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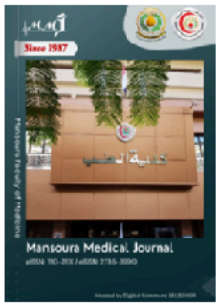

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Developing a Computer-based Program for Language Rehabilitation of Arabic-speaking Aphasic Patients

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ORIGINAL STUDY

Developing a Computer-based Program for Language Rehabilitation of Arabic-speaking Aphasic Patients

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Abstract

Background: **Aphasia is acquired selective impairment of language. Computerized aphasia therapy is useful in language therapy and offers chances for independent practice at home to maximize intensity and improve outcomes. This study aimed to develop a computer-based language rehabilitation program for Arabic-speaking Egyptian aphasic patients ensuring cultural, linguistically, and social suitability and to determine its effectiveness.**

Methods: **We conducted a prospective interventional study on 20 aphasic patients in the age range of 40−65 years, who received rehabilitation for 3 months using a newly designed Arabic software program named 'Takalam.' The program was pilot studied on 10 normal adults before its application to the patient group. Improvement was measured using the Comprehensive Aphasia Test (CAT) and Mansoura Arabic Screening Aphasia Test (MASAT) tests to evaluate the effectiveness of the new software program.**

Results and conclusions: **Statistically significant differences were observed between the pre- and postassessment as regards all items of CAT and most items of the MASAT indicating language improvement. The Arabic software program (Takalam) is a valid and effective tool for language rehabilitation and is culturally and linguistically suitable for Arabic-speaking aphasic patients.**

Keywords: Aphasia, Computer therapy, Rehabilitation, Software, Stroke

1. Introduction

Aphasia is defined as 'acquired selective impairment of language modalities and functions resulting from a focal brain lesion in the dominant hemisphere that affects a person's communicative, social functions and quality of life.' This language impairment can be existent in all the language components across all modalities (speaking, reading, writing, and singing), in the output mode (expression) and/or the input mode (comprehension) (Purdy, 2016).

It has been claimed that computerized aphasia therapy helps provide targeted language therapy and offers chances for independent home practice to maximize intensity, leading to improvements in reading, spelling, and expressive language outcomes (Palmer, 2015). Aphasia-specific computer programs provide exercises that can be completed regularly, targeting personal vocabulary and concentrating on the patient's conversational needs (Mortley et al., 2004). Continuing to provide conventional therapy intensively over a long time is costly and unsustainable. In addition to medical instability, fatigue and confusion may hinder patients' capacity to fully engage in language therapy in the initial weeks post-stroke, decreasing their opportunity to participate in the treatment (Brady et al., 2012).

A lot of computer programs have been used for the rehabilitation of aphasic patients such as the Bungalow Software, which includes many programs designed for expressive aphasia (speaking, writing, etc.) and receptive aphasia (listening, reading, etc) (Bungalow Software, 2018). Parrot Software's online programs provide a wide variety of programs for speech, communication, memory, attention, reading, vocabulary, and cognition (Parrot Software, 2019). The 'step by step' computer therapy approach

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focuses on naming, matching, spelling, memory, and repetition exercises (Palmer, 2015). The C.H.A.T. software (Computerized Home Aphasia Therapy) program consists of several activities for practicing sounds, words, phrases, sentences, melodic intonation therapy, minimally prompted speech, and narration. The C.H.A.T. Software tells persons with aphasia how they are doing without family members or speech–language pathologists (The and Program, 2018).

However, all the previous programs are not applicable in our local context because the main goal of rehabilitation is to train the patient to speak their local language. The pesent study aimed to develop a computer-based language rehabilitation program for Arabic-speaking Egyptian aphasic patients, which isculturally, linguistically, and socially suitable for them and to determine its effectiveness.

2. Patients and methods

2.1. Patients

The current study is a prospective interventional study with an analytic component, which was carried out on 20 aphasic patients and 10 patients' relatives (for pilot study), who were attending the outpatient clinic of the Phoniatric Unit at Mansoura University Hospital from 2018 to 2023. The IRB of the Faculty of Medicine had approved the study (MD.18.09.84). Informed consent was obtained from participants/caregivers before the study.

