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EMERGING SPACE BRIEF

Neurotechnology

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Trending companies

Helius Medical Technologies
ASSURE Neuromonitoring
ONWARD
NeuroStar Advanced Therapy
LivaNova Health innovation that matters

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Overview

Neurotechnology refers to technology that enables people to better understand consciousness, thought, and higher order activities in the brain. Companies in this space are developing brain-machine interfaces, implantable devices, neuroprosthetics, neurostimulators, and neuromonitoring devices.

Background

In the mid-19th century, a groundbreaking discovery by French physician Paul Broca linked specific regions of the brain to distinct functions, such as speech production. This revelation marked the inception of neurotechnology, a field that, over the next century, would blossom into a nexus between machinery and the human central nervous system.

Pioneering neuroimaging techniques, such as magnetic resonance imaging (MRI), transformed our understanding of the brain. Unlike the invasive studies of Broca's era, MRIs provide a non-invasive window into the brain's function and structure, revolutionizing both medical diagnostics and neuroscience research.

Innovations didn't stop at imaging. By the late 20th century, deep brain stimulation (DBS)—surgical implants that directly stimulate neuron clusters in the brain—emerged as a treatment for neurological disorders such as Parkinson's disease. Recent advancements have even enabled paraplegics to regain movement through spine-implanted electrodes. Beyond mobility, neurotechnology has ventured into sensory restoration. Cochlear implants have granted hearing to the deaf, and bionic prosthetics are now bridging the gap between humans and machines by offering amputees a semblance of touch. Similarly, electronic retinal implants are under exploration to restore sight.

Lastly, electroencephalography (EEG) has paved the way for non-invasive brain-machine interfaces. While this technology cannot yet decipher detailed thoughts, it holds the promise of silent communication and advanced control over prosthetics and robots.[1]

1: "Four Great Landmarks in the History of Neurotechnology," OpenMind BBVA, December 12, 2019.

Today, neurotechnology stands at the frontier of understanding and augmenting human capabilities, promising unprecedented advancements in healthcare and human-machine synergy.

Technologies and processes

Neurotechnology encompasses a wide range of tools and techniques that provide insights into consciousness, thought, and higher order activities in the brain. Companies within the neurotechnology realm have been pioneering both non-invasive and invasive methods to record and stimulate brain activity. Here's a breakdown of these processes:[2]

Brain monitoring:

EEG: A foundational non-invasive method that detects the brain's electrical patterns using surface scalp electrodes.

Functional magnetic resonance imaging (fMRI): A non-invasive procedure that visualizes brain activity by monitoring blood flow changes. Though effective, it tends to be more expensive.

Functional near-infrared spectroscopy (fNIRS): A non-invasive tool that uses handheld sensors on the scalp to capture brain activity, offering a more accessible but slightly less detailed view compared to fMRI.

Microneedle implantation: An invasive approach that embeds tiny electrodes in the brain's cortex, delivering highly accurate readings over a confined region.

Brain stimulation:

Transcranial electrical stimulation (tES): A non-invasive approach that sends small electrical waves to the brain via scalp electrodes, potentially activating specific brain regions.

Transcranial magnetic stimulation (TMS): A non-invasive method that uses magnetic waves, administered through scalp coils, to generate electrical flows in the brain, influencing neural interactions. It's been linked to improvements in cognition and memory.

Focused ultrasound (FUS): A non-invasive method that employs targeted infrared light beams, which are delivered through various entry points such as the eyes or nose to activate certain brain areas.

DBS: An invasive technique that involves surgically placed electrodes in the brain, which have been beneficial for conditions such as Parkinson's and epilepsy.

2: "Neurotechnology, How to Reveal the Secrets of the Human Brain?" Iberdrola, n.d., accessed August 23, 2023.

Applications

Medical: Treating neurological disorders, rehabilitation after neural injuries, managing chronic pain, and more.

Communication: Helping individuals with paralysis or other disabilities to communicate using brain-machine interfaces.

Entertainment: Virtual reality and gaming experiences that leverage brain-machine interfaces for immersive experiences.

Research: Better understanding of cognitive processes, consciousness, and brain disorders.

Military: Developing tools for enhanced training, communication, and potentially even remote machine control.

Limitations and market outlook

Neurotechnology, while groundbreaking, comes with multifaceted challenges. At the forefront are safety and ethical concerns. The process of implanting devices into the brain inherently carries medical risks, and the broader implications of altering brain functions pose moral dilemmas. There's also the looming threat of potential misuse of these technologies, either for control or illicit data extraction.

Technical challenges further complicate the landscape. Accurate interpretation of brain data remains a hurdle, and distinguishing genuine signals from background noise is an ongoing struggle. Additionally, ensuring that implanted devices are biocompatible to prevent adverse reactions is paramount.

The financial aspects present another layer of complexity. The high costs associated with the development, maintenance, and implementation of these technologies could potentially limit their accessibility, making them available only to a privileged few. This raises concerns about equitable access to potentially life-changing treatments.

