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Transcranial and Repetitive Transcranial Magnetic Stimulation Driving a Noninvasive Depression Treatment

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Abstract: These days the most devasting disease that is even worse than the new pandemic COVID19 is commonly spreading and exists is human depression to be more specific. The world-wide episode of depression is something that has no permanent cure either among the youngsters in particular and older people in general. Researchers and scientists in the field of medicine and psychology are looking for some noninvasive approaches to treat this disease. Present chemical medications available in the market that are subscribed to patients are not effective as one set of solution across all the patients and in case of deep depression invasive solution such as clinical Electro-Convulsive Therapy (ECT) in most cases should not be prescribed due to tremendous and devasting side effects of it on patients that are going through such treatment for long term as a means of solution to their depression problem. New studies and clinical results are supporting a new generation of magnetic treatment approach that is known as Transcranial Magnetic Stimulation (TMS) or in case of a longer term suggests repetitive Transcranial Magnetic Stimulation (rTMS), both as very non-invasive approaches with almost no adverse side effects on patients that are receiving such clinical treatments. In this paper we study these two recently approved approaches by Food and Drug Administration (FDA) as well as a newly suggested electric energy medicine by utilizing a new form of wave that is known as a Scalar Wave, which is a non-linear, non-Hertzian, standing wave capable of supporting significant effects including carrying information and inducing higher levels of cellular energy, which greatly enhances the performance and effectiveness of the body and immune system.

Key words: Depression, suicide attempt and suicide rate, youngsters, suicide risk management, TMS, rTMS, ECT.

1. Introduction

Suicide due to depression in particular among youngsters is on rise globally and increasing significantly with mortality rate of 25% as well as that historically has had devasting impact in our society [1] among the population no matter of their age group. That goes along with our recent fast-paced thriving toward new technology of electronic gadgets or Personal Digital Assistance (PDA), such as tabletor even daily usage of our smart phones that keep us away from personal social association or distancing with others in general, and situation like COVID19 is additional enhancement to the social isolation like adding salt to injury [2, 3].

Fatal rate of depression globally, even it is not worse than pandemic COVID19 fatality that we are encountering presently, it is no better either. This adversary disease in particular among wealthy countries from Gross Domestic Product (GDP) (Fig. 1) and technical point of view that are ahead of the rest of the world, is on rise as we said at the rate of 25% and continuously is on assenting curve.

Competence between ways of "Traditional Technology" versus today's "Modern Technology" easily reviles that technology plays a vital role in human life and consequently has principal side effects and impacts on "Human Behavior". Therefore, forecasting the future cannot be done without understanding the

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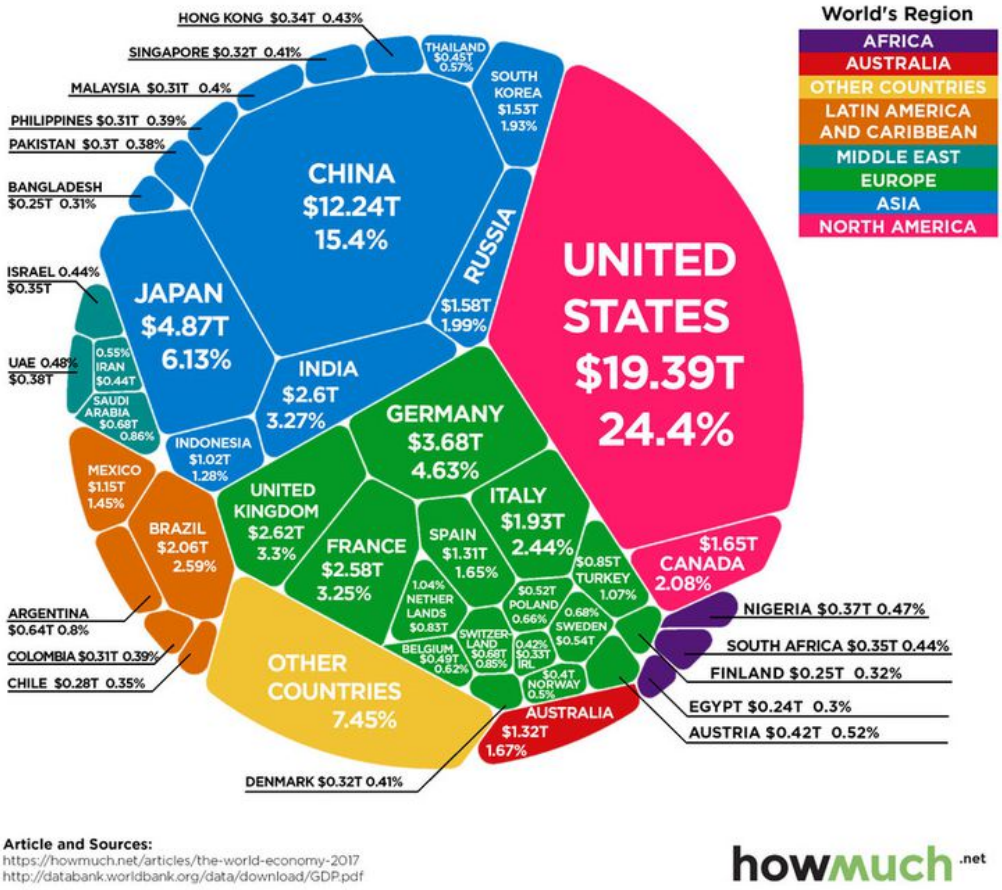


Fig. 1 Global GDP.

role that technology will play in shaping the future of different industries and more importantly, on human behavior and their mood changes as well their social life is concerned including his decision-making process [4].

