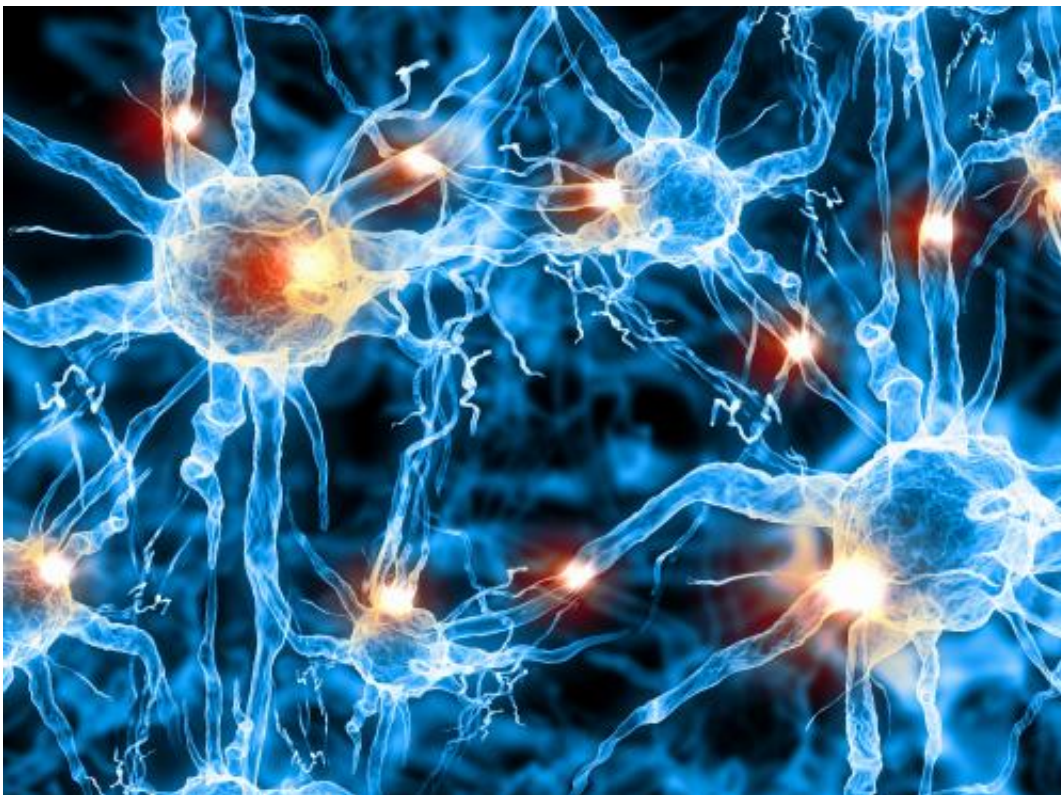


SUBNETS aims for systems-based neurotechnology and understanding for the treatment of neuropsychological illnesses

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Despite the best efforts of the Departments of Defense and Veterans Affairs to protect the health of U.S. servicemembers and veterans, the effects of neuropsychological illness brought on by war, traumatic

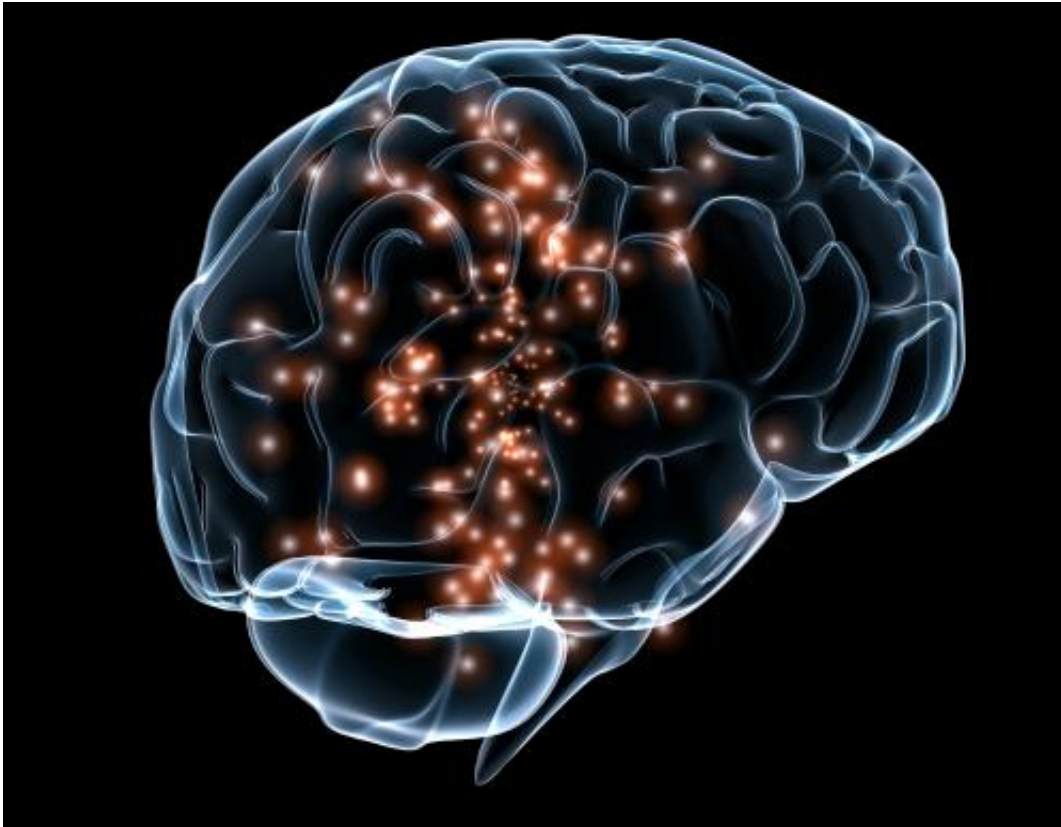
injuries and other experiences are not always easily treated. While current approaches can often help to alleviate the worst effects of these illnesses, they are imprecise and not universally effective. Demand for new therapies is high as mental disorders are the leading cause of hospital bed days and the second leading cause of medical encounters for active duty servicemembers. Among veterans, ten percent of those receiving treatment from the Veterans' Health Administration are provided mental health care or substance abuse counseling.

