Photobiomodulation or Red Low Level Laser Therapy in Nonverbal Autistic Non-Compliant Youth with Directed Hemispheric Stimulation to Encourage Speech: A Case Study

Heather Gioia, MS, Melillo Certified

Abstract

Background:
As of 2023 developmental disabilities were reported in 17% of children by the Center for Disease Control and Prevention (1). High on that list of developmental disabilities were those diagnosed with Autism Spectrum Disorders (Autism) and those statistics have been steadily increasing with few therapeutic options for gaining lifelong skills and functional recovery. In 2000, Autism rates reported were 1 out of every 150 children; in 2018 rates reported were 1 in every 44 children; most recently in 2023 rates reported were 1 in every 36 children. Photobiomodulation or Red-Low-Level-Laser Therapy is postulated to aid in integration of primitive reflexes and boost overall communication, specifically verbal speech.

Methods:
Case study of a 4-year-old male diagnosed with Autism, non-verbal, and non-compliant whose parents were open to Photobiomodulation (PBM) or Red Low-Level-Laser-Therapy (Red LLLT), as a means to aid in recovering function.

Results:
The child was compliant to Red LLLT on a once weekly basis. Review after 12 weeks of Red LLLT showed improvements in both non-verbal and verbal autonomy, verbal dialogue, compliance, eye contact, behavior, academic behavior, transitions, sensory issues, personal dressing skills, cleaning up after himself, family integration, social skills, desire for interaction, independence in getting needs met, affection, and reduction of aggression and outbursts.

Conclusion:
Utilizing the non-invasive method of Red LLLT shows great promise in aiding overall improvement in those diagnosed with Autism.

Keywords:
Autism, Non-verbal Autism, Non-Compliant, Photobiomodulation, Red Low Level Laser Therapy, Functional Neurology, Childhood Neurodevelopmental Disorders, Primitive Reflexes, Melillo Method, Functional Disconnection

Introduction:

Center for Disease Control and Prevention reported the prevalence of Autism Spectrum Disorders (Autism) in 2023 in the United States is 1 in 36 children, up from 1 in 44 (1). Autism affects more than four times as many boys as it does girls. In the United states, 4 in every 100 boys born today will be diagnosed with Autism before the age of 3 and 1 in every 100 girls. Autism affects many areas of development and often is seen with an array of common symptoms including delayed speech, reduced, or even non-verbal communication. According to Dr. Melillo (2), a 1-year-old should be able to speak 3-5 words; an 18 month old should be able to speak 5-10 words; 2-year-old should be able to speak in 2 word meaningful sentences and be able to follow simple commands; a 3-year-old should be able to speak in 3-4 word sentences and have a vocabulary of about 1000 words; a 4-year-old should be able to speak in 4-5 word sentences and have a vocabulary of about 1500 words. American Pediatric Academy asserts a 2-year-old should be able to use two words together and a 3-year-old should be able to tell stories in 2-3 sentences (3). The U.S. Department of Health and Human Services reported statistical trends asserting those with Autism are not receiving needed care, though the earlier they start adjunct intervention the better long-term outcomes expected for those diagnosed (4). Youth X came to me as a 4-year-old with a vocabulary of 32 non-dialogue, but verbal words, according to his mother.

As Autism cases have increased at a significant rate such that diagnosis categories containing criteria for different levels of Autism exist, there has yet to be a concise reporting of those with Autism who are verbal versus non-verbal or minimally verbal. In 2015, Norrelgen et al (5) designed a study to best understand the percentages of these sub-categories and found, in a small-scale study, the proportion of children who met the criteria for nonverbal, minimally verbal, and phrase speech were 15%, 10%, and 75%, respectively. Based on these figures and the most current data for diagnosis, 1 out of every 100 boys may be diagnosed as nonverbal or minimally verbal Autistic. Deficits in compliant behavior is part of the DSM IV criteria. It is then easy to extrapolate that intervention plans should expect to have deficits in compliance.

