



Multi-Component Cognitive-Linguistic Intervention in a Persian-Speaking Patient with Fluent Aphasia: A Single-Case Study

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Abstract

Introduction: Fluent aphasia following hemorrhagic stroke can severely impair language, literacy, and cognitive functions; however, evidence regarding intensive multicomponent interventions in Persian-speaking populations remains limited. This single-case study aimed to describe pre- to post-intervention changes following a 10-week multicomponent cognitive-linguistic intervention in a 41-year-old Persian-speaking man with fluent aphasia after a left-hemisphere hemorrhagic stroke, with particular attention to language, literacy, memory, speech rate, and lexical diversity.

Case Presentation: The patient received 10 weekly 2.5-hour sessions integrating Oral Reading for Language in Aphasia (ORLA), Multiple Oral Re-reading (MOR), Semantic Feature Analysis (SFA), Phonological Components Analysis (PCA), Schuell's stimulation approach, working-memory training, and verbal short-term memory training. Assessments included the spoken subscale of the Persian Diagnostic Aphasia Battery, using the Aphasia Quotient-2 (AQ2); the Persian version of the Montreal Cognitive Assessment (P-MoCA); verbal fluency; digit span; auditory-verbal memory; speech rate; and Type-Token Ratio (TTR). Cognitive reserve was measured using the Cognitive Reserve Index questionnaire (CRIq = 229). Post-intervention, the AQ2 score exceeded the stated clinical cutoff. Reading, writing, repetition, and auditory comprehension reached or approached ceiling levels; verbal and working-memory measures improved; spontaneous speech rate approached the normal range; TTR exceeded the respective cutoffs in both contexts; and previously absent literacy skills reached maximum scores. No decline was observed. The AQ2 change should be interpreted as a change in test classification rather than evidence of complete clinical resolution of aphasia.

Conclusions: This case report documents broad improvements from pre- to post-intervention following an intensive, multicomponent, family-supported cognitive-linguistic intervention in post-stroke fluent aphasia, including improvements in literacy and lexical diversity. Given the single-case pre-post design and the absence of a control condition, these findings do not establish a causal treatment effect.

Keywords: Fluent Aphasia, Hemorrhagic Stroke, Cognitive-Linguistic Therapy, Case Report

1. Introduction

Stroke is one of the leading causes of death and long-term disability worldwide, ranking as the second most frequent cause of mortality in many regions, including North Africa and the Middle East. In these areas, stroke incidence is projected to double by 2030 (1, 2). After a

stroke affecting the language-dominant (left) hemisphere, communication disorders are common, with prevalence rates ranging from 30% to 60% (3). Iranian epidemiological data also indicate a higher stroke incidence and a younger age at onset than in Western populations (4). With the aging population in Iran, the burden of post-stroke

sequelae, particularly aphasia, is expected to increase substantially (5).

Aphasia is defined as an acquired language disorder resulting from neurological damage and is not attributable to general intellectual impairment or sensory-motor deficits (6). It primarily affects comprehension, fluency, naming, and repetition, depending on lesion site and severity (7). Clinically, aphasia is often classified as fluent or nonfluent based on characteristics of connected speech, including speech quantity and rate (8). Nonfluent aphasia is characterized by reduced word production, increased pauses, agrammatism, and slow speech, whereas fluent aphasia features relatively preserved prosody, grammatical structure, and sentence length, although communication is impaired by semantic and word-retrieval deficits (9). In fluent aphasia, which is typically associated with posterior left-hemisphere lesions, motor and physical impairments are often less pronounced. This may lead to underestimation of the patient's language disability, greater frustration, and an elevated risk of depression (10). These factors underscore the need for targeted, comprehensive speech-language interventions for this population.

