Title: The Effects of the Persian Writing Treatment Protocol on Communication Skills in People with Aphasia following Stroke

Running Title: Developing a Treatment Protocol for Stroke Patients with Aphasia

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Abstract

Introduction: Aphasia is one of the most severe post-stroke deficits affecting speech, comprehension, reading, and writing modalities. In some patients, speech is severely impaired, so choosing an alternative or complementary approach for communication seems necessary. Writing has the closest characteristics to verbal language. So, it can be a substitute or facilitate speech, and improve the quality of communication. Therefore, this study aimed to design a writing treatment protocol for Persian stroke patients and investigate its effect on improving communication skills.

Method: first, the writing treatment protocol was designed by considering the characteristics of Persian written language, and its validity was determined by an expert panel, then a single subject study with ABA design was performed on 6 stroke patients suffering from chronic aphasia, non-fluent with limited speech. After the baseline phase, treatment sessions using the developed protocol were conducted 1 hour twice a week for 10 sessions. Finally, a follow-up was performed to evaluate the stability of the treatment.

Results: The results showed that patients' improvement was limited to trained words which were treated using the developed protocol, and no generalization was observed to untrained words. The effect size indices (improvement rate difference, percentage of non-overlapping data, and percentage of overlapping data) showed the acceptable effect of treatment, its effectiveness, and the very high effect of writing therapy in all patients.

Conclusion: Writing treatment using the developed Persian protocol can improve writing performance as well as patients' communication. An important outcome of this study is the introduction of a writing treatment approach as a new intervention for Persian patients with limited speech.

Keywords: Strokes, Acquired aphasia, Treatment protocol, Writing

Highlights

- Communication is affected in stroke patients with aphasia, so choosing an alternative or complementary approach seems necessary.
- Writing can be the best way to communicate because it has almost the closest characteristics of verbal language.
- We developed a new writing treatment protocol and investigated its effect on communication skills in stroke patients.
- Based on the study results, writing treatment using a developed protocol can improve writing performance as well as communication.
- The outcome of this study was introducing a new treatment; especially for the patients with severely impaired speech, along with a high effect on communication.

Plain Language Summary

Stroke is one of the most common causes of death, and if the patients survive, they may suffer from aphasia which affects speech, comprehension, reading, and writing abilities, so it can cause disability. In some cases, verbal language is severely impaired, and the patient loses the ability to communicate via speech, so choosing another way, like writing approach, seems necessary to improve their quality of life and communication. Previous studies confirmed that writing treatments are useful in such patients; therefore, this study aimed to develop a new writing treatment protocol in Persian and the results showed that writing treatment using this protocol can be mentioned as a practical and clinical treatment.

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1. Introduction

Stroke is a focal neurological deficit that results from a localized disorder of cerebral circulation and it is a major cause of death and disability in industrialized countries (Wilson & Raghavan, 2018). It is expected that the number of stroke patients increase to 3.4 million between 2012 and 2030 because of lower mortality rate and the rising population age (Ovbiagele et al., 2013). This increase will be more pronounced in the future decades (Feigin, Norrving, & Mensah, 2017). Aphasia is one of the most severe post-stroke deficits affecting one-third of acute stroke patients (Brady, Kelly, Godwin, Enderby, & Campbell, 2016; Pollock, St George, Fenton, & Firkins, 2012). It is a general term to describe a range of acquired defects in language function following brain damage usually affecting the left hemisphere. Aphasia can affect all receptive and expressive communication modalities, i.e. speech, comprehension, reading and writing, and gestures (Berthier & aging, 2005; Schweizer & Macdonald, 2014).

Since the communication process is affected in people with aphasia (PWA), researchers have always been looking for treatments that can improve their quality of life. There are two major approaches to therapy. Impairment-based treatments target specific language sub-components; it attempts to enhance language functions, such as phonology, lexical-semantics, or syntax in structured therapy to reduce language impairment. The assumption is that doing so will also improve communication skills and, consequently, the quality of life. Another approach is Functional communication treatments which target communication skills more directly and do not emphasize generalization to treat speech or language impairments. Also, more than focusing on impairment, functional treatment focuses on removing environmental barriers to enhance the success of communication (Coppens, 2016). In some cases, verbal language is severely impaired and the PWA lose the ability to communicate through speech, so choosing an alternative or complementary approach seems necessary (P. M. Beeson, Hirsch, & Rewega, 2002). Among the communication ways, writing has almost the closest characteristics to verbal language, and written language can be the best way to communicate, exchange information and meet needs. In fact, in addition to being a substitute for speech, writing can also facilitate it and improve the patient's communication quality (P. M. Beeson, Rewega, Vail, & Rapcsak, 2000; P. M. Beeson, Rising, Kim, & Rapcsak, 2010; P. M. Beeson, Rising, & Volk, 2003). In general, written language is an important communication channel and is more parallel to verbal language than depending on it (Coppens, 2016).

