etc. Also, participants in the first experiment in CARTIF were asked to respond to a test consisting of six questions, with answers given using a 5-level Likert scale. These questions refer to different aspects of the interaction as well as the expectations regarding the robot usage. In addition, after each question, a space for free responses was left. A checklist with different options was also included in the last question, related to the possible usages of the robot as an assistant for the senior users.

4 RESULTS

4.1 Questionnaire results

What follows are the results of the written questionnaire given to the participants of the first experiment, after completing the interaction with the robot. All statistical analysis was made using SPSS 22 with alpha value at 0.05.

Since some of the users had a little knowledge of the robotic platform before the experiment was performed and some had even seen it operate, Mann-Whitney (2-tailed) tests were performed on the answers of each of the test questions to determine if there were significant differences based on previous experience. Mann-Whitney tests were also performed considering the age and sex of the participants as a factor. The results obtained showed that, for all the questions, there was no association between the value obtained and previous experience with the robot, since the mean responses for both groups were not statistically different at the level of significance alpha = 0.05.

From the obtained questionnaire results, we can see that in terms of voice synthesis the users correctly understand what the robot says (Mean = 4.93, Standard Deviation = 0.267). Also, from the captured videos and logs, we can confirm that almost no users asked the robot to repeat any sentence. However, there were two users who referred to the robot's intonation and pronunciation of some sentences as slightly monotonous. In this sense, we have to note that the Android Spanish voice sometimes does not correctly intone some sentences (mainly the ones that contain questions or exclamation tags). In any case, and although alternatives could be sought for voice synthesis, a more realistic voice may be inconsistent with the robotic appearance of the system.

On the other hand, users indicated that the text displayed on the screen could be read perfectly (Media = 4.85, Standard Deviation = 0.362) and also valued positively the ability to customize different aspects of the screen interface such as brightness or contrast.

In terms of interaction, the obtained results show that users consider that talking to the robot is somehow strange (Mean = 3.22, Standard Deviation = 1.013) and that, although the conversation is correctly carried out (Mean = 4.00 , Standard Deviation = 0.679), it is not like talking to a human (Mean = 2.93, Standard Deviation = 1.035).

These results can be understood taking into account the fact that the objective of the first part of the experiment was not to have a human-like interaction and dialog, but to perform an evaluation of the preferences of the users in terms of the interface appearance, as well as the voice volume in real operation conditions. For this reason, the robot's questions and answers in this first part of the experiment were limited to questions such as "Is the font size okay?" or "(referring to the volume of the voice) lower or higher?", which resulted in a limited interaction.

In addition, no response was sent to the user inputs from the WOZ control until a notification from the text recognition system was received, as would happen under autonomous operating conditions. This means that when sending a response to the user, variations in the speed of the given response happened due to the latency of the Google services connection. The obtained scores may therefore be due to a possible mismatch between the robot's appearance and behavioural expectations and the real behaviour, since some users indicated that the interaction was slow and it took the robot quite some time to provide a response.

On the other hand, some users also referred to the robot's lack of mobility in terms of gestural ability. It should be considered that, as shown by the results of [8], when a robot makes body gestures, the comfort distance of users increases, positioning themselves away from the robot to avoid physical contact. Therefore, the arm movements had been limited, so that users were not intimidated when it came to interacting with the touch screen. On the other hand, the robot was programmed to track the user's face, and tracking errors sporadically occurred, causing the robot to look at a luminaire located at the back of the user.

Finally, in terms of the expectations of robot usage, users considered that the robot could be a useful assistance tool (Mean = 4.27, Standard Deviation = 0.778). All users consider the robot useful as a help with daily tasks (calendars, reminders ...). A large majority also find it useful to contact friends and family and offering information. However, users do not see the robot as a friend or partner, nor to organize physical exercises.

In terms of usage expectations beyond those offered in the questionnaire, users considered the robotic platform useful for: "Helping with technology", "Home automation control", "Help with household chores", "Alarm in case of emergency" or "Interaction with third parties: translator".

4.2 General considerations on the results with the senior group

As mentioned before, in a second stage of the experiment, the robot was taken to the senior care facilities of the 'Centro Sociosanitario Hermanas Hospitalarias', Palencia (Spain), where Sacarino interacted with a group of 10 residents. Of these, the results of one of the patients could not be taken into account since, although he enjoyed the interaction, his mental condition did not allow him to interact with the robot in a way that allowed us to obtain relevant results.