Participants were divided into two groups as follows: Group I (pilot testing): 10 normal adults in the age range 40–65 years with average mentality, average physical health, and normal language. Group II (interventional study): 20 aphasic patients in the age range 40–65 years (13 males and 7 females), who received individual therapy sessions by a newly developed software program 'Takalam' (tækæl:æm) twice weekly (30 min each) for 3 months. Aphasic adults with a history of neurological insult leading to language affection were included in the study. However, patients with communication problems due to sensory (hearing or visual) impairment, communication problems due to psychiatric disorders, and neurodegenerative diseases were excluded from the study.

2.2. Methods

A software program named 'Takalam' was developed for the rehabilitation of aphasic patients It went through the following stages before finalization: Design stage, validation stage, pilot testing stage, intellectual property registration, application stage, and statistical analyses.

Design stage: Step 1: the authors reviewed several software programs for aphasia rehabilitation. Step 2: the authors reviewed the most commonly affected language domains of aphasic patients based on standard comprehensive aphasia tests such as the Arabic Comprehensive Aphasia Test (CAT) (Abou El-Ella et al., 2013). Step 3: A new Arabic computer-based program for language rehabilitation of aphasic patients was constructed by the authors taking into consideration social, cultural, and language appropriateness to the Egyptian society for each proposed item in the program. The program was named Takalam as an encouragement for the patients to speak. The program focused on the management of the affected language domains and the communication problems of aphasic patients and was presented three expert phoniatricians from different Egyptian universities to review the program's suitability and content. 'Takalam' program includes exercises for both receptive and expressive abilities and consists of six sections for language therapy comprising 4000 pictures i.e. all the testing screens depend only on the fixed images without any animated options. The program includes 1675 audio files, which were recorded in a special sound-treated studio by the first author. The testing screens and tasks were randomized automatically with every trial of the testing task so that the patient could not anticipate the testing task with unlimited options of testing screens. The proposed scientific concepts of the training materials were expressed as computer-based options in collaboration with a specialized professional technical staff team that included one project manager, one creative director, one instructional designer, four graphics artists/animators, and two software developers. The authors and the technical staff discussed each proposed item in each of the six stages of 'Takalam' before and after the stage of pilot testing suggestions at regular meetings (two to three times per week) along a duration of 4 years. The program provides visual prompts in the form of highlighting the correct answer after 7 s of delayed response of the patient in receptive exercises and the appearance of the right answer in expressive writing exercises. Auditory prompt is also present in the form of hearing the correct answer and the patient can repeat this answer many times. The program is provided with the model answers to the questions in every section. The program is also designed to provide encouragement phrases in case of right or wrong answers. The program can be run using mobiles, laptops, or desktops. The six sections of the designed 'Takalam'

program involved many exercises that were graded in difficulty. These six sections are (1) categorization, (2) naming, (3) matching, (4) comprehension, (5) fluency, (6) reading, writing, and calculating.

Validation stage: Validity refers to the extent to which the program 'Takalam' can be used for the rehabilitation of Arabic-speaking aphasic patients. Three judges of expert phoniatricians from other Egyptian universities were asked to review the constructed rehabilitation program to evaluate content validity.

Pilot testing stage: this aimed to check the materials used, the pattern of presentation of the program items themselves, and their order of presentation. The program 'Takalam' was amended to make the items and the pictures more clear.

Intellectual property registration: a certificate of registration of intellectual property for the program 'Takalam' was made at the 'Information Technology Industry Development Agency [ITIDA] of the Ministry of Communications and Information Technology' in the Arab Republic of Egypt [ARE] on March 2023 as the first multimedia medical program designed for the rehabilitation of aphasic patients under registration number 004268.