Technological renaissance in 21st century that we are going through has a huge impact on our overall behavior, our daily mood. Thus, it is very important for us to be able to recognize and manage any depression resulted as consequence lack of social association between humans and our technical and fast-paced society.

Finding a new yet a non-invasive way of treating depression has been number-one priority of most researchers and scientists in field of psychology, medicine and science, in past decade and has been supported by Food and Drug Administration (FDA) as well.

Seeking such solution would be a replacement for very invasive and possibly dangerous way of treating depressed patients by means of Electro-Convulsive Therapy (ECT). One of adverse side effects of ECT in long term is loss of memory of patients in a form of permeant means.

A new medical approach suggested by scientists that is known as Transcranial Magnetic Stimulation (TMS) or repetitive Transcranial Magnetic Stimulation (rTMS), although these approaches have been in mind of engineers and scientists past few decades and nothing new about it, it has been taken a long time for FDA to approve utilization of these devices to treat the depression [5, 6].

In 2008 the USFDA approved the first magnetic brain stimulation device to treat major depressive disorder, called repetitive Transcranial Magnetic Stimulation (rTMS), the treatment involves applying

noninvasive magnetic pulses to specific regions of the brain.

Generally, rTMS has only been mildly better than placebo at improving depressive symptoms in trials, so its clinical uses have mostly been limited to severe cases of treatment-resistant depression, when every other option has failed. A new study allegedly is claimed by Stanford University scientists stating that a novel form of the treatment and it is called Stanford Accelerated Intelligent Neuromodulation Therapy or SAINT.

Their claim indicates that, the new SAINT technique alters the traditional rTMS treatment in a few key ways. Prior rTMS treatments generate around 600 magnetic pulses per session, whereas the SAINT technique triples that dose to 1,800 pulses per session.

The process and procedure of this treatment by Stanford University researchers was conducted as follows. The treatment schedule was also significantly tweaked by the Stanford team. Instead of the usual one session per day for six weeks schedule, the new method is more aggressive, administering 10 sessions a day, lasting 10 min per session. Most subjects tested reported positive results after just three days of this kind of regime (see Fig. 2).

This is “a small early study reported a 90 percent remission rate lasting up to a month in most subjects”.

Fig. 2 Hand stealing idea light bulbs [7].

The other improvement suggested by the Stanford research is more accurate targeting of the magnetic pulses. To treat depression, the rTMS technique generally targets the dorsolateral prefrontal cortex.

The new SAINT technique aims the stimulation at a very specific sub-region of the dorsolateral prefrontal cortex, close to the subgenual (i.e. subgenual (not comparable), (anatomy), describing an area of the cerebral cortex of the brain) cingulate. Each patient is individually scanned using magnetic-resonance imaging to personalize the targeting to each unique brain.

Alternate to TMS and rTMS, there exist other methodologies that are known as Transcranial Electrical Stimulation (TES) or repetitive Transcranial Electric Stimulation (rTES). Bear in your mind that either of these methodologies such as TMS, rTMS, TES, and rTES is derived from science of physics based on the law of Biot and Savart and all related analysis electrostatic energy [6].

Moreover, all the above wave stimulation types that are used in TMS, rTMS, TES and rTES are transvers kind such as either Transvers Magnetic (TM) or Transvers Electric (TE) Mode, where motion of the wave direction is not along the direction of propagation (see Fig. 3).

In the Transverse Electric and Magnetic (TEM) mode, both the electric field and the magnetic field (which are always perpendicular to one another in free space) are transverse to the direction of travel. If you wonder how this is possible, bear in mind that it is happening in three-dimensional space.

In the Transverse Electric (TE) mode, the electric field is transverse to the direction of propagation while the magnetic field is normal to the direction of propagation.

In the Transverse Magnetic (TM) mode, the magnetic field is transverse to the direction of propagation while the electric field is normal to the direction of propagation.

In summary, all these waves are considered as part of family of Hertzian waves.

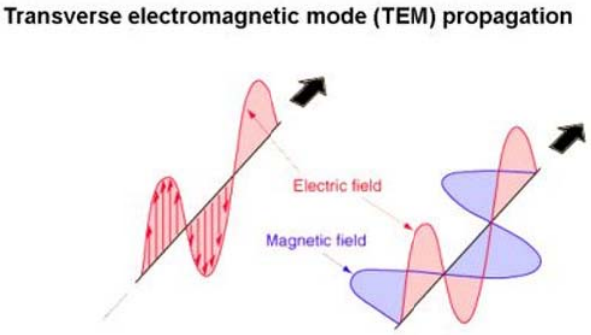


Fig. 3 TM and TE mode wave.

