E-Learning-Based Speech Therapy: A Web Application for Speech Training

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Abstract

In The Netherlands, a web application for speech training, E-learning-based speech therapy (EST), has been developed for patients with dysarthria, a speech disorder resulting from acquired neurological impairments such as stroke or Parkinson's disease. In this report, the EST infrastructure and its potentials for both therapists and patients are elucidated. EST provides patients with dysarthria the opportunity to engage in intensive speech training in their own environment, in addition to undergoing the traditional face-to-face therapy. Moreover, patients with chronic dysarthria can use EST to independently maintain the quality of their speech once the face-to-face sessions with their speech therapist have been completed. This telerehabilitation application allows therapists to remotely compose speech training programs tailored to suit each individual patient. Moreover, therapists can remotely monitor and evaluate changes in the patient's speech. In addition to its value as a device for composing, monitoring, and carrying out web-based speech training, the EST system compiles a database of dysarthric speech. This database is vital for further scientific research in this area.

Key words: *e-health, technology, telehealth, distance learning*

Introduction

In the past decades, considerable attention has been paid to the definition of telemedicine[1] and to the evaluation of telemedicine technologies.[2] The effect of home-based telehealth on clinical care outcomes[3] and users' attitudes toward diverse applications of home telehealth have also been investigated.[4,5] The potentials of telehealth in speech-language pathology have been emphasized only quite recently.[6–8] Applications for remotely assessing speech and language disorders have been explored,[9–12] and the potentials of telerehabilitation for treating people with communication disorders following acquired neurological impairments have been increasingly studied.[13,14] Telerehabilitation applications enable these patients to engage in intensive independent training in their home environment.[7] Highly intensive training has been found to be effective in both motor rehabilitation after stroke[15] and speech and language rehabilitation after stroke and Parkinson's disease.[16–19]

In The Netherlands, a web-based speech training device, E-learning-based speech therapy (EST) (available at www.spraaktraining.nl/), has been developed for patients with dysarthria following acquired neurological impairments. This communication report describes the EST infrastructure and aims at elucidating the potentials of this telerehabilitation application.

Materials and Methods

EST CENTRAL SERVER

A central server forms the keystone of the EST infrastructure (*Fig. 1*). The server hosts two types of recorded speech audio files: target speech files in MP3 format and recorded speech files uploaded by patients (clients) in WAV format. The latter

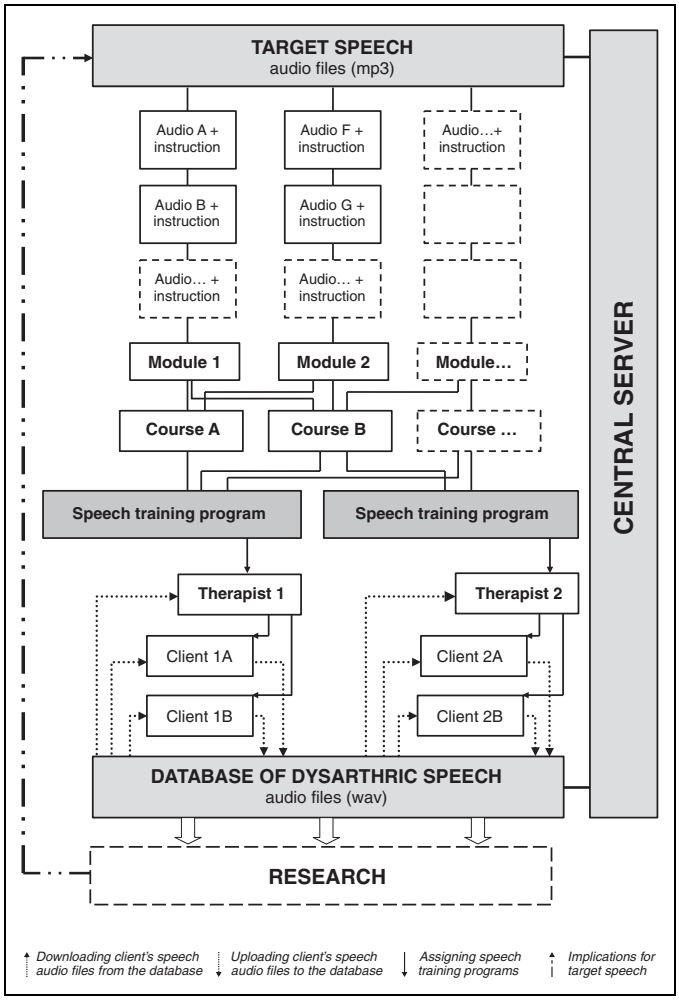

Fig. 1. Infrastructure of the E-learning-based speech therapy system.

