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ENHANCING THE USABILITY OF TELECARE DEVICES

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Abstract: *Demographic and sociological changes in the last 50 years have forced Western societies to create services to attend to elderly people in their homes, where they can live within familiar environments. Telecare involves a device plugged into a telephonic network that provides access to teams of professionals who can attend to the needs of the elderly in their homes. These devices have been designed according to the principles of universal design, but the great number of erroneous calls to telecare centers point to the necessity of enhancing the usability of the devices. One analysis of the cognitive functioning of elderly people showed that a possible cause of these errors could be the difficulty elderly people have when processing language. In our experiment, we tested the hypothesis that the numbers of errors could be reduced by using icons instead of words in the device interface. The results support this hypothesis.*

Keywords: *telecare, usability, elderly people, cognitive deterioration, universal design.*

AGING AND SOCIETAL CHANGES IN CARE GIVING

Among the most important changes that have taken place in today's Western societies are those that result from the exodus from countryside to the cities, the new model of the nuclear family, the changing role of women, and the democratization of family relations. An important consequence of these social changes is that the family is no longer able to satisfy certain needs of its members, mainly because the role of the woman in the family has changed to encompass functions different from what has been traditional.

These social changes are especially relevant in relation to the phenomenon of aging. All around the world, but more so in the most developed countries, there is a constant increment of human life expectancy. This sociodemographic phenomenon means that society has to

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confront the challenges of helping elderly people, who experience a decreasing capacity to care for themselves, to carry out their daily life activities. For this reason, societies have developed social service systems to care for or assist the elderly.

To face these challenges a new research field called *gerontechnology* arose, with a mission to develop products and services adapted to the phenomenon of aging. Gerontechnologists are interested in technologies that help to anticipate (and prepare for) the functional decline that is produced by aging. Therefore, gerontechnologies are designed to enrich the functioning of elderly people, especially in communication, education, and work. In few words, gerontechnology is a field of study in which professionals work to design technologies to compensate for the losses associated with aging.

A central concern for gerontechnology research is to determine the characteristics that an interface of any device must have so that the difficulties derived from aging can be avoided. Said in another way, the focus of the research is to determine what implications aging has for the design of an interface.

Telecare is a set of technologies that provide help to dependent, especially elderly, people by providing access to teams of professionals who can attend to the client's needs 24 hours a day, 365 days a year via a telephonic network. The goals of these technologies are (a) to provide a system that allows the elderly to obtain and to maintain a greater degree of autonomy and well-being in their homes; (b) to facilitate the permanence and integration of the elderly within their social and family environments, thus avoiding many unnecessary situations in which the elderly are uprooted and cared for in an institution; (c) to provide the elderly with security and prompt attention in cases of emergency; and (d) to support the family members who assume the role of supervising their loved one's care.

Telecare came about to solve the problems associated with previous technologies, such as telewarning, a system connected to the telephone that allowed a person to call for help in situations of emergency. This telewarning technology, developed in the 1980s in countries that were pioneers in this kind of social service for helping people in living alone at home (the Nordic countries, Great Britain, and Germany), and similar systems, like the so-called Hope Telephone, were intended to solve many communication problems, as well as to ease the sense of isolation and loneliness that often accompanied the elderly living alone. However, several problems could not be solved by the human operator who answered the call. A study conducted from 1987 to 1991 in France by Templier, Lanata, Baer, and Pasteyer, (1992) showed that 77% of the calls were not emergencies, but were registered as "error of manipulation" or "call to chat," meaning the caller initiated contact with the service for reasons other than an emergency need and the operators couldn't determine if the call resulted from an error or the caller's simple desire to chat.

Furthermore, other difficulties exist, such as falls, diseases, or suffering an assault, that are very frequent situations of vulnerability experienced by elderly people. For example, some studies (Lázaro del Nogal, 1997) have revealed that 25% of those who surpass age 65 experience fall throughout the year. In Spain alone, about 2 million falls and 90,000 fractures each year have been reported (Lázaro del Nogal, 1997). The falls have ominous effects on the person's autonomy, which can be mitigated with fast and diligent help. Nevertheless, there is empirical evidence (Instituto de Migraciones y Servicios Sociales, 1996) that shows that elderly people who fall at home often remain on the ground, far from the telephone, for more than one hour before being able to request aid. As a consequence, the gravity of the fractures

increased and the period of hospitalization was greater, both of which increased the psychological upheaval of the person due to the fear of falls, isolation, and dependency.