2. The Impact of Technology on Mental Health

Mental health refers to our cognitive, behavioral, and emotional wellbeing—it is all about how we think, feel, and behave. The term "mental health" is sometimes used to mean an absence of a mental disorder. Neurological disorders with symptoms such as chronic pain, depression, and insomnia are widespread. Very weak electric fields applied through the skull can enhance or diminish neural activity and modulate brain waves in order to treat many of these common medical problems. This approach is to be contrasted with well-established pharmacological methods or more recent invasive electrical Deep Brain Stimulation (DBS) techniques that require surgery to insert electrodes deep into the brain. We claim that Non-Invasive Brain Stimulation (NIBS) will provide new treatment methods with much greater simplicity, lower cost, and improved safety and in some cases, possibly greater effectiveness.

Mental health can affect daily life, relationships, and even physical health. Mental health also includes a person's ability to enjoy life—to attain a balance between life activities and efforts to achieve psychological resilience [8].

3. Transcranial Magnetic Stimulation (TMS)

Transcranial Magnetic Stimulation (TMS) is a noninvasive method to excite neurons in the brain: weak electric currents are induced in the tissue by rapidly changing magnetic fields (electromagnetic induction) [9]. This way, brain activity can be triggered with minimal discomfort, and the functionality of the circuitry and connectivity of the brain can be studied.

The principle of inductive brain stimulation with eddy currents has been noted since the 19th century. The first successful TMS study was performed in 1985 by Anthony Barker et al. in Sheffield, England. By stimulating different points of the cerebral cortex and recording responses, e.g., from muscles, one may obtain maps of functional brain areas. By measuring functional imaging, e.g. Magnetic Resonance Imaging (MRI) (see Fig. 4) or Electroencephalography (EEG) information may be obtained about the cortex and its reaction to TMS and about area-to-area connections.

TMS is becoming more widely used for treating nonresponsive severe depression. Fig. 4 shows how the TMS coil produces fields that noninvasively interact with the brain.

In Fig. 5, the time-change magnetic field (purple color) induced the electric field and currents (green color) in brain.

Repetitive TMS stimulation (i.e. see Section 4 as well) is known as repetitive Transcranial Magnetic Stimulation (rTMS) and can produce longer lasting changes.

Numerous small-scale pilot studies have shown it could be a treatment tool for various neurological conditions (e.g. migraine, stroke, Parkinson's disease, dystonia, tinnitus) and psychiatric conditions (e.g. major depression, auditory hallucinations).

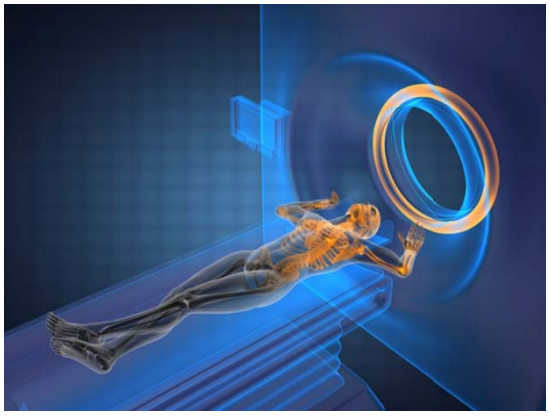


Fig. 4 Illustration of magnetic resonance imaging.

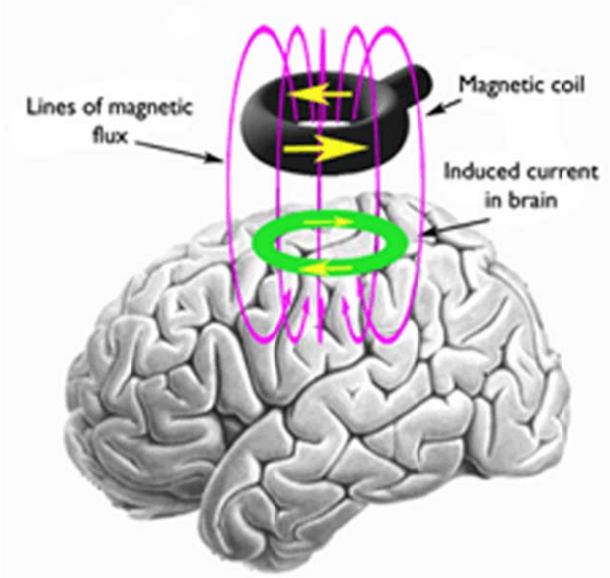


Fig. 5 A TMS coil suspended over the brain [10].

However, this treatment is one of the best suggested and non-invasive solutions and its treatment continuation could be considered as a way of Preventive Maintenances (PM) of keeping the disease under control.

