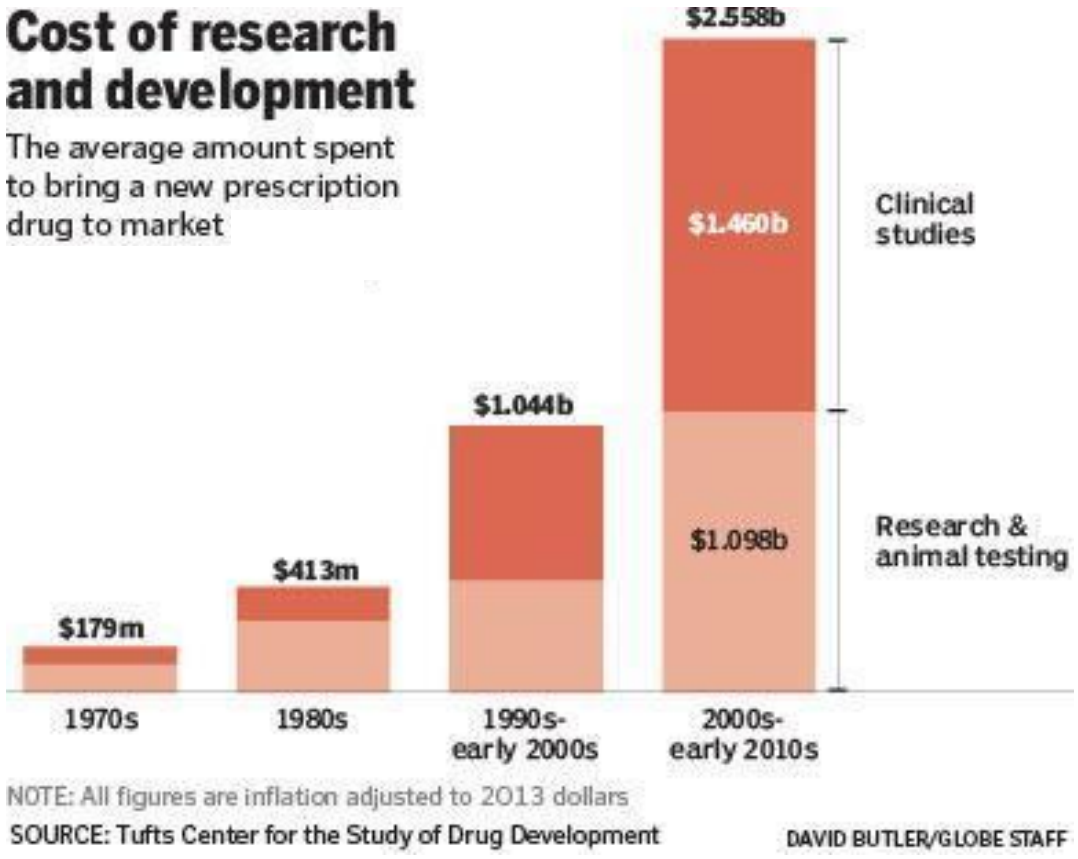
Maastricht University

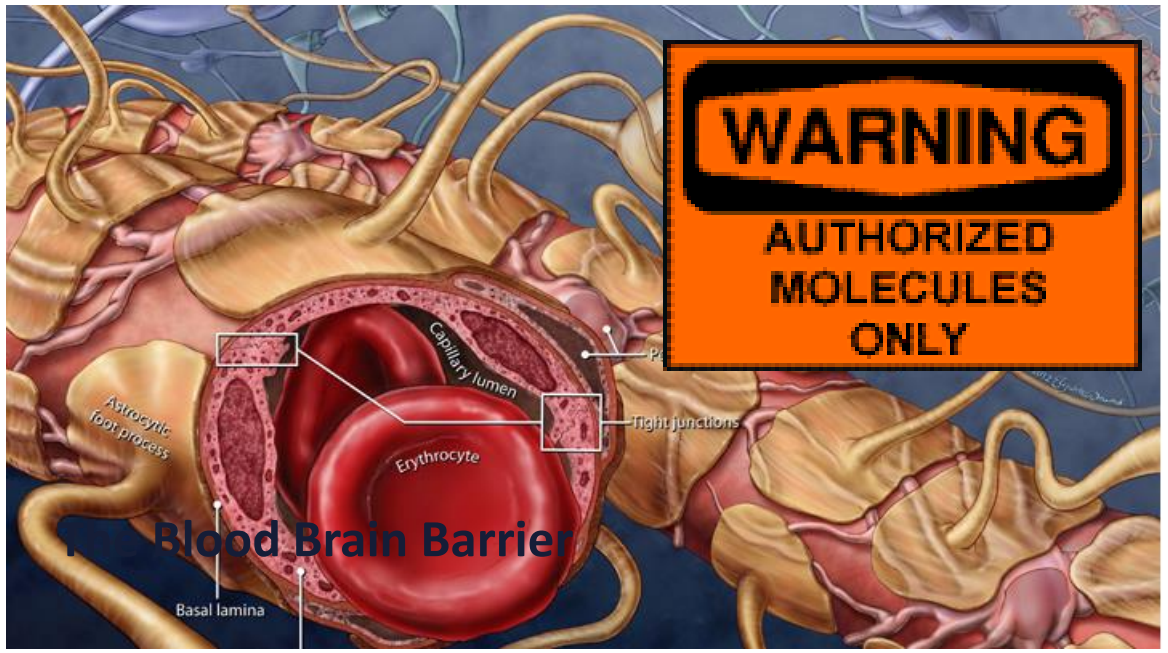
Go the extra mile

Master in Biomedical Sciences

