Telerehabilitation advancements in aphasia. Testing the feasibility, acceptability and efficacy of a computer-based language intervention program.

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Introduction

The effective support of people with neurogenic communication disorders requires individualized, systematic and regular intervention by speech/language therapists (SLTs). Apart from traditional interventions, **computer-based therapies** have been found to be effective in the treatment of **voice and speech disorders** (Halpern et al., 2012), as well as in **word- and sentence-level deficits** (Jokel et al., 2009; Thompson et al., 2010).

PLan-V project "*A Speech and Language Therapy Platform with Virtual Agent*" aims at developing a novel, technologically assisted, speech & language intervention platform that can support the self-management of people with chronic neurogenic communication disorders.

The PLan-V platform provides for the first time in Greek:

Assisted Intervention

Innovative system of technology-assisted intervention

Tasks are assigned remotely by a speech and language therapist and are carried out by the language impaired individual with the aid of a virtual assistant.

- The virtual assistant is used to **provide instructions and feedback** required by each therapy task via a natural and friendly interface.

Type of feedback:
-**visual cue for correctness** (e.g., red/green colour to indicate incorrect/successful trial)
-**verbal elaborative feedback** (e.g. semantic/phonological cueing)

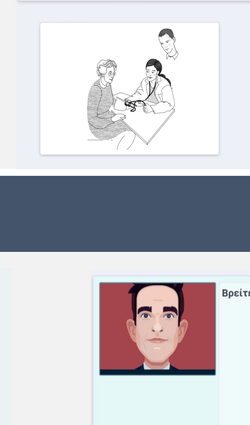
Materials

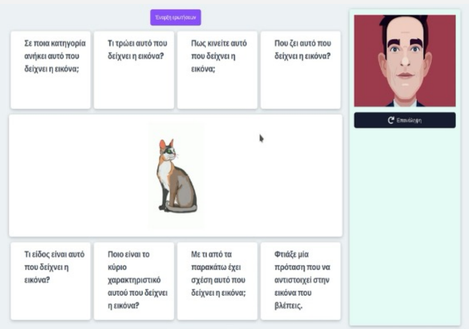
Original and rich speech and language therapy material

The platform includes original customized speech & language therapy material, well grounded on evidence-based intervention practices. The material addresses individuals with **speech** and **language difficulties** of **various types and severity degrees**. It covers language **comprehension** and **production** at different linguistic levels (phonology, lexicon, morphosyntax), including **ranking of tasks according to degrees of difficulty**, depending on individual therapy needs.

Speech therapy protocols:
(a) Vowel prolongation using modal voice
(b) Vowel prolongation using high pitch and low pitch
(c) Vowel prolongation alterating pitch in steps & via gliding
(d) Focus Intonation in sentence production
(e) Focus Intonation in sentence comprehension: internal feedback

- Exercises are based on **speech visualization** in terms of both the acoustic signal and the movements of the vocal tract
- **Improvements in these areas have a global effect on speech intelligibility and naturalness of patients with any type of dysarthria** (e.g., Duffy, 2019).
- Tasks are designed based on common practices for the behavioral management of respiratory, phonatory and prosodic dysfunctions (Yorkston et al., 2003; 2007).





Language therapy protocols: enhance lexical- and sentence-level processes. The software includes word finding, word/sentence comprehension and sentence construction activities. Naming activities provide different cue types i.e., (a) **Phonological** (Leonard et al., 2008), (b) **Orthographical** (Basso et al., 2001), (c) **Semantic** (Boyle, 2004), and (d) **Multiple-cue** (Doesborgh et al., 2004). Sentence-level **comprehension and production** is facilitated with activities of linguistically based (Thompson et al., 2010) or **verb-centered mapping therapies** (Marshall, 1995). Activities for **verb inflection/tense marking** (Faroqi-Shah, 2013) are also included.

Pilot Trial

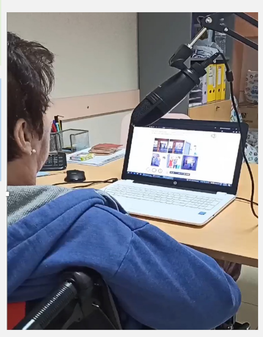
Participants: 5 participants with post-stroke aphasia (2 M, 3F; Mean Age: 63,5) and 23 neurotypical controls (15 F, 8M; Mean Age: 51,6 were recruited.

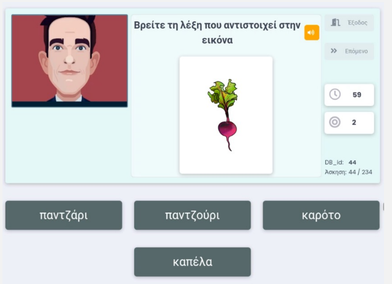
Modality targeted: language comprehension

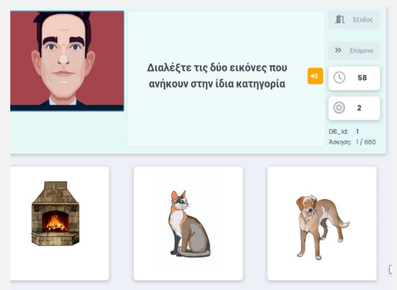
Duration: 1h computer-based language intervention daily/ over 5 consecutive times for 3-4 weeks

Protocol: Treatment targeted semantic deficits and included tasks of auditory word-to-picture matching, spoken description-to-picture matching, auditory synonym and antonym matching task, and a categorical sorting task (superordinary categorization. Participants had to map word forms onto referents by distinguishing from objects containing semantic, phonological or unrelated foils.

