Elderly Users in Ambient Intelligence: Does an Avatar Improve the Interaction?

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Abstract. In order to examine the effect of an avatar in natural interaction with elderly users in ambient intelligent environments, we performed an empirical study with elderly people (normal aging, mild cognitive impairment and Alzheimer's patients) not only on subjective but also on objective measures. The data supports the following: 1) The subjects followed some instructions much better when interacting with the avatar. 2) The presence of the avatar has neither any positive nor negative effect on the recall of elderly people and it has a positive effect only on the subjective measures. 3) We found that elderly people both with and without cognitive impairment are capable of recognizing emotions in the facial expressions of the avatar and 4) they found the experience of having an emotional avatar in the interface a pleasant one. Thus, we conclude that virtual characters could improve the interaction between elderly people and machines, but this would depend greatly on the request task.

1 Introduction

Ambient Intelligence (AmI) builds on three recent key technologies: Ubiquitous Computing, Ubiquitous Communication and Intelligent User Interfaces. The last field, Intelligent User Interface, enables the inhabitants of an AmI environment to control and interact with the environment in a natural (voice, gestures) and personalised way (preferences, context).

Hence, Ambient Intelligence assumes that the interaction between humans and the ambient should be based on the natural communication between people. Moreover, according to Nijholt [12] most of the research on ambient intelligence does not take into account the fact that perhaps people would become confused by ambient intelligence, wouldn't know who to talk to and would not be able to build some kind of social relationship with the anonymous environment that nevertheless supports them, observes them and keeps track of their activities. People speak, gesticulate and feel in human interactions. Therefore, the interaction should be totally different to the present desktop paradigm based on keyboard, mouse and screen.

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To achieve natural communication, communication channels between people and the ambient should be the same ones which people use in human communication. People usually communicate with other people through the following communication elements, based on:

1. The use of the senses of sight and hearing in order to interpret the input data of the communication.
2. The use of corporal and oral language in order to communicate the data of the communication.

A natural interface should be capable of understanding the user input data and reproducing the corresponding output through the same communication channels. Hence, as is shown in Figure 1, in order to achieve a natural interaction our approach is to include the following systems in the ambient:

1. A speech recognition system in order to interpret the user's oral language.
2. A gesture recognition system in order to interpret the user's corporal language.
3. A text to speech system in order to communicate through voice.
4. A facial and corporal animation system in order to communicate through corporal language.

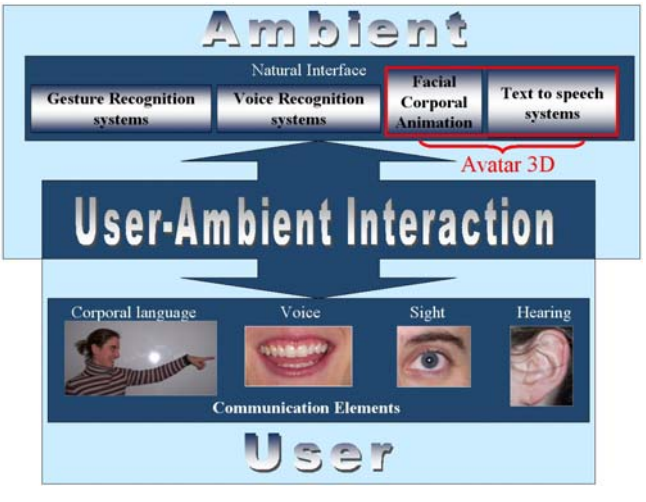

Fig. 1. A natural interaction approach

We have focused our research on the communication from the ambient to the user, that is, on the corporal and verbal language produced by the natural interface. Our approach is based on the use of avatars in simulating this kind of communication. Avatars are virtual characters which make communication between user and machine more natural and interactive. The role of the avatar depends on the application; it can act as a guide or assistant, as an information presenter and can even represent the user in a virtual environment. The character's appearance can be anthropomorphical or cartoon type, 2D or 3D, depending on the end user and on the executing device

(PC, PDA, cell phone, digital television, ...). The main advantage of using avatars within interfaces is to enable the user to interact intuitively with the system by giving him/her the illusion of communicating with a real human. This illusion is obtained by mimicking human communication, i.e. giving the avatar the ability to express emotions through facial and body gestures.