In aphasia rehabilitation field, writing disorder has received less attention than other language modalities. Most treatments in these patients reported in different studies have focused on verbal language, and there are fewer studies on writing treatment (P. M. Beeson et al., 2002; P. M. Beeson et al., 2000; P. M. Beeson et al., 2010; P. M. Beeson et al., 2003). In fact, it does not underestimate the value of writing treatment in PWA, and more recent studies have suggested the special importance of writing as a way to improve communication in PWA and reported the appropriate response of these patients to such treatment (P. M. Beeson, Rising, DeMarco, Foley, & Rapcsak, 2018; Clausen & Besson, 2003; Robson, Marshall, Chiat, Pring, & Disorders, 2001; Thiel, Sage, & Conroy, 2015; Thiel, Sage, & Conroy, 2016). Most of these studies were performed as single and multiple case studies and have used writing treatment based on impairment-based writing therapies at the level of single words or sentences using lexical or phonological methods (P. M. Beeson, Higginson, & Rising, 2013; P. M. Beeson et al., 2018; P. M. Beeson et al., 2010; Thiel & Conroy, 2014). Two lexical-semantic protocols, i.e., Anagram and Copy Treatment

(ACT) and Copy and Recall Treatment (CART) designed by Beeson, were widely used in the writing treatment studies of patients with acquired writing disorder, and all of them have reported these treatments successful in improving patients' writing skills with an increase in their communication functions (P. M. Beeson et al., 2002; P. M. Beeson et al., 2000; P. M. Beeson et al., 2003; P. M. J. A. Beeson, 1999). Other studies have used phonological therapies alone or in combination with lexical therapy methods and most have involved phoneme to grapheme conversion. Similar to lexical therapies, all phonological therapy studies have reported successful results in patients' writing treatment (P. M. Beeson et al., 2018; P. M. Beeson et al., 2010; Thiel et al., 2016).

A general review of the literature concludes that writing treatment serves a variety of purposes, including restoring writing skills, stimulating verbal language, or being an alternative to verbal language, especially for patients with limited speech for communication and all of them are effective (P. M. Beeson et al., 2002; P. M. Beeson et al., 2000; P. M. Beeson et al., 2010; P. M. Beeson et al., 2003; Clausen & Besson, 2003; Coppens, 2016; Thiel et al., 2015; Thiel et al., 2016)

Since there is no comprehensive treatment for writing disorders in people with aphasia in Iran, the main purpose of this study was to design a writing treatment protocol appropriate to the Persian language with the principles of lexical-semantic therapy as a new approach besides the other applied clinical therapies used for PWA and to investigate the effects of writing treatment on improving the communication performance of PWA. The findings of the present study can provide a new perspective for the treatment of stroke patients with Persian-speaking aphasia. This designed writing treatment protocol can be used in treatment plans in the aphasia field for improving patients' communication and quality of life.

2. Materials and methods

This study has two main stages. The first stage deals with developing a writing treatment protocol, and the second stage focuses on determining the effect of the developed protocol on PWA. These steps are described below.

2.1. The first stage: developing a writing treatment protocol

This stage included an extensive review of literature with a focus on writing treatment in PWA especially lexical-semantic approaches. It was modeled in designing Persian writing treatment protocol. This approach involves arranging the component letters of the target word and using the bracketing approach for the patient's failed attempts. In other words, the cues in the treatment step started with simple tasks and gradually became more difficult, and finally, repetitive copies of the correct form of the target word are made.

The steps of writing treatment protocol were designed with considering the characteristics of the Persian written language. Also, the bracketing approach was considered in these steps. The designed protocol included the following steps:

- Providing a picture of the target functional word and asking the PWA to write its name

- Using semantic, phonological, and verbal repetition cues (respectively) to stimulate word retrieval if the patient was unable to write the target word.

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- Presenting the printed word syllables on the paper card (typed in size 92 with simple font) in an irregular manner, so that the PWA can retrieve the target word by arranging them.

- Arranging the printed letters of the word that are presented irregularly to the PWA

- Presenting a few additional letters that included vowels and consonants on the cards, as well as different forms of letters related to a phoneme that were visually similar to the component letters of the target word, so that the PWA can select the correct letters from them and write the target word.

- In the last step, hiding all the writing patterns so that the patient retrieves the written word from memory and finally writes it independently.