Privacy issues, in an age of increasing digital surveillance, are especially pertinent. The intimate nature of direct brain-device communication opens a Pandora's box of data privacy concerns. The potential for unauthorized access to one's most private thoughts and the subsequent misuse of such data is a significant worry.

Recent deal activity

The neurotechnology market clearly has an interest from investors across the public and private sector. Neuralink's recent $280.3 million raise and Saluda Medical's $150.0 million Series E are a testament to the potential of this technology. But those are more of outliers; the next largest deals of 2023 include Paradromics $33.0 million Series A and Precision Neuroscience's $41.0 million Series B. Of course, given current macroeconomic conditions, investors will scrutinize startups much

more closely. Such a capital-intensive technology will need proven functionality, intellectual property, and the resources to navigate what will likely be an arduous regulatory process.

In this regard, Big Tech companies can provide startups with a lifeline in a constrained funding environment. In 2019, Meta acquired CTRL-Labs, which developed a neuromotor signal-detecting wristband. Similarly, Snap, the parent of Snapchat, took over NextMind, which utilizes EEG tech for virtual interactions. Valve, a significant player in the gaming industry, is also collaborating with OpenBCI to explore the integration of brain-computer interfaces with VR headsets.

Quantitative perspective

283 companies	**955** deals	**973** investors	**$8.1B** capital invested
97 deals (TTM) *-10.19% YoY*	**$2.5M** median deal size (TTM) *107.38% YoY*	**$36.7M** median post-money valuation (TTM) *133.33% YoY*	**$973.2M** capital invested (TTM) *0.20% YoY*

*As of August 21, 2023

Top neurotechnology investors*

Investors	Investments	HQ location
US Department of Health and Human Services	20	Washington, US
National Institutes of Health	10	Bethesda, US
United States Department of Defense	10	Washington, US
National Science Foundation	9	Alexandria, US
SOSV	9	Princeton, US
Joyance Partners	7	San Francisco, US
InterWest Health Partners	6	Los Altos, US
ONSET Ventures	6	Menlo Park, US
Patricia Industries	6	Stockholm, Sweden
Plug and Play Tech Center	6	Sunnyvale, US
Venture Kick	6	Zurich, Switzerland
Berkeley SkyDeck	5	Berkeley, US

Source: PitchBook • Geography: Global
*As of August 21, 2023

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Top neurotechnology companies by active patents*

Company	Active patents	Total raised ($M)	HQ location	Year founded
Kernel	59	$55.5	Los Angeles, US	2016
Helius Medical Technologies	34	$61.0	Newtown, US	2014
Bioness	32	$193.6	Santa Clarita, US	2004
Nuvectra	28	N/A	Plano, US	2008
NeuroNexus Technologies	26	N/A	Ann Arbor, US	2004
ONWARD	26	$162.9	Eindhoven, Netherlands	2014
CorTec	21	$21.6	Freiburg, Germany	2010
Neuronetics	17	$306.2	Malvern, US	2001
Interaxon	13	$39.3	Toronto, Canada	2009
Advanced Brain Monitoring	12	$1.2	Carlsbad, US	1997
BrainScope	11	$78.8	Chevy Chase, US	2006
Neuralink	11	$644.2	Fremont, US	2016
NeuroSync	11	$22.5	Holliston, US	2008

Source: PitchBook • Geography: Global
*As of August 21, 2023

Top companies by PitchBook Exit Predictor opportunity score*

Company	Opportunity score	Predicted exit type	Exit probability	Total raised ($M)	HQ location	Year founded
INBRAIN Neuroelectronics	99	M&A	96%	$23.8	Barcelona, Spain	2019
Paradromics	99	IPO	91%	$80.4	Austin, US	2015
Lifescapes	95	M&A	72%	$9.1	Tokyo, Japan	2018
Cognixion	92	M&A	85%	$19.9	Santa Barbara, US	2013
CorTec	89	IPO	90%	$21.6	Freiburg, Germany	2010
Actipulse Neuroscience	86	M&A	78%	$0.9	Cambridge, US	2017
Precision Neuroscience	84	M&A	94%	$53.0	New York, US	2020
Somnee	83	M&A	75%	$14.3	Berkeley, US	2017
Blackrock Neurotech	79	M&A	97%	$49.7	Salt Lake City, US	2008
Interaxon	78	M&A	96%	$39.3	Toronto, Canada	2009

Source: PitchBook • Geography: Global
*As of August 21, 2023
Note: Probability data based on PitchBook VC Exit Predictor Methodology.

Recommended reading

"AI-Driven Neurotechnology 'On Steroids' Needs Regulation, Says Unesco," Financial Times, Clive Cookson, July 12, 2023.

"Digging Below the Surface of Neurotechnology: Casey Lynch," Seeking Alpha, September 6, 2013.

"How Neurotechnology is Expanding the Brain's Frontiers," OpenMind BBVA, September 20, 2019.

"Neurotechnology: Current Developments and Ethical Issues," Frontiers, Oliver Müller and Stefan Rotter, December 13, 2017.