While significant progress has been made in the individual aspects of the "life-likeness" of animated agents, such as their graphical appearance or the quality of their synthetic voice, evidence of their positive impact on human-computer interaction is still rare [13].

In section 2 we will examine the reasons that make us think that using an avatar could improve the interaction between elderly people and the ambient. Then, in section 3 the focus of this research is outlined. The methodology followed is contained in the evaluation and the results are explained in section 4 and in section 5. At the end of this paper, in section 6, we will describe the discussions and conclusions produced by this research.

2 Avatars in Ambient Intelligence

A growing number of research projects have begun to investigate the use of animated life-like characters in natural user interfaces because they present *a priori* a lot of advantages, which have also been validated by many authors:

1. Social Interaction: In 1994, Nass [11] carried out five experiments which provide evidence that individual interactions between human and machine are fundamentally social. More recently, Prendinger et al [16] reached the same conclusion following another evaluation using a novel method based on tracking users' eye movements. His research also shows that users interact with life-like interface agents in an essentially natural way. He also realized that users follow the verbal and non-verbal navigational directives of the agent and mostly look at the agent's face. Human-like behavior occurs during interaction with the computer and human-like behavior is expected of the computer. Computer users turned out to be sensitive to flattery and humor; moreover, they were very much influenced by the properties of the synthesized voice in text to speech synthesis when assigning personality characteristics to a computer [12].
2. User attention: Animated characters are capable of capturing users' attention, engaging users in active tasks, and entertaining them [4]. This is very important for learning environments where a virtual character can have a positive effect on the learning process, more so if it can show affective responses [5].
3. Naturalness: Whether the virtual character is believable or not, the illusion of life is generated and [17] the user has the illusion of interacting with a real person.
4. More information in the transmitted message: in the transmitted message: In communication, facial expressions provide a lot of information. This was demonstrated by Mehrabian [8], who shows in his research, that the 93% of our messages are transmitted through non-verbal language. 55% is mainly based on facial and corporal motions, whilst 38% is based on the use of the voice.

5. Trustworthiness and believability: Generally the agents act when the user authorizes them. If the user has to delegate some tasks to the agent, he/she should trust it. It is believed that the level of trustworthiness is increased by the personification of the agent. Due to this, the design of the avatar is very important. Koda [6] found that a realistic face is rated as more intelligent, engaging, and likable than the less realistic faces.

In agreement with the above findings, Nijholt [12] concluded that embodied agents allow the development of affinitive relationships with their human partners and can therefore help to fulfill the need of affiliation in ambient intelligence environments.

Moreover, Bartneck [1] considered that to be able to employ the full range of dialogue control acts and to amplify the meaning of a message with emotional expression, the ambient intelligent environment needs an anthropomorphic entity to execute facial expressions and gestures.

In spite of these advantages, there is still great controversy about whether the best way to interact with the ambient is through mimicking human communication using virtual characters. A lot of authors have tried to answer this question through real users evaluations. For example, Koda and Maes [6] realized a quantitative analysis of subjects' impressions about a personified interface. They concluded that having faces and facial expressions is considered likable and engaging and that they also require more attention from the user. Walker [21] also argued that the virtual character occupies the users' attention but in a negative way. She compared subjects who answered questions presented via a text display on a screen, with subjects who answered the same questions spoken by a talking face. The subjects who responded to questions presented by text spent more time on the task, made fewer mistakes, and wrote more comments. From these results he concluded that adding human characteristics could make the experience for users worse rather than better, because it would require more effort and lower performance. However, Prendinger et al. [16], using a novel method for evaluating interaction with life-like interface agentsbased on tracking users' eye movements, found that the believability of the agent can be conceived as its ability to effectively direct the user's focus of attention to objects of interest.