In all the above steps, if the patient is not able to write the target functional word, the therapist can arrange the cards correctly for instructing the PWA to use them as a template. After the patient is able to write the word correctly, they should copy the correct pattern three times.

In this way, an initial version of the writing treatment protocol was developed with the short-term plan of writing the functional word correctly that considered a list for training during treatment sessions using the writing treatment protocol. Also, the long-term goal was to communicate and request needs through writing.

To determine the validity of the developed protocol, its final version was made available to 10 experts in the field, including speech and language pathologists and linguists, to apply their comments by considering the purpose of the study as well as the target population. They were asked to comment on the appropriacy of the protocol, and also on correctly prioritizing the cueing hierarchy of the treatment protocol. Then, their answers and suggestions were analyzed and applied to the treatment protocol. The statistical methods used in this section included content validity index (CVI) and content validity ratio (CVR).

2.2. The second stage: evaluating the effectiveness of writing treatment in PWA using the developed protocol.

The research in this section was a single-subject study and ABA design. In such research, few subjects are studied at any time and the changes resulting from the treatment program are evaluated in relation to the same subject, not in relation to other participants; that is, the participant plays both the role of the subject and the control. Regarding the nature of single-subject study and the length of the evaluation and treatment process, in this project, 6 PWA were studied according to the inclusion criteria: unilateral damage of the left hemisphere based on the brain imaging and neurologist diagnosis, deficit due to stroke, no previous history of stroke, no history of cognitive disorder based on MMSE, no other neurological disorder such as Parkinson's and Alzheimer's, chronic stage, i.e. at least 6 months post-onset time, monolingualism, right-handedness, and no concomitant therapeutic intervention during the writing treatment.

First, according to the neurologist's diagnosis and brain imaging report, the location of the lesion was determined, and brain damage in the left hemisphere due to stroke was confirmed. All of the subjects' aphasia was classified as non-fluent. It had been caused by lesions in the left perisylvian regions. Then, the intervention process was explained to PWA and their families for

completing informed consent. Ethical issues were completely considered including the following: All PWA participated in the study voluntarily and were free to leave the study whenever they wanted, their information remained confidential, and the study was approved by the University Ethics Committee Iran Medical Sciences with the code IR.IUMS.REC.1399.429.

A demographic questionnaire was completed for each PWA, including personal information and a medical history report. All PWA were evaluated through initial pre-treatment test including Persian aphasia battery for assessing severity of aphasia in different aspects of language and also for differential diagnosis, the bedside version of Persian diagnostic aphasia battery (P-DAB-1) (R. Nilipour, Pourshahbaz, Ghoreyshi, & neuroscience, 2014) for determining aphasia severity based on aphasia quotient (AQ), and the aphasia naming test (R. J. U. o. W. Nilipour & Rehabilitation Sciences Press, 2011) for clinical assessment of naming skills. Inclusion criteria included patients with aphasia who were in the chronic phase, had brain damage in the left hemisphere, were non-fluent, had limited speech for communication, were not receiving other speech therapy, and were willing to learn writing therapy.

Then, ABA design was performed for each patient. First, the functional words of any participant were selected by consulting with the PWA and their families. These were the personal words that the PWA used frequently in daily life and were divided into 50 trained words into 10 sets of 5 words (which were treated 1 set during each treatment session based on a writing treatment protocol) and 50 untrained words (to evaluate the generalization of treatment to other words that not treated). They were used at baseline and probes during treatment sessions to evaluate the maintenance and stability of scores after treatment in the follow-up phase.

The baseline phase was repeated for 3 consecutive weeks (1 session per week) and their results were plotted as a graph called the baseline diagram. After the baseline phase and stable writing performance of PWA, the intervention phase started using the developed writing treatment protocol. furthermore, according to previous studies, the number of sessions and the duration of treatment intervention were the same for all subjects, and there were 10 sessions performed twice a week for 1 hour (P. M. J. A. Beeson, 1999). At this phase, probes were carried out regularly at the end of each week and both trained and untrained words were evaluated to determine the resulting changes and improvements. These results were drawn as a second graph beside the first diagram. In the third phase, 1 month after intervention sessions, all evaluations were carried out again (two sessions per week). The results were recorded in the diagram. This phase showed the generalization, stabilization or possible changes in treatment. In the end, the Persian aphasia battery, P-DAB-1 and aphasia naming test were re-examined. These stages are shown in detail in figure 1.