4. Repetitive Transcranial Magnetic Stimulation (rTMS)

The potential of repetitive TMS in the treatment of psychiatric disorders was suggested for the first time relatively soon after the development of the first TMS device in 1985. In a study on motor conductivity, changes in mood in several normal volunteers who received single pulses over the motor cortex were described [11]. Following this initial observation, the technical progress and the increasing availability of TMS devices have led to the opportune investigation of rTMS in the treatment of depression. Apart from being the first investigated psychiatric application, it is also the most investigated psychiatric application in many centers all around the world. In addition, an rTMS device has been approved by the FDA in late 2008, and a growing number of private outpatients as well as hospitalized patients with depression are treated in clinical settings (see Fig. 6).

Note that in visual illustration of the induction of electrical currents in the brain (black arrows in brain)

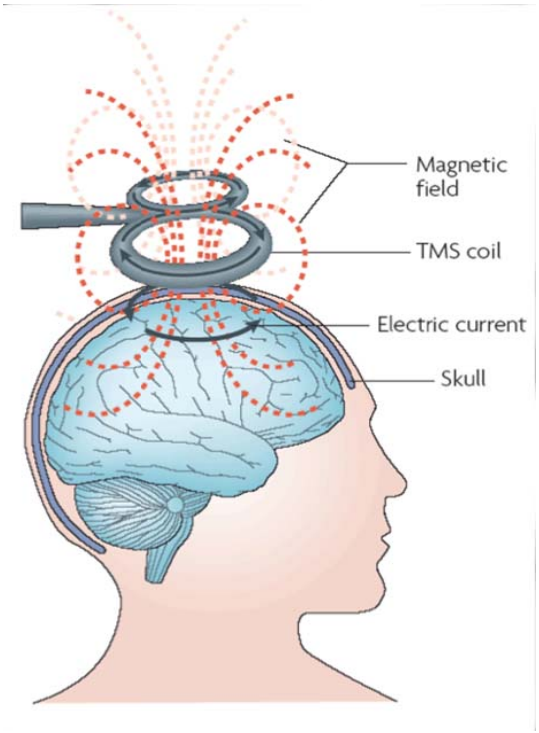


Fig. 6 Magnetic pulses are delivered in the proximity of a conductive medium such as brain along with a secondary current in conductive material.

through Figs. 6-8 magnetic pulses (red/pink) applied by means of the coil (grey 8-shaped figure) positioned above the head. Figure is taken and adapted from Ridding and Rothwell [12].

Bear in mind that the side effect of rTMS is that, sometimes a person may have discomfort at the site on the head where the magnet is placed. The muscles of the scalp, jaw or face may contract or tingle during the procedure. Mild headaches or brief lightheadedness may result. It is also possible that the procedure could cause a seizure, although documented incidences of this are uncommon. Two large-scale studies on the safety of rTMS found that most side effects, such as headaches or scalp discomfort, were mild or moderate, and no seizures occurred. Because the treatment is relatively new, however, long-term side effects are unknown.

5. Transcranial Electrical Stimulation (TES)

Transcranial Electrical Stimulation (TES) is a

neuromodulator technique in which low voltage constant or alternating currents are applied to the human brain via scalp electrodes. The basic idea of TES is that the application of weak currents can interact with neural processing, modify plasticity and entrain brain networks, and that this in turn can modify behavior.

The technique is now widely employed in basic and translational research, and increasingly is also used privately in sport, the military and recreation. The proposed capacity to augment recovery of brain function, by promoting learning and facilitating plasticity, has motivated a burgeoning number of clinical trials in a wide range of disorders of the nervous system [6].

Transcranial electrical and magnetic stimulation techniques encompass a broad physical variety of stimuli, ranging from static magnetic fields or direct current stimulation to pulse magnetic or alternating current stimulation with an almost infinite number of possible stimulus parameters. These techniques are continuously refined by new device developments, including coil or electrode design and flexible control of the stimulus waveforms. They allow us to influence brain function acutely and/or by inducing transient plastic after-effects in a range from minutes to days. Manipulation of stimulus parameters such as pulse shape, intensity, duration, and frequency, and location, size, and orientation of the electrodes or coils enables control of the immediate effects and after-effects. Physiological aspects such as stimulation at rest or during attention or activation may alter effects dramatically, as neuropharmacological drug co-application.

Non-linear relationships between stimulus parameters and physiological effects have to be taken into account.

6. Repetitive Transcranial Electrical Stimulation (rTES)

Repetitive Transcranial Magnetic Stimulation (rTMS) is an electromagnetic therapy similar to TMS. When reviewing the differences in TMS versus rTMS, the key difference lies in the word “repetitive”. As described above, during TMS treatment the device’s magnetic coils switch polarity creating a steady electromagnetic pulse.

In rTMS, the speed at which the magnetic coils change polarity is rapidly increased, usually switching between positive and negative polarities in just microseconds. This creates “repetitive” electromagnetic pulses, which in turn creates stronger electromagnetic induction. Due to the increase in strength, rTMS has the potential to solidify longer lasting changes in the brain, whereby TMS may only induce short.

7. Other Suggested Method of Non-invasive Treatment of Depression

There exists another wave with proper energy that is non-Hertzian, standing wave as we have mentioned before. This wave is known as Scalar Wave (SW) and its motion in respect to propagation direction of the wave is longitudinal, thus it can be considered as Scalar Longitudinal Wave (SLW).

