Making Computer-based Cognitive Stimulation Technologies accessible to Illiterate Elders

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Abstract
We propose the use of ubicomp technologies to make Cognitive Stimulation accessible to elders belonging to marginalized sectors of Mexico. Many of these elders are characterized by their illiteracy and limited economic resources, which make them more vulnerable to diseases such as Alzheimer's.

Keywords
Ubiquitous Computing, Cognitive Stimulation, Elderly

ACM Classification Keywords
K.4.2 Computers and Society: Social Issues: Assistive technologies for persons with disabilities.

Introduction
There is evidence of the fact that a person who participates often in Cognitive Stimulation (CS) activities reduces the risk of suffering a cognitive decline related disease, or improves his/her cognitive functioning and behavior [1]. Furthermore, a low educational level in elders is associated with a higher prevalence of dementia [2]. In Mexico, there are high levels of illiteracy as about one out of three elders is not able to read or write. Additionally almost half of them don't have access to health care insurance and only 20% of them receive a labor pension [3]. Currently, the Mexican government is supporting programs to provide elders belonging to marginalized groups with medical services; however, there is a lack of programs to provide them with attention for coping with cognitive decline. Important limitations for the implementation of CS activities are the lack of specialized personnel and materials [4]. We consider that ubiquitous computing systems could enable the creation of accessible computer-based CS materials and activities for the elderly. Further, making these systems available through current government specialized centers, would not only enable us to address some of the aforementioned limitations, but also to facilitate the participation of elders' relatives in CS activities.

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Technologies for Cognition
Some systems may be used by elders to cope with their cognitive decline, such as Smartbrain [5] and Brain Age

[6] which provide CS exercises and games. Other systems, such as Interactive Multimedia Biographies, stimulate communication by enabling the elderly to share information (such as photos, music, anecdotes) with their relatives [7]. These technologies require that elders have experience with computer-based technologies. However, elders tend to show poor performance in controlling their movements, and greater difficulty in using complex interaction devices. We propose suitable interaction mechanisms so that illiterate elders can actually perform their CS activities and benefit from computer-based CS technologies in a natural and simple way.

Understanding the problem space

In order to design technologies to support CS activities, we performed several studies which enabled us to understand how ubiquitous computing technology could support these interactions.

***Study 1**: Understanding the CS Process*

Through semi-structured interviews with specialists and caregivers, and by analyzing the obtained data using Grounded Theory techniques, we identified that a CS process includes the following phases: i) diagnosing the elder, ii) planning the activity, iii) performing the CS activity, and iv) registering the elder's performance.

***Study 2:** Interactions between actors in a CS session*

To identify those involved in the CS activity, what their roles are and how they interact; we conducted an observational study of a CS session [8]. The participants were 10 elders and 3 caregivers, from a local elder's residence. We identified different interactions, with functions such as: (i) patients requesting help or requesting ending an activity, (ii) caregivers providing directions to patients, encouraging them to perform the CS activity, (iii) caregivers providing feedback to patients and promoting demonstration or help among patients, (iv) caregivers giving directions to other caregivers, seeking help from or delegating tasks to other caregivers, or requesting information regarding a patient, (v) caregivers choosing material for patients, delivering material to patients or removing material from the table.

We observed the need for providing support to caregivers to interact simultaneously with several patients. Some identified areas of opportunity to provide computer-based support include: i) facilitating communication and collaboration between caregivers and elders; ii) facilitating communication and coordination among caregivers, iii) selecting materials and activities according to the needs and preferences of each elder, iv) providing awareness of the status of each individual within the group to caregivers; v) integrating remote family members to elder's activities in order for them to provide assistance to elders.

***Study 3**: Interaction with materials*

Finally, in order to understand the elders' capabilities and preferences, regarding the use of traditional physical objects vs. digital objects, for the execution of CS activities we performed an empirical study, with the participation of thirty elders from a support group from the local municipality [9]. The main results indicate that older adults complete more exercises (5:1), and in less time (1:14), using the physical objects than when using the digital objects. A surprising result from the on-exit survey was that almost all participants (92.5%)

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indicated that they would rather continue performing their CS activities using the computer. These results provide evidence regarding the importance of introducing alternative interaction mechanisms for executing CS activities.

Design Implications

To support the findings described in the previous section, we identified the following system requirements to support the roles and tasks of the different participants involved in a CS activity: i) the system should provide mechanisms for the automated identification of elders, record their work session, and let these records be accessible to specialists; ii) it should provide awareness of the elders' activity level and progress to caregivers; iii) mechanisms to provide coordination, communication and collaboration support between participants of a CS session. Further, we consider relevant iv) to provide mechanisms that enable the integration of remote relatives by sending them notifications on the elder's activity through pervasive technology, such as mobile phones, or home devices such as iTV. An important aspect is v) to maintain a simple, natural and ubiquitous interaction with the technology; this suggests the use of tangible users interfaces (TUIs) for the elderly, which combine easier manipulation with physical objects, and motivation with computer use. Figure 1 shows the main system components. These components are further described in [10]. The following scenario illustrates the use of the system.

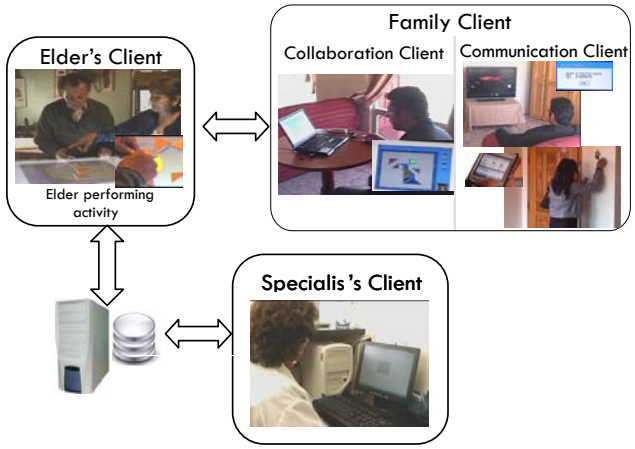

Figure 1. Main elements of Ubiquitous CS System

After his painting class at the elder's center, Carlos moves to the entertainment room, and goes to one of the touch tables. The system detects his presence and displays a welcome message on the table. Then, the system asks him to choose one of the scheduled exercises proposed by the specialist. He chooses the Tangram game and takes the materials indicated. This is reported to Cruz, one of his sons who has subscribed to this service to be notified via their Smartphone. After a few minutes, Carlos has solved two puzzles, but the third one is slightly more complicated than the two previous. Thus, Cruz, who has been receiving reports on the progress of the activity on his Smartphone, goes to his computer and integrates himself into his father's activities. In the Collaboration Client, he can see his father's movements and provide feedback during the assembly of the puzzle through the audio channel that has been initiated between the two applications. In this

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way, Carlos is able to complete 30 minutes of CS activity and 20 minutes of interaction (feedback, support, socialization) with his son. A record of this activity has been registered in order for the specialist to track the evolution of Carlos' cognitive decline.

Conclusions

Due to population aging, there are serious health problems that lie ahead in the world, and especially in developing countries, such as Mexico. Therefore, as a preventive measure to cope with elder's cognitive decline, we have proposed the development of a ubiquitous computing system that provides support to elders that belong to marginalized and poor sectors. Our proposal has two premises: i) facilitating elders' interaction with the technology and ii) making technology accessible to the elderly. In this way, we plan the system to include components of a variety of technologies (e.g. TUIs, Groupware, Pervasive Computing) installed in geriatric residencies, or support groups from the local municipality.

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