



Verb Network Strengthening Treatment Combined with tDCS in Non-fluent Chronic Aphasia

Olga Buivolova¹ (obuivolova@hse.ru), Ekaterina Ivanova¹, Ekaterina Iskra^{1,3}, Olga Soloukhina¹, Olga Pakholiuk⁴, Anastasia Shlyakhova¹, Maria Ivanova⁵, Svetlana Malyutina^{1,2}

¹Center for Language and Brain, National Research University Higher School of Economics, Moscow, Russia

²Federal Center for Brain and Neurotechnologies, Moscow, Russia

³Center for Speech Pathology and Neurorehabilitation, Moscow, Russia

⁴University of Amsterdam, Amsterdam, the Netherlands

⁵University of California, Berkeley, CA



Berkeley
UNIVERSITY OF CALIFORNIA

Center for
Language & Brain

Introduction

- **Verb Network Strengthening Treatment (VNeST):**
 - Aphasia therapy aimed at improving word and sentence production.
 - Works by strengthening the semantic and syntactic networks of verbs because they are the core elements of the language structure
 - Effectiveness shown in English and Korean (Edmonds, Nadeau & Kiran, 2009; Edmonds, 2016)
- **Transcranial direct current stimulation (tDCS):**
 - Safe, non-invasive brain stimulation method
 - Can potentially enhance the effect of language therapy (Galletta et al., 2016)

Research question

- Is there an added benefit of combining VNeST with tDCS in chronic post-stroke aphasia?

Methods

VNeST

20 frequent Russian 2-argument action verbs (e.g., to close, to catch, to drink, to count, to kiss, etc.) practiced in live SLT sessions in the following tasks:

- Step 1. Generation of agents and patients for verbs (Fig. 2)
- Step 2. Reading generated sentences aloud
- Step 3. Expanding sentences (prompted by questions)
- Step 4. Grammaticality judgment
- Step 5. Verb production without cues
- Step 6. Sentence production without cues



Fig. 1. Example of stimulus from the custom verbs and sentences test

Who?	cooks	What?
Mom	cooks	dinner
Chef	cooks	lunch
Soldier	cooks	porridge
Tourist	cooks	soup

Figure 2. Example of agent-patient pairs produced for the verb "to cook" at Step 1.

tDCS

Every day at the beginning of the 1st therapy session. Sponge 5x7 electrodes, 1.5 mA, 20 min. Random assignment to stimulation groups (data collection in progress):

- (1) Anodal stimulation of the left hemisphere (LH) (anode: LH; cathode: left shoulder)
- (2) Bilateral stimulation (anode: LH, cathode: RH).
 - Would it be superior to (1) due to lateralizing language processing to LH and inhibiting maladaptive RH activation? (see TMS: Martin et al., 2009; Weiduschat et al., 2011)
- (3) Sham.

Target: Intact perisylvian cortex, informed by MRI.

Outcome measures

Russian Aphasia Test (RAT; Ivanova et al., 2019)

- Comprehensive test battery for assessment of linguistic function in aphasia
- Consists of 13 subtests covering language comprehension, production, and repetition

Custom tests (Verbs and Sentences)

- Two tests: verb naming and sentence production
- Each contains 20 trained verbs and 20 untrained verbs, balanced for psycholinguistic parameters, to test generalization

References

1. Edmonds, L. A., Nadeau, S. E., & Kiran, S. (2009). Effect of Verb Network Strengthening Treatment (VNeST) on Lexical Retrieval of Content Words in Sentences in Persons with Aphasia. *Aphasiology*, 23(3), 402–424.
2. Edmonds, L. A. (2016). A Review of Verb Network Strengthening Treatment Theory, Methods, Results, and Clinical Implications. *Topics in Language Disorders*, 36(2), 123–135.
3. Galletta, E. E., Conner, P., Vogel-Eyny, A., & Marangolo, P. (2016). Use of tDCS in aphasia rehabilitation: A systematic review of the behavioral interventions implemented with noninvasive brain stimulation for language recovery. *American Journal of Speech-Language Pathology*, 25(45), S854–S867.
4. Ivanova M., Dragoy O., Akhina Y., Soloukhina O., Iskra E., Khudyakova M., Stupina E., Buivolova O., Akhutina T. (2019). Standardizing the Russian Aphasia Test: Normative data of healthy controls and stroke patients. *Frontiers in Human Neuroscience*. Conference Abstract: Academy of Aphasia 57th Annual Meeting.
5. Martin PI., Naeser M.A., Ho M., Treglia E., Kaplan E., Baker E.H., et al. (2009). Research with transcranial magnetic stimulation in the treatment of aphasia. *Curr Neurol Neurosci Rep*, 9, 451–8.
6. Weiduschat N., Thiel A., Rubi-Fessen I., Hartmann A., Kessler J., Merl P., et al. (2011). Effects of repetitive transcranial magnetic stimulation in aphasic stroke: a randomized controlled pilot study. *Stroke*, 42(2), 409–415.