It is noteworthy that, as in other studies [1][2][3], the robot tends to be a topic of conversation among older people, which were intrigued" by the novelty of having the robot around. On the other hand, however, they showed some insecurity at the beginning of the experiment but turned more confident as the conversation developed and more willing to provide personal information after some empathic commentary from Sacarino. This behaviour is in accordance with results in the literature, since there is evidence that a robot's empathic behaviour has positive effects on interaction [18].

An important aspect to keep in mind is that although the users of the care facility were advised of the possibility of interacting with the robot by voice or through the touch screen, and that users are indicated to place themselves at such a distance as to allow them to touch the screen (see Figure 4), older people seem in general terms to prefer spoken interaction.

4.3 Comparison of results in terms of interface configuration

As described before, in a first stage of the experiment the robot performs a series of questions about the configuration of the interface, allowing the user to select the volume of the robot's voice, the size of the displayed text, the brightness of the screen and the button contrast. Table 1 shows the comparison between the results obtained for each of the characteristics in both stages of the experiment (regular users vs senior participants).

During the experiment, the initial configuration of the interface is set at random, but maintaining values that do not vary too much from the central value of each of the characteristics. Collected shows that, more than half of the 27 participants in the CARTIF experiment did not modify the interface configuration given by default, and a large number of those who did so returned to the initial configuration after modifying any of the characteristics. On the contrary, in the case of the care facility, all users modify to a greater or lesser extent the initial values. These results correspond to the indications given in [10] and [11], which emphasize the diversity of impairments that older people experience in terms of sensory functions and mobility, making it difficult to establish an interface configuration that accommodates all users.

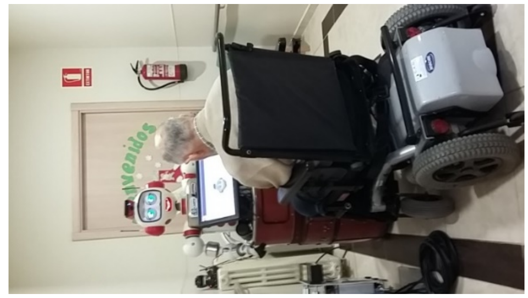

Figure 4: One of the participants interacting with Sacarino at the Care facilities

In terms of volume, the user is given the possibility of selecting from 10 levels: ranging from (~70 dBs) to (~80 dBs) with increments of (~ 1 dB). However, the first tests with senior users indicated that the selected volume range may not be sufficient to allow a correct hearing and understanding, so the range of values increased from ~78 dBs to ~88 dBs. Taking this into account, volume values obtained in the case of the senior users are higher (see Table 1).

In terms of text size and brightness, again a configuration ranging from 0 to 10 was allowed, with the midpoint corresponding to the appearance shown in Figure 2. A slightly higher mean value is observed in the case of Hermanas Hopitalarias, both for the text size and the brightness value.

As for preferences in terms of button appearance, older participants prefer buttons with bright font color over a darker background and buttons with higher contrast. These results seem to have a high correspondence with what was set out in [12].

4.4 Comparison of timing results

For the analysis of the time employed by both groups of users to fulfil the experiment, we have distinguished the two stages into which the experiment is divided: from the initial greeting to the end of the interface configuration; and from the end of the configuration to the final farewell. Table 2 summarizes the times each group employed to complete the first part of the experiment, as well as the total time of the interaction. It can be seen that, for the whole experiment, the total time is similar for both groups. However, for the first part of the experiment, there is a statistically significant difference in the employed time (Mann-Whitney test with $p = 0.019$ (2-tailed)), being clearly higher in the case of the senior users.

Results show that it takes longer for senior users to configure the interface. In fact, sometimes during the configuration of the interface, senior users started to show disinterest, having to be encouraged by the researchers or the caregivers to continue with the experiment.