Therefore, to overcome the problems observed with the use of telewarning and similar systems, UNA (Union Nationale de l'Aide, des Soins et des Services aux Domiciles, n.d.) has elaborated a report with a set of deontological principles for designing new systems for care giving in France that have been applied in other countries as well. The report recommended eliminating systems that only transmit emergency calls from the elderly. Instead, government agencies should look for services that care for all aspects of the life of the dependent person. As a consequence of the application of these principles, a new system called telecare was designed.

Telecare hardware consists of an apparatus wired to the telephone network that has two terminals, one fixed (domiciliary unit, see Figure 1), and another one in the form of a pendant or bracelet (terminal wireless, see Figure 2).

Whenever users are in a situation of urgent help (e.g., they have fallen in the shower), need information, must request some service for themselves or their home, or simply want to know what is on their agendas for the day, they press the corresponding button. For example, telecare users may need to be reminded that they have appointments with their doctors, or that they have to take their medications. By pressing the appropriate button, a user gets in contact with the telecare center where a central computer contains all the sociosanitary histories (e.g., health, family, and environmental conditions) of the user. Special software allows the teleoperator to see on the computer screen immediately the relevant data about the user (data personal, clinical diagnoses, treatments, medicines that she/he takes, name of the health professionals who care for her/him, and contact information for his/her family, reference person, close friend, etc.). With this data, the teleoperator can decide whether to provide a solution to the caller's request with public resources or with private resources (external). Within the telecare center, social workers, medical doctors, psychologists, and so forth, are available to assist the teleoperators.

Figure 1. Fixed Telecare Device[1].

Figure 2. Wireless Telecare Device.

THE DESIGN PROBLEM: ERRONEOUS CALLS

Telecare systems have proved to be a very successful tool for providing help to dependent people and for this reason they are being implemented rapidly in many societies. However, some problems have been detected that need solutions before we can say that telecare systems are truly useful tools. One problem is the enormous number of erroneous calls that have been observed. Erroneous calls are defined here to mean calls by seniors to the service centers for any reason other than what the call-button designation indicates: This encompasses issue of "unwanted calls" (including calls to chat), misdirected calls (caller needed a service other than what the designation button indicated), or calls made in error (button pushed accidentally and so the call was unintended). Figure 3 depicts the number and percentage of calls classified as erroneous received during 2002 and 2003 at the Andalusia Service of Telecare (located in Seville and providing services to users from the Andalusia region in southern Spain; Fundación Andaluzza de Servicios Sociales [Andalusia Foundation for Social Services], 2004**).** We have to note that our definition of erroneous calls could not be more specific at this point because the data presented in the figure, and which motivated our research, was collected without enough details to allow us to know more about the origin and/or purpose of those erroneous calls. It should be noted also that the teleoperators have mentioned to us that sometimes they perceive users call by pressing any button when they just want to talk to someone. Therefore, the high number of the erroneous calls might also include those originated by loneliness. However, our research, because of the existence of misdirected calls, was designed based on the hypothesis that some errors could have a cognitive explanation.

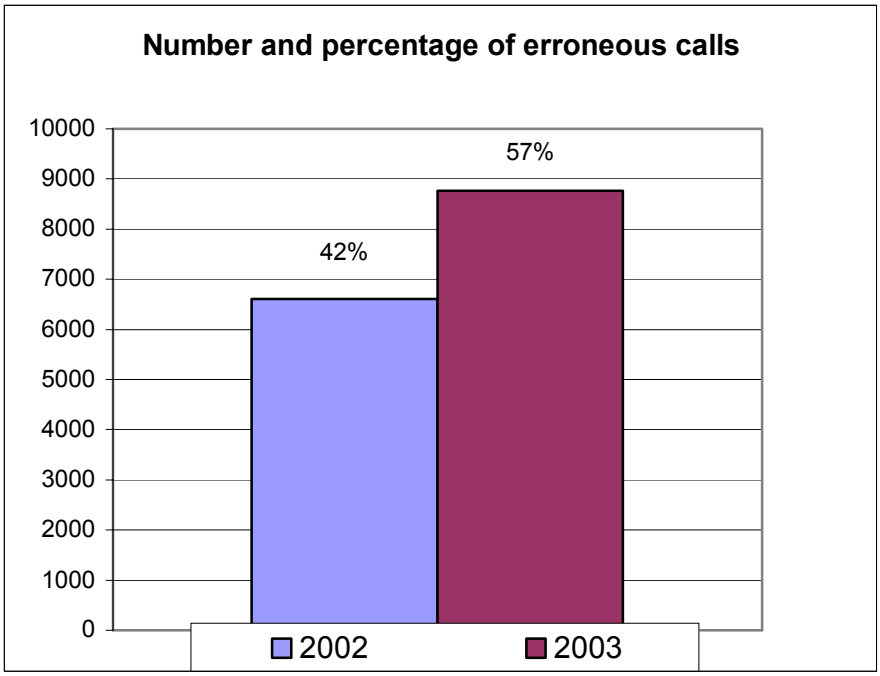

Figure 3. Percentage and number of erroneous calls throughout in 2002 and 2003, at the Andalusia Service of Telecare, Spain.

