



Oct 17, 2025

BEHAVIORAL REHABILITATION PROTOCOL FOR APHASIA ASSOCIATED WITH NEUROMODULATION

DOI

<https://dx.doi.org/10.17504/protocols.io.kqdg3k6jzv25/v1>

Andressa Marques Ferreira Nicácio¹, Maria Teresa Carthery-Goulart², Thais Helena Machado¹

¹Federal University of Minas Gerais (UFMG), Belo Horizonte, Minas Gerais, Brazil;

²Federal University of ABC - UFABC, Santo André, São Paulo, Brazil



Andressa Marques Ferreira Nicácio

Universidade Federal de Minas Gerais

Create & collaborate more with a free account

Edit and publish protocols, collaborate in communities, share insights through comments, and track progress with run records.

Create free account

OPEN  ACCESS



DOI: <https://dx.doi.org/10.17504/protocols.io.kqdg3k6jzv25/v1>

Protocol Citation: Andressa Marques Ferreira Nicácio, Maria Teresa Carthery-Goulart, Thais Helena Machado 2025.

BEHAVIORAL REHABILITATION PROTOCOL FOR APHASIA ASSOCIATED WITH NEUROMODULATION. **protocols.io**

<https://dx.doi.org/10.17504/protocols.io.kqdg3k6jzv25/v1>

License: This is an open access protocol distributed under the terms of the **[Creative Commons Attribution License](#)**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited

Protocol status: Working

We use this protocol and it's working

Created: April 14, 2025

Last Modified: October 17, 2025

Protocol Integer ID: 126668

Keywords: Transcranial direct current stimulation, rehabilitation of speech and language di..., stroke, aphasia, transcranial magnetic stimulation, transcranial direct current stimulation, behavioral rehabilitation protocol for aphasia, chronic aphasia due to stroke, specific rehabilitation protocol, neuromodulation, behavioral rehabilitation protocol, neuromodulation non, transcutaneous direct current stimulation, scarcity of specific rehabilitation protocol, rehabilitation, innovative strategy in the rehabilitation, circuits of the spinal cord, chronic aphasia, rehabilitation process, motor recovery, possible therapeutic role for the technique, inducing neuroplastic change, magnetic stimuli, brain activity, brain injury, language gains in patient, neuronal excitability, stroke, cognitive deficit, spinal cord, cerebral cortex, neuroplastic change, devices such as electrode, behavioral intervention, promoting language gain, possible therapeutic role, based therapeutic proposal, therapeutic proposal, neural pathway, used t

Abstract

Non-invasive neuromodulation has emerged as an innovative strategy in the rehabilitation of motor and cognitive deficits resulting from brain injuries. This approach uses electrical or magnetic stimuli applied to the scalp or spinal cord, using devices such as electrodes or coils, in order to alter brain activity in a precise and controlled manner. Among the most commonly used techniques are Transcranial Magnetic Stimulation (TMS), Transcranial Direct Current Stimulation (tDCS) and Transcutaneous Direct Current Stimulation applied to the spinal cord (tsDCS). The latter stands out for its ability to influence not only the circuits of the spinal cord, but also the neural pathways that connect the brain and spinal cord, inducing neuroplastic changes that can benefit the rehabilitation process. Evidence suggests that tsDCS is able to regulate neuronal excitability both in the medulla and in the cerebral cortex, including areas involved in language. This indicates a possible therapeutic role for the technique in promoting language gains in patients with chronic aphasia due to stroke, as well as contributing to motor recovery. tsDCS is an inexpensive technique, easy to apply and portable, with few contraindications, making it a relevant tool for clinical routine. Studies show that neuromodulation is more effective when combined with behavioral interventions. Considering the scarcity of specific rehabilitation protocols for aphasia, it is essential to disseminate evidence-based therapeutic proposals that can be applied in clinical practice. Our research group has used tsDCS to rehabilitate people with chronic non-fluent aphasia. This protocol aims to demonstrate how to carry out the behavioral rehabilitation protocol associated with tsDCS.



Materials

- Microstim tDCS device, NKL, Brazil
- Alcohol 70
- Cotton
- Saline solution
- Pencil
- Paper
- Therapy materials

Equipment

- 1 The equipment used was NKL, model Microestim (Brazil), powered by a 9V rechargeable battery and certified by the National Health Surveillance Agency (ANVISA).