Most studies have concentrated on subjective measures such as acceptance and believability. Other authors, such as Mülken et al. [10] and Okonkwo et al. [14] have performed an empirical study in order to examine the effect of the avatar not only on subjective but also on objective measures. All of them reached the same conclusion, that the presence of an avatar neither has a positive nor a negative effect but it may have a positive effect on the subject's impression, as the user's experience may be perceived as less difficult and more entertaining.

Motivated by the advantages of having an avatar in natural user interfaces and due to the previous evaluations that underline the positive aspects over the negatives, we decided to integrate a virtual character into an interface for elderly people. However we did not find any previous evaluations using elderly users, so first of all we designed and implemented some prototypes in order to evaluate the effect of an avatar on elderly people.

3 Natural User Interfaces for Elderly People

The use of virtual reality as an evaluation and rehabilitation tool in cognitive impairments has experienced a great peak in recent years. However, as pointed out by Gaggioli [19] there is a lack of discussion about the role that such autonomous virtual humans could have in VR-aided psychotherapy. Their group realized an evaluation of the interaction characteristics required for a successful relationship between the patient and the virtual human. There is also some research taking place concerned with the use of avatars with autistic people [9] however we did not find any work related to avatars and elderly people.

Ogozalek [13] developed some research focused on elderly people and multimedia computer interfaces. In her experiment 64 elderly participants, with an average age of 71, used a text only or multimedia computer interface. She found that a multimedia presentation was better than a text-only screen or printed leaflet in both performance and preference measures. We did not find any research with virtual characters but Ogozalek's evaluation made us think that avatars can improve the interaction between machine and elderly people.

Since we did not find any information about which kind of interface best suits the needs of elderly people and whether elderly people are capable of interacting with avatars, we centered our research on these issues. Another interesting field is concerned with the abilities of elderly people in the area of emotion recognition. Many studies underline the fact that elderly adults are poor at recognising certain emotions. Overall the existing results provide support for an age-related decline in the recognition of some emotions that it is independent of changes in perceptual or cognitive abilities [20]. Hargrave's study [3], examined facial emotion matching, facial emotion labelling and same/different emotion differentiation in Alzheimer's disease patients, healthy elderly volunteers, and elderly non-demented psychiatric outpatients. Compared with both control groups, Alzheimer's patients were significantly impaired in all three measures.

Like Mülken [10] we consider it to be very important to realize an evaluation not only on subjective measures, as with most evaluations, but also on objective measures, above all when we are working with users with cognitive impairment, who cannot fluently express themselves.

In our research, we were mainly interested in the following aspects:

1. Finding out which kind of interface best suits the needs of elderly people both with cognitive impairment and without it.
2. Analyzing whether this kind of user is capable of interacting with avatars.
3. Discovering if the virtual character enhances the performance of users during a specific task .
4. Investigating if the presentation of information by a virtual avatar helped in recalling it.
5. Analyzing whether elderly people with and without cognitive impairment are capable of recognizing emotions in the facial expressions of the avatars.

4 Method

4.1 Subjects

The sample consisted of 15 elderly people distributed in three different groups. The first (n=5) was composed of elderly people without cognitive impairment, in short, those experiencing normal aging. The second group (n=5) was made up of elderly people with mild cognitive impairment, which means that a person has memory problems greater than expected with normal aging, but does not show other symptoms of dementia, such as impaired judgment or reasoning. Finally the third group (n=5) consisted of elderly people in the moderate stage of Alzheimer's disease. These patients suffered from moderate cognitive impairment, behavioural disturbances and needed support in the Activities of Daily Living (ADL). All the subjects were recruited through the Ingema data base.

All of them passed through the same experimental conditions. Before the trial they underwent a neuropsychological assessment with the double aim of objectively measuring their memory status, and of sorting the subjects into the different groups. With respect to the Alzheimer's patients, these subjects had been previously diagnosed by a neurologist according to NINCDS-ADRDA criteria [7].