As we can observe, there was an increase in the number of erroneous calls from 2002 to 2003. In 2002 the calls by error constituted 42% (6,607 of a total 15,375) of the calls that took place in the Center of Attention at the Andalusia Service of Telecare, and in 2003 those errors rose to 57% (8,769 calls of a total of 15,376). The problem this presents is that although the caller called in error, there is always the possibility that it is an emergency call, and perhaps resources are expended unnecessarily. For example, since the same operators handle all incoming calls, they may be busy with an error call when a legitimate call is not being addressed. They might also allocate resources (i.e., ambulances) automatically to attend those error calls, and those resources could be needed to attend to other users. These data reflect a situation that must be addressed by considering how telecare is designed from the point of view of human-machine interaction.

The telecare systems today are designed according to the principle of universal design. According to Ron Mace (2006), *universal design*, also known as *design for all*, can be defined as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (¶1). According to Seminario Iberoamericano sobre Discapacidad y Accesibilidad en la Red ([SIDAR] Ibero-American Seminar on Disability and Accessibility on the Net, 2006), universal design is based on seven principles. The design must (a) be useful and valid for the diversity of people, and provide the same forms of use for all the users; (b) be flexible and accommodate the diversity of preferences and individual abilities; (c) be simple and intuitive; (d) communicate effectively the information that the user needs, considering the environmental conditions or the sensorial capacities of the user; (e) have tolerance for error, and diminish the negative consequences of involuntary and accidental actions; (f) demand little physical effort; and (g) have size and space accessible for using the device functions easily.

Apparently these principles, which were implemented in the Andalusia Service of Telecare, are not enough since erroneous calls continue. Therefore, we feel that research is needed to find design solutions to reduce the number of errors that the users of this system commit. And we believe that the solutions of design should be based on the analysis of the cognitive characteristics of users. This analysis has to be done within a psychological framework.

The Principle of Mutual Dependency

Cañas, Salmerón, and Fajardo (2005) have proposed a method for analyzing user interaction with artifacts. The method is based on the *principle of mutual dependency,* which states that the human cognitive functions implied in the task will depend on the functions that are present in the interface and that the functions of the interface that help in performing a task will be those that are more appropriate to the human cognitive functions that are implied in the task. For example, the appropriate interface functions will be those that correspond to the structure and function of the human working memory.

Therefore, according to this principle of mutual dependency, designers should consider that any modification, substitution, or introduction of a new function in the interface will result in a change in the human cognitive functions that intervene in the task. In addition, anything that is particular or constraining in the characteristics of the human cognitive functions that are present in some or in all users will set a limitation on the possible functions that are included in the interface. For example, users that have some limitations in their

working memory functions would require interface functions that overlook or compensate for these limitations.

So, in summary, the concept of mutual dependency means that

(a) The functions of the interface that are optimal for performing a task will be those that are more adapted to the human cognitive functions that are implied in the task.

(b) The human cognitive functions implied in the task will depend on the functions that are present in the interface.

(c) Any modification, substitution, or introduction of a function in the interface will imply a change in the human cognitive functions of the users.

(d) Any limitation in the characteristics of the human cognitive functions present in any or all of the users will imply limitations in the possible functions included in the interface.

The conceptual framework behind this principle is related to work being done by researchers around the world. For example, at the Center for Research and Education on Aging and Technology Enhancement (CREATE), in Florida, USA, research based on the principle of person-technology congruity is being conducted. The focus is to understand how older users' sensory/perceptual, cognitive, and psychomotor capabilities fit to the demands of new technologies designed for them (Czaja, Sharit, Charness, Fisk, & Rogers, 2001). Their principle of person-technology congruity is quite similar to our principle of mutual dependency.

Therefore, in line with the principle of mutual dependency, we began our research by analyzing the cognitive functioning of the users of telecare systems as the first step in finding solutions to the number of erroneous calls.

