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Editorial

Brain Photobiomodulation – Preliminary Results from Regional Cerebral Oximetry and Thermal Imaging

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Abstract: A new equipment for LED (light emitting diode) brain photobiomodulation is introduced. Preliminary results from regional cerebral oxygen saturation and from thermography are shown before, during and after stimulation. The procedure offers a new way to quantify biological effects of a possible innovative therapeutically method. However further measurements are absolutely necessary.

Keywords: Photobiomodulation; brain; LED (light emitting diode) stimulation; light therapy; wavelength; stroke; dementia; mental diseases; regional cerebral oxygen saturation; thermal imaging; LED helmet

Brain photobiomodulation (PBM) with red to near-infrared (NIR) light emitting diodes (LED) could maybe an innovative therapy for a variety of neurological and psychological disorders [1]. Red/NIR light can stimulate mitochondrial respiratory chain complex IV (cytochrome c oxidase) and increase ATP (adenosintriphosphat) synthesis [1-3]. In addition, light absorption by ion channels leads to the release of Ca2+ and to the activation of transcription factors and gene expression [1]. Brain PBM therapy could improve the metabolic capacity of neurons and is able to stimulate anti-inflammatory, anti-apoptotic and antioxidant responses, as well as neurogenesis and synaptogenesis [1]. Findings support that PBM may enhance for example frontal brain functions of older adults in a safe and cost-effective manner [4].

This article will introduce a new LED equipment (Figure 1) for brain photobiomodulation including preliminary results from near infrared spectroscopic measurements and thermal imaging.

Figure 1. First measurement with the innovative LED (light emitting diode) photobiomodulation helmet (prototype from Suyzeko (Shenzhen Guangyang Zhongkang Technology Limited / China)) at the TCM (Traditional Chinese Medicine) Research Center at the Medical University of Graz, Austria, Europe performed at December 25, 2018.

First promising basic and clinical trials concerning brain photobiomodulation have already been scientifically proven, however there is currently still a lack of useful devices for therapeutic procedures [1-8]. Suyzeko (Shenzhen Guangyang Zhongkang Technology Limited, China) has developed a prototype of such an innovative device. At the TCM Research Center (chairman: Gerhard Litscher) of the Medical University of Graz first test measurements were carried out with this construction (Figure 1). Preliminary data of this pilot measurement are presented here.

The equipment is currently based on infrared LED using a wavelength of 810 nm. This wavelength has to be proven recently (2018) to be one of the best for transcranial laser/light stimulation [9]. The results are confirmed by measurements performed from our research team [5-8,10].

For the new stimulation helmet altogether 256 LED with a wavelength of 810 nm have been used (Figure 2). The investigations were performed with all LEDs (n=256) in an active mode (60 mW one LED; 24 mW/cm^2; ~ 15 W total helmet). Duration of the stimulation was 15 min. Figure 2 also shows the light transmission for a human skull (middle and right side). Further calculations for the transmission factor see previous publications [6-11].