The socio demographical characteristics of the participants were the following: there were 9 females and 6 males taking part in the study. The average age was 72.33 years and the range oscillated between 61 and 80 years. All the subjects were Spanish speaking. Concerning the experience of the participants with TIC'S, we found that the device they most-used was the mobile phone (50%), while the 25% had ever used the computer.

As usual in this kind of research, each participant or by default their guardian, was requested to voluntarily sign the informed consent form demonstrating their willingness to participate in the study. In addition, each participant signed a consent form which allowed us to video record the trial. These recordings were analyzed in order to obtain the qualitative data.

4.2 The Design of the Experiment

In order to answer all the questions mentioned above we divided the experiment into two parts. The first part focused on evaluating which kind of interface best suits the needs of elderly people and on discovering the effect of the virtual character on the interaction. The second part was centred on the capacity of elderly people to recognize the emotions of the avatar.

4.2.1 Part One: Evaluation of Interfaces for Elderly People

In this experiment we presented three kinds of interfaces to each subject individually. For each kind of interface the subject had to perform two tasks. The first task was to write on a sheet of paper the answer to a question posed by the interface. The second task was to visualize some images presented by the interface. These images were organized into three different kinds of objects (daily, non-daily and pictograms). They were presented in sequences of three items at a time. Each interface worked as follows:

1. Conversational Virtual Character interface: The request to write the users name on a sheet of paper was made by the virtual character in full screen. Afterwards, the virtual character also showed and named each of the nine objects in the half screen. The features of the avatar used for this interface are explained in section 4.2 and its appearance is shown in Figure 3.
2. Text and speech interface: The request to write the user's favourite colour on a sheet of paper was made by a voice and written text in full screen. Afterwards, the voice and the text also showed and named each of the nine objects in the half screen. The appearance of this interface is shown in Figures 4 and 5.
3. Text interface: The request to write down the name of the city where the user lived on a sheet of paper was made by written text in full screen. Afterwards, the written text presented the name of the nine objects. The appearance of this interface is shown in Figures 4 and 5.

4.2.2 Second Part: Evaluation of Emotion Recognition

In this experiment we presented an interface composed of six buttons and the avatar zone to each subject individually. First of all, the avatar showed a neutral expression. When the experimenter clicked a button, the avatar showed one of the basic emotions: joy, sadness, angry, disgust, surprise or fear. The features of the avatar used for this interface are explained in section 4.2 and its appearance is shown in Figure 2.

4.2.3 Features of the Avatar

In order to design the virtual character, in line with mentioned in section 2, we created the avatars for this experiment with the following characteristics: gender, appearance, speaking capability and believability (natural behavior and facial expressions capability).

Oknown [14] found out that there are some gender-based and individual differences in the user's perception of a life-like character, which need to be taken into account when designing the virtual characters. For this reason, we used two avatars for the experiment. Both of them had anthropomorphic appearance. The first was a young woman with red hair as shown in Figure 3. This avatar was capable of reproducing text synchronized with lip movements.

The second avatar (used in the emotional interaction interface) was a young man (Figure 2) with the ability to express emotions. The animation techniques used were based on morphing and they were developed in a previous work by Ortiz et al. [15].

In order to achieve natural behavior, both, non-verbal and verbal behavior is essential. We integrated the following rules into the system:

1. Non-verbal behavior is automatically given to the avatar. This behavior is mainly based on an undulating head motion until speech is continued. The virtual character is never motionless, giving the illusion that it is alive and waiting for user feedback.
2. Eye motion is randomly directed towards both sides and is very smooth. The pupils are dilated and contracted giving the illusion that it is watching different points of light.
3. The avatar blinks randomly.
4. The eyebrows are raised with changes of *tone* and *pitch*

5. We have to take into account differences in *tone* and *pitch* in order to understand that there is a specific stress for semantic reasons. The facial animation is strengthened by raising the eyebrows and making the head nod.
6. A long pause between words or sentences makes the avatar blinks.
7. The blinks are also synchronized with the open vowels (a,e,o).