Robert Melillo (6) asserts neurobehavioral disorders, such as Autism, are a result of imbalances and immature cortical development largely correlated with unintegrated primitive reflexes and are primarily the result of environmental and epigenetic factors that are tractable to change. However, when a child is defiant and unwilling to cooperate with primitive reflex integration exercises or a continuous protocol of hemispheric integration, can Red LLLT alone affect appropriate change in cortical networks across the range of expected results previously achieved through movement and hemispheric stimulation?

Melillo et al (7) supports the notion that the inhibition of retained primitive reflexes positively affects cognition and motor function in the interregional brain functional disconnectivity and maturational delays of the immature brain networks noted in Autism. Flavell et al (8) acknowledge synaptic activity within the brain are effected by sensory experience and become critical for development of neural circuits. The resulting experience-driven synaptic activity effects membrane depolarization, calcium influx into select neurons within neural circuits, various cellular changes that lead to integrating primitive reflexes and altering their relationship to delayed cortical maturation. This case study looks at the potential of altering and/or effecting synaptic activity, neural networks, cellular change and ultimately maturation of cortical networks leading to reduction of Autistic symptoms through Red LLLT since directed hemispheric movement is unattainable in the non-compliant group of those diagnosed with Autism. Normal process of cortical maturity through movement results in inhibition of primitive reflexes, which increases long range connections and the size of the corpus callosum, resulting in reduction of functional disconnection syndrome. However, if the child cannot affect change through movement alone, can we access these beneficial neural changes with Red LLLT?

Smaller, underactive brain regions have been noted to represent delays in development in areas of the brain in neurobehavioral disorders, such as Autism, Melillo et al (7). Synchronized oscillations play a role in stabilizing and pruning connections effecting functional and anatomical asymmetries and imbalances noted by Melillo et al (7). Hamblin (9) reported two independent studies with transcranial photobiomodulation (tPBM) using Red LLLT to stimulate synaptogenesis and neuroplasticity wherein which both studies yielded positive results and findings in categories measured specifically in those with Autism, ultimately suggesting further studies should be conducted on the benefits of Red LLLT through tPBM. Salehpour et al (10) reports that tPBM aids in: increased synaptogenesis, increased angiogenesis, increase blood flow, anti-inflammation, anti-apoptosis, increased neuron progenitor cells, increased antioxidants SOD, increased neutrophins, and reduced neuron excitotoxicity. Furthermore, Red light stimulates complex IV of the mitochondrial respiratory chain and increases ATP synthesis (Figure 1). Salehpour et al (10) has scoured the benefits of varying tPBM and reported the positive expectations for those diagnosed with Autism. The authors of those studies concluded clinical and even home-based PBM therapy with laser will yield to be a leader in the field of neurorehabilitation (Figure 2). Hamilton et al (11) explored PBM as an effective therapeutic tool for those diagnosed with Autism and found it to be a safe and ideal option requiring further exploration (Figure 3). Estrada-Rojas et al (12) conducted a study using tPBM along with speech therapy and concluded that tPBM enhanced speech rate, utterance length and increased complex grammatical structure.

Methods:

A 4-year-old male entered a Functional Recovery practice to access the Melillo Method in order to overcome symptoms that are categorized as a diagnosis of Autism, especially non-functioning speech. The child's history that was offered by the mother was reviewed prior to the first session. The child was non-compliant with checking for primitive reflexes, hemispheric weakness, visual, auditory, vestibular or any other form of notable asymmetry. He also was non-compliant for any method of sensory tools that could be used to direct hemispheric stimulation to benefit his system that required constant stimulation or to be left on him. He was non-complaint with any level of rehabilitation on his own or at home by his parents. Both parents consented for their child to participate as a case study for future research.