Deterioration of Elderly Cognitive Functioning

Different cognitive functions deteriorate with age. (For a recent review of this topic, see Fisk, Rogers, Charness, Czaja, & Sharit, 2004.) Visual functions start deteriorating at around age 40 (D. W. Kline & Scialfa, 1996). But the important problems appear around the age of 60, when people show a reduction of their field of vision, which means a stimulus must be in the center of their field of vision to be detected (Cerella, 1985). Hearing also diminishes with age. Around 20% is lost between the ages of 45 and 54 years, reaching 75% between 75 and 79 years of age (Fozard, 1990; D. W. Kline & Scialfa, 1996). Feldman and Reger (1967) found that people 80 years old miss about 25% of the words during conversations. In general, they are unable to follow a conversation in a group of people when everybody speaks at the same time, and this worsens in stressful situations (Corso, 1977). Speech deteriorates due to either a reduction in motor control or to a loss of the ability to listen to oneself or to others. Therefore, the ability to produce words declines with time, even as the time necessary to produce a word increases (Mackay & Abrams, 1996).

With age, response time in complex motor tasks gets longer (Light & Spiriduso, 1990; Spiriduso & Macrae, 1990). Elderly people show a smaller capacity to perform repetitive tasks that demand great speed, although with enough training they can deal with tasks like striking quickly with a finger (Krampe & Ericsson, 1996). Other evidence suggests that the decline that takes place in the accomplishment of tasks can be compensated for with advanced planning (Welford, 1985).

Attention is also affected by age. Vercruyssen (1996) indicated that elderly people have problems maintaining their attention for long periods of time. This author also suggested (p. 66) that tasks requiring fast and continuing searches are particularly tiring for them. With regard to selective attention, the ability to maintain the attention in the presence of distracters diminishes with age (Conelly & Hasher, 1993). Kane, Hasher, Stoltzfus, Zacks, and Connelly (1995) suggested that this happens because the elderly lose the capacity to inhibit responses to distracting items.

There is an impairment of episodic and procedural memory (Howard & Howard, 1996). This impairment is also observed in the semantic memory but it does not become important until an advanced age. Some studies show a small deficit in the ability to recognize simple, familiar items in tasks of (previously exposed) memory, but there is a significant deficit in the contents of the memory (Hoyer & Rybash, 1992). When the learning material contains histories, text, or interviews, this deficit also occurs in the recognition of significant forms (Hertzog & Rogers, 1989; Hultsch, Masson, & Small, 1991; Stine & Wingfield, 1987). On the other hand, the memory of diverse movements of the fingers that are involved in the verbal memory and/or the memory of motor sequences does not show deterioration with the age (Rybash, Roodin, & Hoyer, 1995). However, as indicated by Krampe and Ericsson (1996), a great amount of practice is necessary to maintain the ability at an expert level, as is the case of the better piano players.

Therefore, as this short review reveals, there are many cognitive functions that deteriorate with age that could explain the high number of erroneous calls. However, we want to address just one of them in this paper: The difficulty that elderly people have when processing language. Older adults maintain and could even improve knowledge of words and word meanings (cognitively), but they suffer deficits in the ability to produce the spoken and/or written forms of words (Burke & Shafto, 2004). They show problems producing well-known words. It has been suggested that older adults´ language abilities are affected by working memory limitations on the production of complex syntactic constructions (Kemper, Kynette, Rash, Sprott, & O'Brien, 1989). That would indicate that these limitations are ones of retrieval rather than comprehension. This phenomenon is related to the well-established distinction between *knowing* and *remembering* that explains phenomena such as the so-called *feeling of knowing* and *tip-of-the-tongue* (Koriat, 1998). Both phenomena could be interpreted by saying that you know something but you can not retrieve it. However, it could be also a problem of word recognition. According to Nelson's semantic-sensorial model (Nelson & Reed, 1976; Nelson, Reed, & Walling, 1976), words have an indirect access to meaning. When reading a word you have to go through a lexical process to recognize letter, phonemes, and so forth, before you access its meaning. On the contrary, pictures have direct access to meaning. Therefore, the language deterioration showed by elderly people could be due to both word recognition and retrieval. And if language deterioration is a factor for the telecare users, then that could explain the erroneous calls. The user interface of the telecare terminals provides labels in words only to indicate the function of each button: If the user is having difficulty with word retrieval, then she/he would have difficulty selecting the appropriate button to press for service.