Regarding the emotional features, several research papers have focused on defining how humans express the emotions they are experiencing. Darwin was one of the pioneers in this field. His studies resulted in an emotional theory which has been followed by researchers such as Ekman [2]. Ekman's theory is perhaps the most successful and most followed for representing facial expressions. In 1978 he developed a system for coding facial actions called FACS (The Facial Action Coding System). FACS is a comprehensive, anatomically based system for measuring all visually discernible facial movement. FACS describes all visually distinguishable facial activity on the basis of 44 unique action units (AUs), as well as several categories of head and eye positions and movements. In our work, shown in Figure 2, we transfered these studies to the emotional dramatization of the avatars.

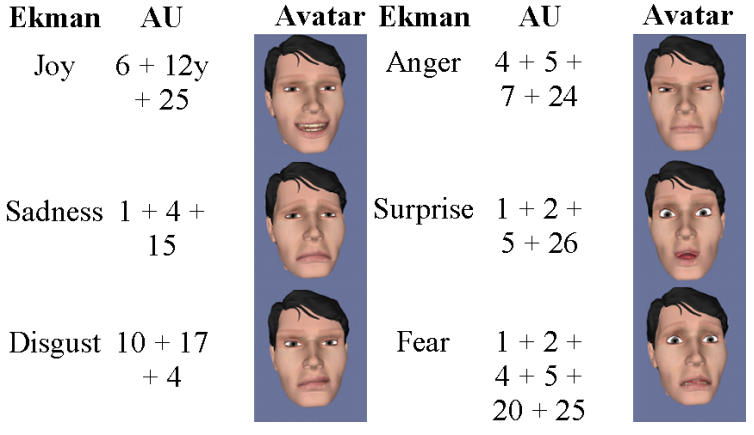

Fig. 2. Avatar expressing emotions following Ekman's AUs

4.3 Questionnaires

Each participant was administered a neuropsychological assessment in which several questionnaires were given to them before the beginning of the trial. First of all a participant form was distributed in order to collect personal data and register their experience with TICS. Concerning the neuropsychological tools, two scales were used, the Rey Auditory Verbal Learning Test [18] and the stories of the Weschler Memory Scale-R Logical Memory [22]. The first test evaluates the ability of people to learn word lists. It is the forerunner of other testsconcerning verbal learning using lists of words. The second scale evaluates the ability to recall logical stories.

Finally, with the goal obtaining information related to the interfaces two questionnaires were specifically developed for both parts of the experiment (Ïnterfaces

for Elderly People" and Ëmotion recognition"). These questionnaires were designed following the conclusions obtained by state of the art technology. Like Mülken, we divided both questionnaires into two parts. In the first part we assessed the effect of the avatar on the objective measures with respect to the required task (feedback, recall and emotions recognition). In the second part, we were interested in the influence of the avatar on subjective assessments of the interface (in terms of its likeability, pleasantness, entertainability, ease and complexity).

4.4 Apparatus

The experiment was run on a Pentium IV PC with Windows 2000 Professional SO. The information was presented to the subjects on a TFT 19" color monitor. The text reproduced by the virtual character or by the audio-text interface was synthesized by Scan Soft RealSpeak Solo v4.0 with a female voice. We also used a Webcam, speakers, paper and pens to perform the experiment.

4.5 Procedure

As explained earlier, the subjects were found through The Ingema (Matia Gerontological Institute Foundation) database and contacted by telephone. Each participant signed a consent form and afterwards was enrolled in the neuropsychological assessment. The next step was the performance of the research. The study was carried out in Ingema's laboratories. During each experimental session, a psychologist was present in order to answer any possible questions and to ensure that everything proceeded as intended. The subjects were informed that in the first part of the experiment some information would be presented in three different ways; with a virtual character, with text and voice and finally only with text. They were also informed that in the second part of the experiment they should say which emotion was represented by the virtual character. The procedure was as follows:

1. The virtual character asked the user to write their name on a sheet of paper as shown in Figure 3.
2. The virtual character showed three daily objects as is shown in Figure 3.