2.3.Statistical analysis

In this single-subject study, baseline, intervention and follow-up diagrams were drawn for all the subjects. Visual analysis (stability and changes in within-condition and between-condition) and effect size indices like improvement rate difference (IRD), percentage of non-overlapping data (PND), and percentage of overlapping data (POD) were examined. In analyzing the results of Persian aphasia battery, the aphasia naming test and P-DAB-1 test before and after treatment based on the developed writing treatment protocol, non-parametric Wilcoxon was used. All the statistical analyses were performed using SPSS software (version 22) at 95% confidence level.

3. Results

3.1. The first stage of the study

Content validity of developed writing treatment protocol was determined by an expert panel. It was provided to 10 experts to comment on each step of this protocol in three categories: necessary, useful but not necessary and not necessary, and then CVR was determined. The CVR for all steps was greater than (0.62) as in Lawshe table. This indicates that essential steps have been taken in this treatment protocol. In order to calculate CVI, the experts were asked to score the three criteria of relevance, simplicity and clarity of the developed protocol steps based on a four-point Likert scale (not relevant, somewhat relevant, quite relevant, and very relevant, in which 0 reflected no relevance between the mentioned items, and 4 indicated the most relevance). The CVI showed that the experts chose quite relevant and very relevant options for all the designed steps, and the CVI score was higher than 0.90, so it was appropriate.

3.2. The second stage of the study

Six patients with aphasia following a stroke in the left hemisphere were studied, all of whom were right-handed before the stroke but they used the left hand to write in this study because of right hemiplegia or paresis after lesion. The demographic characteristics of the participants are shown in Table 1.

Several patients may participate in single-subject studies, but the data are analyzed separately for each participant and the subject performance changes are scored in each session in different phases. In the present study, the effect of intervention in 50 trained words using the writing treatment protocol in the baseline phase, weekly probes, and follow-up in PWA is shown in Table 2.

The pre-treatment results showed that before treatment, no person with aphasia was able to write even one of the selected functional words, which was shown in the baseline sessions (3 times) with zero scores. Initial evaluations before the starting treatment showed that among the 6 people with aphasia, only two patients (1 and 3) were interested in re-learning writing performance. However, the other four patients did not try because of frustration and stated that they could not write words, but after starting the writing therapy session using the developed protocol, interesting results were obtained for all PWA. Improvement during intervention was shown by higher scores per session. A noteworthy point is that the scores at the follow-up phase showed that this progress was consistent and did not decrease over time.

Visual analysis which is the basis of single-subject studies and also observing patients' performance in generalizing treatment to untrained words, the scores at baseline, intervention phases, and its stability in follow-up sessions for each subject in trained and untrained words are shown in Figures 2 and 3.

The results showed that patients' improvement was limited to the trained words that were treated using developed protocol during the intervention sessions and no generalization was observed to other words (except for subject 1 who was able to write an untrained word without treatment, this may be due to the similarity of this word to one of the trained words) and the participants did not make significant improvement in untrained words compared to the initial baseline assessments.

Based on the diagrams in visual analysis, level, trend and stability of the data in different phases (baseline, intervention and follow-up) were examined and compared within-condition and between-condition. The within-condition analysis showed that the scores at the baseline in the stability envelope and variation range are stable and the trend direction is steady and stable. Data are variable in the intervention phase and the trend direction is ascending, which indicates the improvement of patients' performance after using the writing treatment.

In between-condition analysis, changes are examined from one condition to the next (baseline to intervention), and in all PWA, the trend was positive and changed from stable to variable. The results of calculating PND, POD and IRD also showed the acceptable effect of treatment, its effectiveness, and the very high effect of writing therapy in all PWA. Details of within-condition and between-condition analysis of each subject can be seen in Tables 3 and 4.

The results of comparing the patients language performance pre- and post-treatment in Persian aphasia battery showed a statistically significant difference of simple commands (p=0.05), letter and word recognition (p=0.03), Words reading (p=0.02), sentences reading (p=0.03), reading comprehension (p=0.02), confrontation naming (p=0.04) and free naming (p=0.05) subtests but there was no significant difference in other subtests of this test.

Since in the present study, writing treatment was performed so the writing tasks including copying, writing of letters, words, and sentences of Persian aphasia battery were analyzed in detail. Furthermore, the results showed that although there were no differences between pre- and post-treatment scores, the PWA were able to write some words in sentences subtest of this post-treatment test. These were the same words that were learned during the treatment, but no qualitative improvement in scores was reported because the correct score in this test is given to the patient only when he/she is able to write whole sentences so the performance improvement can only be reported quantitatively.

The performance of the participants in speech content and auditory comprehension subtests of P-DAB-1 pre- and post-treatment was not significantly different, but the scores of naming (p=0.066) and repetition (p=0.317) subtests indicate a change after the writing treatment, which can be seen in both tasks, although this increase is not significant.