There could be a simple design solution based on the fact that empirical research has found that aging does not affect the retention of pictorial stimuli (Rybarczyk, Hart, & Harkins, 1987). In a study conducted by Park, Royal, Dudley, and Morell (1988), picture recognition did not show an age-related decline until a week later. Winograd, Smith, and

Simon (1982) have compared verbal and visual encoding by younger and older subjects to determine whether there would be a picture superiority effect that does not change with age. The Picture Superiority Effect (PSE; pictures are recognized and remembered better than words) has been reported in a great variety of semantic tasks (e.g., Pellegrino, Rosinski, Chiesi, & Siegel, 1977) and episodic tasks (Kinjo & Snodgrass, 2000; Paivio & Csapo, 1973). Winograd et al. (1982) found the PSE in both age groups. The finding of a PSE in older subjects indicated that nonverbal codes can be used effectively by people in all age groups to facilitate memory performance. Rissenberg and Glanzer (1986) tested the hypothesis that the PSE in recall would decrease with age in two experiments with undergraduates, older adults with normal memory for their age, and older adults with significant memory impairment. Although the results showed that the PSE declined with age, it was still present in older adults. Moreover, it could be re-established in older adults with normal memory by instructing them to verbalize overtly during the item presentation.

In the field of human-computer interaction, the well-known icon superiority effect has been demonstrated many times in interface design. For example, Arend, Muthig, and Wandmacher (1987) showed the superiority of icons over verbal commands in six different text editor tasks. Spence and Parr (1991) found that responses were faster with icons in a problem-solving task that required choices among multiple alternatives on several variables. Similar results have been found in traffic research. T. J. Kline, Ghali, and Kline (1990) found that the comprehension of text signs could be affected by visual acuity, which is a common problem among old people.

EXPERIMENTAL COMPARISON BETWEEN ICON AND VERBAL LABELS OF TELECARE FUNCTIONS

Based on the research presented above, our hypothesis was that we can reduce the numbers of errors by using icons to indicate the functions on the device interface instead of words. In order to test this hypothesis, we conducted a study in two phases. First, we surveyed a number of people to determine which icon best represented each element presented on the interface. Then, in an experimental setting with a number of experimental subjects, some of them users of telecare systems and some nonusers, we presented the word and icon versions of those function items to the test subjects, who then had to perform a simulation of a calling task.

Phase One: Icon Selection

The purpose of this phase of our study was to select the icons for the design of the graphical interface. The icons selected in this phase were then compared in the experimental phase with their verbal counterparts.

Participants

A sample of 72 subjects was selected (24 young adults, 24 adults, and 24 elderly adults, with an average age of 46 years) through a stratified sampling with the attributes of age and

educative level. Age had three levels: young people (average age = 20 years old, range = 18-24 years), 24 adults (average age = 36 years old, range = 25-55 years) and 24 elderly adults (average age = 72 years, range = 56-92 years). All groups contained participants in equal numbers (25% each) possessing one of four educational levels: without primary studies, completed primary studies, completed secondary studies, and completed university studies. All subjects were native speakers of Spanish, the language of the testing.

Materials and Instrumentation

We selected four functions that could be found on the most popular telecare devices: *Familia* [Family], *Emergencia* [Emergency], *Averias* [Failures], and *Información* [Information]. The function Family is used when the user wants to contact a member of her/his family. Emergency means that something is happening (e.g., some medical problem) that needs urgent attention. The function Failures relates to any problem with some home equipment (e.g., the refrigerator is not working). Finally, Information is used for getting some information about anything that interests the user (e.g., name and address of a doctor). All users of telecare devices are familiar with these categories. These functions are listed on the standard devices, but users can change them to any other function labels they like more.

Then we selected six icons for each of the functions from *The Handbook of Pictorial Symbols* (Rudolfh & William, 1974) that contains a collection of 3,250 icons. The icons were presented in a computer display by software developed in visual BASIC 6.0 especially for this study.

Procedure

At the beginning of the session, participants answered a set of questions regarding demographic data, such as age, gender, educational level, type and percentage of disability, and so forth. Percentage of disability is a measure used by the Spanish Administration to assign public resources to people with disabilities; it is assigned by a committee of professionals (medical doctors, psychologists, social workers, etc.). However, it should be noted that the measure includes not only the medical and psychological condition of the person, but also some social variables.

Then, we presented the participants with a booklet with forms in which the concepts for the functions were presented. The participants were to select one icon from the six options that best represented each function's concept. We must note that since this study was done in Spanish, it is possible that people in different cultures might select a different icon for the same word concept.