In longitudinal waves (LW) the displacement of the medium is parallel to the propagation of the wave. A wave in “slinky” is a good visualization. Sound waves in air are longitudinal waves (see Fig. 7).

In summary, it is a wave in which the oscillation is in and opposite to the direction of wave propagation. Sound waves (and primary-wavesor (P-Waves) in general) are longitudinal waves. On the other hand, a wave motion in which the particles of the medium oscillate about their mean positions in the direction of propagation of the wave is called longitudinal wave.

However, if we want to expand the subject of LW, before we go deeper into the subject of Scalar Longitudinal Wave (SLW), for longitudinal wave the

Fig. 7 Depiction of a longitudinal wave.

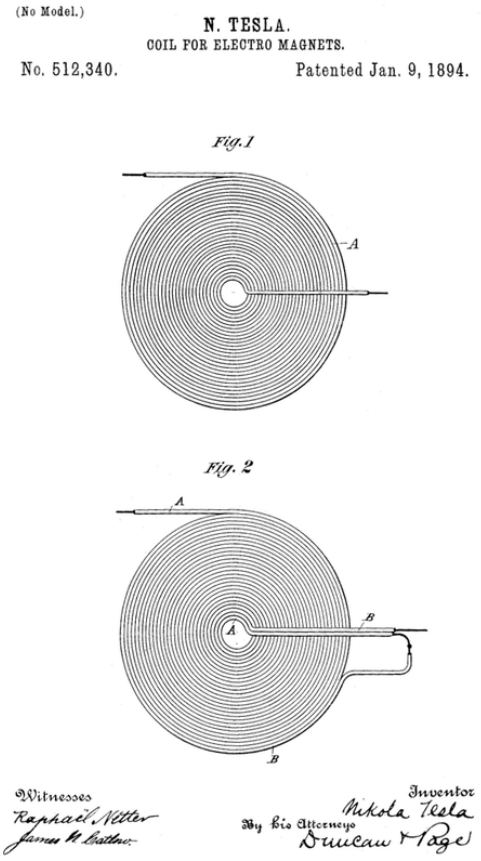
vibration of the particles of the medium is in the direction of wave propagation. A longitudinal wave proceeds in the form of compression and rarefaction which is the stretch and compression in the same direction as the wave moves. For a longitudinal wave at places of compression the pressure and density tend to be the maximum, while at places where rarefaction takes place, the pressure and density are the minimum. In gases only, longitudinal wave can propagate. Longitudinal waves are known as compression waves.

A longitudinal wave traveling through a medium in the form of compressions or Condensations (C) and Rarefaction (A) compression is a region of the medium in which particles are compressed, i.e. particles come closer, i.e. distance between the particles becomes less than the normal distance between them. Thus, there is temporary decrease in volume and as a consequent increase in density of the medium in the region of compression. A rarefaction is a region of the medium in which particles are rarefied, i.e. particles get farther apart than what they normally are. Thus, there is temporary increase in volume and a consequent decrease in density of the medium in the region of rarefaction [13].

Existence of this wave is nothing new and it was discovered and experimentally was demonstrated by Nikola Tesla and was patented on January 9, 1894 under patent number No. 512,340 with concept of Coil for Electro-Magnets (see Fig. 8).

In this patent, Tesla proposed two types of energy existed in the cosmos: scalar and electromagnetic energy. Because of the lack of technology to detect scalar energy, electromagnetic energy was more widely accepted and utilized. To prove scalar energy existed, Tesla experimented with abrupt discharges of electrostatic potentials, which released scalar energy from the vacuum of space also known as the "ether". Tesla referred to "scalar energy" as "radiant energy" and felt that this was the primal force in the universe.

Theoretically, the equation of this wave can be derived from Maxwell Ampere's Equation by virtue


(No Model.)

N. TESLA.

COIL FOR ELECTRO MAGNETS.

No. 512,340. Patented Jan. 9, 1894.

Fig. 1

Fig. 2

Witnesses

Raphael Netter

James W. Crothers

Inventor

Nikola Tesla

By his Attorneys

Duncan & Page

Fig. 8 Tesla coil for electromagnet, Tesla Patent #512,340.

More Complete Equation (MCE) of Ampere Maxwell's Equation, where the missing term of scalar wave partial differential equation will appear by elegantly deriving Tesla's result of his patent as well as explaining many other unexplained physical effects in science [13, 14].

This wave is capable of supporting significant effects including carrying information and inducing higher levels of cellular energy, which greatly enhances the performance and effectiveness of the body and immune system. Additionally, it helps to clear negative cellular memory by shifting polarity, similar to erasing the memory of a cassette tape with a magnet. Scalar waves allegedly, travel faster than the speed of light and do not decay over time or distance.

Scalar waves are self-contained three-dimensional waves that spin on a fixed axis. Non-linear waves propagate through the body via the crystalline lattices of the elaborate collagen network and physically look like what is shown in Fig. 9.

