Neuronavigated 1 Hz repetitive Transcranial Magnetic Stimulation (rTMS) in Chronic post-Stroke Aphasia

Anastasios M. Georgiou & Maria Kambanaros
Department of Rehabilitation Sciences, Cyprus University of Technology, Cyprus

Background

Aphasia, an acquired communication disorder, afflicts more than one third of all stroke survivors (Heiss & Thiel, 2016). In recent years, brain stimulation techniques have been applied to stroke patients with aphasia to facilitate language recovery. Transcranial magnetic stimulation (TMS) is one type of noninvasive brain stimulation (NIBS) technique used in the evolving field of neurostimulation protocols for stroke rehabilitation (Cappa, 2011).

Research Aim:

To explore whether 1 Hz repetitive TMS (rTMS) as a standalone treatment could modify performance on language tests 1 day and/or 2 months post treatment when administered for 10 consecutive days over the right pars triangularis (pTr) of 3 individuals with chronic post-stroke aphasia.

Methodology

The Participants – Demographics

Three stroke survivors with residual language deficits who had all suffered a left middle cerebral artery (MCA) stroke at least 6 months before enrolment.

P1: female; 72 years old; moderate-severe anomic aphasia; 50 months post-stroke (ischemic); 12 years of education
P2: male; 55 years old; severe global aphasia; 8 months post-stroke (ischemic); 17 years of education
P3: male; 26 years old; mild anomic aphasia; 109 months post-stroke (ischemic); 16 years of education

Language Assessments

✓ The Greek version of the *Boston Diagnostic Aphasia Examination* – Short Form (BDAE-SF) (Messinis, Kastellakis, Panagea & Papathanasopoulos, 2013)

✓ The short version of the Greek *Peabody Picture Vocabulary Test*–Revised (PPVT-R) (Simos, Sideridis, Protopapas & Mouzaki, 2011)

✓ 19 informative verbs from the *Greek Object and Action Test* (GOAT) (Kambanaros, 2004)

✓ The *Multilingual Assessment Instrument for Narratives* (MAIN) (Gagarina et al., 2012)

Other Assessments

✓ The *Raven's Coloured Progressive Matrices* (RCPM) (Raven, Raven & Court, 1998) was used to measure nonverbal IQ.

✓ The *Stroke and aphasia quality of life scale-39 item* (SAQOL-39g) (Kartsona & Hilari, 2007).

➢ All language and cognitive tests were used at 4 points in time during the study (i.e. 12 days prior and 1 day before treatment for baseline measurements; one day after treatment and at 2 months follow-up). Quality of life was assessed one time at baseline (1 day before treatment) and 2 months post treatment.

Neuronavigated Transcranial Magnetic Stimulation (1 Hz rTMS)

- After obtaining individual resting motor thresholds (RMTs) using electromyography (EMG) of the left first dorsal interosseous (FDI) , the participants underwent 1 Hz rTMS at 80% of their individual RMT with a 70 mm figure-8 coil (Magstim Co., Wales, UK) connected to a Magstim Super Rapid2 stimulator. Stimulation parameters were in accordance with the guidelines proposed by Wassermann (1998). The position of the coil was guided by a frameless stereotactic neuronavigation system (ANT NEURO) that uses the individual patients' MRI scan to precisely localize the target area for stimulation (i.e. right pTr).
- Each participant received 10 daily stimulation treatments (10 consecutive days). The duration of each treatment was 20 minutes that included 1200 TMS pulses.

Statistical Analysis

- Weighted Statistics (WEST) and in particular the procedures "West-Trend" and "West-ROC" (one tailed) as suggested by Howard, Best and Nickels (2015) were applied. For the purposes of this study, those statistical procedures were conducted to evaluate a) the significance of treatment versus non-treatment (short-term effects of rTMS (Pre 1 – Pre 2 – Post 1) and b) the short-term vs long-term effects of rTMS (Pre 2 – Post 1 – Follow-up).