Application stage: Pre-rehabilitation assessment was administered to all aphasic patients in the form of history taking, complete neurological examination with imaging study, then IQ assessment using the Standard Progressive Matrices (Raven et al., 1960) and language assessment using Mansoura Aphasia Screening Arabic Test (MASAT) (Abou-Elsaad et al., 2018) and Arabic Comprehensive aphasia test (CAT) [8] as a baseline assessment before rehabilitation. Rehabilitation program: All patients received language therapy at the Phoniatric Unit, MUH using the software program 'Takalam' twice/week for 30 min for at least 3 months and continued using the program at home for 30 min daily on the phoniatricain guidance. The patients or caregivers were trained on the program and informed on how the program can be self-used at home. Each patient was assigned to an individualized treatment plan according to his language defects, where we focused on some tasks, and other tasks was ruled out according to the aphasia type. During the weekly clinic sessions, the clinician decided to either keep the patient working on the same task or to adjust the treatment plan in response to the patient's progress. Postrehabilitation assessment: Language reevaluation was performed after 3 months of the rehabilitation program for all aphasic patients using the Mansoura Aphasia Screening Arabic Test (MASAT) (Abou-Elsaad et al., 2018) and Arabic Comprehensive aphasia test (CAT) (Raven et al., 1960) to detect improvement in language abilities.

Statistical analysis and data interpretation: SPSS software, version 25 (SPSS Inc., PASW statistics for Windows version 25. Chicago: SPSS Inc.) was used to analyze the data. Numbers and percentages were used to describe qualitative data. Regarding quantitative data, median (minimum and maximum) was used for non-normally distributed data and mean ± standard deviation for normally distributed data after using the Kolmogrov–Smirnov test to test normality. The results were deemed significant at the $\leq$0.05 level. Z test was used to compare proportions of improvement. Mann–Whitney U and Kruskal–Wallis test were used to compare two groups and more than two groups, respectively for non-normally distributed data. Wilcoxon signed rank test was used to compare pre- and posttreatment.

3. Results

3.1. Results of judge validity

The three judges unanimously agreed that the program 'Takalam' is suitable for the rehabilitation of Arabic-speaking aphasic patient, and it is culturally and linguistically suitable for them. The program was amended to their suggestions and a few modifications were made accordingly.

3.2. Results of pilot testing

The program was amended according to the suggestions of the normal group (group I) to make the items more clear. Larger pictures were recommended slightly delaying the spontaneous correct answer in all the program stages. Also, some pictures were replaced by more familiar ones.

3.3. Results of the interventional therapy

3.3.1. Descriptive statistics

Group II included 20 aphasic patients in the age range of 40–65 years (mean 53.45 ± 6.76) including 13 males and 7 females. Ten (50 %) of the aphasic patients were educated and 10 (50 %) were illiterate. IQ ranged from 57 to 93 (mean 71.94 ± 11.04); 85 % of the patients had ischemic stroke, while 15 % had hemorrhagic stroke. Broca's aphasia was encountered in 45 % of the patient group (Table 1).

3.3.2. Comparison between the results of the MASAT before and after rehabilitation

Statistically significant differences were observed between pre- and post-assessments regarding

Table 1. Descriptive statistics of the studied cases.

	$n = 20$ (%)
Sex	
Male	13 (65.0)
Female	7 (35.0)
Not educated	10 (50.0)
Educated	10 (50.0)
Stroke	
Ischemic	17 (85.0)
Hemorrhagic	3 (15.0)
Duration from onset (months)	
Median (min–max)	4.5 (1–16)
Occupation	
Housewives	7 (35.0)
Manual worker	6 (30.0)
Employee	6 (30.0)
Retired	1 (5.0)
Age (mean ± SD)	40–65 (53.45 ± 6.76)
IQ (progressive matrices)	
Mean ± SD	71.94 ± 11.04
Median (min–max)	(57–93)
Type	
Anomia	3 (15)
Broca	9 (45)
Conduction	1 (5)
Global	4 (20)
Transcortical sensory	1 (5)
Wernicks	2 (10)

Data expressed as number (%) or mean ± SD.

repetition, naming, comprehension, reading, writing, total score, and severity, showing higher scores in post–assessment,indicating improvement in these parameters with no statistically significant differences in fluency and calculation (Table 2).

3.3.3. Comparison between the results of the CAT before and after rehabilitation

The scores of all items of CAT were significantly higher in the post-assessment as compared with the pre assessment, indicating improvement of these parameters (Table 3).