Results

We calculated the percentage of times that each of the six icons was selected for each interface element. Figure 4 shows the percentage of choices for the six icons for the interface elements. For example, for the concept Family, 55% of the participants chose icon number 6.

The selected icons for each interface element can be seen in Figure 5. The icons that we selected for the experimental phase of the study were those that were chosen by the significant majority of the people.

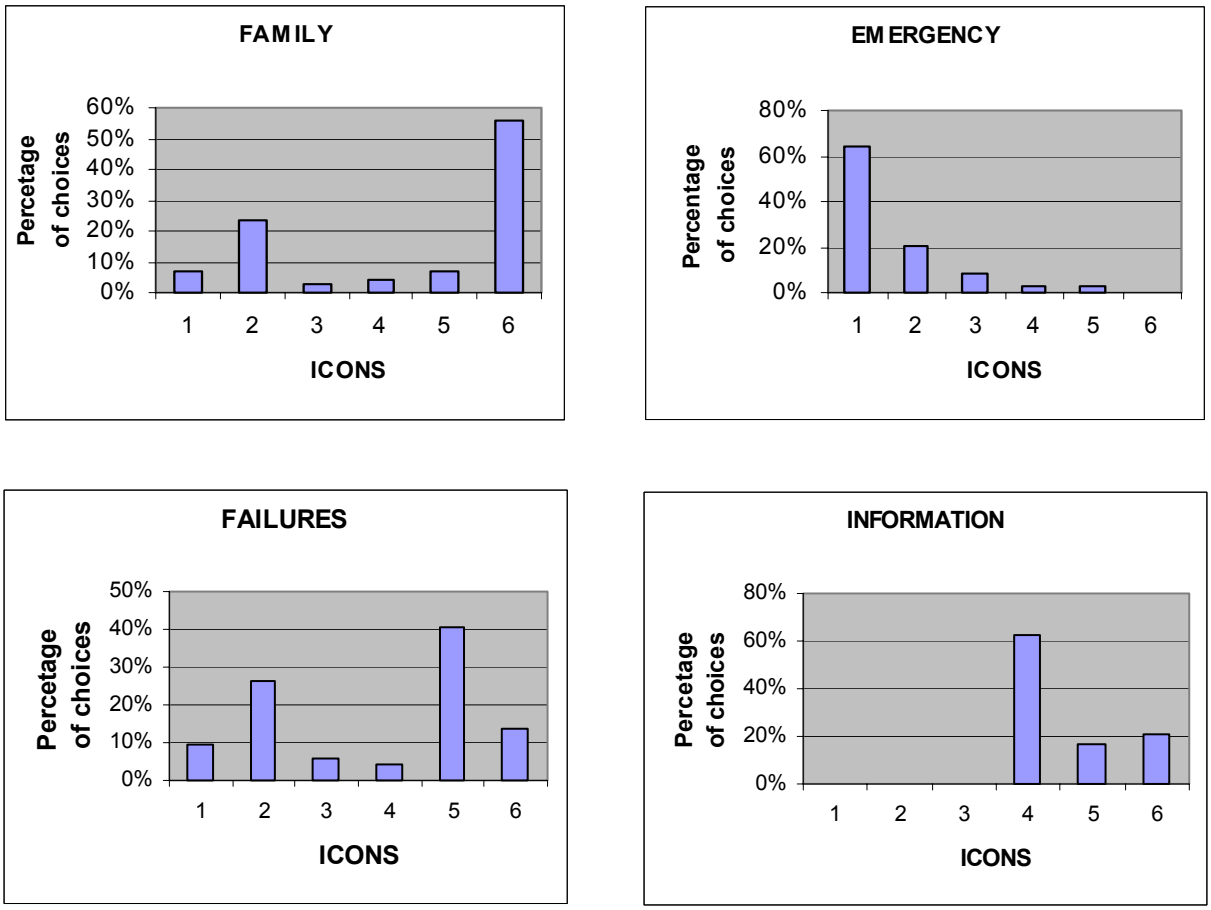

Figure 4. Percentage of choices for the six icons for the interface element.

