Assistive Technology: From Research to Practice
P. Encarnação et al. (Eds.)
IOS Press, 2013

doi:10.3233/978-1-61499-304-9-585

Lisling 3D: A Serious Game for the Treatment of Portuguese Aphasic Patients

Yves Rybarczyk[a,1], José Fonseca[b], and Ricardo Martins[a]
[a] *Department of Electrical Engineering, New University of Lisbon, Portugal*
[b] *Language Research Laboratory, Medical Faculty of Lisbon, Portugal*

Abstract. The game described in this article was developed for the treatment of lusophone aphasic patients. Various information technologies were used in order to create a multimedia platform of rehabilitation. The objective of this software is to provide a complementary tool for the classical speech therapy, which enhances the patient's recovering through the completion of exercises adapted to the different symptoms of the disease. The principal features of the game are: i) a realistic 3D virtual environment that enables the interaction with modeled objects and ii) a dynamic interface that allows the addition of new therapeutic tasks in order to get a customizable and easily upgradable platform. One of the main scientific contributions of this project is the fact that it is the only product of this sort tailored to the Portuguese population of aphasics.

Keywords. Stroke rehabilitation technology, serious games, 3D virtual environment, Human-Machine Interaction (HMI).

Introduction

1.1. Aphasia and Rehabilitation Technologies

Aphasia is an acquired disorder of language functions, which surges after a stroke. The main characteristics of this disease are alteration of oral expression, auditory comprehension, reading and writing. Speech and language therapy has revealed its efficiency in the treatment of aphasic patients [1].

In 1967 the first results that applied a therapeutic technique using a personal computer were published [2]. From this date, many other rehabilitation programs have used Information Technologies (IT) as a complementary or, even more, autonomous therapeutic means. The purpose of the large majority of the existing software is only to treat some specific linguistic impairments of the patient. For example, these computer programs target oral naming of objects [3], auditive identification of objects [4], writing of nouns [5], writing identification of nouns [6] ...

On the contrary, the first version of the "Lisling" program [7] belongs to the limited group of therapeutic software that aims to provide a holistic treatment of the different types of aphasia (for other examples, see [8] [9]). Another emblematic feature of this software is the fact that it uses bi-dimensional visual items. This paper presents "Lisling 3D", which provides a 3D graphical environment and natural user interfaces in order to transform the previous multimedia program into a serious game.

[1] Corresponding Author.

1.2. Why to Create a 3D Therapeutic Game?

Creating a computer game as a rehabilitation tool allows the patients to practice the therapeutic exercises at any time and with increased autonomy. This method takes advantages of displaying diverse types of stimulus such as animations, 3D models, sounds and texts, making the tool more enjoyable. In addition, the patients may receive instantaneous feedback regarding their performance, which is a crucial motivational factor for the treatment [10].

Using 3D virtual environment makes it possible to add more innovative tasks than the ones existing in the traditional tools. A large part of the aphasic patients have difficulties in understanding orders. For instance, if you ask such patients to put a glass on the table, they may understand what the glass and the table mean and correctly identify each single object, but they may not be able to comprehend the entire meaning of the instruction [11] [12]. Virtual environments enable the training of the understanding skills through the completion of tasks that involve object manipulations and/or everyday life activities, which are impossible to simulate with a 2D environment [13].

2. System Description

The therapeutic tool for aphasic patients, "Lisling 3D", is developed as a 3D serious game (implementation based on the Blender game engine) that can be used at home, under the supervision of a relative or autonomously. Exercises take place in an environment that simulates a realistic house, modeled in 3D. The software uses tri-dimensional representations of objects, animations, synthesized speech and writing items. Five categories of tasks have been developed by a group of speech and language therapists from the Saint Mary's Hospital of Lisbon, in order to enable a complete treatment adapted to the different aphasic symptoms (Fig. 1). A XML database is used to allow the integration of new exercises and to save the data of the patients.

Writing exercises/texts	Substantives Infinitive Verbs Phrases – Insert Nouns Phrases – Insert Verbs in Present Phrases – Insert Prepositions Phrases – Phonological Errors Phrases – Disordered Words Texts – Insert Nouns Texts – Insert Verbs Texts – Insert Function Words Texts – Insert Words
Word selections	Responsive Naming Word Intruder
Object identifications	Object Identifications Simple Phrases Nouns Matching Phrases Matching
Questions yes/no	Writing/Auditive – Phrases Yes/No
Motor tasks	Simple Tasks Complex Tasks

Figure 1. Categories of tasks implemented

2.1. Tasks/Exercises

Writing Exercises/Texts

In these tasks, the patient has to write a noun correctly, a sentence or to fill in the gaps in a paragraph. In Figure 2, a patient is writing the name of the 3D modeled object displayed on the screen (e.g., “Toothbrush”).

