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The Effect of Combining Inhibitory Control and Errorless Naming Treatment on Word Retrieval Deficits in Patients with Aphasia: Design and Protocol of a Pilot Randomized Double-Blinded Clinical Trial

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Abstract

Background: The relation between language deficits and inhibitory control as the hallmark component of executive function in persons with aphasia is controversial. Studies that have been done in aphasia syndrome and language impairment have documented difficulties in executive function abilities as well. Inhibitory control issues are common in aphasic persons who demonstrate word retrieval deficits. The current project is a study protocol with the aim to develop a treatment paradigm, which simultaneously considers word retrieval and inhibitory control mechanism.
Methods: A total of 20 literate, right-handed, 30 to 65 years-old native Farsi speakers with post stroke aphasia without severe motor speech disorder will be recruited to participate in this randomized, double-blind clinical trial protocol. Subjects in 2 experimental and active control groups will undergo 12 sessions of treatment. The experimental group will include 10 patients who receive the combined treatment and the rest of patients in the active control group will be presented the errorless naming treatment. A 2nd speech and language pathologist will evaluate the participants before and after the treatment and at 1 month follow up.
Discussion: Based on previous studies that suggest the co-morbidity of word retrieval deficits and inhibitory control problems in aphasia syndrome, it is predicted that the combined treatment will affect word retrieval deficits more than errorless naming treatment alone.

Keywords: Aphasia, Word Retrieval, Inhibitory Control, Treatment

1. Background

Aphasia is an acquired multimodal language disorder, which is a common consequence of brain damage that affects several output (e.g., spoken and written language) and input modalities (e.g., comprehension and reading) (1). Although partial to total recovery has been reported after aphasia, a number of linguistic disturbances persist that affect every day communication for many individuals with aphasia (PWA) (2).

The most common annoying features of aphasia is word retrieval deficits (henceforth, WRD) (3), which disrupts the access to proper word from the mental lexicon (4). The negative impact of WRD on verbal communication is significant and interrupts an effective and meaningful conversation (5). Due to the fact that WRD exacerbate the communication ability and consequently decrease the quality of life of PWA, the treatment of WRD for these individuals as well as the person who communicates with them has paramount importance (4).

The vast majority of WRD interventions in PWA over the past 100 years have been based on the behavioral approach; compensatory and alternative methods (6), however, the findings implied that the efficacy of behavioral interventions for PWAs with a similar severity of language impairments is variable (7). There is growing empirical and clinical concern among aphasiologists that non-linguistic aspects of cognition may be responsible for diversity of effectiveness of the same treatment protocols for PWAs and should be taking into account for planning the interventions (8). The language system is not the only indicator of functional communication; indeed other factors including non-linguistic cognitive components such as executive functions (EF) seem to play an important role in communication success. Furthermore, some studies have illustrated a direct relationship between PWAs' performance in linguistic and EF tests and PWAs have deficits in general EF (9, 10).

The inhibitory control (IC) system is one of the EF' subsystems that is essential for successful lexical selection during word retrieval, which actively inhibits lexical competitors during target word selection. Word retrieval (WR) in PWA is often characterized by interference from the simultaneous activation of semantic and phonological items, which results in semantic paraphasia and phonological paraphasia (11). Some studies reported that IC problems and linguistic deficits are often coexist in PWA aphasia and lead to slower and less accurate lexical retrieval relative to healthy people (12, 13).

The interference paradigm has been commonly used to examine the role of IC in WR. For instance, the semantically blocked cyclic naming task is a fast picture-naming task in which pictures must be named in successive trials. Stimuli are arranged in a block on the basis of semantic similarity (congruent or homogenous conditions), or set along with stimuli from different categories (incongruent or mixed conditions). The difference between congruent and mixed blocks is named the "Semantic Interference Effect" (SIE). A greater value of SIE indicates less efficacy of inhibitory control mechanism (14). It is supposed that in the congruent block, due to semantic associations between the items, previously named items remain active during the naming of the ongoing target. Hence, the continuous need to inhibit these competitors results in a delay in word retrieval. Furthermore, during the congruent condition of the paradigm, non-fluent PWAs have shown higher SIE relative to neurologically healthy patients (13, 15).