Client history reported:
The pediatric client is a 4-year-old male, birthed with complications of chorioamnionitis that was caught immediately and treated successfully. The client lost eye contact within months, he has never spoken clearly though was able to babble around 9 months of age through 15 months of age when that abated. During that time, he did non-specifically babble mama and dada. His motor skills have been average to advanced, being able to crawl, sit, pull, stand, and walk at age appropriate targets. He has yet to stay dry at night or successfully actuate toilet mastery. He has been seen by multiple doctors and specialists to assess the following systems: vision, auditory, vestibular, immune, neurology, and genetic. He has also seen the following specialists: speech and language, physical therapy, and occupational therapy. He had tubes placed in his ears at age 3. Currently, he is in part-time special education program. He also has a 2-year-old sibling in the home.

Parents are concerned with lack of speech, relationship with sibling and family, relationship with peers, emotional health, behavior, and physical health. He has not reached functional communication or exceeded in communication since the time around 15-17 months where his communication dropped off. Mom reports his affect as active, irritable, hypersensitive, withdrawn, and difficult. While his language and social development are reportedly slow, his motor development and mental development (ability to do puzzles, problem solve, count, understand concepts) is advanced. Aside from speech, some of the more concerning matters include his inability to have his needs met and feel connected in his world.

Parents filled out a function checklist on behalf of their son. The following are issues noted on the forms: Difficulty remaining still (may actively seek movement such as spinning and/or rocking); hypersensitive to sounds, inability to sing in tune; hesitant and limited speech; mild light sensitivity; constant fidgeting and moving; perseverates on thoughts, events, desires, or sounds; problem identifying body parts in space; bumps into things often; dislikes being touched; does not like to wear clothes on arms, legs, or around house; hates tags on clothes; never sniffs; extremely picky eater and avoids foods based on presentation; often has troubles with constipation; and chews on things occasionally. They report he is a sweet boy, but he is unable to even gesture what he wants. He often screams, kicks, hits, and bites. He has no volume control and often is loud even when he is not mad. He lacks perception in his strength and can’t control how hard he hits, wiggles, or hurts when climbing on people.

His parents also filled out a childhood hemispheric dominance profile form that suggests a right hemisphere deficiency profile. This correlates with Dr. Robert Melillo’s Method findings such that the profile of the brain with Autism is a left hemisphere dominance and right hemisphere deficiency (2).

Upon initial examination it became clear that non-compliance was going to overrule any direct assessment so observation and quick points of obtaining information was all that was accessible as a means of measurement. Rooting reflex observed on the left side of the face +3; plantar grasp and plantar reflex were noticed equally in both feet at +3. At the 7th session, and only at this time, the spinal galant reflex was noticed +2 and seemed to integrate during the session. No other reflexes were able to be tested at this time or throughout this 12-week study.

Due to parents' desire to improve their son's abilities it was decided to focus the hourly sessions once a week to offer Red LLLT or PBM and any other tools that Youth X would allow. Avant LZ30-Z Red laser 637 nm with 1000mw was used once a week in the one-hour session. Each session always included using Red LLLT starting at 21 minutes in the first session and working up to between 30 and 33 minutes from the seventh session on through the twelfth session. Areas of the brain or body that may have received Red LLLT included: all three sections of the brainstem, vagus nerve (accessed through the neck), each lobe (prefrontal, frontal, both temporal, both parietal, occipital), cerebellum, motor and sensory strips, and each hemisphere. Each session included 2-5 minutes of the Rezzimax scraping over the spine, under each foot, and along the left arm and leg. Most sessions included Metrotimer app offering light and sound into the left ear at 54 hertz calibrated to the note "C" from 10-60 seconds total. Sometimes the use of simultaneous light and sound included tapping his feet or hands to the beat, per his tolerance. Each session included trying to spin Youth X slow to left 10 times and fast to the right 10 times. Spinning was not consistent week-to-week depending on his compliance. Each session included 10-60 seconds of mild electrical stimulation with a SCENAR on the left side of the body (direct contact to some or all the following: feet, hands, arms, legs, left side of back and/or over the head) as tolerated.