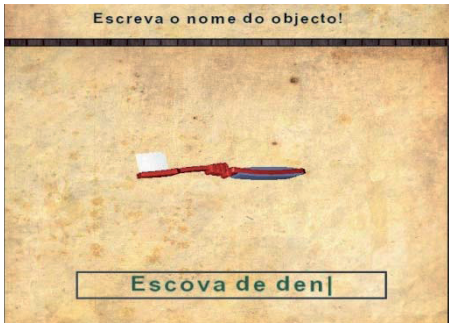

Figure 2. Example of substantive writing.

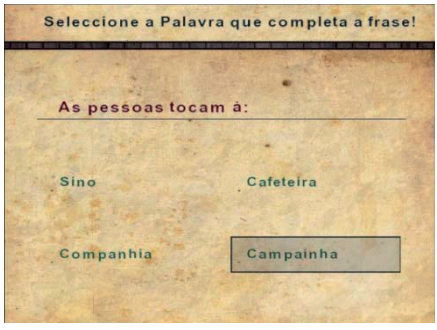

Figure 3. Example of responsive naming.

Word Selections

Here, the user is asked to select a specific word from a list of different ones, in order to follow a determined rule. The Figure 3 shows an example of responsive naming in which the patient has to complete the phrase with the right word (e.g., “People ring the < door bell >”).

Object identifications

In an exercise of object identification, the user has to explore the virtual environment with the aim of finding the object that matches the writing or auditive word displayed by the computer program. For example, if the task is carried out in the living-room, the patient may have to point out (red circle) specific home furniture, such as a chair (Fig. 4).

Figure 4. Example of object identification.

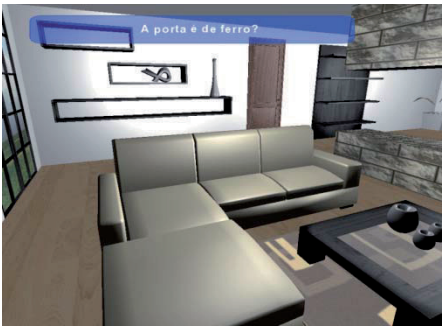

Figure 5. Example of questions.

Questions Yes/No

This category is similar to the previous one, but you must respond to a question. For instance, the system may ask: “Is the door iron?” (Fig. 5). So, the users have to move inside the room in order to seek the information that enables them to answer the question.

Motor tasks

These last exercises are quite different from the other ones because they allow us to train the comprehension skills of the aphasic patients through completion of natural movements. The tasks are related to day-to-day activities such as transporting an object, turn on/turn off a machine, open/close a door (Fig. 6) ...

Figure 6. Example of simple tasks

2.2. User Control Interfaces

In our system, the question of the implementation of the user control interfaces is crucial for two main reasons. First, aphasia is usually associated with motor disabilities, which obliges us to interface natural and intuitive commands. Second, in order to get closer to the kinematic of a movement performed in the real world, which is especially relevant for the category of motor tasks, we must provide a control mode with enough degrees of freedom (DOF). Thus, besides the traditional input systems existing in a common computer (keyboard and mouse), a 6 DOF joystick and a Wii Remote command were connected with the software. The sensitivity of the control can be adjusted by the user with the intention of being adapted to a large number of patients.

3. System Evaluation

3.1. Materials and Methods

Experimental protocol

At present, we have not carried out any tests with patients, due to the fact this tool is still a prototype and we do not want to create false expectations. However, after a demonstration of Lisling 3D, we asked nineteen speech and language therapists to evaluate the relevance of this software in the treatment of aphasia, through a seven level scale questionnaire using a visual Likert scale ranging from 0 to 6 points. The therapists were in average 31 years-old (20 – 62 years) and had an average of 7.4 years professional experience (1 – 31 years).

Questionnaire

Questions asked to the speech and language therapists are listed below:

1. Do you think the tool will be easy/intuitive to use by the patients (especially for the task completions)?
2. How easy is the navigation through the software (in the sense of finding easily the options you are looking for)?
3. Is the computer program appealing/enjoyable (in the sense of the user having the desire to use it frequently)?

