



Transcranial direct current stimulation to treat aphasia: Longitudinal analysis of a randomized controlled trial



Post-stroke aphasia is a pervasive language disorder that affects communication and quality of life. Behavioral aphasia therapy is currently standard of care; however, in the chronic phase of recovery (>6 months post stroke), gains are often minimal. A number of studies have suggested that active transcranial direct current stimulation (A-tDCS) may improve treatment outcomes when coupled with behavioral aphasia therapy. However, many of these studies included small sample sizes or only single cases.

In the first randomized controlled trial of A-tDCS as adjuvant to behavioral aphasia treatment, using a futility design, our group showed that further study of A-tDCS to improve aphasia treatment outcome is warranted [1]. The trial was planned as a futility design, and the primary findings have been reported. However, as an exploratory follow-up analysis to the futility analyses reported in Fridriksson et al. we performed a one-sided, superiority analysis comparing the effect of A-tDCS to sham tDCS (S-tDCS) as adjuvant to aphasia treatment. Consistent with our initial tDCS studies [2,3], we hypothesized that aphasia treatment coupled with A-tDCS would result in greater improvement compared to when it was paired with S-tDCS. The outcome of treatment was based on improvement in treated (“Naming 80”) and untreated (Philadelphia Naming Test; PNT [4]) naming ability, a commonly impaired function across aphasia types. Participants (N = 74) were assigned to A-tDCS or S-tDCS while completing 15 sessions of behavioral naming treatment (45 minutes/session). Outcome measures were obtained at baseline, one, four, and 24 weeks post-treatment.

Here, we report results from a mixed effects model of the improvement for both the PNT and Naming 80, separately, adjusting for tDCS condition, time of post-treatment assessment (classification variable), tDCS condition x time, and baseline WAB-AQ. Improvement in naming was calculated by dividing pre-to-post treatment changes by the potential improvement at baseline (proportional improvement). Consistent with our one-sided futility hypothesis previously reported in Fridriksson et al. [1], we report one-tailed tests of ‘A-tDCS > S-tDCS’ with a significance level of 0.05. The main effect for the A-tDCS treatment was $p = 0.022$ for Naming 80 and $p = 0.042$ for PNT. There was no evidence of an

interaction of treatment over time. The Cohen's d 's (unadjusted mean difference/pooled standard deviation) for the treatment difference (A-tDCS vs. S-tDCS) were 0.48, 0.50, 0.40 for Naming 80 and 0.41, 0.35, 0.41 for the PNT at one, four, and 24 weeks post-treatment, respectively (Fig. 1).

In general, the results from these analyses are consistent with what other studies have found [2,3,5–8]: A-tDCS applied to the left hemisphere during aphasia treatment improves outcome. In spite of these promising results, further trials are needed to verify the effects revealed here and to identify other crucial treatment aspects such as electrode placement, optimal dosage, more ecologically valid treatment and outcome measures, as well as cortical stimulation targets that yield the best outcome. It is also important to point out that the effect sizes reported here pertain to the difference between the experimental condition, A-tDCS, over the control condition, S-tDCS, and not the actual effect of the aphasia treatment. The magnitude of these effect sizes ranged from small to medium, suggesting that if these effects generalize to other kinds of aphasia treatment, it could mean that adjuvant A-tDCS adds considerable enhancement of outcome. As we discussed in Fridriksson et al. [1], the aphasia treatment task utilized in the current trial was not selected because we thought it represented optimal aphasia treatment. Rather, it was chosen to ensure tight experimental control across the experimental and control conditions. Nevertheless, the treatment task included the basic elements of impairment-based aphasia treatment – stimulus, response, and contingency – suggesting its outcome, while perhaps smaller in magnitude, mirrors that of other more traditional treatment approaches [9–11]. More research is necessary to test whether A-tDCS improves overall aphasia severity, functional recovery, or aphasia-related quality of life.