DARPA created the Systems-Based Neurotechnology for Emerging Therapies (SUBNETS) program to pursue advances in neuroscience and neurotechnology that could lead to new clinical understanding of how neuropsychological illnesses manifest in the brain and to advanced therapies to reduce the burden and severity of illness in afflicted troops and veterans. The program will pursue a new investigative approach that establishes the characteristics of distributed neural systems and attempts to develop and apply therapies that incorporate near real-time recording, analysis and stimulation in next-generation devices inspired by current Deep Brain Stimulation (DBS).

DBS already exists as a therapy option for certain neurologic and neuropsychological illnesses in patients who are not responsive to other therapies. Approximately 100,000 people around the globe live with a DBS implant, a device that delivers electrical stimulation to reduce the motor impairment caused by Parkinson's disease and dystonia. These devices are also being studied as therapy for depression, obsessive compulsive disorder, Tourette's and epilepsy.

Despite recent advances, clinicians and researchers remain limited by the tools available to study, understand and treat systems of the brain. To achieve maximum benefit, clinicians are often forced to complete a slow, repetitive and imprecise cycle of observing behaviors and fine-tuning drug or behavioral therapy until the effects of a disease are

reduced. The science has, to this point, been largely based on a century of identifying associations between features of complex behaviors and diffuse understanding of the brain.



SUBNETS seeks to move beyond this limited understanding to create new interventions based on new insights that can be gained from the intersection of neuroscience, neurotechnology and clinical therapy. While there is no question that brain activity, anatomy and behavior are functionally linked, there is a growing body of evidence to suggest that many neural and behavioral processes are not localized to specific anatomical regions, but are emergent from systems that span several

regions of the brain. SUBNETS will attempt to establish the capability to record and model how these systems function in both normal conditions, among volunteers⁴ seeking treatment for unrelated neurologic disorders, as well as among impaired clinical research participants.

DARPA is specifically interested in evaluating the underlying systems which contribute to the following conditions as described by the Diagnostic and Statistical Manual of Mental Disorders: Post-Traumatic Stress Disorder, Major Depression, Borderline Personality Disorder and General Anxiety Disorder. DARPA also seeks to evaluate the representation in the central nervous system of: Traumatic Brain Injury, Substance Abuse/Addiction and Fibromyalgia/Chronic Pain.

"If SUBNETS is successful, it will advance neuropsychiatry beyond the realm of dialogue-driven observations and resultant trial and error and into the realm of therapy driven by quantifiable characteristics of neural state," said Justin Sanchez, DARPA program manager. "SUBNETS is a push toward innovative, informed and precise neurotechnological therapy to produce major improvements in quality of life for servicemembers and veterans who have very few options with existing therapies. These are patients for whom current medical understanding of diseases like chronic pain or fatigue, unmanageable depression or severe post-traumatic stress disorder can't provide meaningful relief."

As described in a [broad agency announcement](#), the work will require development of novel medical hardware, complex modeling of human [neural systems](#), clinical neurology and animal research. DARPA expects that successful teams will span across disciplines including psychiatry, neurosurgery, neural engineering, microelectronics, neuroscience, statistics and computational modeling.

"We're talking about a whole systems approach to the brain, not a disease-by-disease examination of a single process or a subset of

processes," Sanchez said. "SUBNETS is going to be a cross-disciplinary, expansive team effort and the program will integrate and build upon historical DARPA research investments."

Because programs like SUBNETS push the leading edge of science, they are sometimes society's first encounter with the dilemmas associated with new technologies. DARPA pursues these technologies because of their promise, but the Agency understands that it is important to consider ethical, legal, societal and policy questions. For that reason, DARPA has convened an Ethical, Legal and Social Implications (ELSI) panel to inform and advise SUBNETS and other emerging neuroscience efforts. The panel's membership represents the academic community, medical ethicists, and clinical and research scientists. ELSI panelists will provide guidance in addition to the standard oversight provided by DARPA and Department of Defense internal review boards that govern human and animal use and the Presidential Commission for the Study of Bioethical Issues that will oversee SUBNETS as part of the BRAIN Initiative.

More information: Armed Forces Health Surveillance Center, Summary of Mental Disorder Hospitalizations, Active and Reserve Components, U.S. Armed Forces, 2000-2012, *Medical Surveillance Monthly Report*, 2013 Jul; 20(7):4-11.

Provided by DARPA

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