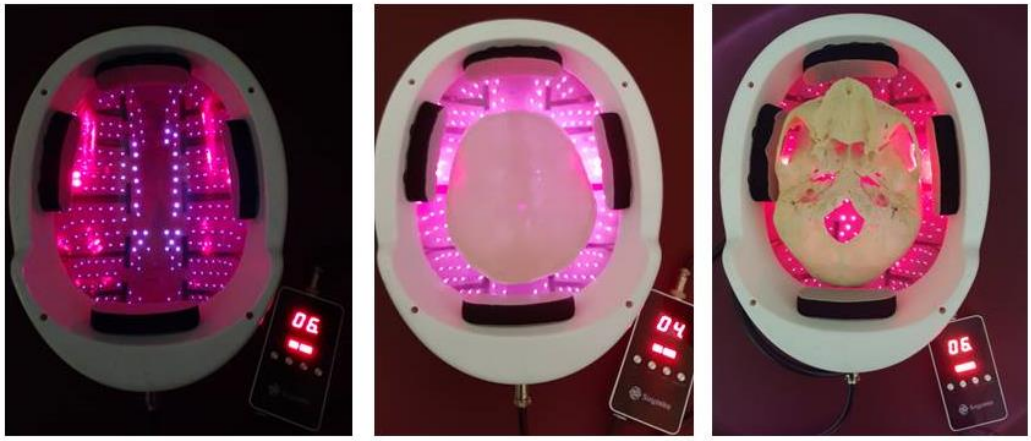

Figure 2. Helmet from Suyzeko (Shenzhen, China) for possible brain photobiomodulation therapy (January 3, 2019).

The measurements of the changes of the regional cerebral oxygen saturation (rSO_2) were performed using an INVOS 5100C Oximeter (Somanetics Corp., Troy, USA) instrument. Near infrared spectroscopy is a noninvasive method for measuring rSO_2 through the intact skull, which has been applied successfully in medical basic research and clinical indications for many years [6]. Near-infrared light (730 and 805 nm) is emitted through the skin and after passing different kinds of tissue (skin and bone) the returned light is detected at two distances from the light source (3 and 4 cm). Based upon this principle, the spectral absorption of blood in deeper structures (2–4 cm) can be determined and defined as rSO_2 [5,12]. The sensors were applied in the frontal area on the right and left side of the brain of the healthy volunteer (see Figure 1). To minimize external light influence, the head in this area was covered with an elastic band during the recording and stimulation procedure. After a resting time of 20 minutes, the LED stimulation was switched on. The results of the three sections (before (20 min), during (15 min), and after (20 min) stimulation) are indicated in Figure 3. Note the significant increase in rSO_2 (left and right side) during and still after transcranial LED stimulation.

