



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

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## 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 1<sup>st</sup> 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

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### 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

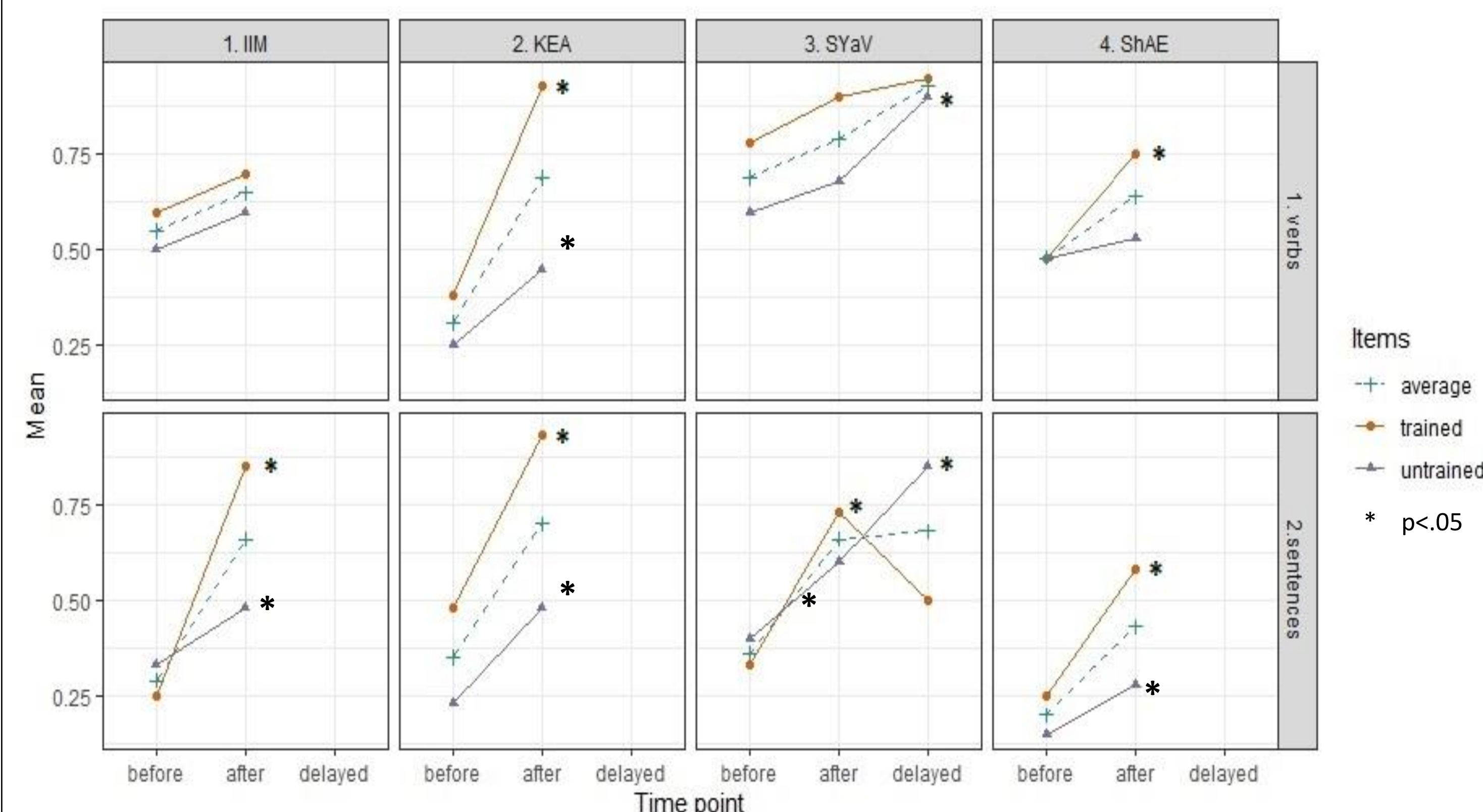
### Custom tests

**Verbs:** no significant improvement

**Sentences:** significant improvement driven mainly by trained items

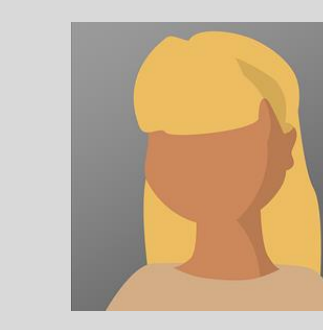
Test	Accuracy before	Accuracy after	P-value
<b>RAT</b>			
Comprehension	.92	.87	>.05
Production	.75	.74	>.05
Repetition	.65	.68	>.05
Average	.65	.63	>.05
<b>Custom tests</b>			
Verbs	.55	.65	>.05
Sentences	.29	.66	<.05

## 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
<b>RAT</b>			
Comprehension	.94	.96	>.05
Production	.56	.65	>.05
Repetition	.47	.22	>.05
Average	.38	.43	>.05
<b>Custom tests</b>			
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
<b>RAT</b>			
Comprehension	.73	.71	>.05
Production	.67	.83	>.05
Repetition	.83	.88	>.05
Average	.72	.85	>.05
<b>Custom tests</b>			
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
<b>RAT</b>			
Comprehension	.71	.79	>.05
Production	.66	.62	>.05
Repetition	.46	.42	>.05
Average	.51	.47	>.05
<b>Custom tests</b>			
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?