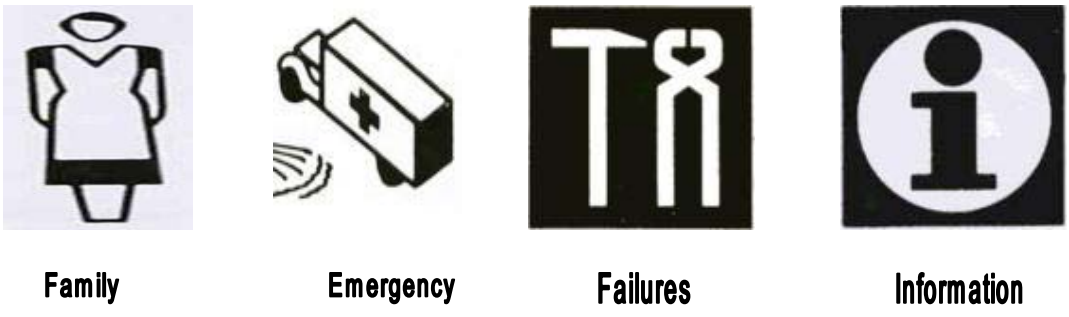

Figure 5. Selected icons for each interface element.

Phase Two: Testing the Icons

The second phase of our study was conducted to test the reliability of the icons in facilitating accurate use of the functions on the telecare interface. In this phase we compared the icons selected in the first phase to their corresponding word labels.

Participants

One hundred and twenty people participated in the experiment. Sixty of them were users of the Andalusian Telecare Service, with an average age of 76 years. The other 60 participants were nonuser control subjects, matched to the experimental telecare users on education level, gender, percentage of disability, and age. All participants were native Spanish speakers; the testing was conducted in Spanish.

Materials and Instrumentation

The stimuli were the four concepts used in the previous phase: Family, Emergency, Failures, and Information. Each icon and its corresponding verbal format were presented separately on a computer screen by the software designed to run this experiment. Due to the lack of personnel and the equipment in our laboratory to design new devices, it was not possible to use modified telecare devices in this study.

Procedure

The experimental session started by asking the participant demographic data about her/himself (age, sex, educational level, and type and percentage of disability). The experimental trials consisted of presenting the four concepts in one of the two possible formats (icon or verbal) depending on the group to which the participant belonged. Both the users and nonusers groups were split into two subgroups, which then performed the task either in the icon condition or the verbal condition. Therefore, there were four groups with 30 participants in each: the User-Graphical condition, the User-Verbal condition, the Nonuser-Graphical condition, and the Nonuser-Verbal condition.

Then a request to call situation was presented in a written format on the computer screen, the subject had to press a key on the computer keyboard to choose the concept (visually or graphically, depending on the subgroup) that would be appropriate for that call. For example, the participant saw a message in the center of the screen saying “Call a family member,” which then disappeared and the four concepts (in either the verbal or graphic format) were presented. The concept options remained on the screen until the participant pressed one key with her/his choice.

Only one concept was presented in each trial. Therefore, each participant was involved in four experimental trials plus a practical trial in which a concept not related to the telecare devices was presented. The order of presentation of the four experimental concepts was random and different for each participant.

Design

The design was a 2 x 2 factorial design, with Type of User (User and Nonuser) and Type of Interface (Graphical and Verbal) as the between-subjects factors. The dependent variable was number of errors. Response time was discarded as a dependent variable since it involved the motor ability of the user, which evidently could be different for both type of participants, since the two groups were not matched on motor ability.

Results

Figure 6 shows the results of this experimental phase. We performed an analysis of the covariance on the data with Type of Interface (Graphical or Verbal) and Type of User (User or Nonuser) as independent variables, and Gender and Educational Level as covariates. The dependent variable was the number of errors.

There was no main effect of Type of User, but Type of Interface showed a significant effect, F (1, 119) = 10.72, MSE = 3.00. On the other hand, the interaction was close to significance, F (1, 119) = 3.40, MSE = 0.95, $p < .07$. An analysis of the simple effects showed that the differences between users in the condition of Verbal Interface were significant, F (1, 114) = 10.72, MSE = 0.28, $p < .01$, whereas the differences in the condition of Graphical Interface were not, F (1, 114) = 3.29, MSE = 0.28, p = 0.7.