Stroke is broadly categorized into ischemic stroke, caused by vascular occlusion, and hemorrhagic stroke, caused by intracranial bleeding (11). Although hemorrhagic stroke is less common, it tends to occur at a younger age and present with greater initial severity (12). Previous studies have suggested greater functional recovery following hemorrhagic stroke than following ischemic stroke; however, more recent studies have reported mixed findings, with some showing comparable or less favorable outcomes after hemorrhagic stroke (13, 14). Aphasia is a common consequence of stroke, although its reported frequency varies substantially across populations, stroke characteristics, and the timing and methods of assessment. Recent evidence suggests that approximately one-third of stroke survivors experience aphasia, whereas studies in Persian-speaking populations have reported higher rates during the acute phase (15 - 16). These findings highlight the need for effective, evidence-based rehabilitation programs tailored to the linguistic and clinical characteristics of the local population.

The present study describes a 10-week, individualized, multicomponent cognitive-linguistic intervention in a 41-year-old Persian-speaking man with fluent aphasia following a left-hemisphere hemorrhagic stroke. The intervention combined established language-based

approaches, including Oral Reading for Language in Aphasia (ORLA), Multiple Oral Re-reading (MOR), Semantic Feature Analysis (SFA), Phonological Components Analysis (PCA), and Schuell's stimulation approach, with working-memory and verbal short-term memory training. The components were selected based on the patient's baseline cognitive-linguistic profile and were intended to address interacting deficits in language, literacy, lexical retrieval, and memory rather than to evaluate a novel therapeutic technique. The distinctive contribution of this report lies in its detailed description of a multidomain intervention and corresponding pre- and post-intervention characterization in a Persian-speaking patient with fluent aphasia after hemorrhagic stroke, an underrepresented population in the aphasia rehabilitation literature. This context is particularly relevant because Persian has language- and orthography-specific characteristics that may influence the relationship between spoken and written language and should be considered when interpreting language and literacy outcomes. In addition to conventional language outcomes, the report examines changes in literacy, verbal and working memory, speech rate, and lexical diversity. As a single-case report without a control condition, the study is intended to provide a detailed clinical description and generate hypotheses for future controlled investigations rather than to establish treatment efficacy.

2. Case Presentation

2.1. Study Design and Ethical Considerations

A descriptive single-case pre-post design was used to characterize changes in cognitive-linguistic performance following an individualized speech-language therapy program tailored to the patient's cognitive-linguistic profile. Given the absence of a control condition, repeated baseline measurements, and delayed follow-up, the design was intended to document observed pre- to post-intervention changes rather than to establish a causal treatment effect. All procedures, including baseline assessments, the 10-week intervention, and post-intervention evaluations, followed standard ethical guidelines. Ethical approval was obtained from the Ethics Committee of Iran University of Medical Sciences (IR.IUMS.REC.1403.819). Written informed consent for participation and publication of this case report and its associated clinical information was obtained from the patient.

2.2. Participant and Clinical Background

The patient, K.N., was a 41-year-old, right-handed, Persian-speaking man with a master's degree in Mechanical Engineering. He had a history of depression but no reported history of head trauma, other neurological disorders, neurodegenerative disease, or hypertension. He was cognitively active and had previously studied English and German.

Symptom onset was acute and characterized by severe headache, visual disturbance, and loss of consciousness, leading to a diagnosis of hemorrhagic stroke. The patient was hospitalized immediately after symptom onset and remained hospitalized for approximately one month. Initial noncontrast brain computed tomography (CT) revealed an intraparenchymal hemorrhage in the left temporoparietal lobe with peripheral edema and mass effect, accompanied by a thin left temporoparietal subdural hemorrhage. A left craniotomy was also noted, with no midline shift or brain herniation. Subsequent CT angiography with three-dimensional reconstruction showed no evidence of aneurysm or stenosis, whereas follow-up imaging demonstrated left temporal and parieto-occipital encephalomalacia. After discharge, the patient continued his recovery and, following an additional recovery interval, presented for speech-language assessment and rehabilitation. The stroke occurred approximately three months before the baseline assessment. At baseline, residual language and cognitive deficits were consistent with fluent aphasia. During the study period, he was taking Depakine 500 mg and Lobel 500 mg twice daily, with no reported medication changes. No concurrent speech-language therapy or other rehabilitation treatment was received during the 10-week intervention period. Following the stroke, the patient presented with fluent speech accompanied by prominent word-retrieval and language-processing difficulties. The clinical presentation and subsequent language assessment were consistent with a fluent aphasic profile. This classification was based on the patient's fluent verbal output, relatively preserved sentence structure and prosody, prominent naming and word-retrieval difficulties, and impairments in higher-level auditory comprehension and repetition observed during the language assessment.