In conclusion, aphasia therapy accompanied by A-tDCS may improve outcome in those with chronic aphasia, compared to those who receive S-tDCS. In a population that tends to make minimal post-treatment gains in the chronic stage of recovery, the addition of tDCS to behavioral therapy has the potential to improve the efficiency and efficacy of the clinical management of aphasia, although further research is needed to confirm these findings.

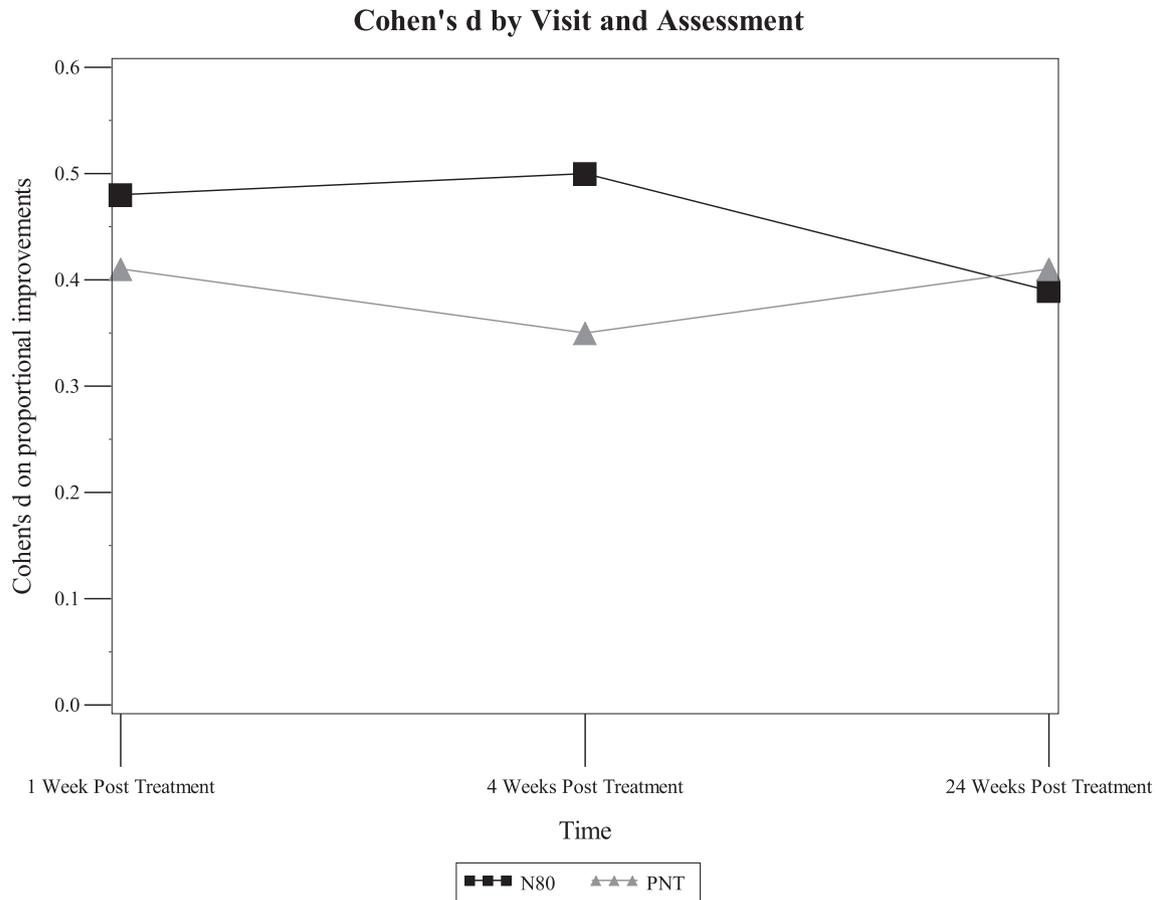


Fig. 1. Effect sizes (Cohen's d) by visit and assessment for proportional improvement on the two naming tests that comprised the outcome factor. The lines represent effect sizes for the Naming 80 (N80; trained items) and PNT (untrained items) across the three post-treatment assessment timepoints.

References

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