Skin preparation

- 2 Before application, the skin of the region corresponding to the T9-T11 vertebrae was sanitized with 70% alcohol.

Position of stimulation electrodes

- 3 Stimulation was carried out using two surface electrodes (anode and cathode) measuring 5×7 cm (35 cm^2), wrapped in sponges soaked in saline solution. The anode electrode was positioned over the region of interest (vertebrae T9-T11), while the cathode was fixed to the right deltoid muscle

The stimulus

- 4 tsDCS is performed by applying a direct, single-phase, low-intensity current (2 mA) through electrodes positioned on the spinal cord, with different polarities (anode and cathode), for 20 minutes.

Behavioral Rehabilitation

- 5 The therapeutic interventions were conducted in 15 sessions, all lasting 1 hour, over 3 consecutive weeks (Monday to Friday)
- 6 **Session 1 - Stimulating lexical access via semantics**
 - 6.1 Introduction to the Lexical Cascade Model: Present the lexical cascade model, using a visual scheme (flowcharts) to represent the stages involved in language production. To make it easier to understand, illustrate each stage with an everyday word.
 - 6.2 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.

- 6.3 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 6.4 Semantic categorization (training list): Ask the patient to sort the picture cards according to the same category.
- 6.5 Pairing written word and picture: Place the pictures on the table and give the patient the written words to place next to the corresponding picture.
- 6.6 Pairing with a semantic image: putting together images that are related to each other.
- 6.7 Evocation by contiguity (training list): evoking words that are related to the image card presented, either because they are objects, related actions, fruit, etc.

7 **Session 2 - Encouraging motor-phonoarticulatory planning**

- 7.1 What is motor planning? - Explain the phonoarticulatory process with visual support
- 7.2 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.
- 7.3 Word repetition - (training list) - Repeat the word one syllable at a time with vowel prolongation and exaggerated articulation, with monitoring in front of the mirror and visual support of the speech organ demonstrating the point and form of articulation.
- 7.4 Repeating words (training list) - Repeating the whole word with a pause between syllables, vowel lengthening and exaggerated articulation, with monitoring in front of a mirror and visual support of the speech organ demonstrating the point and form of articulation.

8 **Session 3 - Stimulating lexical access by phonological means + motor-phonoarticulatory planning**

- 8.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.

- 8.2 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 8.3 Reading words (training list): Reading the list of words with pauses between syllables, vowel lengthening and exaggerated articulation
- 8.4 Phonological categorization (training list): Phonological categorization (training list): group the picture cards according to the same phonological characteristics
- 8.5 Chain association with the words on the training list: The patient has to say a word that is related to each other, forming a chain of words.
- 8.6 Word repetition - (training list) - Repeat the word one syllable at a time with vowel prolongation and exaggerated articulation, with monitoring in front of the mirror and visual support of the speech organ demonstrating the point and form of articulation.
- 8.7 Syllabic segmentation: The patient listens to the word and must orally segment it into syllables, clapping their hands to mark how many syllables it has

9 **Session 4- Improving comprehension of complex orders**

- 9.1 Identify and name actions (training list) - simple sentence level (sharing subject, verb, or predicate): Based on an image, the patient must identify the main action and construct a simple sentence (subject + verb or subject + verb + complement).
- 9.2 Pair the written sentence with the appropriate image (training list): The patient receives a written sentence and must choose the image that best represents the content of the sentence from two or more options.

10 **Session 5 - Improving oral language expression at the syntactic level**

- 10.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.
- 10.2 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 10.3 Association verb + complement (training list): The individual must associate a verb presented in writing with an appropriate complement taken from the training list, forming

coherent semantic pairs that can be used to construct simple sentences.

- 10.4 Simple sentence construction - Subject + Verb + Complement (training list): The individual will have to formulate complete sentences from action figures by organizing them into a simple syntactic structure.
- 10.5 Repeating sentences: repeating sentences, consciously controlling the speed of speech, prosody and overarticulation.