Inclusion criteria were: a) a confirmed clinical diagnosis of fluent aphasia following a left-hemisphere hemorrhagic stroke; b) the ability to actively participate in

therapy sessions; c) at least a high school diploma; and d) the absence of severe uncontrolled psychiatric disorders. Exclusion criteria included an acute disabling illness, rapid neurological decline, or lack of patient or family willingness to cooperate during the treatment period.

2.3. Assessment Tools and Baseline Evaluation

A battery of standardized tests was administered to assess the patient's cognitive and language abilities at baseline. General cognitive function was screened using the Persian version of the Montreal Cognitive Assessment (P-MoCA) (17). Language abilities were evaluated using the spoken subscale of the Persian Diagnostic Aphasia Battery (P-DAB-2), with the Aphasia Quotient-2 (AQ2) score used as the overall language measure (18). The AQ2 was used to characterize overall language performance and the aphasic profile based on auditory comprehension, verbal expression, repetition, and naming. The patient's aphasic profile was determined from the overall pattern of performance across connected speech, auditory comprehension, naming, repetition, reading, and writing rather than from the AQ2 total score alone. Working memory was measured using forward and backward digit-span tasks, and auditory-verbal memory was assessed using immediate and delayed recall procedures. Phonological and semantic fluency tasks were used to examine lexical retrieval and verbal fluency. Cognitive reserve was estimated using the Cognitive Reserve Index questionnaire (CRIq) (19). These assessments provided a comprehensive baseline profile of the patient's cognitive-linguistic functioning.

2.4. Baseline Findings

A single baseline assessment was conducted approximately three months after the stroke and immediately before initiation of the intervention. The patient's AQ2 score was 69.7, indicating moderate aphasia with impairments in connected speech and naming. On the P-MoCA, he scored 16 out of 30 (20), reflecting moderate cognitive impairment, particularly in memory, attention, naming, and abstract reasoning.

Working memory, assessed by digit span, yielded scores of 4 forward and 4 backward (total, 8), meeting the cutoff value of ≤ 6 that indicates below-average performance (21). Immediate verbal memory was 2 (below cutoff ≥ 4), whereas delayed verbal memory was 3 (at cutoff ≥ 3) (22). On verbal fluency tasks, he produced 14 phonemic and 10 semantic items. Compared with Persian normative data

(phonemic reference, 36; semantic reference, 62), these scores indicated moderate phonemic and severe semantic fluency deficits (23).

Speech rate was 89.14 words per minute (WPM) in spontaneous speech and 54 WPM in narrative contexts. The Type-Token Ratio (TTR) ranges from 0 to 1 and was 0.41 for descriptive speech and 0.47 for spontaneous speech, compared with reference values of 0.64 and 0.48, respectively. His cognitive reserve index score was 229, well above the standard threshold of ≥ 130 , indicating a high level of cognitive reserve (19).

Collectively, these baseline findings provided a comprehensive cognitive-linguistic profile that guided the subsequent intervention.

2.5. Intervention Procedures

Therapy sessions took place in a quiet clinical room at the School of Rehabilitation Sciences, Iran University of Medical Sciences. The patient was fully alert and engaged throughout all sessions, and a family member attended each session to provide emotional support and facilitate home-based follow-up activities. The intervention comprised 10 weekly individual sessions, each lasting 2.5 hours. The program was delivered in a stepwise, structured format, with clear therapeutic goals established for each phase of treatment.