Results

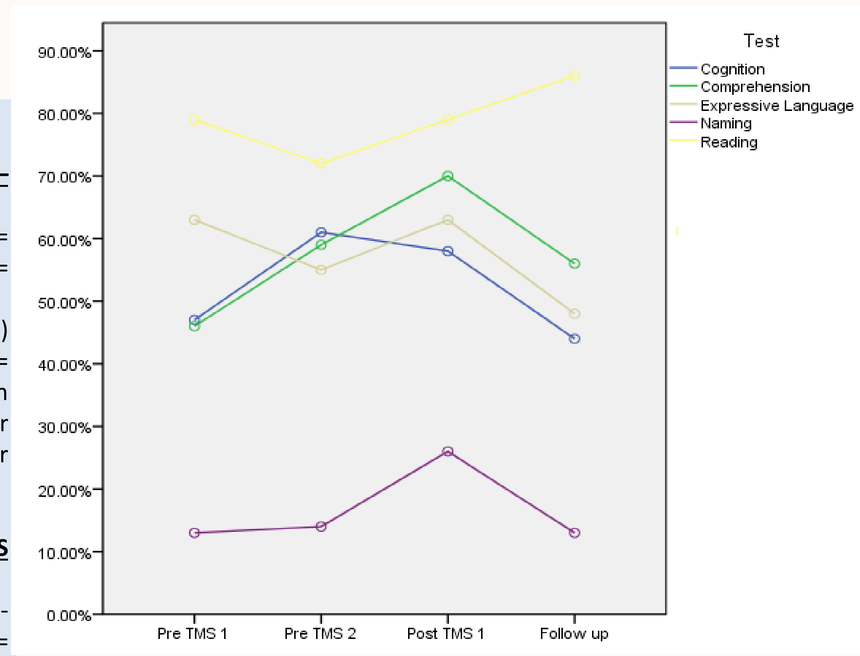
Participant 1 (72 year old female)

Short-term effects of 1 Hz rTMS (Pre 1 – Pre 2 – Post 1)

•No overall improvement in cognition (t(35) = 1.07, p = .14), expressive language (t(25) = 0, p = .50) and reading (t(28) = 0, p = .50).
• Overall improvement in comprehension (t(63) = 3.37, p < .001) and naming (t(33) = 2.31, p = 0.01), but the improvement was not higher in the treated versus the untreated period for either comprehension (t(63) = -.13, p = .55) or naming (t(25) = 1.09, p = .14).

Short-term vs. long-term effects of 1 Hz rTMS (Pre 2 – Post 1 – Follow-up)

•No overall improvement in cognition (t(35) = -2.23, p = .98), comprehension (t(63) = -.046, p = .67), expressive language (t(25) = -1, p = .83), naming (t(33) = -0.29, p = .61) and reading (t(28) = 1.44, p = .08).