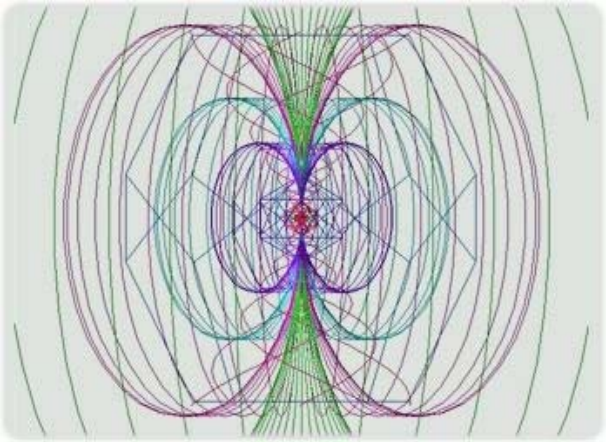


Fig. 9 What do scalar wave look like [15].

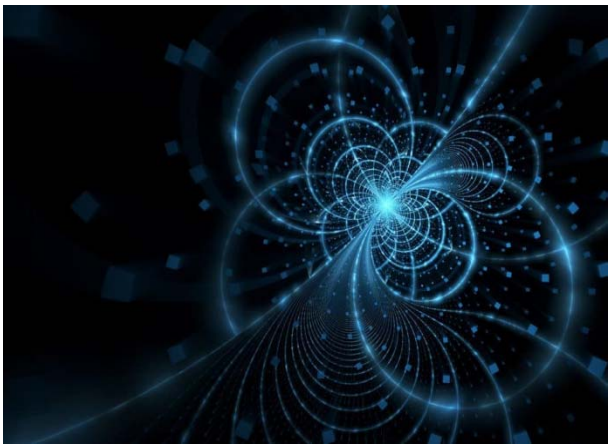


Fig. 10 Looks of scalar wave [16].

Technically speaking, scalar electromagnetic waves have magnitude but no direction, since they are imagined to be the result of two electromagnetic waves that are 180 degrees out of phase with one another, which leads to both signals being canceled out. This results in a kind of “pressure wave”.

Mathematical physicist James Clerk Maxwell, in his original mathematical equations concerning electromagnetism, established the theoretical existence of scalar electromagnetic waves. After his death, however, later physicists assumed these equations were meaningless, since scalar waves had not been empirically observed and repeatedly verified among the scientific community at large.

As we have stated and as it is depicted in Fig. 10 [16], scalar waves are conceived as longitudinal waves, as are sound waves. Unlike the transversal waves of electromagnetism, which move up and down perpendicularly to the direction of propagation, longitudinal waves vibrate in line with the direction of propagation. Transversal waves can be observed in water ripples: the ripples move up and down as the overall waves move outward, so that there are two actions; one moving up and down, and the other propagating in a specific direction outward.

Some general properties of scalar waves (of the beneficial kind) include:

- travel faster than the speed of light;
- seem to transcend space and time;
- cause the molecular structure of water to become coherently reordered;
- positively increase immune function in mammals;
- are involved in the formation process in nature.

There are a lot of benefits that can fall within domain of scalar wave and one of the most important aspects of it is in application of medical field.

Not all scalar waves, or subtle energies, are beneficial to living systems. Electromagnetism of the 60 Hz AC variety, for example, emanates a secondary longitudinal/scalar wave that is typically detrimental to living systems.

However, to utilize the SLW as an application in biofield technology effectively, we need to cancel the detrimental aspect of wave scale and transmit it into a beneficial wave, therefore this innovative approach qualifies the medical application of SLW, where we can approach that biomedical folks to suggest such invention and ask for funding there as well. Last three bullets point in above is vital interest in biofield approach application of SLW.

Other major benefits of scalar waves, that other researchers are allegedly claiming as part of its medical utilization are listed below, however most of them are getting tested and clinically have not been implemented as an ultimate solution [16]:

- May eliminate and nullify the effects of man-made frequencies in the human body (cell phones, computers, Wi-Fi, microwaves, and other sources).

- May increase the energy level of every single cell in the body to the ideal 70-90 millivolt range.
- May improve immune function by as much as 149% proven in laboratory studies.
- May cleanse the blood, improving triglyceride levels, as well as protein and fat particles floating in the blood.
- May improve cell wall permeability thus facilitating the intake of nutrients into each and every cell and the elimination of waste from each and every cell.
- May decrease the surface tension of substances such as food, water, and supplements, thus enhancing the body's ability to assimilate and hydrate.
- May inhibit the uptake of noradrenaline to support better mood.
- May balance the hemispheres of the brain as measured by EEG tests.
- May improve focus as demonstrated by increased amplitude of EEG frequencies.
- May catalyze heightened states of awareness and creativity.

Experts in the field are claiming that, the human body has crystalline structures in every cell wall that are capable of holding a charge. When the human body enters a scalar field, the electro-magnetic field of the individual becomes stimulated as artistically depicted in Fig. 11. Scalar energy has this unique property which enables it to embed itself into objects in its field.