Goal: to **improve semantic processing and to facilitate word retrieval** by strengthening the meaning-word-form connection and enhancing the associations between concepts within the semantic network (Boyle & Coehlo, 1995; Drew & Thompson, 1999; Wambaugh et al., 2001; Howard et al., 2006).

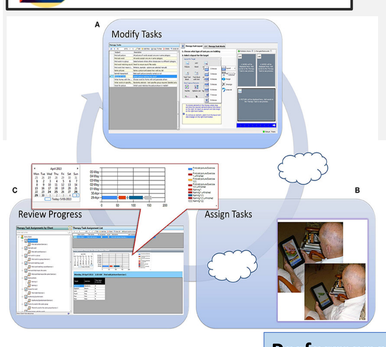






Data Management

Management of content and user data



The clinician can:
-Develop individualized treatment plans to assign for their clients
-Customize/Modify the difficulty level of the tasks
-Monitor participants' progress both on the whole battery of tasks and on each task individually so that specific difficulties can be identified.

- A comprehensive **learning analytics** system provides control, support planning and monitoring for clinicians and patients.
- The system collects and processes data regarding the users and the usage of PLan-V to fulfil two objectives:

1. To support clients in their everyday engagement with the system (performance tracking, visualization primitives).
2. To support data processing and facilitate explorative analysis by clinicians (data reporting that will enable them to choose and sequence content and activities depending on participants' performance).

Usage Data
- Application usage
  - Users' Info
  - Start/finish time

Performance Report
- task actions/choices
- voice recordings of verbal responses
- reaction times
- info regarding provided feedback
- final outcome

Discussion

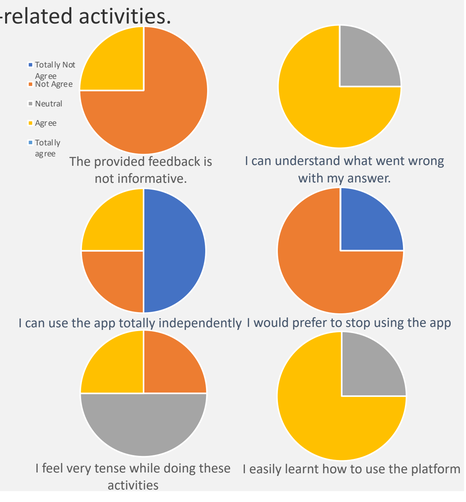
- ✓ PLan-V allows clinicians to construct remote therapy sessions selecting from activities of different levels of difficulty. A virtual therapist is used to assist, provide directions and feedback via a natural and friendly interface. Progress is monitored via recorded tasks, scores and timed responses, enabling clinicians to choose and sequence content and activities, depending on participants' performance.
- ✓ Patients' oral responses will be evaluated through an automated speech recognition algorithm.
- ✓ A comprehensive learning analytics system provides control, support planning and monitoring for clinicians and patients.
- ✓ Our pilot results suggest that Plan-V telerehabilitation platform can be effectively used for the remote administration of speech and language therapy, with beneficiary outcomes in post-stroke aphasia.
- ✓ In line with previous studies, our preliminary data demonstrate that remote intervention is feasible and valid, and high levels of satisfaction are reported by both therapists and patients (Adrian et al., 2003; Fink, Brecher, Sobel, & Schwartz, 2005; Jokel, Cupit, Rochon, & Leonard, 2009).

Feasibility & Acceptability

Feasibility measures include evaluation of the remote technical setup and support, while acceptability was evaluated via a Likert rating scale (1-5) measuring participant engagement and satisfaction with the remote setting and enhancement of their communication skills affecting the quality of their social and family-related activities.

Table 1. Adapted motivation inventory questionnaire scale.

- **Feasibility:**
  - Training sequences were too long.
  - Training was too difficult for me.
- **Materials:**
  - I couldn't understand the provided feedback
  - Materials reflected my difficulties
- **Technology:**
  - I didn't manage to use the app totally indepedently
  - I had problems connecting to internet
- **Interest/Enjoyment:**
  - Activity was fun to do.
  - I thought training was boring.
  - I thought training was frustrating.
- **Value/Usefulness:**
  - I thought training helped me to feel better.
  - I would like to continue training in the future.
- **Pressure/Tension:**
  - I felt very tense while doing this activity.
  - I was worried about getting the training right.
- **Quality of Life:**
  - I feel more enganged in communication with family members after using the app



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