Given the role of naming problems in functional communication and the variation effectiveness of linguistic therapies, there is an identified need for introducing a new treatment paradigm with a novel approach to the recovery of WR deficits in PWA; hence the current study will be a preliminary attempt to design a new protocol treatment, which would consider IC domains to improve WR difficulties. More specifically, we are going to investigate the efficacy of combined treatment (CT) and errorless naming treatment (ENT) upon WR difficulties in PWA. We will hypothesize that: 1) CT will more positively affect WR deficits than ENT alone; and, 2) CT will also result in communicative effectiveness gains, the ultimate goal of aphasia therapy.

2. Methods

2.1. Study Design and Setting

This study protocol will be a pilot randomized, double-blind clinical trial, which will be done at the neurology clinic of Sina Farshchian hospital, Hamedan University of Medical Sciences, Hamedan, Iran.

2.2. Ethical Approval

The present project has been proved by the ethics committee of Tehran University of Medical Sciences (IR.TUMS.FNM.REC.1396.2096) and has been submitted in the Iranian registry of clinical trial (IRCT2017042933682N1). All patients will sign the inform consent form before participating in the study.

2.3. Patients

A total of 20 right-handed patients, 30 to 65 years-old native Farsi speakers, with chronic non-fluent aphasia - established by administration of the Persian Mississippi Aphasia screening test (MAST-P) (16), caused by left hemisphere stroke will be recruited from the outpatient neurology clinic. All patients must have at least elementary literacy skills. The exclusion criteria will be the presence of concurrent disorders including psychiatric problems, severe apraxia, and dysarthria.

2.4. Adverse Effect

It should be noticed that our assessment tools and treatment protocols are not invasive; therefore, no side effects are anticipated.

2.5. Randomization

The randomization will be done by a computer-generated sequence, concealed in randomized list of numbers, sealed in opaque envelopes, and will be held by a secretary. Before data collection, the patients will be randomly assigned to one of 2 groups, ENT (n = 10) or CT (n = 10), by secretary, which is not involved in recruitment, assessment, or intervention stages. All patients, the examiner, and the SLPs will be blinded to treatment allocation. Outcome measures in patients will be assessed by a 2nd speech-language pathologist (SLP) at 3 time points: before treatment, immediately after treatment, and 1 month later as a follow up.

2.6. Interventions

All patients in both groups will receive individual therapy in 12 sessions (45 - 60 minutes per session) of treatment, 3 times a week (every other day). Before treatment, patients will be requested to not participate in any other aphasia treatment program and also no treatment for 3 months period preceding study participation.

- Errorless naming treatment (ENT)

In this project, patients in the active control group will be treated through ENT. Totally, stimuli will be 220 black and white line drawings taken from PPNTs (17), which will

be used in blocked cyclic naming tasks as well. In each session, the patient will be presented 40 to 60 pictures. ENT includes 5 stages for each item (18):

1- The stimuli will be presented on the computer screen one by one.

2- The SLP will say the name of the item and then ask the patient to repeat it 3 times.

3- Then, the written form of the item will be added to the picture on the computer screen and the patient will be asked to read it aloud 3 times.

4- Finally, after 5 seconds, the patient must recall the name of the item and repeat it 3 times.

5- If patients couldn't say the correct word, that picture (s) would be excluded and at the end of session it will be presented again.

It should be noted that in step 1 to 4, if the patient could repeat the correct word 2 out of 3 times, it will be accepted and will go to the next part.

- Combined treatment

The patients in the experimental group will be treated by CT, which will contain ENT plus an IC paradigm. The CT protocol will be designed using the blocked-cyclic picture-naming task with words in Farsi. The experimental paradigm will be based on the Schnur11, 12. This treatment protocol will have 2 parts; semantically-organized blocks and phonologically-organized blocks.

In each session, generally in ENT, 40 to 60 items and after a rest, 7 blocks with the homogeneous-mixed/ semantic-phonologic by random order will be presented to the patients as IC treatment. Each block will contain 5 cycles. Per cycle, 5 items will appear simultaneously on the screen, therefore, the target image will be in the center in the red box and the other images (4) will surround it. The patient should name the surrounded items first and then the target item.

- Semantically-organized blocks

A total of 100 items will select from PPNTs to comprise 20 semantically-related blocks. Each block will include 5 exemplars from the same semantic category presented together in a set (e.g., animal). Each set (block) of 5 pictures will be repeated 5 times (cycle1 to 5) with a different item order, forming a block of 25 pictures (Table 1).

In the semantically-mixed block, each item from the semantically-related block will be presented along with 4 items from different semantic categories (Table 1); there will be 5 cycles for 1 semantically-mixed block for a total of 20 mixed blocks. Phonological overlap of items within a block will be kept to a minimum.

