EXOMIND™

Mechanism of Action

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Brain Function

The human brain is a vital part of the central nervous system (CNS) that controls human senses, thoughts, and actions.[1] EXOMIND™ stimulates specific parts of the brain using ExoTMS™ technology to treat Major Depressive Disorder (MDD).

The brain is primarily divided into two hemispheres, with functions differing on the left and right sides. Broadly, the left hemisphere is more involved in logical thinking, while the right hemisphere is associated with creativity.[2]

The brain consists of three layers: the brainstem, the limbic system, and the cerebral cortex.[2] The brainstem connects the brain to the spinal cord and regulates automatic body processes like breathing.[3] The limbic system is located above the brainstem and controls homeostasis functions, olfactory senses, and emotion.[2,4] The cerebral cortex has four lobes with different functions: the frontal lobe controls voluntary movement, memory, language, and problem solving; the occipital lobe processes visual information; the temporal lobe processes auditory information; and the parietal lobe processes proprioceptive sensory information like movement and positioning.[2]

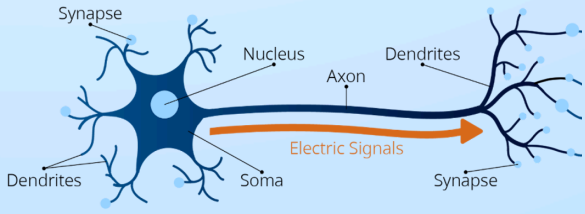

Figure 1. Structure of a neuron.[5]

At the cellular level, the brain is composed of billions of neurons.[1] Neurons are specialized cells with branches called dendrites and axons.[6] Neurons communicate by sending electrical and chemical signals across the junctions between dendrites, called synapses.[6] When neurons become electrically excited, their electric signals travel from the cell body (soma), down the axon, and through the synapses to communicate with other cells (see Figure 1).[6] Chemicals called neurotransmitters are exchanged at the synapses in a process known as neurotransmission.[6,7,8] Increased connectivity between synapses promotes faster neurotransmission, higher resilience to damage, and enhanced excitability of the neurons.[8] Neuropsychiatric conditions like Alzheimer's disease, addiction, and depression have been linked to disruption or weakening in synaptic connectivity.[8,9]

Neuroplasticity

Neuroplasticity is the process by which the CNS reorganizes itself at the structural level in response to stimuli.[10] It facilitates branching in axons and dendrites, increasing the number of synaptic connections, and reinforcing existing neuronal connections (see Figure 2).[11,12,13] Key proteins called neurotrophins facilitate this process by supporting the growth and survival of neurons.[6,7,8]

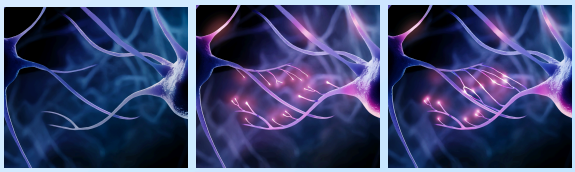

Figure 2. Conceptual depiction of neuroplasticity. From left to right: pre-treatment; neuronal adaptation; post-treatment.

This adaptability supports critical functions like mood regulation, learning, and memory.[14] Neuroplasticity also plays a role in brain injury recovery by reorganizing, strengthening, and forming neural connections.[14]

Lifestyle factors such as healthy diets, aerobic and resistance exercise, and sufficient sleep hygiene have been linked to increased neuroplasticity.[14,15] Inversely, factors like aging, stress, and trauma have been known to weaken neuroplasticity by atrophying dendrites, lowering neurotrophin levels, and reducing synaptic connections.[9,13,15]

Transcranial Magnetic Stimulation

Transcranial magnetic stimulation (TMS) uses electromagnetic induction to create a targeted electric field in the key areas of the brain. The application of TMS stimulates ionic currents within the brain to polarize and depolarize its neurons.[16,17]

Studies have documented an increase in neurotransmission, neurotrophin production, and overall brain activity in patients after TMS application, indicating increased neuroplasticity.[11,18,19] MRI scans after TMS application have shown widespread improved brain activity in the treatment area and beyond (see Figure 3).[20]

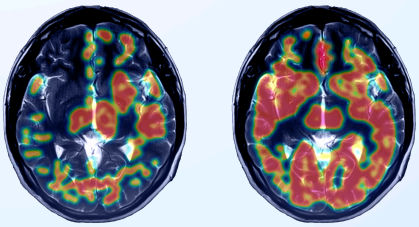

Figure 3. Graphical representation of pre- and post-TMS application based on research into MDD treatment.[20]

TMS devices offer a variety of stimulation patterns for different applications. Repetitive TMS (rTMS) is the repeated stimulation of target areas in a single session to induce changes in neural activity after treatment.[21]

TMS & The DLPFC

The dorsolateral prefrontal cortex (DLPFC) is the outer, upper section of the cerebral cortex that is involved in emotional regulation, memory, and attention (see Figure 4).[22] The DLPFC initiates dopamine production and manages reward-response in the deeper, mesolimbic area of the brain.[22,23]

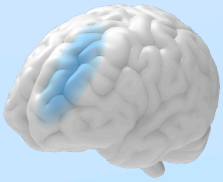

Figure 4. The human brain, with the left DLPFC highlighted blue.

TMS can be applied to the DLPFC to address dysfunction in neuronal activity.[17] High frequency stimulation of the brain upregulates activity in the targeted area, whereas low frequency stimulation inhibits activity in the treatment area.[10,17] MDD has been treated clinically by applying high frequency TMS to the left DLPFC or low frequency TMS to the right DLPFC.[17]

High frequency TMS applied to the left DLPFC has been associated with increased levels of key neurotransmitters including glutamate, gamma-aminobutyric acid (GABA), and dopamine.[11] In patients with depression and generalized anxiety disorder, this application method has also been shown to increase levels of brain-derived neurotrophic factor (BDNF), a key neurotrophin in neuroplasticity.[11,12,13] Structurally, research has documented improved axon microstructures in the DLPFC and increased connectivity between the DLPFC and other regions of the brain after TMS treatment.[24]

ExoTMS™

EXOMIND utilizes ExoTMS technology to apply rTMS to the left DLPFC. While standard TMS uses rectangular pulses, ExoTMS uses ramp-up pulses to gradually deliver the energy (see Figure 5). This wave delivery method allows time for the patient to adapt, ensuring maximum comfort and sustainable therapy.

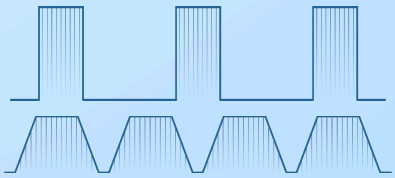

Figure 5. Standard TMS pulse delivery (top) and ExoTMS Ramp-up Pulse Delivery (bottom).

Summary

rTMS has been shown to increase neurotransmitter concentration and neuron connectivity. EXOMIND uses ExoTMS technology to comfortably deliver pulses within the brain and promote neuroplasticity in key brain areas.

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