Results:

According to reports from the mother, nanny, and school aids Youth X showed improvement from the first day of treatment and has continued to make significant leaps of improvement weekly, if not daily. During session one he named the colors red, orange, green, yellow, blue, pink, and said "all done". These were all new words to be verbalized by him. Mom reported a "language explosion" the first 24 hours following the first session. After session one he spelled out "BINGO" in response to having heard the song with his nanny. Previously he had not written a word. The penmanship was advanced for a 4-year-old. Only in sessions 1 & 2 did he inappropriately put toys in his mouth. This behavior started to diminish. After the second session, Youth X started to make associations with words as they relate to himself, such as "my daddy" and "my show". He also started to make emotional connections by using words like "snuggle". He also started to make more connections with his younger sibling, including snuggling next to her as she slept and falling asleep next to her, as mom wrote, "because he cares about her". His play with his younger sibling started to change and be more inclusive and helpful, instead of oppositional and aggravated. He acknowledged that he was proud of himself and in response to praise he gave a big hug. Three-syllable words also started to occur after the second session. A teacher from school sent a video of him sorting colored shapes and using the proper words as he sorted and stacked them correctly.

Parents are incredibly involved in Youth Xs progress. As each new issue presented itself, they always met him with a positive solution. Youth X shows incredible resolve in solutioning problems to help him get his needs met. Behaviors have shifted to less negative and much more positive and inclusive over this 12-week study. After session 3 he found himself enclosed in a room with his younger sibling and bit her arm (hickey-style) so she would yell for an adult because he was hungry. The parents ordered him a push-button to call should he find himself in a similar situation.

After the third week the parents began reporting 3 and 4-word sentences starting to peak through. Parents offered Youth X a prize at the store if he could state the name of the prize. He was able to communicate back in dialogue with the correct name of the toy (after week 12 parents sent me a photo of him having this toy hug another toy showing understanding of care between two objects).

After the fourth week he started acknowledging his schedule. When bath time was late he went to the other parent to get started and said “go wash shower”. After the fifth session he spilled liquid on the table and wiped it up with baby wipes. He previously only caused messes and never offered to clean up on his own or help. At this point, sessions in the office no longer included Youth X yelling or batting tools away from him. If he didn’t prefer a therapeutic intervention or tool he simply moved away instead. He also started referring to himself in praise, “you did it, yay!” when playing by himself. After the sixth session he started asking to snuggle, “I snuggle”. He also started to try to dress himself, putting on his own shoes and socks. He started counting into the teens and clearly using the letters “L” and “C”. He started saying 5-syllable words like “hippopotamus”. He also started making the sound of music to communicate the show he wanted to watch. At the end of session seven he no longer displayed meltdowns to leave and was noticeably more compliant. Mom reports he is excited when he gets to the sidewalk in front of the office and knows he is coming for another session. At the end of session eight he allowed the practitioner to take off his shoes and socks and put them on to leave. He cleaned up his toys and zipped them up. He said, “good job” and “goodbye”. In school the following week he wanted to play "xylophone” and said that word to the teachers.

After session nine Mom stated that he is becoming more independent, making more eye contact, getting better at transitions, and is overall more compliant (including dressing himself being nearly able to put on his own shirt). He started to leave sessions happily. He also was using his own name while playing during the session. After session ten Youth X offered a huge hug to the practitioner. Mom stated he started using 4 sentence words “what shape is this”, she said “he seems more like he is living in a world within the world instead of being controlled by the world”. She continues to see huge gains. His mom reported that he engaged in play with his sister, sharing, responding to commands within the home and properly commenting with dialogue such as, mom said, “please get off of the table”. He replied with, “don’t want to”. Mom says, “you have to”, so he did. He also started to get more expressive after session ten. He offered his mom spontaneous kisses and hugs and expressed deep cries. He also called his mom, “mommy” for the first time and said, “I love you” to her! His nanny had been gone for the past 4 weeks and was surprised with the level of change in him over that short period of time. The pediatrician even noticed a difference within the past month.