- Phonologically-organized blocks

A phonologically-related block will be comprised of 5 items with the same initial phoneme (in Farsi: e.g., /š/). Similar to the semantically-related block, each set (block) of 5 pictures will be repeated 5 times (cycle 1 to 5).

In the phonologically-mixed block, each item from the phonologically-related block (e.g., items starting with /š/) will be shown with 4 pictures representing items that start with a different initial phoneme (Table 1). Overall, there will be 20 mixed blocks.

2.7. Outcome Measures

2.7.1. Primary Outcome Measures

- Picture naming test

Picture naming will be assessed by the parallel picture naming tests (PPNTs); PPNTs are neuropsychological tools for evaluating WR difficulties in Farsi-speaking adults with or without aphasia. The cut-off point of the tests is the highest level of sensitivity (86 correct responses). Two parallel tests have acceptable internal consistency (Cronbach's Alpha greater than 0.90) and external test-retest stability. For each correct answer, PWA will receive 1 point, which will be summed to give a total score (17).

- Spoken word-picture matching task

The matching spoken word-picture outcome measure will be used to identify and monitor the type of naming deficit (e.g., WR problems are semantically- vs. phonologically-based). This task consists of 50 phonemic and 50 semantic items. Each item consists of a spoken name, which is matched to one of the 4 pictures. The total score for PWA will be reported.

- Word/non-word repetition task

This task is a diagnostic test to determine the presence of phonological impairment and contains 30 words controlled for word frequency and length. There are 10 single syllable, 10 2-syllable, and 10 3-syllable words. In addition, 30 non-words spoken will contain 10 single syllable, 10 2-syllable, and 10 3-syllable non-words. Patients should repeat words and non-words spoken after the examiner. The patients' responses will be recorded as "correct" or "error". Scoring for this task will be similar to PPNT.

2.7.2. Secondary Outcome Measures

- Communicative Effectiveness Index (CETI)

Communicative effectiveness will be measured via CETI. The CETI is a 16-item questionnaire about ordinary communication situation or activity. Inter-rater reliability of the original CETI is 0.73 (95% confidence interval). Each item will be completed separately by a significant other (patient's carer) using a visual analogue scale (0 = not at all able, 10 = as able as before stroke). The scores will be summed to comprise the patient's score. The maximum score on this scale is 160 (19).

- Stroop task

Table 1. Stimuli Organized Into the Semantic and Phonologic Blocks

	Semantic Block		Phonologic Block	
	Homogenous	**Mixed**	**Homogenous**	**Mixed**
Cycle 1	/gorbe/	/gorbe/	/šir/	/šir/
	/fil/	/damæn/	/šelæ/	/saæt/
	/zærafe/	/sib/	/šælvar/	/mælæx/
	/rubah/	/mašin/	/šokolat/	/qašoq/
	/ʾæsb/	/polis/	/šane/	/doctor/
Cycle 2	/fil/	/fil/	/šælvar/	/šelæ/
	gorbe/	/kæfš/	šokolat/	/baqali/
	/ʾæsb/	/sæbæd/	/šelæ/	/pænjere/
	/zærafe/	/porteqal/	/šane/	/tup/
	/rubah/	/quri/	/šir/	/sir/
Cycle 3	/zærafe/	/ʾæsb/	/šane/	/šælvar/
	/ʾæsb/	/medad/	/šir/	/yax/
	/gorbe/	/sændæli/	šokolat/	/qolabi/
	/fil/	/bælal/	/šelæ/	/keik/
	/rubah/	/badbadæk/	/šælvar/	/ferešte/
Cycle 4	/ʾæsb/	/zærafe/	/šelæ/	/šokolat/
	/zærafe/	/ʾærusak/	/šælvar/	/mæsjed/
	/fil/	/šælvar/	/šane/	/tavus/
	/rubah/	/kæbab/	/šir/	/deræxt/
	/gorbe/	/livan/	šokolat/	/pa/
Cycle 5	/rubah/	/rubah/	/šelæ/	/šane/
	/ʾæsb/	/dudkeš/	šokolat/	/gav/
	/zærafe/	/qablæme/	/šir/	/naxon/
	fil/	/moz/	/šælvar/	/sigar/
	gorbe/	/kot/	/šane/	/ketri/

The Stroop color-word test (SCWT) is a neuropsychological test used to assess the ability to inhibit cognitive interference or distracting stimuli that disturb the processing of target stimuli. In the present study, we will use the Iranian version of the Stroop, which has 2 conditions, congruent and incongruent (20). In the Iranian Stroop task, each condition includes 48 words. The test-retest reliability of this test has been found to range from 0.80 to 0.91. The "Response Time" (RT) will be calculated for both congruent and incongruent stimuli and the "Interference Time" will be calculated by subtracting the incongruent RT from the congruent RT. In addition, the "Interference Score" will be determined by subtracting the correct scores of incongruent condition from the correct scores in congruent condition (21).