4. From the therapeutic point of view, is the tool well organized/structured?
5. How would you evaluate the visual/graphical definition?
6. How would you evaluate the audio/vocal definition?
7. How would you evaluate the completeness of the therapeutic tool, regarding the different dimensions of language (expression and comprehension), if you compare it with the traditional approach (pencil and paper)?
8. Do you believe this tool would be useful/complementary in your professional activity?
9. Is the software globally appropriate for the rehabilitation of aphasic adults?
10. In your opinion, are the exercises proposed relevant?
11. Is there a sufficient variety of exercises?
12. Do you agree that the types of help provided are appropriated?
13. Are there sufficient types of help?

3.2. Results

All the answers of the questionnaire are above average (Fig. 7). The question about the usefulness/complementary of the tool regarding professional activity gets the highest score (5.8 points). The lowest score is about the sound quality (3.3 points).

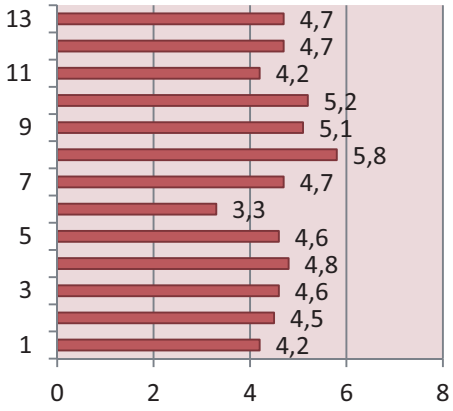

Figure 7. Average evaluation for the 13 questions.

4. Conclusions

The paper presents a therapeutic tool with the purpose to stimulate the global language functions. The software uses a realistic 3D graphical world, in order to provide a high sensation of immersion/presence for the patient. The advantage of such computational therapy is to increase the practice of rehabilitation exercises and, consequently, the expectations of recovery [14]. The tool is implemented on the bases of a serious game, in the sense that i) it displays playful exercises and ii) it presents the patient's score at the end of each task (a history of the performances is also available). The natural desire to improve the score at each session allows an effortless intensification of the rehabilitation process, thanks to the motivational factor. Overall, the computer program is assessed as useful and hopeful by the speech and language therapists. The next step

will be to test the software in an aphasic population to evaluate the relevance of session training on the patient's daily activities, and to compare the performance with a traditional speech therapy.

References

[1] A. Basso, Prognostic factors in aphasia, *Aphasiology,* 6 (1992), 337-348.
[2] G. Pizzamiglio, and M. Roberts, Writing in aphasia: a learning study, *Cortex, 3* (1967), 250-257.
[3] G. Deloche, et al., Confrontation naming rehabilitation in aphasics: a computerised written technique, *Neuropsychological Rehabilitation, 2* (1992), 117-124.
[4] R. Mills, and R. Thomas, Microcomputerized language therapy for the aphasic patient, *IEEE Proceedings of the John Hopkins First National search for Personal Computing to Aid the Handicapped* (1981), 45-46.
[5] X. Seron, et al., A computer-based therapy for the treatment of aphasic subjects with writing disorders, *JSHD, 45* (1980), 45-48.
[6] R.C. Katz, and V.T. Nagy, An intelligent computer-based spelling task for chronic aphasic patients, *Clinical Aphasiology: Conference Proceeding,* BRK Publishers, Minneapolis, 1984.
[7] J. Fonseca, et al., Lisling – Multimedia program for aphasics training, *4th European AAATE Conference,* Porto Carras, Greece, 1997.
[8] F.J. Stachowiak, Computer-Based aphasia therapy with the Lingware/STACH System, *Developments in the assessment and rehabilitation of brain-damaged patient: Perspectives from a European Concerted Action,* Gunter Narr Verlag, Tubingen, 1993.
[9] J.M. Vendrell, Microcomputers in language rehabilitation, *Developments in the assessment and rehabilitation of brain-damaged patients: Perspectives from a European Concerted Action,* Gunter Narr Verlag, Tubingen, 1993.
[10] I. Robertson, Does computerized cognitive rehabilitation work?, *Aphasiology, 4* (1990), 381-405.
[11] A. Basso, *Aphasia and its Therapy,* Oxford University Press, New York, 2003.
[12] Y. Rybarczyk, and J. Fonseca, Tangible interface for a rehabilitation of comprehension in aphasic patients, *11th European AAATE Conference,* Maastricht, Netherlands, 2011.
[13] C. Sik Lányi, et al., Using IT to inform and rehabilitate aphasic patients, *Informing Science Journal, 9* (2006), 163-179.
[14] R. Palmer, et al., Computer therapy compared with usual care for people with long-standing aphasia poststroke: a pilot randomized controlled trial, *Stroke, 43* (2012), 1904-1911.