When we started this study, Youth X was just starting school as it was the end of August. He was having issues with transitions, being on the bus, staying clothed on the bus, and getting off the bus. The day before the third session he got on and off the bus with no issue. After the tenth session he put on a backpack (new to him as he previously did not like a backpack for sensory issues) and happily awaited the bus with excitement for the upcoming ride to school. After the eleventh session not only was he excited to enter the building for therapy, he expressed emotions when it was time to leave. Mom reported “he cried on the way to the car at the end of the session as he was sad to leave”. His ability to experience and express emotions is not only developing, but improving quickly. He was able to recover from his sadness quickly and recalibrate according to his mom. Later that evening he was put in a time out and met his mom’s eyes through a crack in the door and said, “come here”. The next day he said his first sentence relating to his environment, “it’s a bus!”. He started to initiate play by tickling his mom for the first time. He also showed interest in using the potty appropriately. After session twelve he said “good-bye” to me when I said “good-bye” to him, developing his ability to dialogue. When he left, he told his mom to “stop” the car while she was driving and to be “careful” appropriately. He told her he wanted to eat a “hot dog” and when he got home, he sat down and started reading the book, Brown Bear. He read every word correctly. He had never indicated the ability to read, but he knew all of the animals and their colors, and his mom was convinced he knew the book well enough to read it. Mom also reports that his smile is bigger!

Limitations and future research:
This case study is the observation of one child. It seems reasonable to have a larger population to study. This child has two highly intellectual and academic parents with multiple advanced degrees. It is likely he has a greater IQ potential than other children who may be in the same category. Understanding the potential and limits of intellectual capacity may play a role in the potential gains of recovery using any modality, even photobiomodulation. Measurements for daily life functions could be helpful to score and/or assess in every category of gains for better understanding of potential opportunities with Red LLLT or PBM therapeutically.

Conclusion:
Utilizing non-invasive methods such as Red LLLT or Photobiomodulation and directed hemispheric stimulation to help integrate retained primitive reflexes and boost the weaker hemisphere seems to have the potential to benefit those diagnosed with Autism with limited-to-no verbal skills even if they are not able to be compliant with any therapeutic activities. The benefits of Red LLLT were seen in nearly every measurable category of daily life functions. Future research should investigate more in-depth measurements and outcomes of areas of gains noticed within this case study.

References

1. Centers for Disease Control and Prevention. (2023, April 4). *Data and statistics on Autism Spectrum Disorder.* Centers for Disease Control and Prevention. Retrieved November 13, 2023, from https://www.cdc.gov/ncbddd/autism/data.html

2. Melillo R. *Disconnected Kids*. Penguin Group; 2009.

3. Child developmental milestones - aapdc.org. Child Developmental Milestones. January 2014. Accessed November 18, 2023. https://www.aapdc.org/wp-content/uploads/2014/01/Early-Stages-Milestones-EN-2011.pdf.

4. Increase the proportion of children with autism spectrum disorder who receive special services by age 4 years - mich-18. Increase the proportion of children with autism spectrum disorder who receive special services by age 4 years - MICH-18 - Healthy People 2030. 2021. Accessed November 18, 2023. https://health.gov/healthypeople/objectives-and-data/browse-objectives/children/increase-proportion-children-autism-spectrum-disorder-who-receive-special-services-age-4-years-mich-18.

5. Norrelgen F;Fernell E;Eriksson M;Hedvall Å;Persson C;Sjölin M;Gillberg C;Kjellmer L; Children with autism spectrum disorders who do not develop phrase speech in the preschool years. Autism : the international journal of research and practice. November 2015. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/25488002/.