Fig. 3. Appearance of Virtual Character

Table 1. Questionnaire 1

Questionnaire 1
Which objects do you remember?
On a scale of 1 to 10, which presentation did you like more?
On a scale of 1 to 10, how do you rate the pleasantness of each presentation?
On a scale of 1 to 10,how do you rate the entertainability of each presentation?
On a scale of 1 to 10, how do you rate the easiness of each presentation?
On a scale of 1 to 10, how do you rate the complexity of each presentation?

Fig. 4. Appearance of Text and Speech Interface

3. The text and speech interface showed three daily objects.
4. The text interface showed three daily objects.
5. The user filled out the questionnaire 1 (Table 1).
6. The text and speech interface asked the user to write down their favourite color on a piece of paper.
7. The virtual character showed three non-daily objects.
8. The text and speech interface showed three non-daily objects.
9. The text interface showed three non-daily objects.

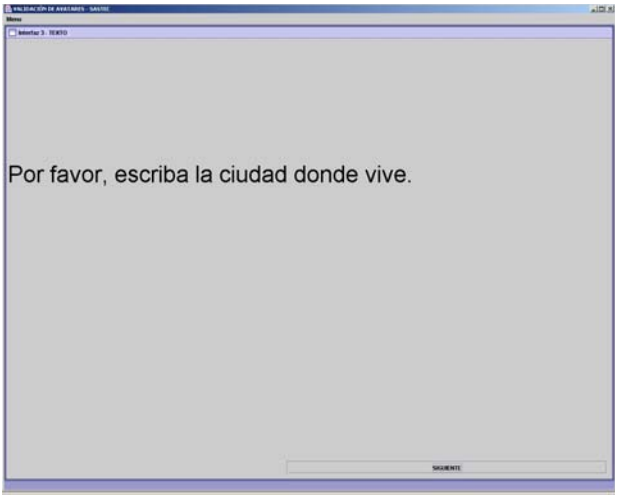

Fig. 5. Appearance of Text Interface.

Table 2. Questionnaire 2

Questionnaire 2
On a scale of 1 to 10, how do you rate the ease of each emotion identification?
On a scale of 1 to 10, how do you rate the realism of each emotion?
Which of the avatars did you like more, the woman or the man?
Did you like that this virtual character appears in another applications?
Would you like it if this virtual character appeared in other applications?

10. The user filled out the questionnaire 1 (Table 1).
11. The text interface asked the user to write down the name of their city on a piece of paper as shown in Figure 5.
12. The virtual character showed three pictograms.
13. The text and speech interface showed three pictograms.
14. The text interface showed three pictograms.
15. The user filled out the questionnaire 1 (Table 1).
16. Each avatar emotion was shown to the user, who then described the emotion they were seeing (Figure 2).
17. The user filled out the questionnaire 2 (Table 2).

5 Results

The collected data has been analyzed using the statistical analysis software SPSS version 12.0, obtaining the following results.

5.1 Evaluation of Interfaces for Elderly People

During the first task, in which the users were asked by the interfaces to follow the instructions mentioned in section 4.5, it was found that all the subjects (normal aging, mild cognitive impairment and moderate Alzheimer's patients) correctly performed the requested task 92% of the time when asked by the avatar, 75% of the time for the text and speech interface, and 66% of the time for the text interface. These percentages clearly show that the users, in general, followed some instructions much better when interacting with the avatar.