11 **Session 6 - Encouraging motor-phonoarticulatory planning**

- 11.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.
- 11.2 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 11.3 Word repetition - (training list) - Repeat the word one syllable at a time with vowel prolongation and exaggerated articulation, with monitoring in front of the mirror and visual support of the speech organ demonstrating the point and form of articulation.
- 11.4 Repetition of words (training list) - with pause between syllables, vowel prolongation and exaggerated articulation - monitoring in front of mirror, visual support of the speech organ demonstrating the point and manner of articulation
- 11.5 Reading of words (training list) with visual support of the speech organ demonstrating the point and manner of articulation - pause between syllables, vowel prolongation and exaggerated articulation

12 **Session 7 - Stimulating lexical access via semantics + motor-phonoarticulatory planning**

- 12.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.
- 12.2 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 12.3 Free association of semantically related words (training list) - repetition of words with exaggerated articulation: present the patient with a word and ask them to freely produce

a word semantically related to the one presented. The patient then repeats the original word with exaggerated and clear articulation.

- 12.4 Description of the images (training list): The patient must observe the image presented and describe it, according to the questions: what? who? when? where? how? why?

13 **Session 8 - Improving comprehension of complex orders**

- 13.1 Identifying and naming actions (training list) - simple sentence level (sharing subject, verb or predicate): Present the patient with a set of pictures with different actions. You should point out which corresponds to what has been said.
- 13.2 Pairing the written sentence with the appropriate image (training list): The patient must read written sentences and identify the image that best represents the content of the sentence.

14 **Session 9 - Improving the expression of oral language at a syntactic level + motor-phonoarticulatory planning**

- 14.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.
- 14.2 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 14.3 Verb + complement association (training list): The patient must associate a verb with an appropriate complement, forming coherent combinations that can be used to construct simple sentences.
- 14.4 Simple sentence construction - Subject + Verb + Complement (training list): The task consists of forming simple, coherent sentences following the syntactic structure Subject + Verb + Complement.
- 14.5 Repeating sentences: repeating sentences, consciously controlling the speed of speech, prosody and overarticulation.

15 **Session 10 - Stimulating lexical access by phonological means + motor-phonoarticulatory planning**

- 15.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try

to name the item. If the patient can't name it, offer clues according to the lexical cascade.

15.2 Reading the list of words (training list) - using the metronome: reading the list of words aloud, following the rhythm marked by a metronome.

15.3 Chain association with words from the training list: The patient has to say a word that starts with the same letter, forming a chain of words.

15.4 Phonological trait analysis task (training list): The individual must analyze and reflect on characteristics of speech sounds, based on words from the training list. "What is the initial sound?", "How many syllables?", "What is the final sound?", "The word rhymes with...", "This word reminds me of..."

16 **Session 11 - Improving the expression of oral language at syntactic level + motor-phonoarticulatory planning**

16.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.

16.2 Copying the written word: present the patient with a written word as a model and ask them to copy it

16.3 Word repetition - (training list) - Repeat the word one syllable at a time with vowel prolongation and exaggerated articulation, with monitoring in front of the mirror and visual support of the speech organ demonstrating the point and form of articulation.

16.4 Simple sentence construction - Subject + Verb + Complement (training list) with prosody and speed training: The individual will have to formulate complete sentences from action figures, organizing them into a simple syntactic structure.

16.5 Task to strengthen the verb network (training list): The individual is encouraged to activate and expand their repertoire of verbs based on associations by answering the questions: "Who?" "When?" "What?" "Where?".

17 **Session 12 - Improving comprehension of complex orders**

17.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.

17.2 Copying the written word: present the patient with a written word as a model and ask them to copy it

17.3 Reading words (training list): Reading the list of words with pauses between syllables, vowel lengthening and exaggerated articulation

17.4 Identifying and naming actions - complex sentence level - syntagmatic relationships between lexical elements (training list)

18 **Session 13 - Stimulating lexical access via semantics + motor- planning**

18.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.

18.2 Copying the written word: present the patient with a written word as a model and ask them to copy it

18.3 Completing sentences (training list) using the metronome: The individual is given a sentence to start with (e.g. "I like...") and must complete it with an appropriate word or expression, fluently, following the rhythm of the previously established metronome.

18.4 Semantic characteristics analysis task (training list): The patient is encouraged to reflect on the meaning attributes of the target words, activating information associated with the concept by answering the questions: "Which category does it belong to?", "What is it used for?", "It does what?", "What does it look like?", "Where is it found?", "It reminds me of..."