The intervention consisted of seven complementary components: ORLA, MOR, SFA, PCA, Schuell's stimulation approach, working-memory exercises, and verbal short-term memory training. Each weekly session lasted approximately 2.5 hours, with short breaks provided as needed to reduce fatigue and maintain attention. The relative emphasis placed on each component varied across sessions according to the patient's baseline deficits, task performance, and therapeutic goals.

Tasks were presented in a graded manner, beginning with simpler linguistic or cognitive demands and progressing toward greater lexical, phonological, semantic, reading, memory, or sentence-level complexity as the patient demonstrated adequate performance. During naming and language-production tasks, semantic, phonological, verbal, or visual cues were provided when necessary to facilitate successful responses. Support was reduced as the patient demonstrated improved accuracy or independence.

ORLA was used primarily for sentence-level reading practice, with repeated oral reading and progressively

more complex sentence material. MOR was incorporated to support reading accuracy and fluency. SFA and PCA were used to facilitate lexical retrieval through semantic and phonological activation, respectively. Schuell-based stimulation activities were used to provide structured auditory and verbal language stimulation. Working-memory and verbal short-term memory activities included multi-step commands, reverse counting, multiplication-table tasks, and retention and recall of verbally presented information. The selection and progression of tasks were adjusted according to the patient's performance during each session.

Structured home practice was assigned twice daily for approximately 30 minutes per session. The family member assisted with completion of the assigned activities and supported adherence to the home-practice schedule.

The intervention was delivered by the same clinician across all treatment sessions using the structured treatment plan described above. Independent treatment-fidelity assessment or external session rating was not performed. Therefore, fidelity to the planned intervention was based on the clinician's consistent use of the session structure and treatment components rather than on independent fidelity verification.

The 10-session program was divided into three phases. The initial phase (Sessions 1 - 3) targeted auditory short-term memory (up to 5 - 6 items), two-step command comprehension, and naming using SFA and PCA. ORLA was introduced for sentence-level reading during the early sessions.

The intermediate phase (Sessions 4 - 7) included working-memory tasks (reverse counting and multiplication tables), auditory comprehension using yes/no questions and dictation, automatic speech (collocations, proverbs, and poems), and continued naming practice with SFA and PCA.

The final phase (Sessions 8 - 10) focused on functional communication. Activities included semantic and phonemic fluency, working-memory tasks, sentence completion, and MOR to improve reading speed and accuracy. A final interview reviewed progress and assessed outcomes.

Structured home-based assignments were provided to the patient twice per day, with each session lasting 30 minutes and a family member serving as a home facilitator. These activities were intended to ensure continuity of practice beyond the clinical setting and promote transfer of acquired skills to daily communicative interactions.

2.6. Post-Intervention Assessment

Immediately after completion of the 10-week intervention, all baseline measures (AQ2, P-MoCA, verbal fluency, digit span, and auditory-verbal memory tests) were readministered. No delayed follow-up assessment was conducted after the post-intervention evaluation. These post-intervention assessments tracked the patient's progress and provided the outcome data reported below. No alternate forms were used, and the assessment was conducted by the treating clinician.

2.7. Outcomes Overview

A 10-week single-case cognitive-linguistic therapy program was implemented, with one session per week, each session lasting 2.5 hours. All sessions followed a consistent protocol, and a family member actively participated throughout the sessions. Pre- and post-intervention assessments employed identical standardized instruments, including the P-MoCA for cognitive screening, AQ2 for comprehensive language evaluation, auditory-verbal memory tests, semantic and phonological verbal fluency tasks, and forward and backward digit-span measures. This multidimensional battery provided a comprehensive baseline of the patient's cognitive and linguistic profile, allowing characterization of pre- and post-intervention changes.

2.8. Pre- and Post-Intervention Scores

Table 1 presents the patient's performance on all language and cognitive measures before and immediately after the intervention. The patient demonstrated notable improvements across most domains, including global language function, reading and writing, repetition, auditory comprehension, working memory, verbal fluency, naming, speech rate, and lexical diversity. These pre- and post-intervention comparisons describe the observed changes across language and cognitive domains and provide the basis for the more detailed subdomain analyses presented below.