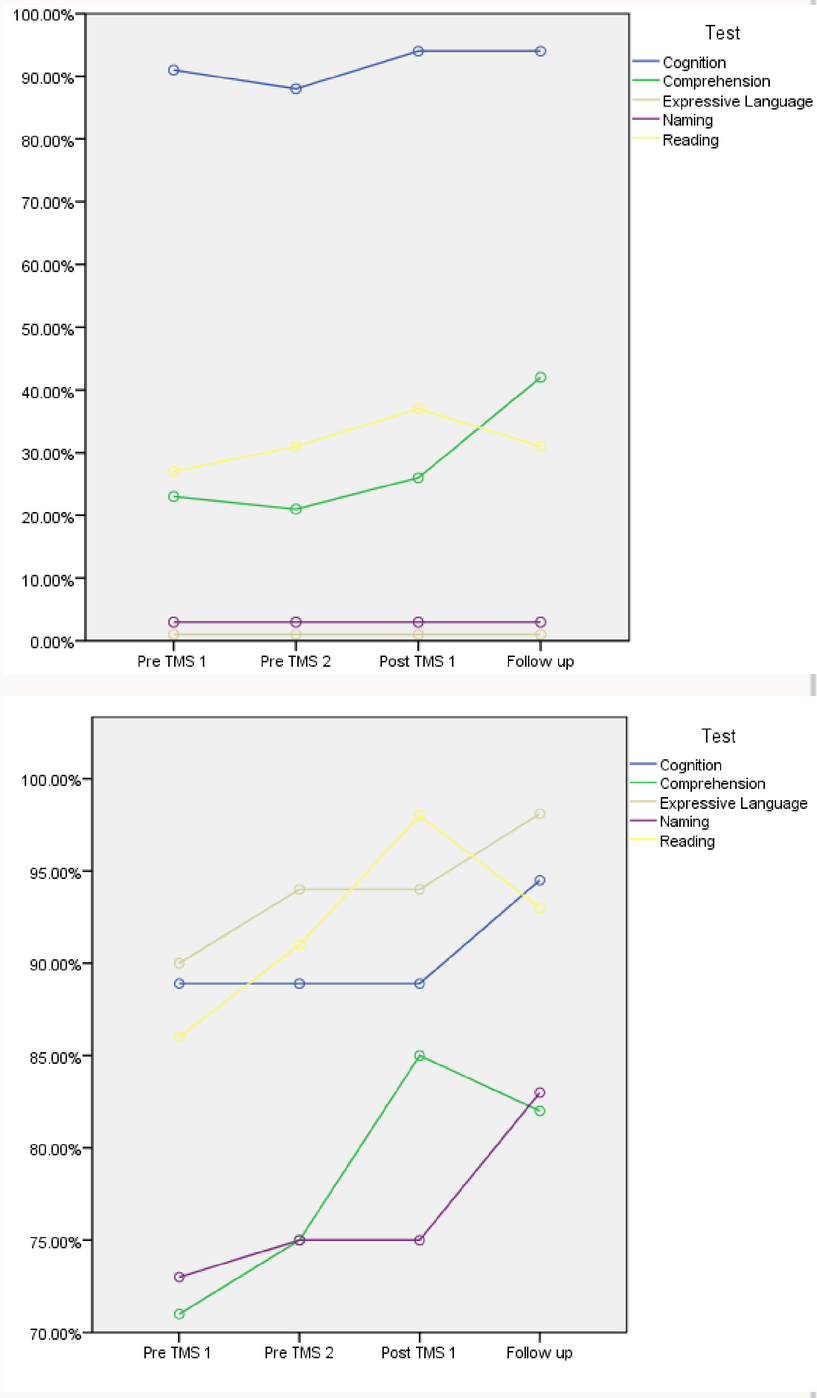
Participant 2 (55 year old male)

Short-term effects of 1 Hz rTMS (Pre 1 – Pre 2 – Post 1)

•No overall improvement in cognition (t(35) = 0.43, p = .33), comprehension (t(63) = 0.46, p = .32), expressive language, naming, and reading (t(28) = 1.36, p = .09).

Short-term vs. long-term effects of 1 Hz rTMS (Pre 2 – Post 1 – Follow-up)

•No overall improvement in cognition (t(35) = 1, p = .16), expressive language, naming, and reading (t(28) = 0, p = .50).
• Overall improvement in comprehension (t(63) = 2.72, p < .01), but this improvement was not higher in the follow-up stage compared to the short-term (t(63) = 1.15, p = .12).



Participant 3 (26 year old male)

Short-term effects of 1 Hz rTMS (Pre 1 – Pre 2 – Post 1)

•No overall improvement in cognition (t(35) = 0, p = 0.5), expressive language (t(25) = 0.70, p = .25) and naming (t(33) = 0.37, p =.35).
• Overall improvement in comprehension (t(63) = 2.60, p < .001) and reading (t(28) = 2.25, p = .02), but the improvement was not higher in the treated versus the untreated period for either comprehension (t(63) = 0.77, p = .21) or reading (t(28) = -0.15, p = .44).

