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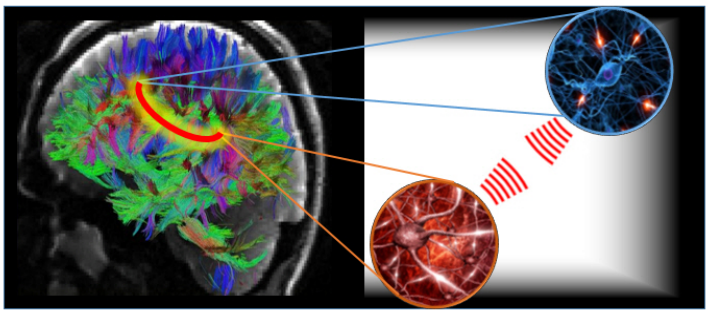
Finding of New Neurological Networks May Provide Therapeutic Treatment for Neurological Dysfunction and Mental Health Disorders

TAMPA, FLA. (July 6, 2016): The human nervous system provides extremely energy efficient, highly complex realization and control of how we sense and think. For machines designed by humans, the ideas of energy efficiency and complexity are at odds, thus the question of how the nervous system *really* works has received intense scrutiny for decades. Researchers at the University of South Florida under the direction of Dr. Sal Morgera have discovered a sophisticated electric near-field generated in an energy efficient, natural manner by our millions of nerve fibers.

The work represents an entirely new perspective on central nervous system structure and function. The researchers have discovered, for example, that the optic nerve has one million electromagnetic circuits forming a neurological network of extraordinary sophistication in which individual nerve fibers exhibit the social properties of communication, competition and collaboration. This paradigm shift in understanding will lead to minimally invasive devices that read and alter the electromagnetic fields and provide therapeutic treatment for the millions that suffer from neurological dysfunction and mental health disorders. The graphic below explains the discovery in simple terms.



Part of this graphic courtesy of www.humanconnectome.org

On the left-half of the graphic is the human connectome shown as a tractographic map of the nerve fiber connections in the human brain. This mapping of anatomical connections is the *fixed network* of the brain. It is well known that this fixed brain network is not entirely successful in explaining brain function, especially for cognitive tasks. On the right-half of the graphic are blowups showing neurons in two representative regions of the brain. The discovery is the presence of an electric near-field between these neurons, or neuronal groups, a point illustrated by the red spherical waves. These near-field waves communicate action potential activity and fine details of their respective regions in a bi-directional manner. This creates a wireless connection, as shown by the red loop across these brain regions in the left-half of the graphic. Thus, the brain consists of a fixed network augmented by a *wireless network* which helps to explain how physically disparate regions of the brain connect so quickly during the execution of cognitive tasks. Furthermore, neurological diseases, such as Multiple Sclerosis, Parkinson's and Autism Spectrum Disorder, are associated with dysfunctions that are similar to those experienced in conventional wireless networks.

Researchers in the University of South Florida Bioengineering Laboratory believe that the discovery of electric near-field networks in the central nervous system will lead to a much greater understanding of this highly complex system and relief for the millions that suffer neurological diseases and dysfunctions, such as Multiple Sclerosis, Parkinson's and Autism Spectrum Disorder. The plan is to passively read the signatures of the internal electric near-fields (the *endogenous* fields) using specially designed antennas in order to diagnose neurological dysfunction and then to *rationally design* time-varying, frequency-rich electric fields (the *exogenous* fields) that can be externally applied to actively interact with the internal fields and treat the dysfunction by "tuning" the central nervous system.

Photo: Stockphoto

Developing individualized therapy for patients with neurological and neuropsychiatric disorders is the gold standard, a standard that can only be reached by understanding a patient's electric near-field signatures. A futuristic look at this area which is just gaining traction in the realm of clinical medicine is to have minimally invasive devices for diagnosis and treatment that are individually programmed and adaptable to change. These devices may function with USB-like software delivered to an implanted device as shown in the graphic above or by other means, but what is certain is that the effect and impact on meeting societal needs will indeed be powerful.

1. S.D. Morgera, *The Fixed and Wireless Cooperative Networks of the Brain,* in Proc. **Society for Brain Mapping and Therapeutics 13th Annual World Congress**, Miami, April 8-10, 2016 **(Invited Speaker)**.
2. S.D. Morgera, *Near Field Axonal Communication Networks and Their Role in Neurodegenerative Diseases*, in Proc. **Biomedical Engineering Society BMES 2015 Annual Meeting**, Tampa, October 7-10, 2015.
3. S.D. Morgera, *Reactive Near Field Electromagnetic Axonal Communication Channels and Their Role in Neurodegenerative Diseases*, in Proc. **IEEE EMBS EMBC 2015**, Milano, August 25-29, 2015.

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Additional information on the University of South Florida Bioengineering Laboratory, integrated with the Defense and Intelligence Research Laboratory (DIRL), may be found at http://www.usf.edu/engineering/ee/research/index.aspx or directly from Dr. Morgera.