2.9. AQ2 Subtest Analysis

The detailed AQ2 subtest results are presented in Table 2. AQ2 subtest analysis revealed a stable core of basic auditory comprehension (objects, pictures, shapes, letters, numbers, colors, room items, and fingers), with most scores at ceiling. In contrast, complex receptive skills improved markedly, including body-part orientation and

multi-step commands. Productive language skills also showed meaningful gains: repetition, naming, sentence completion, single-word responses, and picture-word matching all improved, with the latter two reaching ceiling. Notably, oral reading, reading comprehension, and free writing increased from zero to maximum scores. Phonemic cueing also improved. Verbal fluency, copying, and dictation remained unchanged. Overall, the patient showed targeted improvements in expressive and complex receptive domains, whereas basic language functions remained intact.

2.10. Key Language Skills

The patient's performance on seven selected language domains, all of which demonstrated improvement following the intervention, is shown in Figure 1. Expressive and lexical skills, including repetition, naming and word retrieval, single-word responses, and oral reading of sentences, were selected to capture gains in output-related abilities. Auditory comprehension of multi-step commands was included to reflect progress in higher-order receptive processing. Foundational literacy skills, represented by reading comprehension and free writing, were incorporated to illustrate improvements from baseline scores of zero. This visual summary shows gains across expressive and complex receptive domains.

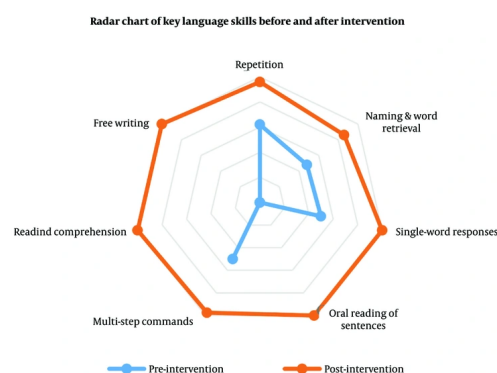


Figure 1. Radar chart of key language skills before and after intervention.

2.11. Overall Cognitive-Linguistic Performance

A grouped bar chart comparing pre- and post-intervention scores across all language and cognitive

Table 1. Pre- and Post-Intervention Scores Across Language and Cognitive Measures ^a

Measures	Pre-intervention	Post-intervention	Numeric Change	Percent Change	Clinical Interpretation
AQ2 Total Score	69.7	94.9	+25.2	+36.2%	Post-intervention score exceeded the stated clinical cutoff.
Reading	3.9	10	+6.1	+56.4%	Remarkable improvement
Writing	6.6	10	+3.4	+51.5%	Marked improvement
Repetition	6.2	9.6	+3.4	+54.8%	Moderate to marked improvement
Auditory Comprehension	7.45	9.65	+2.20	+29.5%	Moderate improvement
Immediate Verbal Memory	2	6	+4	+200%	Improved from below the cutoff to above the cutoff
Delayed Verbal Memory	3	5	+2	+66.7%	Improved from the cutoff value to above the cutoff
Digit Span Forward	4	10	+6	+150%	Improved from below the cutoff to above the cutoff
Digit Span Backward	4	7	+3	+75%	Improved from below the cutoff to above the cutoff
P-MoCA	16	26	+10	+62.5%	Improved from moderate impairment to normal range
Semantic Verbal Fluency	10	34	+24	+240%	Improved, below reference (34/62)
Phonological Verbal Fluency	14	41	+27	+192.9%	Normalized (exceeded reference: 41 > 36)
Narrative Speech Rate (words/min)	54	92.66	+38.66	+71.6%	Improved but remained below cutoff
Spontaneous Speech Rate (words/min)	89.14	129.09	+39.95	+44.8%	Approached normal range
Type-Token Ratio (TTR) in Narrative	0.41	0.87	+0.46	+112.2%	Below cutoff at baseline to above cutoff
TTR in Spontaneous	0.47	0.90	+0.43	+91.5%	Close to cutoff at baseline to above cutoff