18.5 Word repetition (training list) - whole word with pause between syllables, vowel prolongation and exaggerated articulation - monitoring in front of mirror, using visual support of the speech organ demonstrating the point and manner of articulation

19 **Session 14 - Improving the expression of oral language at a syntactic level + motor-phonoarticulatory planning**

19.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.

19.2 Copying the written word: present the patient with a written word as a model and ask them to copy it

- 19.3 Word repetition - (training list) - Repeat the word one syllable at a time with vowel prolongation and exaggerated articulation, with monitoring in front of the mirror and visual support of the speech organ demonstrating the point and form of articulation.
- 19.4 Completing sentences with subject, verb and complement suppression (training list) + reading sentences with speed and prosody control
- 20 **Session 15 - Stimulating lexical access via semantics and improving oral language expression at a syntactic level**
- 20.1 Oral naming of figures (training list) - Facilitation using lexical cascade: Show the picture and ask "What is this?". Give the patient enough time to process the information and try to name the item. If the patient can't name it, offer clues according to the lexical cascade.
- 20.2 Copying the written word: present the patient with a written word as a model and ask them to copy it
- 20.3 Semantic characteristics analysis task (training list): The patient is encouraged to reflect on the meaning attributes of the target words, activating information associated with the concept by answering the questions: "Which category does it belong to?", "What is it used for?", "It does what?", "What does it look like?", "Where is it found?", "It reminds me of..."
- 20.4 Simple sentence construction - Subject + Verb + Complement (training list): The individual will have to formulate complete sentences from action figures, organizing them into a simple syntactic structure.
- 20.5 Organizing sentences (training list): The individual receives scrambled words that form a simple sentence and is asked to organize them in the correct order, respecting the syntactic structure of the Portuguese language.

Protocol references

- 1 - Zhao Q, Wang J, Li Z, Song L, Li X. Effect of Anodic Transcranial Direct Current Stimulation Combined With Speech Language Therapy on Nonfluent Poststroke Aphasia. *Neuromodulation* [Internet]. 2021 Jul 1 [cited 2025 Jan 11];24(5):923–9. Available from: <http://www.neuromodulationjournal.org/article/S1094715921062012/fulltext>
- 2 - Elsner B, Kugler J, Mehrholz J. Transcranial direct current stimulation (tDCS) for improving aphasia after stroke: a systematic review with network meta-analysis of randomized controlled trials. *J Neuroeng Rehabil* [Internet]. 2020 Jul 8 [cited 2025 Mar 6];17(1):88. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC7346463/>
- 3 - Zheng ZS, Wang J, Lee S, Wang KXL, Zhang B, Howard M, et al. Cerebellar transcranial direct current stimulation improves quality of life in individuals with chronic poststroke aphasia. *Sci Rep* [Internet]. 2025 Dec 1 [cited 2025 Mar 6];15(1):6898. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC11865529/>
- 4 - Marangolo P, Vasta S, Manfredini A, Caltagirone C. What Else Can Be Done by the Spinal Cord? A Review on the Effectiveness of Transspinal Direct Current Stimulation (tsDCS) in Stroke Recovery. *International Journal of Molecular Sciences* 2023, Vol 24, Page 10173 [Internet]. 2023 Jun 15 [cited 2025 Mar 4];24(12):10173. Available from: <https://www.mdpi.com/1422-0067/24/12/10173/htm>
- 5 - Marangolo P, Fiori V, Caltagirone C, Incoccia C, Gili T. Stairways to the brain: Transcutaneous spinal direct current stimulation (tsDCS) modulates a cerebellar-cortical network enhancing verb recovery. *Brain Res*. 2020 Jan 15;1727.
- 6 - Marangolo P, Fiori V, Shofany J, Gili T, Caltagirone C, Cucuzza G, et al. Moving beyond the brain: Transcutaneous spinal direct current stimulation in post-stroke aphasia. *Front Neurol*. 2017 Aug 8;8(AUG).
- 7 - Pisano F, Caltagirone C, Incoccia C, Marangolo P. Spinal or cortical direct current stimulation: Which is the best? Evidence from apraxia of speech in post-stroke aphasia. *Behavioural Brain Research*. 2021 Feb 5;399:113019
- 8 - Jordi Peña-Casanova, M. PEREZ PAMIES. *Reabilitação da afasia e transtornos associados*. 2005.