Companies like QuWaveHarmmoizer [17] use scalar technology to return the body to a more original and appropriate electrical matrix. A scalar energy field with health-boosting properties is generated by the device which envelopes everything exposed to it. One of the key benefits this provides is that it helps keep the electrical charge across cell membranes at an optimal level.

Scalar energy has some other amazing properties. It repairs itself. It can cancel out the harmful effects of 60 cycle power line pollutions (which we have everywhere), electromagnetic fields, radiation, and microwaves.

Scalar energy is a natural good energy and does not have any side effects; it can potentially harmonize your body's life-force by strengthening your bio-energy which supposedly, achieves holistic wellness.

Suggest an invention of device of Multiple Wave Oscillator (MWO) and patented by Georges Lakhovsky (US Patent #1,962,565 and US Patent #2,351,055), which is invention of an apparatus with circuit oscillating under multiple wavelengths as depicted in Figs. 12 and 13.

This invention relates generally to electric devices excited by electric impulses and more particularly to multiple wavelength conducting and/or producing means. This invention has for its primary object the provision of such means disposed within a vacuum tube or a tube containing rare gas or gases.

Considering Nikola Tesla patent No. 512,340 and invention of Coil for Electro-Magnets concept, one can build the scalar waves that are traditionally connected

Fig. 11 Scalar energy life effect.

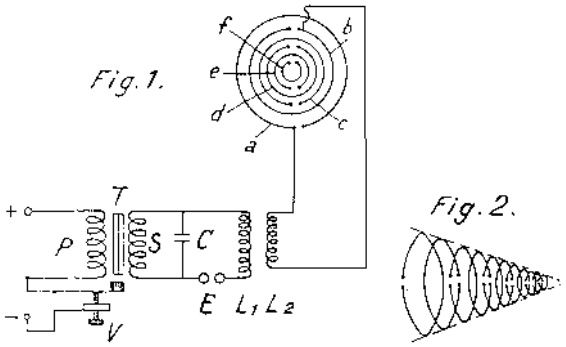


Fig. 12 Suggested circuitry for MWO, US Patent #1,962,565, June 12, 1944.

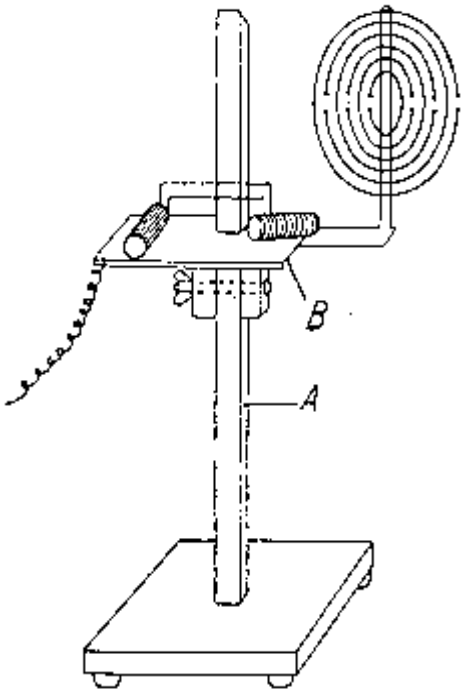


Fig. 13 Tube for producing appropriate wavelengths, US Patent #1,962,565, June 12, 1944 by Georges Lakhovsky.

Fig. 14 Scalar wave health therapy.

will health, personal happiness and wellbeing, as the picture illustrated in Fig. 14.

Overall, it seems that Scalar Energy has the ability to increase the energy potential of the cell. Scalar energy can bring the energy level to the optimum -70 millivolts. Cancer cells are low energy cells. By raising cell voltage with scalar energy, the cell in question will no longer need to multiply uncontrollably and hence slow down the spreading of cancer cells.

Energy medicine brings flow, balance, and renewal to the body's vital energies and energy medicine is the oldest, safest, most organic, most accessible, and most affordable medicine there is.

According to Dr. Mehmet Oz on series of his TV shows, he says that energy medicine is the next frontier and:

"We begin to realize that the next big frontier…in medicine is energy medicine."

In conclusion, due to the nature and characteristic of scalar wave behavior, the energy cannot be measured using the modern day instruments which are designed to measure Hertzian energy frequencies and wavelengths. However, its effect on objects can be strikingly demonstrated with Kirlian photography or Gas Discharge Visualization.

Moreover, traditional science has told us that all energy can be measured and quantified, and if you cannot see it, you do not need to believe it is real. However, in the field of quantum physics, it has been shown that fields of energy impact and influence other fields of energy constantly. Thoughts have been shown to produce biological effects in humans, plants and organisms. Thoughts and other energy vibrations travel in an immeasurable, ever-present Scalar Zero Point Energy field.

8. Artificial Intelligence Driven Treatment of Depression

With tremendous technical approach toward Artificial Intelligence (AI) with help and augmentation of Machine Learning (ML) and Depp Learning (DL), using AI and brain stimulation will improve the procedure for better performance of TMS and rTMS treatment of depression. AI along with its other two components can keep historical data of each patient and compare it with present data that are taken around patients' brain cells behavior in respect to interaction with wave of TMA and rTMS [18].