Short-term vs. long-term effects of 1 Hz rTMS (Pre 2 – Post 1 – Follow-up)

•No overall improvement in cognition (problem solving skills) (t(35) = 1, p = .16), expressive language (t(25) = 1, p = .16), naming (t(33) = 1.49, p = .07) and reading (t(28) = .44, p = .33)
•Overall improvement in comprehension (t(63) = 1.69, p = .04), but this improvement was not higher in the follow-up stage compared to the short-term (t(63) = -1.58, p = .93).

Conclusion

Trends towards improvement in several language domains in the short- and/or long-term were exhibited by all 3 participants. This shows that TMS as a standalone treatment has potential to drive changes in language performance in chronic aphasia post-stroke. Regarding functional communication, the total number of narrative words showed a trend to increase post-treatment and 2 months post-treatment in participant 3 and; a trend to decrease in participant 1. Quality of life (QoL) did not significantly change as a result of the treatment in any of the participants. Weighted statistics is suitable for studies with small sample sizes, heterogeneous participants and does not exclude any participant from receiving treatment.

•Cappa, S. (2011). The neural basis of aphasia rehabilitation: Evidence from neuroimaging and neurostimulation. *Neuropsychological Rehabilitation, 21*(5), 742-754.
•Gagarina, N., Klop, D., Kunnari, S., Tantele, K., Välimaa, T., Balčiūnienė, I., ... Walters, J. (2012). *MAIN: Multilingual Assessment Instrument for Narratives* [Part I]/ Download materials to be used for assessment IIa) Pictorial stimuli; IIb) Adaption of MAIN in different languages: Guidelines for assessment; Protocols, Scoring Sheets for Cat, Dog, Baby Birds, Baby Goats; Background questions; Story scripts [Part II] (ZAS Papers in Linguistics 56). Berlin: ZAS.
•Heiss, W. D., & Thiel, A. (2016). Basic Principles of rTMS in Aphasia Treatment After Stroke. In T., Platz (Ed). *Therapeutic rTMS in Neurology. Principles, Evidence, and Practice Recommendations* (73-85). New York: Springer.
•Howard, D., Best, W., & Nickels, L. (2015). Optimising the design of intervention studies: critiques and ways forward. *Aphasiology*, *29*(5), 526-562.
•Kambanaros, M. (2004). *Verb and noun processing in late bilingual individuals with anomic aphasia* (Doctoral dissertation). Flinders University of South Australia, School of Medicine.
•Kartsona, A., & Hilari, K. (2007). Quality of life in aphasia: Greek adaptation of the stroke and aphasia quality of life scale-39 item (SAQOL-39). *Europa Medicophysica,* 43(1), 27-35.
•Messinis, L., Panagea, E., Papathanasopoulos, P., & Kastellakis, A. (2013). *Boston Diagnostic Aphasia Examination-Short Form in Greek Language.* Patras: Gotsis.
•Raven, J., Raven, J. C., & Court, J. H. (1998). *Manual for Raven's Progressive Matrices and Vocabulary Scales*. Section 2: The Coloured Progressive Matrices. San Antonio, TX: Harcourt Assessment.
•Simos, P. G., Sideridis, D. G., Protopapas, A., & Mouzaki, A. (2011). Psychometric evaluation of a receptive vocabulary test for Greek elementary students. *Assessment of Affective Intervention,* 37 (1), 34-49.
•Wassermann, E. M. (1998). Risk and safety of repetitive transcranial magnetic stimulation: report and suggested guidelines from the International Workshop on the Safety of Repetitive Transcranial Magnetic Stimulation, June 5-7, 1996. *Electroencephalography and Clinical Neurophysiology,* 108(1), 1-16.

Assessment of Post-Stroke Aphasia for Rehabilitation Research (ASPIRE) EXCELLENCE/1216/0517. The Project EXCELLENCE/1216/0517 is co-financed by the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation.

Contact : anastasios.georgiou@cut.ac.cy