3.3.4. Comparison between results of MASAT before and after rehabilitation according to the type of aphasia

Patients with Broca's aphasia demonstrated statistically significant improvement in repetition, naming, writing, and total score (Table 4).

3.3.5. Comparison between results of CAT before and after rehabilitation according to the type of aphasia

Patients with Broca's aphasia demonstrated statistically significant improvement in repetition, naming, spoken and written comprehension,

Table 2. Comparison between the results of the Mansoura Aphasia Screening Arabic Test before and after rehabilitation.

	Baseline	After	Test of significance
Repetition	6.0 (0.0–12.0)	8 (0–12)	z = 3.09 $P = 0.002$*
Naming	1.0 (0–15)	6 (1–20)	z = 3.93 $P = 0.001$*
Comprehension	12 (0–12)	9.1 (2–12)	z = 2.0 $P = 0.046$*
Fluency	0 (0–2)	0 (0–2)	z = 0.0 $P = 1.0$
Reading	0 (0–4)	0 (0–4)	z = 4.05 $P < 0.001$*
Writing	0 (0–4)	0 (0–4)	z = 3.98 $P < 0.001$*
Calculation	0 (0–4)	0 (0–4)	z = 1.63 $P = 0.102$
Total score	20.5 (2–43)	27 (5–56)	z = 3.92 $P < 0.001$*
Severity			
Mild	3 (15.0)	5 (25)	
Moderate	7 (35.0)	8 (40)	$P = 0.025$*
Severe	10 (50.0)	7 (35)	

Parameters described as median (min–max), number, and percentage *Statistical significance was determined using Mann Whitney *U* test and Monte Carlo test *P** less than 0.05 (significant).

Table 3. Comparison between the results of the comprehensive aphasia test before and after rehabilitation.

	Baseline	After	Test of significance
CAT (repetition)	48.9 ± 6.53	52.5 ± 6.37	t = 8.58 $P < 0.001$*
CAT (naming)	47.60 ± 5.85	54.8 ± 5.93	t = 8.72 $P < 0.001$*
Spoken	41.95 ± 12.11	45.45 ± 12.33	t = 6.01 $P = 0.001$*
Written	40 ± 3.4	41.15 ± 9.39	t = 3.03 $P = 0.007$*
Spoken pic	47.1 ± 5.47	49.65 ± 6.21	t = 2.27 $P = 0.035$*
Written pic	48 ± 4.14	49.45 ± 6.27	t = 3.15 $P = 0.005$*
Reading	47.85 ± 4.27	48.55 ± 4.82	t = 2.27 $P = 0.035$*
Writing	44.75 ± 5.37	45.90 ± 6.64	t = 3.15 $P = 0.005$*
Total	45.76 ± 5.27	48.42 ± 6.17	t = 7.33 $P < 0.001$*

Parameters described as mean ± SD, *statistically significant t: Student's *t* test *P**<0.05 (significant).

Table 4. Comparison between results of Mansoura Aphasia Screening Arabic Test before and after rehabilitation according to the type of aphasia.