Table 1: Obtained results for the interface configuration

	Volume(0 - 10)	Text size(0 - 10)	Brightness(0 – 10)	keep initial config (%)
CARTIF (N=27)	M = 6.07 SD = 1.32	M = 4.61 SD = 0.98	M = 4.96 SD = 1.24	59%
CARE CENTER **(N=9)**	M = 6.22 SD = 0.44	M = 5 SD = 0.00	M = 5.33 SD = 0.50	22%

M = Mean; SD = Standard Deviation

Table 2: Interaction timing for each group of participants for the first part of the experiment (interface configuration) and for the overall experiment

	Group	N	Mean	Standard Deviation
Interface configuration time (sec)	CARTIF	27	78.8462	17.46011
	CARE CENTER	9	113.4444	42.66764
Total interaction time (sec)	CARTIF	27	496.5769	78.97249
	CARE CENTER	9	479.7778	131.05035

In order to explore which factors influence the ease of use of the interface, different screens with slight modifications were created for each characteristic, and were introduced and explained by the robot in different ways. If we consider the reaction time as the time that elapses between the robot completing a question related to the configuration of a parameter and the first valid response given by the user (other comments not related to the configuration are not taken into account), we see that, in the case of the participants in CARTIF, they have no difficulty in understanding any of the configuration screens. On the contrary, in the case of the older participants, these times are different for each person and vary depending on the configuration screen. This indicates that the way the question is asked, and the way the text in the buttons gives feedback, influences the capacity of understanding of the seniors.

In the second part of the experiment, however, when more personal topics (such as family or place of birth) are introduced, senior users are more prone to participate in the conversation with the robot. However, the time spent by users of CARTIF in this second stage is greater than that of users of Hermanas Hospitalarias. It is observed that senior users, besides preferring simple questions, respond with short and simple answers and do not try to push the conversation beyond the boundaries that the questions of the robot establish, nor do they try to explore the possibilities of a more complex dialog with the robot. This could be an indicator of reticence about engaging in a deeper conversation. However, analysing the videos of the interactions, we see that senior participants show more courtesy towards the robot, and try to avoid imposing.

4.5 Comparison of the usage expectations

In addition to the questions included in the questionnaire, during the dialog in second part of the experiment, some questions were included that sought to gather information on the preferences of participants in terms of their thoughts on the usage expectations for the robot. This kind of covert "survey" was included as older people may show difficulties in responding to a written survey with Likert scales, such as the one given to the CARTIF participants.

In order to be able to compare the results, the same questions about usage expectations were asked during the robot dialog with both groups of participants. These questions included four topics related to possible services that the robot could offer: information and news related to the place of birth, possibility of playing music according to the user's tastes, possibility of using the robot interface to make video calls to relatives, and the possibility of the robot providing news to the users.

Comparing the obtained answers (Figure 5), we see that in both cases users would like the robot to provide information about their place of birth and play music according to their tastes. In addition, they do not care that the information obtained during the interaction is stored for future interactions.

5 CONCLUSIONS

In the present paper, we have presented the results of the experiment that involved the interaction of our humanoid robotic platform Sacarino and two groups of participants: middle-aged participants from the Cartif Technological Center and senior participants from the senior care facilities at the 'Centro Sociosanitario Hermanas Hospitalarias', Palencia (Spain). In terms of usability, one of the aspects considered in the literature to evaluate different robotic assistance technologies is the time spent for task completion. For example, in [19], they propose the comparison of the time spent by a person with a certain "disability" in completing a certain normalized task against the time used by a regular person as a metric for the performance of robotic assistive technologies. In this sense, in our case, the average time employed by the senior participants for the configuration of the interface is 43% higher than that of the users of CARTIF.

In [12], it is mentioned that the seniors lose the ability to understand the double meaning of sentences and even lose the flow of the conversation. They also state that when giving advice to senior persons it is convenient to state explicitly what they need to do. On the other hand, [10] recommends simplicity and reducing the number of options as much as possible to limit the cognitive

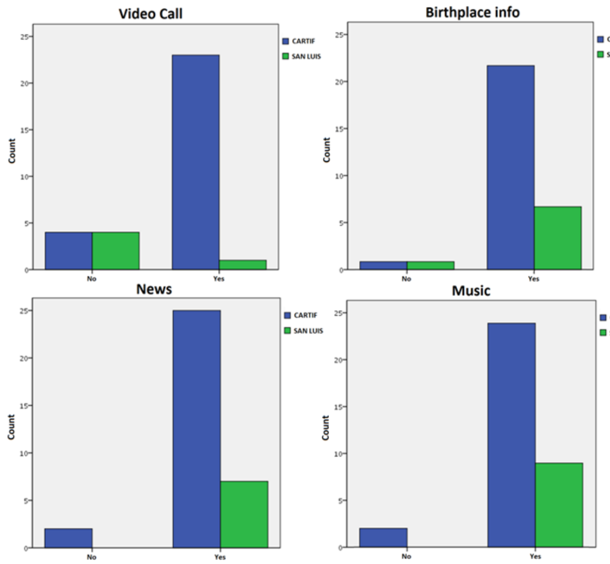

Figure 5: Obtained results regarding robot usage expectations for both groups obtained from the dialog between the robot and the participants. (Green=CARTIF; Blue=CARE FACILITIES)