Findings related to Persian aphasia naming test scores also showed that the naming performance of all PWA after treatment using the writing treatment protocol has increased, and in general these changes are significant (p = 0.027). This indicates the naming skill in all the PWA was improved after the writing treatment.

4. Discussion

The present study was conducted with the main purpose of investigating the effects of the writing protocol as an effective augmentative method to improve the communication skills of Persian PWA, and provided writing treatment for these patients for the first time. One of the secondary goals of this research was to develop the protocol appropriate to the written Persian language. The main feature of this treatment protocol was deciding the functional words by PWA and their families. In some traditional aphasia treatments, the therapist is responsible for choosing the target words for the treatment, but the main advantage of this protocol was personal words that were chosen by PWA for communication, which lead to higher chance of using these words in

daily communication. Previous studies have stated that the patient's choice of functional words for writing treatment is an important component of intervention because it encourages the patient to use these written words to improve and complement their conversational communication (P. M. Beeson et al., 2002; P. M. Beeson et al., 2003; P. M. J. A. Beeson, 1999). For example, Beeson (1999) in her study as a part of the treatment process asked the patient to use the trained written words to complete his conversations and determined its success based on the family report, and the results showed improvement in the use of target words in daily interactions (P. M. J. A. Beeson, 1999). Robson et al. (2001) encouraged patients to apply the words learned in therapy for communicating with another person in the final stages of their study. At this stage, the patients' families reported that they used written words to communicate (Robson et al., 2001).

In the present study, the patients' performance in the follow-up phase and family statements (that reports successful written communication using trained words to express needs) showed efficiency the writing treatment on daily communication. It is suggested that follow-up sessions should be conducted at longer intervals in future studies in order to investigate the long-term effect. Another important factor that affects the use of selected functional words in communication and makes treatment more successful is the patients' need for those words, because the more the PWA need and use the words in daily interactions, the more likely that they employ the selected words. In addition, previous studies suggested that it is important to consider variables such as words visualization, frequency and familiarity in aphasia assessment because all these factors facilitate treatment (Bemani, Moayedfar, & Ghasisin, 2021), so in the present study, they were considered well and their effects were observed on the patients' improvement. These results are consistent with the study of Robson et al. (2001) stating that the use of personal and functional words for each patient increases the probability of treatment success (Robson et al., 2001).

Another feature of this protocol was the bracketing approach for the simplification of incorrect writing attempts and providing anagrams and patterns for helping PWA to decide the placement of the letters. This ability to arrange, review, and revise the component letters among printed cards without time limitation provides a special condition for PWA that is not available for speech production. Beeson (1999) stated that the simplification of tasks and the provision of written word letters are essential components for patients with processing deficits, and suggested that these patients can use written communication if they are unable to speak (P. M. J. A. Beeson, 1999). Repetitive copies at each step of the writing treatment protocol is another positive feature that stimulates written representations of memory and activates the graphemic buffer, so that the PWA will be able to write the target word faster in subsequent attempts. This writing treatment protocol, based on lexical-semantic approach, was able to cover both short-term and long-term goals due to its special features. Improving writing performance and writing of trained words with the visual stimulus, and then communication through writing, showed the effectiveness of this writing method. These findings was also reported in the studies of Beeson (1999), Robson et al. (2001), Beeson et al. (2002), and Clausen et al. (2003).

Another aim of this study was to evaluate the effectiveness of writing treatment using the developed protocol in PWA. The findings showed that although the PWA were different in demographic characteristics and language abilities in an initial assessment, they all made significant improvement post-treatment. Regarding PND, POD and IRD indices, this improvement was non-random, and there was a remarkable effect of writing treatment on trained

words. In general, the results reported in this stage are consistent with the studies of Beeson (1999), Robson et al. (2001), Beeson et al. (2002), Clausen et al. (2003), Ball et al. (2011), and Thiel (2016), all of whom reported performance improvement in PWA after writing treatment. They also stated that lexical-semantic writing treatments are effective regardless of the type, severity, and post-onset time of aphasia (Ball, de Riesthal, Breeding, & Mendoza, 2011; P. M. Beeson et al., 2002; P. M. J. A. Beeson, 1999; Clausen & Besson, 2003; Robson et al., 2001; Thiel et al., 2016). In addition, Beeson et al. (2003) stated the severity and poor writing skills could not limit treatment outcomes (P. M. Beeson et al., 2003), which were fully similar to the findings of the present study in terms of the aphasia severity. Furthermore, the inability to write a single word in the baseline phase did not prevent the improvement and re-learning of writing based on the developed protocol, and all PWA showed significant results after the treatment. Clausen et al. (2003) reported that writing treatment could be beneficial in persistent speech impairments regardless of the time passed since the onset of the lesion (Clausen & Besson, 2003). It is similar to the present findings, because in this study, the post onset time in PWA varied from 2 to 8 years, but all of them responded well to the writing treatment protocol.