	Anomia	Broca	Conduction	Global	Transcortical sensory	Wernicke	test of significance
Repetition							
Before	12	6 (0–10)	6	1 (0–3)	12	3 (0–6	**KW=12.81 *P*=0.025***
After	12	8 (2–10)	10	3 (0–3)	12	6 (3–8)	**KW=14.64 *P*=0.012***
p#	1.0	**0.016***	1.0	0.180	1.0	0.180	
Naming							
Before	6 (4–15)	0 (0–7)	13	0 (0–2)	0	3 (0–5)	**KW=8.95 *P*=0.111**
After	18 (15–20)	6 (3–16)	20	2 (1–4)	6	6 (3–8)	**KW=13.18 *P*=0.012***
p#	0.109	**0.008***	1.0	0.064	1.0	0.157	
Comprehension							
Before	12	12	12	2 (2–4)	2	3 (0–6)	**KW=18.09 *P*=0.003***
After	12	12	12	4 (2–4)	4	4 (2–6)	**KW=18.13 *P*=0.003***
p#	1.0	1.0	1.0	0.157	1.0	0.317	
Fluency							
Before	2	0 (0–1)	2	0	2	2	**KW=17.56 *P*=0.004***
After	2	0 (0–1)	2	0	2	2	**KW=17.56 *P*=0.004***
p#	1.0	1.0	1.0	1.0	1.0	1.0	
Reading							
Before	4 (0–4)	0 (0–2)	0	0	0	0	KW = 6.88 *P* = 0.230
After	4 (0–4)	0 (0–3)	0	0	0	0	KW = 6.87 *P* = 0.230
p#	1.0	1.0	1.0	1.0	1.0	1.0	
Writing							
Before	2 (0–3)	2 (0–4)	0	0	0	0	KW = 6.57 *P* = 0.255
After	2 (0–4)	3 (0–4)	0	0	0	0	KW = 9.51 *P* = 0.09
p#	0.109	**0.008***	1.0	1.0	1.0	1.0	
Calculation							
Before	4 (0–4)	0 (0–4)	0	0	0	0	KW = 6.30 *P* = 0.278
After	4 (0–4)	0 (0–4)	0	0	0	0	KW = 6.48 *P* = 0.263
p#	1.0	0.102	1.0	1.0	1.0	1.0	
Total							
Before	41 (40–43)	22 (12–33)	33	4 (2–7)	16	11 (2–19)	**KW=14.78 *P*=0.01***
After	51 (46–56)	28 (18–45)	44	8 (5–9)	24	17 (10–24)	**KW=15.86 *P*=0.007***
p#	0.109	**0.008***	1.0	0.07	1.0	0.180	

KW: Kruskal–Wallis test, *statistically significant, #*P* value of Wilcoxon signed rank test to compare between pre- and posttreatment.

writing, and total score while anomic aphasia demonstrated statistically significant improvement in the naming and repetition and spoken picture description (Table 5).

4. Discussion

Language therapy for aphasia supports the recovery of functional communication, receptive language, and expressive language (Brady et al., 2012). Access to phoniatric services is challenging in rural and remote areas and remains a problem worldwide. Equally problematic, and often underestimated, are the difficulties faced by aphasic patients who have severe physical problems. Apart from the cost issues, it is difficult, if not impossible, to consistently travel to and from a treatment facility. Although face-to-face treatment has long been regarded the 'gold standard' of care, phoniatricians must take into account alternate means to provide services to meet the communication needs of a changing community and to guarantee that the most effective treatment plans are carried out. The application of telemedicine to augment or, in certain circumstances, replace conventional face-to-face interventions is one potential remedy for these service issues (Theodoros, 2008).

This study aimed to develop a computer-based language rehabilitation program for Arabic-speaking Egyptian aphasic patients, which is culturally, linguistically, and socially suitable for them and to determine its effectiveness as a phoniatric approach for the management of their language and communication problems.

The study was conducted on 20 aphasic patients in the age range of 40–65 years (mean 53.45 ± 6.76) including 13 males and 7 females. Ten (50 %) of the aphasic patients were educated, while 10 (50 %) were illiterate. IQ ranged from 57 to 93 (mean 71.94 ± 11.04). The 20 aphasia patients had post-stroke aphasia. Such finding coincides with that obtained by Berthier (2005), who found that stroke in both acute and chronic phases is one of the most common causes of aphasia. Acutely, it is estimated that 21–38 % of stroke patients are aphasic.

Table 5. Comparison between results of CAT before and after rehabilitation according to the type of aphasia.