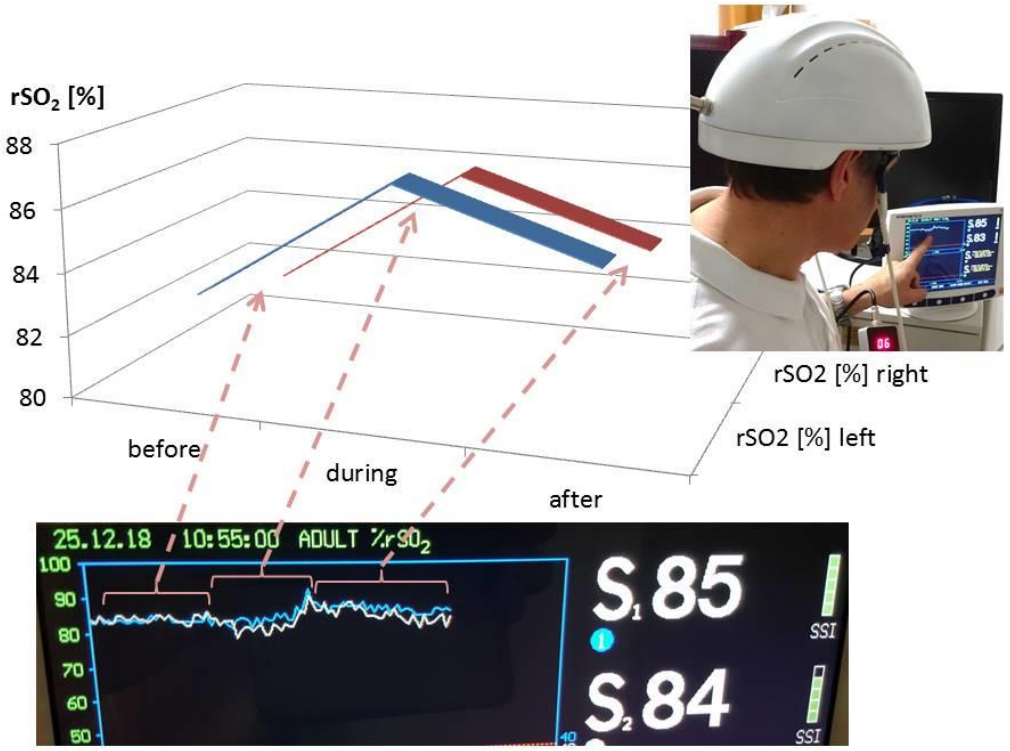

Figure 3. Results of the first pilot measurement with the LED stimulation helmet from Suyzeko (Shenzhen, China). Note the increase in the reginal cerebral oxygen saturation during and after stimulation on the left and right side).

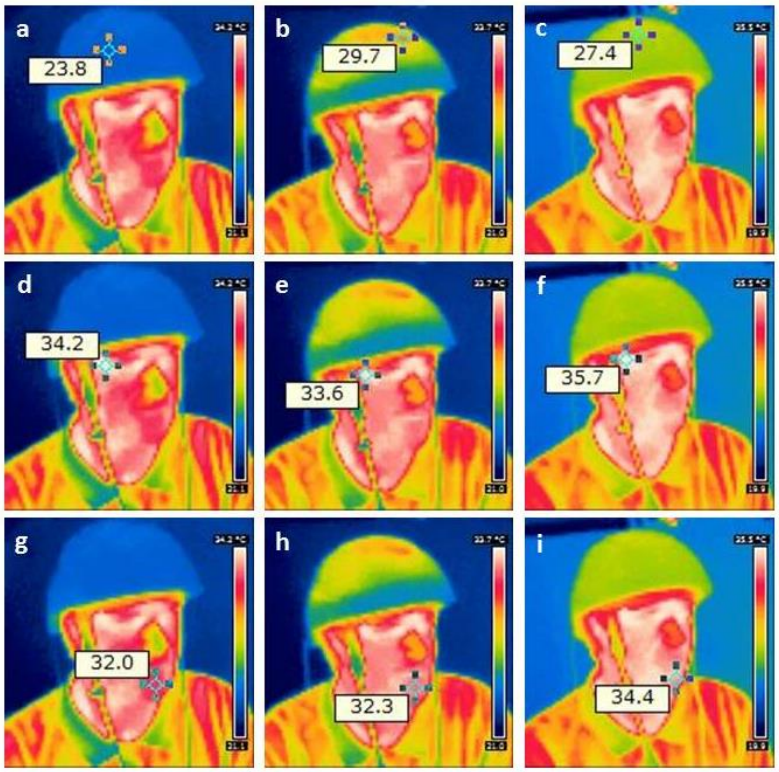

Figure 4. Results from thermal imaging of the first pilot measurement using the new stimulation helmet. Note the increase in temperature on the helmet (upper row; a before, b during, and c after stimulation) on the forehead (middle row; d – f) and on the chin (lower row; g -i).

PBM therapy was developed more than 50 years ago, however there is still no common agreement on the parameters and protocols for its clinical application. Some research teams have recommended the use of a power density less than 100 mW/cm^2 and an energy density of 4 to 10 J/cm^2 [11]. Others groups recommend as much as 50 J/cm^2 at the tissue surface [11]. The parameters like wavelength, energy, fluence, power, irradiance, pulse mode, treatment duration, and repetition rate can be applied in a wide range. Our present preliminary results showed a clear response of cerebral rSO_2 in relation to the LED stimulation. However it has to be mentioned that the temperature increases significantly and these effects have to be taken into account in further studies in detail. There is also the fact that ineffective studies in cells with high mitochondrial activity appeared to be more often due to over-dosing than to under-dosing [11]. Therefore clinical studies concerning the optimal stimulation doses are necessary.

Anyway, the preliminary results are very promising however on must certainly invest further research work in order to be able to use for example this new kind of PBM as a therapeutic method.

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Conflicts of Interest: The author declares no conflict of interest.

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