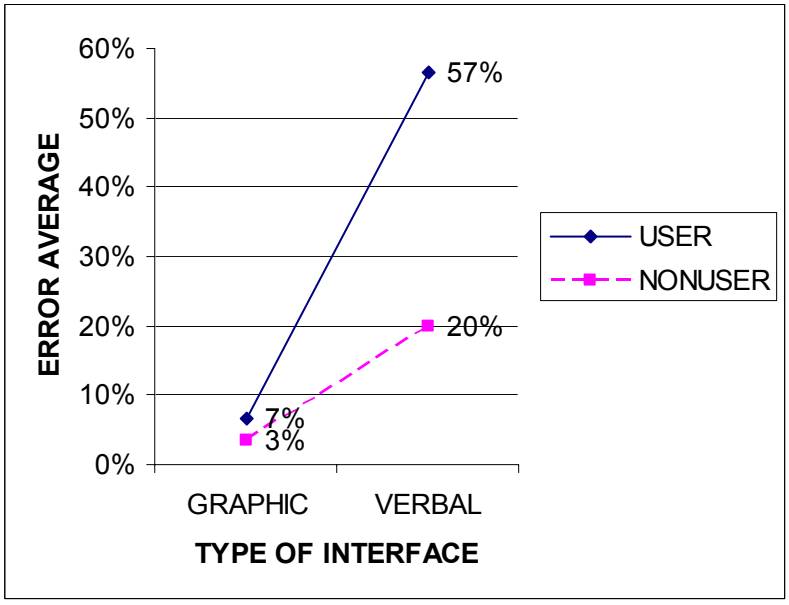

Figure 6. Error average for users and nonusers of Telecare systems.

Discussion

The results of the experimental phase show clearly that a possible cause of the calls in error observed in a telecare services could be due to the exclusive verbal design of the current telecare interfaces. The comparisons between the performances of users and nonusers with both interfaces revealed two important issues. In the first place, for both types of users, the Graphical Interface reduced the number of errors. Second, and more important, the differences in the number of errors that were observed between both types of users were reduced enormously with the Graphical Interface. In other words, users committed significantly more errors than the nonusers with the Verbal Interface, whereas the number of committed errors was very similar among participants with the Graphical Interface.

We can interpret these results within Paivio's (1991) dual coding theory. People commit fewer errors with a graphical interface because they understand the meaning of the buttons better than with a verbal interface. Meaning is better accessed with picture than with words

and both types of cognitive representations (visual and verbal) of the icons allow an even better access to meaning. Accessing the meaning of words alone is more confused because words have just one cognitive representation (verbal).

However, other models could also explain these results. For example, Nelson's semantic-sensorial model (Nelson & Reed, 1976; Nelson, Reed, & Walling, 1976) would predict that people commit fewer errors with the graphical interface because the visual characteristics of icons are more distinguishing than those of words and the access to their meaning is direct. To access the meaning of words it is necessary to process their visual and phonetic characteristics.

GENERAL CONCLUSIONS

The main conclusion that could be reached from the results of this experiment is that the principle of universal design must be complemented by an analysis of the cognitive functioning of the users if we want to improve telecare system design. Although we have only tested a single hypothesis that refers to the graphical or verbal characteristics of the interface, we found results that could point to an important cause of erroneous calls. Therefore, it seems reasonable that if we look deep into the cognitive analysis of user interaction with telecare systems, as suggested by the principle of mutual dependency, we should be able to find other potentially important variables. This analysis could be based on empirical research done in cognitive psychology with elderly people, as well as with cognitive theories, such as Shallice and Cooper's (2000) theory that has been developed to explain the erroneous conduct of people. In practical terms, we must say that this research will solve an important economical problem at the Telecare Services, since erroneous calls mean an important loss of resources.

It is important to note also that although there could be other possible noncognitive explanations (e.g., accidental physical pressure on the telecare device) for the large number of erroneous calls observed by telecare providers, the cognitive functioning of elderly people may also play a significant role in this scenario. Therefore, we believe that it is worth the effort to explore hypotheses based on the analysis of the cognitive functioning of elderly people.

Finally, it is also important to say that a possible flaw in our experimental design was that we did not make any evaluation of the cognitive ability of our participants. Therefore, even if the participant were matched on four control variables (educative level, gender, percentage of disability, and age), the participants in the User group could be more cognitive deteriorated than participants in the Nonuser group. The participants in the User group were people that had requested the installation of telecare devices, and that could mean that they are less able to live by themselves.

The only criterion related to cognitive ability that we could have used to judge cognitive ability was the percentage of disability, but it comprises medical, psychological, and social variables. However, the Andalusian Service of Telecare requires that potential users have a minimum of psychophysical conditions to operate the device. It could be interesting to repeat this study with some assessment of the participants' cognitive ability to test this factor's effect more appropriately.

ENDNOTE

1. Although all new units of telecare devices delivered to clients contain specific terminology related to call destinations at the telecare service center as the speed dial options, clients are free to rename or alter this terminology for their convenience. This unit shows the speed dial options preferred by a particular user.

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