	Anomia	Broca	Conduction	Global	Transcortical sensory	Wernicke	test of significance
Cat (repetition)							
Before	60.67 ± 6.43	48.56 ± 3.12	48 ± 0	42.75 ± 2.36	50 ± 0	45 ± 5.65	**F=8.02 *P*=0.001***
After	63.33 ± 5.85	52.22 ± 3.34	55 ± 0	45.25 ± 2.22	55 ± 0	49.5 ± 2.12	**F=9.36 *P*<0.001***
	0.015*	**<0.001***	1.0	0.063	1.0	0.323	
Cat (naming)							
Before	55 ± 4.35	47.78 ± 4.84	56 ± 0	43.75 ± 3.5	42 ± 0	42 ± 0	**F=4.15 *P*=0.016***
After	64 ± 1	54.56 ± 4.95	62 ± 0	49.25 ± 0.5	53 ± 0	50.50 ± 0.71	**F=6.59 *P*=0.002***
	0.05*	**0.002***	1.0	0.059	1.0	0.037*	
Spoken							
Before	54 ± 3.61	47.78 ± 8.06	52 ± 0	28.5 ± 1	27 ± 0	27 ± 0	**F=11.42 *P*<0.001***
After	56 ± 3.61	52.78 ± 6.38	54 ± 0	31 ± 2.95	31 ± 0	28.5 ± 0.71	**F=18.48 *P*<0.001***
	1.0	**0.001***	1.0	0.127	1.0	0.205	
Written							
Before	46 ± 12	41.89 ± 9.3	43 ± 0	35 ± 2	34 ± 0	34 ± 0	F = 1.003 *P* = 0.451
After	48 ± 13.11	43.56 ± 10.17	43 ± 0	35.5 ± 3	34 ± 0	34 ± 0	F = 1.11 *P* = 0.397
	0.225	**0.03***	1.0	0.391	1.0	1.0	
Spoken.pic							
Before	53.33 ± 0.58	45.11 ± 2.20	65 ± 0	44.75 ± 1.5	44 ± 0	44 ± 0	**F=31.66 *P*<0.001***
After	55.67 ± 1.15	49.22 ± 4.35	67 ± 0	45.25 ± 2.5	47 ± 0	44 ± 0	**F=9.06 *P*=0.001***
	0.02*	0.0148	1.0	0.391	1.0	0.037*	
Written.pic							
Before	53 ± 6.25	48.11 ± 4.19	46 ± 0	46 ± 0	46 ± 0	46 ± 0	F = 1.37 *P* = 0.294
After	55.67 ± 8.74	50.44 ± 6.83	46 ± 0	46 ± 0	46 ± 0	46 ± 0	F = 1.16 *P* = 0.372
	0.300	0.098	1.0	1.0	1.0	1.0	
Reading							
Before	52.33 ± 6.6	48 ± 3.77	53 ± 0	45 ± 0	45 ± 0	45 ± 0	F = 1.98 *P* = 0.143
After	53.67 ± 7.77	49.11 ± 4.04	53 ± 0	45 ± 0	45 ± 0	45 ± 0	F = 2.11 *P* = 0.125
	0.184	0.107	1.0	1.0	1.0	1.0	
Writing							
Before	48.67 ± 7.57	46.56 ± 4.64	50 ± 0	40 ± 0	40 ± 0	40 ± 0	F = 2.55 *P* = 0.08
After	50.33 ± 9.29	48.56 ± 5.94	50 ± 0	40 ± 0	40 ± 0	40 ± 0	F = 2.36 *P* = 0.095
	0.300	**0.009***	1.0	1.0	1.0	1.0	
Total							
Before	52.85 ± 4.75	46.72 ± 3.63	51.62 ± 0	40.72 ± 0.21	41 ± 0	40.34 ± 0.66	**F=6.97 *P*=0.002***
After	55.82 ± 5.91	50.05 ± 4.72	53.75 ± 0	42.15 ± 0.77	43.87 ± 0.0	42.19 ± 0.09	**F=5.28 *P*=0.006***
	0.058	**0.001***	1.0	0.061	1.0	0.136	

F: One-Way ANOVA test, #*P* value of paired t-test to compare between pre- and post-treatment.

It is worth mentioning that global aphasia is the most common type affecting as many as 25–32 % of aphasic patients, while other classic aphasias described within the Boston system of classification are seen less frequently (Laska et al., 2001; Godefroy et al., 2002; Pedersen et al., 2003). In this study, the most common type was Broca's aphasia, which constituted 45 % of the 20 patients' group, global aphasia constituted 20 %, anomic aphasia 15 %, Wernick's aphasia 10 %, and conduction aphasia and transcortical aphasia each constituted 5 %. This could be attributed to the small sample size of the studied patients and global aphasic patients tend to drop out of therapy due to other accompanying physical disabilities.