6. Melillo, R. Primitive reflexes and their relationship to delayed cortical maturation, under connectivity and functional disconnection in childhood neurobehavioral disorders. *Nova Science Publishers, Inc.*2011; vol 1(Issue 2).

7. Melillo R;Leisman G;Machado C;Machado-Ferrer Y;Chinchilla-Acosta M;Kamgang S;Melillo T;Carmeli E; Retained primitive reflexes and potential for intervention in autistic spectrum disorders. Frontiers in neurology. July 7, 2022. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/35873782/.

8. Flavell SW, Greenberg, ME. Signaling mechanisms linking neuronal activity to gene expression and plasticity of the nervous system. Annual review of neuroscience. 2008. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/18558867/.

9. Hamblin MR. Could photobiomodulation treat autism spectrum disorder? Photobiomodulation, photomedicine, and laser surgery. June 14, 2022. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/35613405/.

10. Salehpour F;Mahmoudi J;Kamari F;Sadigh-Eteghad S;Rasta SH;Hamblin MR; Brain Photobiomodulation therapy: A narrative review. Molecular neurobiology. August 2018. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/29327206/.

11. Hamilton C;Liebert A;Pang V;Magistretti P;Mitrofanis J; Lights on for autism: Exploring photobiomodulation as an effective therapeutic option. Neurology international. October 27, 2022. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/36412693/.

12. Estrada-Rojas K,Ortiz NPC. Increased improvement in speech-language skills after transcranial photobiomodulation plus speech-language therapy, compared to speech-language therapy alone: Case report with aphasia. Photobiomodulation, photomedicine, and laser surgery. May 2023. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/36999917/.

Figures

Figure 1.

1. Salehpour F;Mahmoudi J;Kamari F;Sadigh-Eteghad S;Rasta SH;Hamblin MR; Brain Photobiomodulation therapy: A narrative review. Molecular neurobiology. August 2018. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/29327206/.

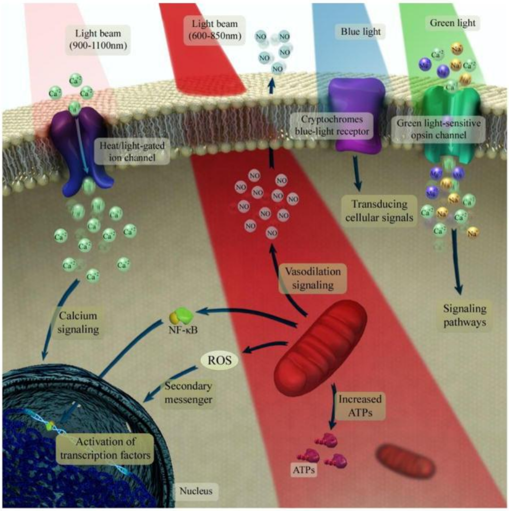

Figure 1. Photobiomodulation underlying mechanisms at the cellular and molecular levels. Light at 600-850 nm is absorbed by the mitochondrial electron transfer chain and leads to upregulation of the neuronal respiratory capacity. The near-infrared light at range of 900-1100 nm is absorbed by structural water clusters formed in or on heat/light-gated ion channels. An increase in vibrational energy of water cluster leads to perturb the protein structure and opening the channel which ultimately allows modulation of intracellular Ca +2 levels. The absorption of green light by neuronal opsin photoreceptors (OPN2-5) activates transient receptor potential

channels which causes non-selective permeabilization to Ca^{2+}, Na^{+} and Mg^{2+}. The cryptochromes (a class of flavoprotein blue-light signaling receptors) absorb blue light and seems to activate the transducing cellular signals via part of the optic nerve to the suprachiasmatic nucleus in the brain, which is important in regulation of the circadian clock.

Figure 2.

2. Salehpour F;Mahmoudi J;Kamari F;Sadigh-Eteghad S;Rasta SH;Hamblin MR; Brain Photobiomodulation therapy: A narrative review. Molecular neurobiology. August 2018. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/29327206/.