Specialization in Neuromodulation

The Limits of Psychopharmacology





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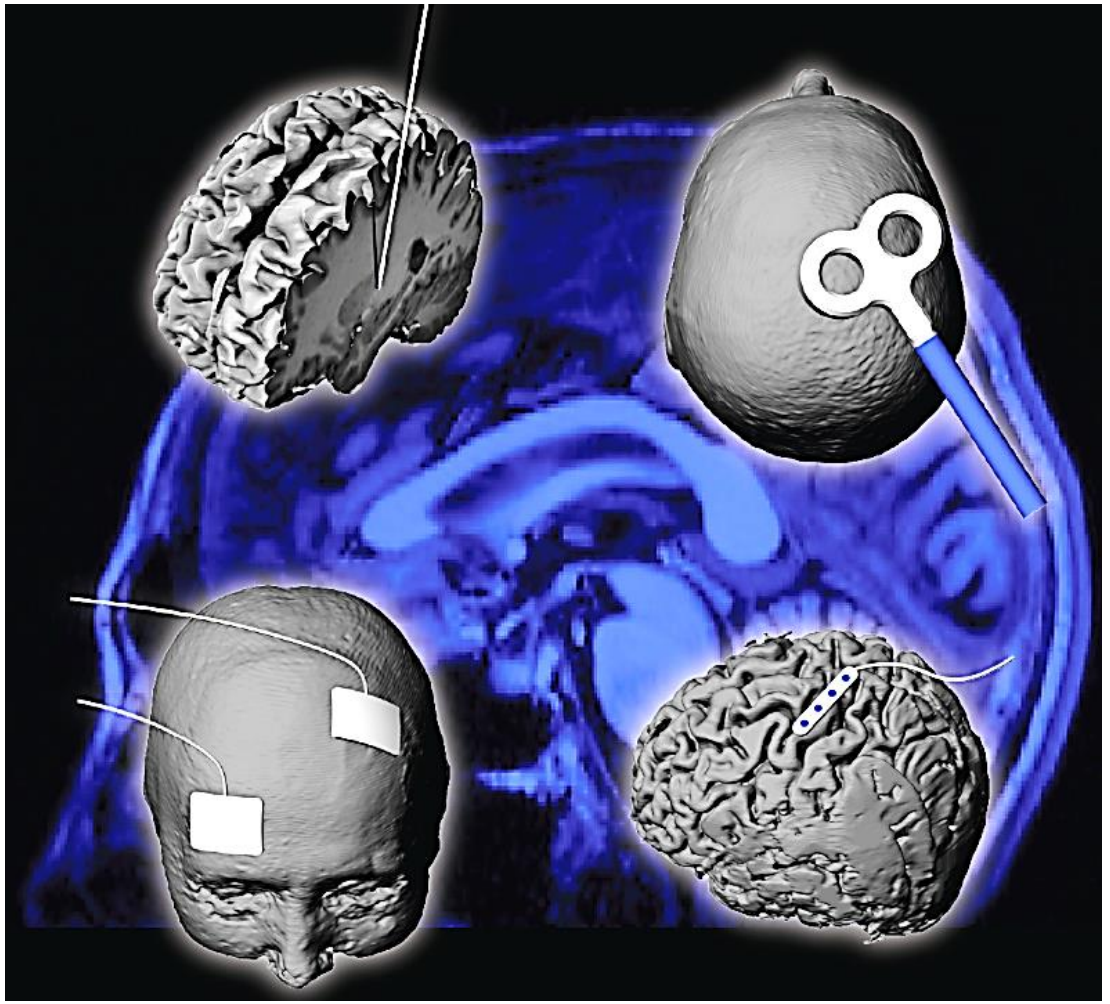
Go the extra mile