The results of writing treatment generalization to untrained words showed that none of the patients were able to write these words after the treatment sessions. It can be stated that PWA were able to re-learn trained words during treatment and it was specific to these items, and there was no evidence of the improvement of untrained words writing. According to writing cognitive models, the stored memory is created from repetitive copies of target words during protocol steps known as graphemic output lexicon that can be accessed directly from the semantic system. Since there were no repetitive copies of untrained words, no improvement in these words was observed after the treatment. These findings are similar to the results of the study by Beeson (1999), Robson et al. (2001), and Beeson et al. (2002). They noted that patients' progress was item-specific and limited to the trained items (P. M. Beeson et al., 2002; P. M. J. A. Beeson, 1999; Robson et al., 2001). The findings do not agree with those obtained from the studies of Thiel et al. (2016), Beeson et al. (2018), Pettit and Tope (2018) and Fein et al. (2020) who mentioned that their writing therapies can be generalized to other untrained words (P. M. Beeson et al., 2018; Fein, Bayley, Rising, & Beeson, 2020; Pettit & Tope, 2018; Thiel et al., 2016). This difference in the results may be due to the treatment approach as used in the mentioned studies because they did not use lexical-semantic writing treatment or used this treatment in combination with other approaches and thus reported generalization to untrained words. It was revealed that although there was no generalization to untrained words, PWA were able to write trained words in different situations post-treatment, such as answering questions without using a picture. It can be considered a generalization of treatment in different situations. Sometimes the target picture during spontaneous communication cannot be provided, so observing this generalization is considered a positive capability, which shows that the writing treatment can meet the needs of daily life situations. Another interesting finding that was observed during and after the treatment sessions was the improved ability to use simple drawing as a complement to their speech or drawing a schematic form of what they had difficulty expressing and naming to facilitate their communication.

The results showed improvement in some language abilities in initial tests after the writing treatment using the developed protocol which was mentioned in the findings section. In this regard, there are few studies that have examined the effect of writing treatments on language

components in PWA. In addition, naming and word retrieval disorders are common in these patients as major persistent language deficits that affect spoken and written language (P. M. Beeson & Egnor, 2006). According to the cognitive model, the main cause of the naming disorder may be the impairment of semantics, phonology, orthography components or the linkage between them as central language processing components. The importance of naming disorder in PWA has encouraged the development of several treatment approaches that improve semantic, phonological, written and spoken performance. The connections between these lexical processing components provide the basis for using different treatments to improve naming abilities. Therapies used for word retrieval in PWA may use a variety of approaches such as semantic knowledge and lexical-semantic relations (Boyle, 2004; Kiran & Thompson, 2003), phonological processing and speech production (Franklin, Buerk, & Howard, 2002), or orthographic and written representations. While there are numerous studies on using semantic or phonological competency approaches (Wisenburn & Mahoney, 2009), relatively few studies have examined writing as a tool for speech improvement. There is evidence from previous studies that, when a patient with aphasia is unable to use speech for communication, other alternative modalities such as gestures, drawing, or written language may complement or replace speech because written and spoken communication commonly have similar language processes (Black, Behrmann, Bass, & Hacker, 1989; Rapp, Caramazza, & language, 1997). In addition, it has been reported that in some patients, strengthening the central lexical-semantic system can lead to simultaneous improvement of spoken and written naming abilities (P. M. J. A. Beeson, 1999), which is similar to the findings of the present study, as the results of this study also reported improvement in naming skills after writing treatment using the developed protocol in all the mentioned three tests pre- and post-treatment. This improvement can be considered an advantage for this treatment, which is not limited to the written language and can enhance verbal naming and some other language skills. Improving post-treatment naming ability using the writing treatment protocol in the present study is consistent with the study of Beeson and Egnor (2006). They used a combination of written and verbal naming therapy in their study to investigate the effect of copy and word retrieval therapy with verbal repetition of target words, and compared this combined approach with a treatment that had only verbal repetition. They concluded that combination therapy led to greater improvement in verbal naming performance than the verbal naming therapy alone. In general, they stated that the combination therapy uses the residual phonological ability and establishes a link between written function and phonology (P. M. Beeson & Egnor, 2006). The results of Beeson et al. research (2013) also showed that the writing treatment approach improved writing and verbal naming abilities (P. M. Beeson et al., 2013). Regarding this, the results of the present study are different from Ball et al. (2011) who used lexical-semantic therapies by adding verbal repetition to writing therapy in patients with severe aphasia. Their findings showed that all the participants improved their writing skills, but none of them showed any improvement in their verbal naming performance. The researchers stated that this difference may be due to adding verbal repetition to treatment tasks that are not particularly appropriate for PWA with comorbid disorders, including apraxia (Ball et al., 2011). Further studies are needed to confirm these findings.