effort needed by the seniors. This is reflected clearly in the reaction times obtained for the senior users for each of the screens. These reaction times clearly increase when the question is not explicit and the options feedback is not entirely clear, or when the cognitive demands increase. For these reasons, it can be concluded that, either by speech or by screen interface, the way the questions are asked and the options presented influences the capacity of understanding of the seniors.

On the other hand, despite the fact that senior users were told about the possibility of interacting with the robot both by voice and with the touch screen, and that disabled users were invited to place themselves at a distance that allows them to actually touch the screen (see Figure 4), senior people seem to prefer spoken interaction. This result may be related to the reluctance of older people to use new technologies, as well as the visual and physical difficulties they suffer. For this reason, we conclude that although the display of information on the screen is useful as a method of reinforcing comprehension, the use of anthropomorphic interfaces that allow communication channels similar to those employed during human to human interaction can be an incentive to motivate senior users towards the use of technology. These results are similar to those obtained in [21], where a study is carried out to explore the expectations of users in having a future robotic companion at home. It shows that users prefer communication channels like those employed when interacting with other humans.

The fact that none of the participants from either group cares about the fact that the robot stores the information obtained during the interaction for future interactions is an interesting result, especially taking into account the fact that during the interaction, there is quite a large amount of personal data shared between the person and the robot (age, date and place of birth, place of residence, family members, marital status, etc.). This indicates that users trust the robot, which as indicated in [20], is one of the main indicators in terms of social acceptance of a robot.

Taking into account the formulated research questions, we can conclude the importance of the users taking part in the development of the robot, as well as the need to use a specific interaction design for each scope of operation. To increase the odds of obtaining a usable robotic system, one of the usual recommendations is to develop the system taking into account the end user, which is known as "user-centered design". However, the results obtained in this first pilot experiment show that, even though we have a priori considered the requirements of senior people and the recommendations given by other studies [9][10], there are many different factors that can influence the performance of a social assistant robot. In this sense, it is common practice in robotic rehabilitation systems to include users during the development stages of the system, which is known as "participatory design". The same type of methodology should be used for social assistive robotic systems for the seniors, where the performance and acceptance of technology are influenced by various factors such as "acceptance by users, ease of use or effectiveness of the device entry" [19].

In fact, many of the results obtained for the middle-aged group differ from those obtained for the senior users. For example, senior people do not seem to care about the use of short or impersonal sentences, whereas in the case of the CARTIF participants, it is an important aspect of the interaction. In addition, none of the senior users refer to the small gestural capacity of the robot, and in fact a participant from the care facility complained that the robot could move its arms and hit him.

In terms of the operating domain, there are obvious differences. For example, in the case of the hotel environment, the first design of the robot did not include a touch screen, but we had to include it, as errors in voice recognition due to ambient noise resulted in the need to include an additional communication channel. On the contrary, we see that in the case of interaction with senior people, the touch screen is a very little used element, at least in terms of user input. On the other hand, in terms of the dialog in the case of the hotel, the robot speech required sentences capable of attracting the user, as well as being sufficiently complex and variable to maintain the users' attention. These results correspond to the expectations of middle-aged people (as in the case of Cartif), but they cannot be extrapolated to the seniors, who prefer simple dialogs and short sentences.

Finally, it is clear that the design of the interface of the screen should be designed taking into account the accessibility requirements of older people, with large letters, few buttons and simple interfaces. Again, this is contrary to the results obtained in the hotel environment where, although a self-explanatory and user-friendly interface is necessary, it must be attractive enough and with a certain number of different possibilities to maintain the attention of the users.

From this first study, our future lines of work are focused on the refinement of the robotic platform, so that (like our studies in the hotel environment) we can conduct long-term interaction studies in the care facilities, which can draw conclusions concerning the operation and interaction of the robot in real conditions for long periods of time.

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