Stroke strikes men more often due to a higher rate of smoking and stressful situations among males than females (El Tallawy et al., 2015). That may explain the higher prevalence of stroke among males in this study, which is 65 % compared with 35 % of aphasic female patients.

In this study, the newly developed program (Takalam) for the rehabilitation of the Arabic-speaking Egyptian aphasic patients was constructed in the Phoniatric Unit, Mansoura University Hospitals. It was constructed by the authors taking into consideration social, culturalm and language appropriateness to the Egyptian society for each proposed item in the program. The program is named 'Takalam),' which means 'speak' with the concept to encourage the patient to speak.

All the intervention tasks of the 'Takalam' program were tailored to the patient's needs and impairment, utilizing a comprehensive approach to assess and promote all aspects of language. The objectives were to extend sentence length, to facilitate access to the lexical store, to enhance oral and written comprehension, and to encourage the

development of pragmatic and narrative skills. Collections of tasks were used, comprising individual aphasia exercises, for example, oral and written naming and reading sentences and text. Furthermore, naming pictures, matching, categorization, and other items were used as additional tasks.

In the current study, significant improvement in repetition, naming, comprehension, severity, and total score of MASAT (Abou-Elsaad et al., 2018) were observed between pre- and post-rehabilitation using 'Takalam' software program. Statistically significant differences were also found between the pre- and post-assessment as regards results of the comprehensive aphasia test (CAT) (Abou El-Ella et al., 2013). There was significant improvement in all the domains of the test with highly significant improvement in repetition, naming, spoken comprehension, and total score and less improvement in written comprehension, spoken and written picture description, reading, and writing. The comprehensive language assessment was more precise to measure the improvement in each item due to its detailed structure.

Individuals with expressive aphasia seem to be the most amenable to rehabilitation since they can comprehend the method used in a particular rehabilitation technique or, at the very least, the instructions for utilizing it. However, there has been little success in receptive aphasia rehabilitation trials. In our study, patients with Broca aphasia showed significant improvement post-rehabilitation, followed by anomic aphasia more than other types. Such finding coincides with that obtained by Bakheit (Bakheit et al., 2007), who found that patients with Broca aphasia seem to have the best prognosis for improvement of their language abilities.

Research on aphasia telerehabilitation has often used synchronous or hybrid approaches with fewer studies on asynchronous models in early literature. Asynchronous telerehabilitation has, however, been the subject of earlier research, like the study reported in two publications by Wade et al. (2003) and Mortley et al. (2004). In their experiment, participants received therapy at home through an asynchronous telerehabilitation platform that utilized the computer-based aphasia therapy program 'StepByStep.' Seven individuals with chronic aphasia poststroke with word retrieval difficulties were included in a case series design. Use of the asynchronous telerehabilitation model resulted in increased intensity and access to therapy, and word retrieval was significantly improved. Participants showed positive responses to the mode of therapy delivery and reported increased confidence, self-esteem, and functional communication (Hill and Breslin, 2016).

The findings of this study imply that people with chronic aphasia may benefit from computer-based language therapy in terms of their linguistic and functional communication abilities.

The positive changes in the present study were associated with the use of a comprehensive, computer-based aphasia therapy program offering a hierarchy of tasks across multiple language domains. It implies that comprehensive language treatment has a general therapeutic advantage. Practice across several domains may have scaffolding effects that result in greater total improvements. To summarize the results of the study, the Arabic software program 'Takalam' is a valid and effective tool for the rehabilitation of the Arabic-speaking aphasic patients. The limitations of the study were the small sample size and lack of a long-term follow-up.

4.1. Conclusion

The newly designed Arabic software program (Takalam) is a valid and effective tool for the rehabilitation of Arabic-speaking aphasic patients. The results were promising, and the program is culturally and linguistically suitable for Arabic-speaking aphasic patients, targeting most of the phases of rehabilitation.

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Conflicts of interest

None declared.

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