Regarding the relationship between reading and writing, it was found that all the PWA in the present study had significant improvement in the reading task subtest (i.e. letter and word recognition, word reading, sentence reading, and reading comprehension) after writing treatment using the developed protocol. In this regard, some studies show that the underlying cause of

reading and writing disorder in people with aphasia is a defect in phonological processing ability that is not specific to the written language (Crisp & Lambon Ralph, 2006; Rapcsak et al., 2009). Cognitive models also showed that writing and reading are closely related, so the improvement in the reading ability after writing treatment in the present study was not unexpected and is similar to the results of Beeson et al. (2010) study. They found that the patients' reading and writing skills were enhanced through writing treatment by strengthening both lexical and non-lexical paths in these patients (P. M. Beeson et al., 2010).

Finally, it was revealed in the present study that the developed writing treatment protocol significantly improved patients' communication, so it is suggested that writing therapies can be used in early treatment sessions for stroke patients with aphasia. Also, it is helpful for these patients to communicate as much as possible with a variety of modalities. In this research, the writing therapy was based on lexical-semantic approaches to illuminate the efficiency of such approaches on communication. Other more comprehensive studies are needed for complete and comprehensive treatment and further improvement of patient function, which employ phonological writing treatments following or alongside lexical-semantic writing approaches.

5. Conclusion

Writing disorder occurs in people with aphasia following stroke. In this connection, writing treatments are known to be effective in improving communication in these patients. It was also found that using a developed Persian protocol can improve writing performance as well as patients' communication. The results of the present study were aligned with the previous studies that used the lexical-semantic writing therapy method and reported positive results in improving the communication of their patients so an important outcome of this study is the introduction of a writing treatment approach for Persian patients with limited speech as it can improve patients' communication ability.

Author Contributions:

Conceptualization, [Mousavi, Jalilevand, Ashayeri]; Methodology, [Mousavi, Jalilevand, Abolghasemi]; Investigation, [Mousavi]; Writing – Original Draft, Author names [all authors]; Writing – Review & Editing, Author names [Mousavi, Jalilevand]; Funding Acquisition, [all authors]; Resources, [Mousavi]; Supervision, Author names [Jalilevand, Ashayeri, Abolghasemi]

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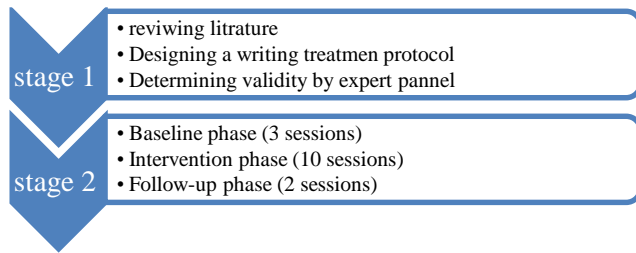
stage 1
- reviwing litrature
- Designing a writing treatmen protocol
- Determining validity by expert pannel

stage 2
- Baseline phase (3 sessions)
- Intervention phase (10 sessions)
- Follow-up phase (2 sessions)

Fig.1. two stages of the study

Table 1. Demographic characteristics of the PWA

Participants	P1	P2	P3	P4	P5	P6
Sex	F	F	M	F	M	F
Age (year)	57	71	43	52	59	65
Education (year)	16	12	16	14	16	14
Handedness (pre-post)	R/L	R/L	R/L	R/L	R/L	R/L
Post onset time (year)	2	8	3	2	4	6
AQ (pre treatment-	71.60	41.60	68.30	58.30	48.30	46.60
post treatment)	75	48.30	70	58.30	50	46.60

M: Male; F: Female.
AQ: based on P-DAB-1

Table 2. Writing scores of PWA in trained words using the developed writing treatment protocol in the baseline, intervention and follow-up phases.

