Increased Functional Connectivity Within Intrinsic Neural Networks in Chronic Stroke Following Treatment with Red/Near-Infrared Transcranial Photobiomodulation: Case Series with Improved Naming in Aphasia

Margaret A. Naeser, Michael D. Ho, Paula I. Martin, Michael R. Hamblin, and Bang-Bon Koo

Published Online: 12 Feb 2020 https://doi.org/10.1089/photob.2019.4630

Abstract

Objective: To examine effects of four different transcranial, red/near-infrared (NIR), light-emitting diode (tLED) protocols on naming ability in persons with aphasia (PWA) due to left hemisphere (LH) stroke. This is the first study to report beneficial effects from tLED therapy in *chronic* stroke, and parallel changes on functional magnetic resonance imaging (fMRI).

Materials and methods: Six PWA, 2–18 years post-stroke, in whom 18 tLED treatments were applied (3 × /week, 6 weeks) using LED cluster heads: 500 mW, red (633 nm) and NIR (870 nm), 22.48 cm^2, 22.2 mW/cm^2.

Key words: Aphasia treatment, stroke, default mode network, functional connectivity, PBM and fMRI

Results: After Protocol A with bilateral LED placements, including midline, at scalp vertex over left and right supplementary motor areas (L and R SMAs), picture naming was not improved. P1 underwent pre-/postovert, picture-naming *task-fMRI* scans; P2 could not. After Protocol A, P1 showed increased activation in LH and right hemisphere, including L and R SMAs. After Protocol B with LEDs *only* on ipsilesional, LH side, naming ability significantly improved for P1 and P2; the fMRI scans for P1 then showed activation *only* on the ipsilesional LH side. After Protocol C with LED placements on ipsilesional LH side, plus *one midline placement* over mesial prefrontal cortex (mPFC) at front hairline, a cortical node of the default mode network (DMN), P3 and P4 had only moderate/poor response, and no increase in functional connectivity on resting-state functional-connectivity MRI. After Protocol D, however, with LED placements on ipsilesional LH side, plus over *two midline nodes of DMN*, mPFC, and precuneus (high parietal) *simultaneously*, P5 and P6 each had good response with significant increase in functional connectivity within DMN, $p < 0.0005$; salience network, $p < 0.0005$; and central executive network, $p < 0.05$.

Conclusions: NIR photons can affect surface brain cortex areas subjacent to where LEDs are applied on the scalp. Improved naming ability was present with optimal Protocol D. Transcranial photobiomodulation may be an additional noninvasive therapy for stroke.