^a Abbreviations: AQ2, Aphasia Quotient-2; P-MoCA, Persian version of the Montreal Cognitive Assessment; TTR, Type-Token Ratio.

measures is shown in [Figure 2](#). Most measures improved. Global language performance increased substantially, with the post-intervention AQ2 score exceeding the stated clinical cutoff. This finding should be interpreted as a change in test classification rather than evidence of complete clinical resolution of aphasia. Reading and writing both reached ceiling scores, representing substantial gains from initially low levels. Repetition and auditory comprehension showed moderate to marked improvements and approached ceiling levels. All verbal-memory and working-memory measures improved to the stated normal range. Phonological verbal fluency normalized, exceeding the reference score, whereas semantic verbal fluency improved substantially but remained below the reference. Spontaneous speech rate approached the normal range, whereas narrative speech rate improved but remained below the cutoff. No decline was observed in any measure. This profile demonstrates widespread improvement across the measured cognitive-linguistic domains during the observation period.

2.12. Summary of Findings

Overall, the multilevel assessment results revealed a pattern of broad improvement across most cognitive-linguistic domains following the 10-week intervention. Foundational language abilities, including basic auditory comprehension, letter and word recognition, and copying, remained at ceiling levels, indicating preservation of well-established skills. In contrast, previously impaired functions such as reading comprehension, free writing, and oral reading of sentences showed large gains, reaching maximum scores from baseline scores of zero. Higher-order expressive domains, including repetition, naming, single-word responses, and picture-word matching, also

demonstrated marked improvement, reflecting enhanced lexical access and phonological retrieval. Working-memory and verbal-memory measures improved post-intervention. Speech rate in spontaneous contexts approached the normal range, whereas narrative speech rate improved but remained below the cutoff. TTR increased in both narrative and spontaneous contexts and exceeded the respective cutoffs post-intervention. No decline was observed in any domain. Collectively, these findings describe broad pre- to post-intervention improvements across expressive, memory-related, and literacy measures; however, the single-case pre-post design does not permit determination of whether these changes were attributable specifically to the intervention.

3. Discussion

3.1. Overview of Findings

This single-case study documented substantial pre- to post-intervention improvements across multiple language and cognitive domains in a 41-year-old man with fluent aphasia following a left-hemisphere hemorrhagic stroke. Notably, the post-intervention AQ2 score exceeded the stated clinical cutoff, representing a substantial improvement in overall language performance. However, this change should not be interpreted as a complete clinical resolution of aphasia, particularly given the residual difficulties observed in semantic verbal fluency and narrative speech rate. Reading, writing, repetition, and auditory comprehension all reached or approached ceiling levels, whereas verbal-memory and working-memory measures improved post-intervention. These findings occurred relatively early after the stroke (approximately

Table 2. Comparison of AQ2 Subtest Performance Across Pre- and Post-Treatment Phases ^a