2.8. Statistics

Collected data will be analyzed using the statistical package for social sciences (SPSS) software version 20.0 for windows. To describe the information, central tendencies and dispersion will be reported. Before analytic statistics, the normality of the data will be tested by the K-S test. If there are suitable statistical assumptions, repeated measure ANOVAs will be used to investigate the main effects of time and group, and time*group interaction for the primary and secondary outcome measures. Bonferroni test will be used for paired, multiple comparisons. If the data does not meet normality assumptions, equivalent nonparametric tests will be used.

3. Results

Characteristics of the participants will be shown in Table 2. Main effects of time and group and their interaction effect on primary and secondary outcome measures will be illustrated in Table 3.

Table 2. Demographic Characteristics of Study Participants

	Groups	
	Experimental	Control
Age, y[a]		
Sex, %		
Male		
Female		
Postonset, mo		
Aphasia quotient[a]		

Abbreviation: SD, standard deviation.
[a]Values are expressed as mean ± SD.

Table 3. Main Effects of Time and Group and Their Interaction Effect on Primary and Secondary Outcome Measures (CI = 95%)

Outcome Measure/Effects	df	F	P Value
WR			
Time			
Group			
Time*group			
Time			
NWR			
Group			
Time*group			
SWPM (semantic)			
Time			
Group			
Time*group			
SWPM (phonologic)			
Time			
Group			
Time*group			
PPNT			
Time			
Group			
Time*group			
Stroop			
Time			
Group			
Time*group			
CETI			
Time			
Group			
Time*group			

Abbreviations: CETI, communicative effectiveness index; CI, confident interval; NWR, non word repetition; PPNT, Parallel Picture Naming Test; SWPM, Spoken Word Picture Matching; WR, word repetition.

4. Discussion

The current study will investigate the effect of a combined intervention, which includes a linguistic treatment (ENT) plus a cognitive therapy (IC) to treat a common and debilitating problem, the WR deficits of PWA. WR treatments most frequently involve rehabilitative strategies, which only concentrate on linguistic tests to plan a treatment based on language deficits (4). To the best of our knowledge, this study will be the 1st to date to design and examine a treatment protocol, which considers the inhibitory control system during treating word retrieval deficits in aphasia.

Past investigations have shown that individuals with aphasia, in addition to linguistic deficits, demonstrate some signs of IC impairments (13, 22, 23). In this regard, models of word production suggest successful lexical retrieval is dependent on the ability to limit interference from co-activated lexical-semantic representations (24).

The present study will predict probable recovery in the WR ability of PWA after receiving CT. Primary outcome measures such as the PPNT score are expected to improve across time in both the experimental and active control groups. Although ENT will improve WR ability in PWAs, CT, with its combination of ENT and targeting the IC mechanism, is expected to have more effectiveness in diminishing WR errors, in addition, consideration of the IC mechanism by using semantically and phonologically blocked cyclic naming tasks, will improve patients 'ability of IC and therefore get better scores on the Stroop task. It is expected that patients in the experimental group will more efficiently inhibit distracters following treatment, and thus, the level of interference on the Stroop task will decrease for these patients. All of these expected improvements could additionally enhance communicative efficacy in PWA; for example, greater inhibition of distracters (possible WR options) should reduce naming difficulties and lead to PWA having more effective communication in daily situations. For this reason, the total CETI score will be expected to raise

and indicate that this novel combined treatment influenced patients' communicative effectiveness more than the errorless naming treatment alone.

Many traditional speech therapy interventions for PWAs that only target linguistic abilities lead to nominal change, likely due to the fact that some stroke survivors show deficits in both language and cognition components, such as, memory, attention, and executive functions. Additionally, initial studies have shown that focusing on these cognitive sub-systems directly enhances the improvement of aphasia treatments (7, 25).

In this protocol, the main limitation could be the small sample size. Then, for generalization of the results, it is suggested in the future that some studies with larger sample sizes are needed.

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Footnote

Conflict of Interests: The authors declare no conflict of interests.

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