(semi)automatically create a central database. Connected to the central server, the speech processing program "Praat"[20] enables analyses of overall pitch and intensity of speech audio files uploaded by clients.

APPLICATION REQUIREMENTS

A desktop computer or a laptop with an Internet connection (bandwidth of at least 256 kbit/s) provides users with access to the server. Clients' computers require adobe shockwave player and adobe flash player, as the current EST client application uses components from these software packages. The flash application is involved in the user interface and communication with the shockwave component. The shockwave player serves as an audio recorder and file transfer protocol. This file transfer protocol facilitates file exchange between computers by standardizing procedures that differ between operating systems.

ARCHITECTURE OF EST TRAINING PROGRAMS

A speech training program consists of one or more courses. Each course contains at least one training module. Each module has a fixed combination of audio files and instructional text to carry out the exercises. The training programs may be modified by changing the combination of courses and modules.

Results

The EST system provides distinct user groups with access to the server and enables the generation of a speech database.

USERS

Administrators. Administrators supply the prerequisites for therapists and clients to operate the system. They assign user accounts to therapists and clients and are authorized to edit general and instructional text throughout the EST navigation system. Administrators build training modules and establish a module's "passive" or "active" mode. A passive mode can temporarily prevent therapist access to a module (for instance, when a module is under construction). Finally, administrators create test modules for purposes of speech assessment and evaluation. A test module contains text associated with the speech stimuli for the client to produce, record, and upload.

Speech therapists. Therapists are authorized to compose tailor-made speech training programs and to adjust the active or passive mode of each course in the program. They assign target values to the speech parameters "overall pitch" and "intensity" for each client. To evaluate a client's speech, the therapist selects the "analysis" function to compare the target and the realized values of these parameters. Clients' speech files can be downloaded using Praat for further acoustical analyses.

Clients. Clients have access to their individual speech training programs composed by their therapist. For each client, the training procedure consists of the following steps:

1. Selecting a training item from the prescribed course.
2. Listening to a target speech sample, downloaded from the central server, using a headset.

3. Recording the imitation attempt via the headset's microphone connected to the laptop or computer.
4. Comparing the target and the recorded samples by selecting "compare." This comparison is based on auditory feedback only.
5. Deciding whether the speech attempt will be uploaded to the central server by selecting the "save" button.
6. Once the recorded speech has been uploaded, a client's auditory discrimination is supported by automatic visual feedback for intensity and overall pitch.
7. Determining whether a new speech attempt is required to approach the target speech.

SPEECH DATABASE

A database of dysarthric speech is (semi)automatically compiled by uploading clients' speech to the central server. This database contains speech audio files uploaded by clients during their training sessions as well as during test modules. The test modules provide realizations of standardized speech materials. Each uploaded audio file is accompanied by an XML file containing the target values of pitch (Hz) and intensity (dB), and another XML file containing realized values of pitch and intensity as a function of time.

The database provides therapists with centrally stored speech recordings produced by individual clients, thus facilitating objective evaluation of therapy effects. An additional benefit of this database is that large amounts of dysarthric speech become available for further scientific research in the field of speech pathology and speech technology.

Discussion

This report shows the potentials of EST for telerehabilitation. The technical feasibility of the described EST system has already been verified empirically. Unlike the traditional face-to-face therapy, EST provides less opportunity for clinical observations and therapeutic recommendations to improve clients' speech. This might seem inconsistent with the American Speech-Language Hearing Association standard for telehealth, which states that the quality of services delivered via telepractice must be consistent with that of face-to-face delivery.[21] However, the aim of EST is not to substitute, but to support and intensify, regular speech training. In addition, EST enables patients with chronic dysarthria to independently maintain speech quality after completing their regular therapy. With the aging population in mind, EST might provide a solution for the maintenance of a sound balance between the need for, and the availability of, speech training for patients with chronic dysarthria.

Future Directions

The efficacy and cost-effectiveness of EST, as well as users' satisfaction, need to be evaluated. To this end, clinical studies including dysarthric patients with various neurological impairments are in progress.

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Disclosure Statement

The authors declare that they contributed to the paper, that there are no conflicting interests in the submission of the paper, and that no competing financial interests exist. They agree to the byline order as mentioned in the manuscript.

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