Measures	Pre-intervention	Post-intervention	Numeric Change	Percent Change	Clinical Interpretation
Continuous Speech Content	8	10	+2	+25%	Mild to moderate improvement
Speech Fluency, Grammatical Accuracy, and Paraphasic Errors	7	9	+2	+28.6%	Moderate improvement
Auditory Comprehension: Yes/No Questions	9.5	9.5	0	0	No change
Auditory Comprehension: Object Recognition	10	10	0	0	No change
Auditory Comprehension: Picture-Object Matching	10	10	0	0	No change
Auditory Comprehension: Shape Recognition	8.3	10	+1.7	+20.5%	Moderate improvement
Auditory Comprehension: Letter Recognition	10	10	0	0	No change
Auditory Comprehension: Number Recognition	10	10	0	0	No change
Auditory Comprehension: Color Recognition	10	10	0	0	No change
Auditory Comprehension: Room Object Identification	10	10	0	0	No change
Auditory Comprehension: Body Part Recognition	6.6	8.3	+1.7	+25.8%	Mild to moderate improvement
Auditory Comprehension: Finger Identification	10	10	0	0	No change
Auditory Comprehension: Body Part Orientation	2.85	8.5	+5.65	+198.2%	Significant improvement
Auditory Comprehension: Multi-step Commands	5	9.75	+4.75	+95%	Significant improvement
Repetition	6.2	9.6	+3.4	+54.8%	Moderate to marked improvement
Naming & Word Retrieval	4.8	8.6	+3.8	+79.2%	Significant improvement
Verbal Fluency	10	10	0	0	No change
Sentence Completion	8	10	+2	+25%	Mild to moderate improvement
Single-Word Responses	5	10	+5	+100%	Significant improvement
Oral Reading of Sentences	0	10	+10	N/A	Remarkable improvement
Letter and Word Recognition	10	10	0	0	No change
Phonemic Cueing	6.25	10	+3.75	+60%	Moderate to marked improvement
Picture-Word Matching	4	10	+6	+150%	Significant improvement
Reading Comprehension	0	10	+10	N/A	Remarkable improvement
Copying	10	10	0	0	No change
Dictation of Letters & Words	10	10	0	0	No change
Dictation of Sentences	10	10	0	0	No change
Free Writing	0	10	+10	N/A	Remarkable improvement

^a Abbreviation: AQ2, Aphasia Quotient-2.

three months), and the patient's high cognitive reserve may have influenced the observed recovery pattern (24).

3.2. Patterns of Improvement and Stability

The outcome pattern indicated broad improvement rather than selective gains. Skills that were severely impaired or absent at baseline, including oral reading of sentences, reading comprehension, and free writing, showed large gains from zero to maximum scores. These changes were observed across both basic and higher-order linguistic processes. In contrast, measures such as verbal fluency and copying remained unchanged, likely reflecting functions that were already at ceiling. No decline was

observed in any domain during the post-intervention assessment (25, 26, 27).

3.3. Comparison with Existing Evidence

Previous studies have reported that multi-component interventions, including ORLA, MOR, SFA, and PCA, can improve naming, reading, and comprehension in post-stroke aphasia (28, 29). The present results are consistent with this evidence and extend the clinical description to a Persian-speaking patient with fluent aphasia after a hemorrhagic stroke. The observed improvements in memory and digit-span measures also support consideration of working-memory training in aphasia rehabilitation, consistent with Choinski et al. (30), who

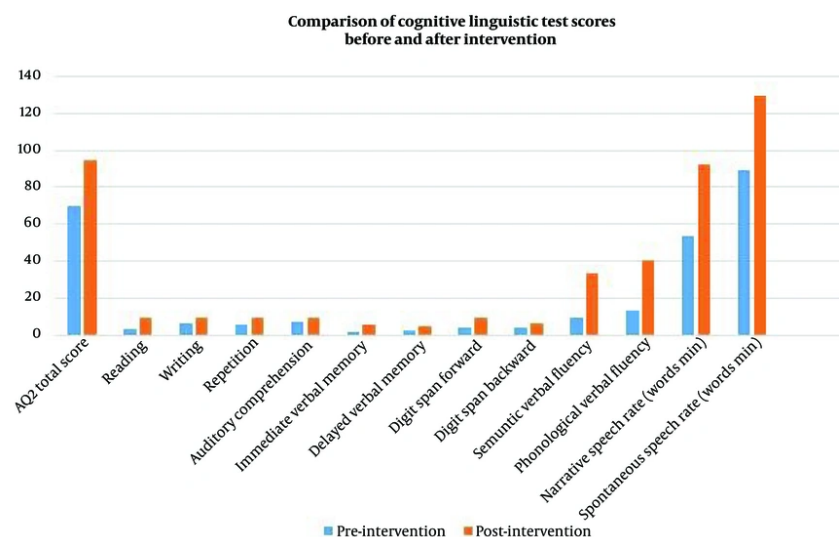


Figure 2. Comparison of cognitive-linguistic test scores before and after intervention.

reported that working-memory deficits often co-occur with aphasia and can improve through targeted exercises.