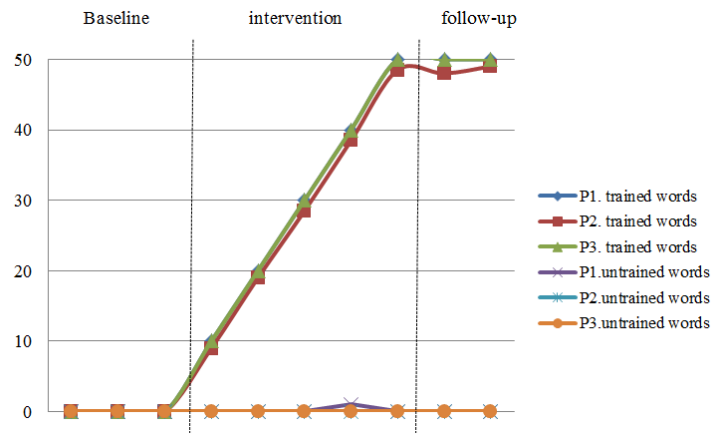| Phases	P1	P2	P3	P4	P5	P6
Baseline 1	0	0	0	0	0	0
Baseline 2	0	0	0	0	0	0
Baseline 3	0	0	0	0	0	0
Probe 1	10	9	10	10	10	9.5
Probe 2	20	19	20	20	20	19
Probe 3	30	28.5	30	29	30	28
Probe 4	40	38.5	40	39	40	38
Probe 5	50	48.5	50	49	50	48
Follow-up 1	50	48	50	49	49	48
Follow-up 2	50	49	50	49	50	48

Fig. 2. Scores of trained and untrained words during the three phases of baseline, intervention and follow-up in subjects 1 to 3. The sessions are on the x axis and the number of words is on the y axis.
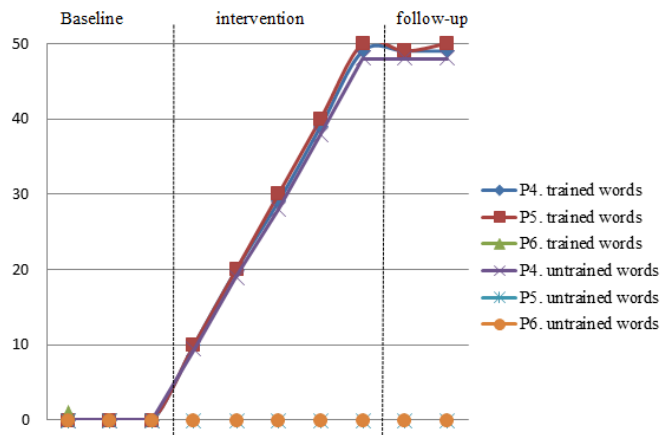

Fig. 3. Scores of trained and untrained words during the three phases of baseline, intervention and follow-up in subjects 4 to 6. The sessions are on the x axis and the number of words is on the y axis.

Table 3. Within-condition (A and B) analysis for PWA after using the writing treatment protocol

Condition	Baseline (A)						Intervention (B)					
participants	P1	P2	P3	P4	P5	P6	P1	P2	P3	P4	P5	P6
Condition duration	3	3	3	3	3	3	10	10	10	10	10	10
Level												
Median	0	0	0	0	0	0	30	28.5	30	29	30	28
Mean	0	0	0	0	0	0	30	28.70	30	29.40	30	28.50
variation range	0	0	0	0	0	0	10-50	9-48.5	10-50	10-49	10-50	9.5-48
Percentage of stability envelope	100	100	100	100	100	100	20	20	20	20	20	20
stability envelope variation range	Stable	stable	stable	stable	stable	stable	variable	variable	variable	variable	variable	variable
Level variation												
Absolute difference	0	0	0	0	0	0	40	39.5	40	39	40	38.5
Trend												
Direction	Steady	steady	steady	steady	steady	steady	ascending	ascending	ascending	ascending	ascending	ascending
Stability	Stable	stable	stable	stable	stable	variable	variable	variable	variable	variable	variable	stable

Condition	Baseline and intervention					
participants	P1	P2	P3	P4	P5	P6
Trend changes						
Direction						
Trend type **Stability**	Positive Stable/ Ascending	Positive Stable/ Ascending	Positive Stable/ Ascending	Positive Stable/ Ascending	Positive Stable/ Ascending	Positive Stable/ Ascending
Level changes						
Absolute difference	0 to 10	0 to 9	0 to 10	0 to 10	0 to 10	0 to 9.5
Median difference	0 to 30	0 to 28.5	0 to 30	0 to 29	0 to 30	0 to 28
Mean difference	0 to 30	0 to 28.70	0 to 30	0 to 29.40	0 to 30	0 to 28.50
effect size indices						
PND	100	100	100	100	100	100
POD	0	0	0	0	0	0
IRD	100	100	100	100	100	100