The study itself involves collecting neuroimaging and genetic information from multiple sites in order to understand the mechanisms of mental illness. The translational portion of this is applying this information to clinic. How genes and brain networks interact to cause mental disorders, and how we can use this information to match patients to specific treatment choices by studying the neuron and perception of each patient brain, allows us to find the proper means of applying the procedure.

AI can help us to keep a precise and accurate data base and with right computer algorithm imbedded in AI even suggest the best possible procedure and treatment.

To enable this, the researchers will look for patterns in a very large amount of imaging and clinical data collected in Europe and Canada. That is where Artificial Intelligence comes in. In order to understand the patterns that are clinically useful, they use a technique called Machine Learning that trains a computer to recognize expected patterns and then make predictions for new patients.

The data are being collected from six centers, coordinated by Dr. Emanuel Schwarz at the University of Heidelberg, Mannheim, Germany. In addition to the center here in London, Ontario, other partners include Munich, Germany; Oslo, Norway; Rotterdam, Netherlands; and Montpellier, France.

The researchers also applied their AI algorithm to data from a separate study in which people had Electroencephalogram (EEG) testing before undergoing transcranial magnetic stimulation (TMS), a brain-stimulation technique to treat depression. They found that people who were not expected to respond well to sertraline, based on their brain waves, tended to have positive responses to TMS.

9. Conclusion

Transcranial magnetic stimulation (TMS) and repetitive TMS (rTMS) are indirect and non-invasive methods used to induce excitability changes in the motor cortex via a wire coil generating a magnetic field that passes through the scalp. Today, TMS has become a key method to investigate brain functioning in humans. Moreover, because rTMS can lead to long-lasting after-effects in the brain, it is thought to be able to induce plasticity. This tool appears to be a potential therapy for neurological and psychiatric diseases. However, the physiological mechanisms underlying the effects induced by TMS and rTMS have not yet been clearly identified. The purpose of the present review is to summarize the main knowledge available for TMS and rTMS to allow for understanding their mode of action and to specify the different parameters that influence their effects. This review takes an inventory of the most-used rTMS paradigms in clinical research and exhibits the hypotheses commonly assumed to explain rTMS after-effects.

With new clinical progress and obtaining new evidences treating depression via TMS or rTMS with backup from FDA, it seems chain medical cents such as Sutter, Mayo clinic, Stanford medical center and others make this type of treatment as part of offered non-invasive treatment depression and offer it to public and insurance companies that are covering the cost of treatment.

In fact, these treatments are now becoming as common as ECT type treatment, which is very invasive procedure.

During an rTMS session, an electromagnetic coil is placed against your scalp near your forehead. The electromagnet painlessly delivers a magnetic pulse that stimulates nerve cells in the region of your brain involved in mood control and depression. It is thought to activate regions of the brain that have decreased activity in depression (see Fig. 15).

Though the biology of why rTMS works is not completely understood, the stimulation appears to impact how the brain is working, which in turn seems to ease depression symptoms and improve mood.

There are different ways to perform the procedure, and techniques may change as experts learn more about the most effective ways to perform treatments [19].

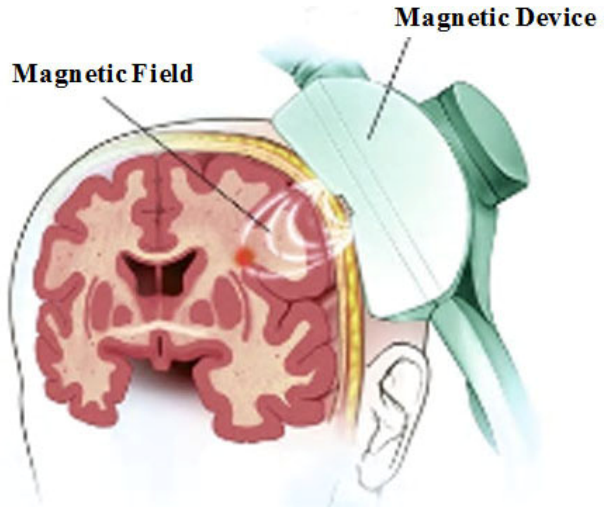


Fig. 15 Repetitive transcranial magnetic stimulation (rTMS).

It is suggested that transcranial electric stimulation can activate pyramidal tract projections both directly and indirectly in a manner similar to that described after direct stimulation of the exposed cortex in the monkey. This produces both D- and I-waves in the pyramidal tract. At high intensities of stimulation, the stimulus can spread into the brain and activate pyramidal tract axons several centimeters below the cortical surface. Magnetic stimulation at moderate intensities produces electromyographic (EMG) responses with latencies 1-2 ms longer than those after electric stimulation.

Non-Hertzian wave such as scalar wave also opens a new door to non-invasive treatment of depression, as well as Alzheimer disease at any energy level below 60 Hz as well as other application in medical field of psychology. This procedure although offered by certain private operational clinic yet needs to be approved by FDA and becomes a world-wide clinical practice, but there a lot of research and studies are in progress and results of treatments are getting published and they can be found on Internet.

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