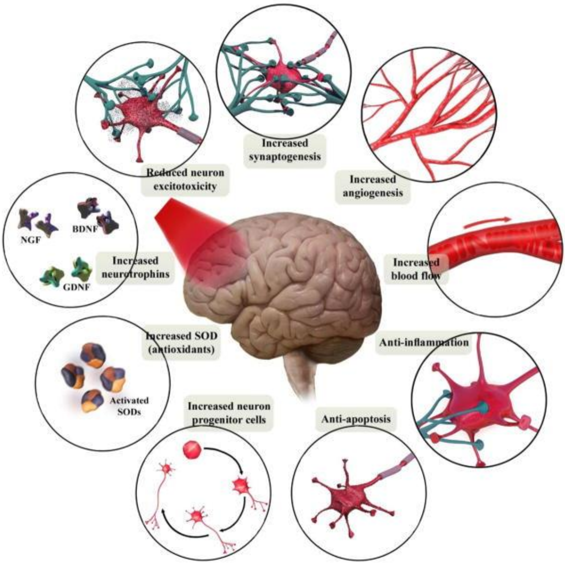

Figure 2. **Brain tissue-specific functional processes that occur after brain photobiomodulation therapy.** On a cellular level, Photobiomodulation can reduce apoptosis and excitoxicity, increase antioxidants, neurotrophins and stimulate neuroprogenitor cells. On a tissue level, Photobiomodulation therapy can increase blood flow and angiogenesis, reduce inflammation and help neurons form new connections. BDNF, brain-derived neurotrophic factor; GDNF, glial-derived neurotrophic factor; NGF, nerve growth factor; SOD, superoxide dismutase.

Figure 3

3. Hamilton C;Liebert A;Pang V;Magistretti P;Mitrofanis J; Lights on for autism: Exploring photobiomodulation as an effective therapeutic option. Neurology international. October 27, 2022. Accessed November 13, 2023. https://pubmed.ncbi.nlm.nih.gov/36412693/.

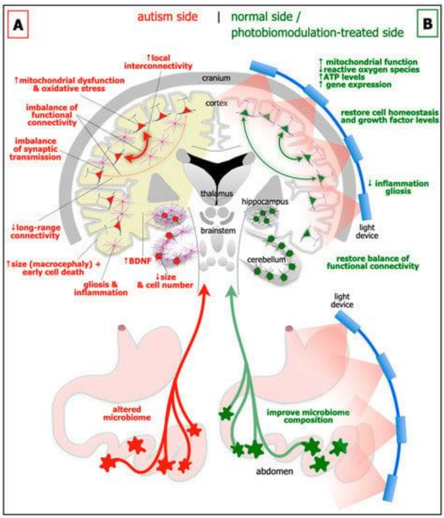

Figure 3. **Schematic diagrams of the major abnormalities evident in autism** (A; left side) as compared to normal, and after photobiomodulation treatment (B; right side). Autism is characterized by an altered microbiome in the gastrointestinal system (red star-like shapes), decrease in size of cerebellum and cerebellar cell number, increase in brain-derived neurotrophic factor (BDNF) levels in brain (yellow shade) and blood plasma, gliosis and inflammation in brain (pink cells), macrocephaly (increase in size of cortex), decrease in activity of long-range connectivity in cortex (thin red arrows), synaptic imbalance in brain, imbalance of functional connectivity, dysfunction and oxidative stress in brain (red cells) and increase in local interconnectivity in cortex (thick red arrows). We hypothesize that many if not all of these abnormalities will improve after photobiomodulation treatment to the head and to the abdomen (green cells and arrows). In particular, photobiomodulation will prompt; an increase in mitochondrial function, adenosine triphosphate (ATP) levels and gene expression, a reduction of oxidative stress, inflammation and gliosis, a restoration of cell homeostasis and growth factor levels, together with a restoration of a balanced functional activity across the brain.