3.4. Role of Cognitive Reserve and Young Age

The patient's high cognitive reserve (CRIq = 229) and relatively young age (41 years) may have contributed to the observed outcomes. High cognitive reserve has been associated with neural plasticity and treatment response in post-stroke populations (31, 32). Moreover, younger age at stroke onset has been associated with better recovery prospects, possibly because of greater neural redundancy and compensatory capacity (33). These factors may therefore have influenced recovery across multiple domains.

3.5. Clinical and Functional Significance

From a clinical standpoint, the improvements observed in naming, repetition, reading, and writing represent measurable changes in test performance and may have supported everyday communication and literacy; however, functional outcomes were not formally measured. No validated functional-communication, participation, mood, or quality-of-life measures were administered. Several months after treatment, the patient informally reported returning to work, social activities, and German-language learning. These observations are presented as patient-

reported follow-up information rather than formally measured treatment outcomes (34). Structured home practice, supported by a family member, may have provided additional opportunities for practice and generalization, although its independent contribution to the observed changes cannot be determined.

3.6. Limitations

This study has several important limitations. First, the single-case pre-post design, with only one baseline assessment and no control condition or repeated measurements during treatment, does not allow the observed changes to be attributed specifically to the intervention. Spontaneous recovery during the post-stroke period, regression to the mean, and potential practice effects associated with repeated assessment may have contributed to the observed improvements. In addition, structured home practice and family involvement may have influenced the patient's performance and cannot be separated from the effects observed during the clinical intervention. Any concurrent clinical care or changes in the patient's condition during the observation period may also have contributed to the outcomes. Second, because the post-intervention assessment was conducted immediately after treatment and no delayed follow-up was available, the durability of the observed changes cannot be determined. Finally, the intervention included multiple

therapeutic components, making it impossible to determine the contribution of any individual technique. Future single-case studies should incorporate multiple baseline or repeated pre-intervention measurements, untreated or control conditions where feasible, independent outcome assessment, and longer-term follow-up to better distinguish treatment-associated changes from spontaneous recovery and other potential influences.

3.7. Conclusion

This case report describes broad pre- to post-intervention changes following a structured, individualized, multi-component cognitive-linguistic intervention in a Persian-speaking patient with fluent aphasia after a left-hemisphere hemorrhagic stroke. Improvements were observed across several language, reading, writing, memory, speech-rate, and lexical-diversity measures, although residual difficulties remained in some domains. The report does not establish a causal treatment effect because of its single-case pre-post design, absence of a control condition, and the possibility of spontaneous recovery, practice effects, and contributions from home-based practice or other clinical factors. Its primary contribution is the detailed characterization of a multi-domain rehabilitation approach in an underrepresented Persian-speaking population and the description of changes across multiple cognitive-linguistic outcomes. These observations may help inform clinical hypothesis generation and the design of future controlled studies examining individualized, multi-component rehabilitation for fluent aphasia.

Footnotes

AI Use Disclosure: The authors declare that no generative AI tools were used in the creation of this article.

Authors' Contribution: Study Concept and Design: A. S., N. J., and Z. B.; Analysis and Interpretation of Data: A. S. and Z. B.; Manuscript Drafting: Z. B.; Critical Revision for Important Intellectual Content: A. S., Y. A., N. J., and H. A.; Statistical Analysis: Z. B.

Conflict of Interests Statement: The authors declare that they have no conflicts of interest related to this work.

Data Availability: The dataset presented in the study is available on request from the corresponding author during submission or after publication. The data are not

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Ethical Approval: This study was approved by the Ethics Committee of Iran University of Medical Sciences under ethical approval code [IR.IUMS.REC.1403.819](#).

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