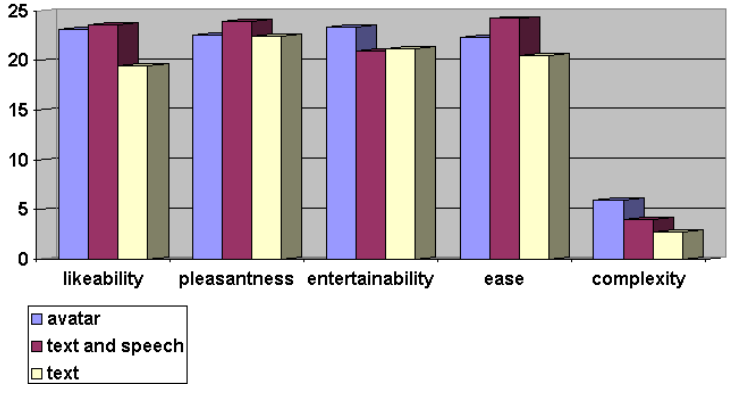

Fig. 6. Normal ageing results

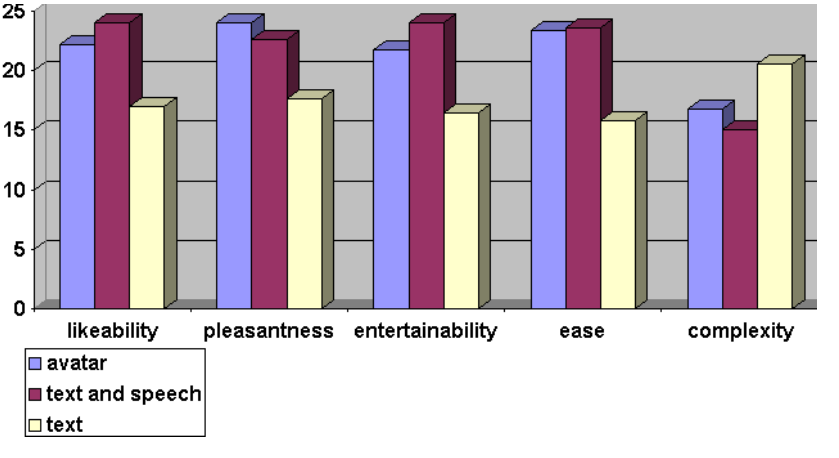

Fig. 7. Mild impairment results

Statistical analysis was performed using the Kruskal-Wallis test to establish differences, using a level of significance of less than 0.05. Values are the mean and the standard deviation. Some important results obtained during the evaluation are the following: in the second task, where each interface shows the user different objects which they have to remember later, quite significant results ($p < .05$) were obtained with the group of subjects with mild cognitive impairment, since these users were able to remember the objects better when presented by the text rather than by the other interfaces. However, within this collective these results could also be due to the recency effect because this interface was presented last.

Some other important results obtained during the evaluation are the following:

1. Every interface was evaluated in terms of its likeability, pleasantness, entertainability, ease and complexity. The interface which obtained the highest scores for the first four variables, was the text and speech interface, followed by the avatar and the text interface. In the complexity evaluation the order was inverted, with the text interface being the most complex, followed by the avatar and the text and speech interface. It was not possible to administer the questionnaires to Alzheimer's disease patients as they did not understand the questions or they answered without criteria. The results for subjects with normal aging are shown in Figure 6 and the results for subjects with mild cognitive impairment are shown in Figure 7.
2. At the end of the questionnaire there were two questions regarding the willingness of the subject to have the virtual character appear in other computational applications. The total groups' average was 8.1. This was higher for subjects with mild cognitive impairment than for subjects with normal ageing (8.4 and 7.8 respectively).

5.2 Evaluation of Emotion Recognition

The ease and rate of the emotional reality created by the avatar were the variables taken into account for the evaluation of this part of the experiment.

Table 3. Emotions recognition: Success percentage

Group	Joy	Anger	Sadness	Disgust	Fear	Surprise
Normal ageing	100%	60%	80%	20%	20%	60%
Mild impairment	100%	40%	60%	0%	20%	80%
Alzheimer patients	50%	0%	100%	0%	0%	50%

It was not possible to distribute the questionnaires to Alzheimer's patients because they did not understand the questions or they answered without criteria. For the other two groups the average for the ease variable was very similar (41, the range being, from 0 to 60). For the reality rate we obtained 44.8 in the normal ageing group and 42.6 in the mild cognitive impairment group. The results are shown in Table 3.