Participant 1. IIM

Female, 42 y.o., 13 years of education, designer. Ischemic stroke. Therapy 2.3 years post-stroke. Severe efferent motor and dynamic aphasia. Stimulation parameters: Group 1 (anode: intact LH perisylvian cortex, cathode: left shoulder)

Results:

RAT: no significant improvement

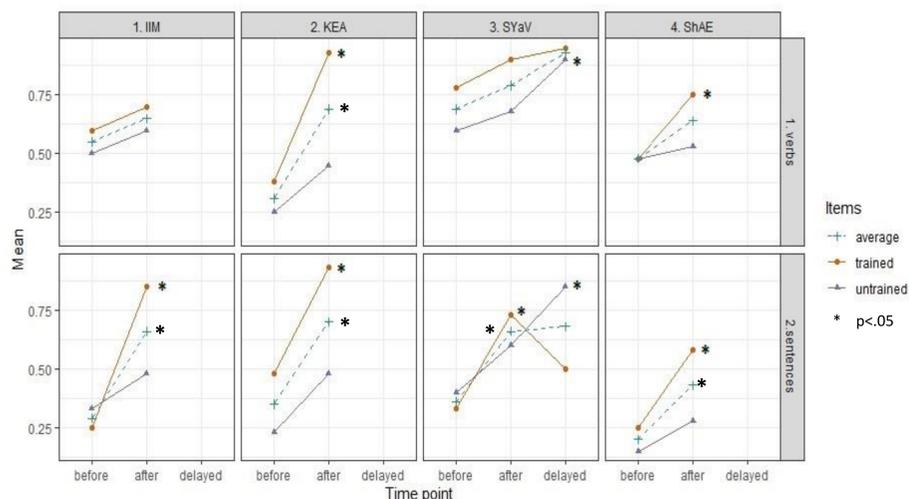
Custom tests

Verbs: no significant improvement

Sentences: significant improvement driven mainly by trained items

Test	Accuracy before	Accuracy after	P-value
RAT			
Comprehension	.92	.87	>.05
Production	.75	.74	>.05
Repetition	.65	.68	>.05
Average	.65	.63	>.05
Custom tests			
Verbs	.55	.65	>.05
Sentences	.29	.66	<.05

Accuracy on trained and untrained verbs in the custom test



Discussion and Conclusions

- A combination of VNeST with tDCS in Russian-speaking people with chronic severe non-fluent aphasia showed **promising results**.
- The added benefit of **stimulation** can hardly be determined at this stage. Data collection is ongoing.
- All participants significantly improved on **sentence production**. These findings are consistent with the aim of the VNeST therapy and crucial for people with non-fluent aphasia.
- At immediate testing, significant improvement was detected only in trained items. However, participant SYaV, who performed delayed testing after three months, improved significantly on untrained items in sentence production and reported an overall improvement in daily communication. In the future, we will perform delayed testing for all participants.



Participant 2. KEA

Female, 45 y.o., 12 years of education, nurse. Ischemic stroke. Therapy 1.2 years post stroke. Severe complex motor aphasia. Stimulation parameters: Group 3 (sham).

Results:

RAT: no significant improvement

Custom tests

Verbs: significant improvement driven mainly by trained items

Sentences: significant improvement driven mainly by trained items

Test	Accuracy before	Accuracy after	P-value
RAT			
Comprehension	.94	.96	>.05
Production	.56	.65	>.05
Repetition	.47	.22	>.05
Average	.38	.43	>.05
Custom tests			
Verbs	.31	.69	<.05
Sentences	.35	.70	<.05



Participant 3. SYaV

Male, 61 y.o., 12 years of education, driver. Ischemic stroke. Therapy 5 months post stroke. Severe dynamic aphasia. Stimulation parameters: Group 2 (anode: intact LH perisylvian cortex, cathode: RH, contralaterally to anode) Also performed delayed testing in 3 months after therapy.

Results:

RAT: no significant improvement

Custom tests

Verbs: Immediate testing: no significant improvement.

Delayed testing: generalization to untrained items.

Sentences: Immediate testing: significant improvement driven mainly by trained items. Delayed testing: generalization to untrained items.

Test	Accuracy before	Accuracy after	P-value
RAT			
Comprehension	.73	.71	>.05
Production	.67	.83	>.05
Repetition	.83	.88	>.05
Average	.72	.85	>.05
Custom tests			
Verbs	.69	.79	>.05
Sentences	.36	.66	<.05



Participant 4. ShAE

Male, 68 y.o., 15 years of education, retired. Ischemic stroke. Therapy 8 months post stroke. Severe complex motor aphasia. Stimulation parameters: Group 2 (anode – intact LH perisylvian cortex, cathode: RH, contralaterally to anode)

Results:

RAT: no significant improvement

Custom tests

Verbs: improvement driven mainly by trained items.

However, overall improvement was not significant.

Sentences: significant improvement driven mainly by trained items

Test	Accuracy before	Accuracy after	P-value
RAT			
Comprehension	.71	.79	>.05
Production	.66	.62	>.05
Repetition	.46	.42	>.05
Average	.51	.47	>.05
Custom tests			
Verbs	.48	.64	>.05
Sentences	.20	.43	<.05

Discussion and Conclusions (continued)

- Questions to be answered:
 - Does tDCS in general enhance the effect of language therapy?
 - Is 'lateralizing' stimulation (Group 2) superior to anodal LH stimulation?
- Question beyond the scope of the study:
 - Within intact perisylvian cortex, how close to the lesion should the stimulation be targeted?