6 Discussion and Conclusions

We performed an empirical study with elderly people (normal aging, mild cognitive impairment and Alzheimer's patients) to examine the effect of the avatar not only on subjective but also on objective measures. The first objective measure we took into account was user feedback to the avatar questions. The data obtained supports the fact that subjects followed some instructions much better when interacting with the avatar. 92% of the subjects performed the requested task correctly when asked by the avatar but only 66% answered correctly when the questions were asked by the text interface. This result contradicts the conclusion reached by Walter [21], who wondered why subjects who answered the same questions posed by avatars required more time. As he argued, this could be because the presence of another person usually serves to increase arousal and motivation on the part of someone asked to perform a task. However, this fact can also lead to an improvement in performance if the task is not very complex but to a degraded performance if the task is complex. Our questions were very simple due to the kind of users participating in the experiment.

The second objective measure was concerned with recall. We found that users were better able to remember objects when they were presented by the text interface rather than by the other interfaces. These results were found in users with mild cognitive impairment but this data could be explained by the recency effect, which means that they could better recall the last information presented. We did not find any significant statistical differences in the other groups.

According to these results and following on from Mülken's [10] conclusion, we deduced that the presence of the avatar has neither any positive nor negative effect on recall. Mülken obtained a positive effect only through assessing the subjective measures, that is, on the subject's impression of the presentation. Our results are consistent with this conclusion assuming that the results of the mild cognitive impairment group were due to the recency effect. However, when we asked the users about whether they would like this virtual character to appear in other computational applications, we obtained an average result of 8.1.

If the recency effect were not the reason, these results may have been obtained because the users were not used to interacting with virtual characters and therefore their attention was focusing on the particular characteristics of the avatar and not on the presentation itself. Hence, the avatar plays a distracter role in the recall task, something frequently found in people with cognitive impairment. If the users were to become accustomed to the avatars, the distraction effect could be decreased.

However, Walker [21], Prendinger [16] and Hongpaisanwiwat [4], reached the conclusion that avatars did not lead to a poorer performance through distracting people and that they are capable of capturing users attention and engaging them in active tasks. We opt for the reason stated above, that the presence of the avatar neither

has neither any positive nor negative effect on the recall of elderly people and that it has a positive effect only on the subjective measures.

Regarding the capacity of elderly people, with or without cognitive impairment, to recognize emotions, we observed that joy and sadness were the emotions identified best and also that the subjects scored them as being the most realistic. By contrast, the most difficult to recognise and the least was disgust. A great deal of consistency is apparent in this regard and many studies underline that elderly adults are poor at recognising certain emotions. Hargrave [3] developed an evaluation with Alzheimer's disease patients, healthy elderly volunteers, and elderly non demented psychiatric outpatients. Compared with both control groups Alzheimer's patients were significantly impaired on all three measures. Those results are consistent with our study in the sense that Alzheimer's patients have deficits in recognizing facial emotions.

We found that healthy elderly people and elderly people with mild cognitive impairment are capable of recognizing the emotions in the facial expressions of the avatar and that they found the experience of having an emotional avatar in the interface as pleasant.

During the process of designing a natural interface for ambient intelligent environments for elderly users we decided to mix text, speech and virtual characters depending on the request task. According to this research, if it is desired that a user carry out a task, the user will perform better if the avatar makes the request. However, if it is required that the user remember some information, having an avatar in the interface is something that should be considered carefully because the effect of an avatar does not affect objectively and, if the user is not used to interacting with an avatar, it wouldplay a distracter role. Moreover, we consider it to be very important to give emotional capacities to the avatar as elderly people can recognize them and they also make the interface more pleasant. However, when designing the avatar's emotions, it is important to consider which emotions are best recognized by each group. The least recognized emotions were anger, disgust and fear, so the avatar should use these emotions very carefully and less frequently.

In the future, we will plan to expand this evaluation with subjects ranging from 22 to 40 years old and we also plan to compare these results with those obtained with elderly subjects. This would resolve the issue of the unknown nature of some of these results which may have been due to the users having little experience with computers.

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