Neuromodulation

using electrical stimulation or magnetic fields to influence parts of the (central) nervous system

a large and multidisciplinary field of scientific inquiry with great clinical potential



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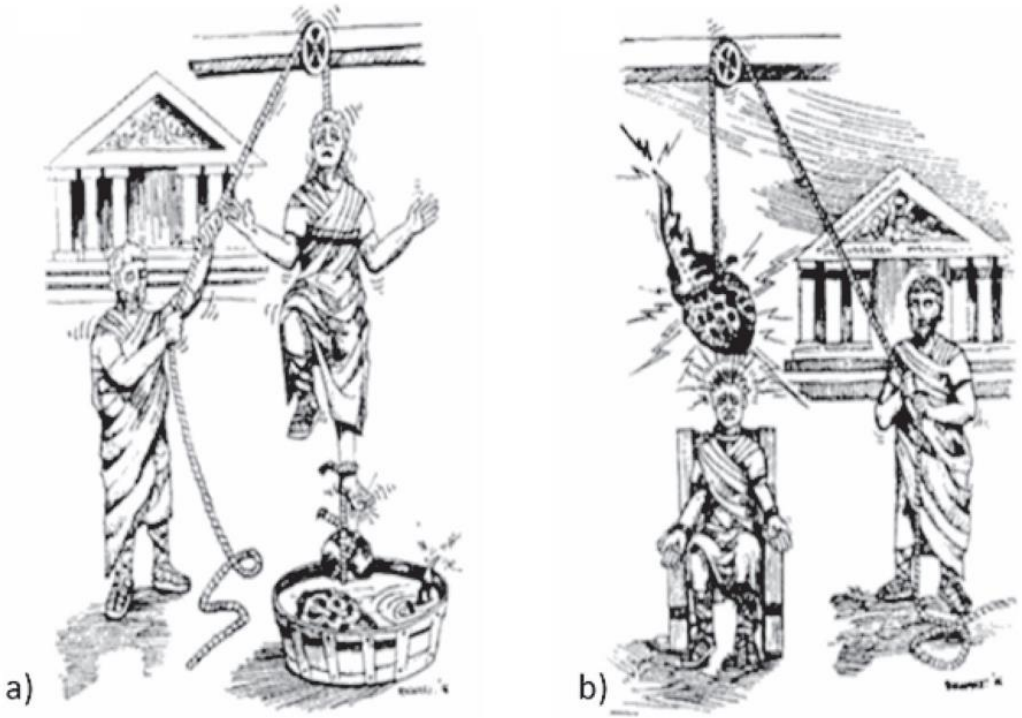
2500+ Years of Neuromodulation History

black torpedo fish was used in ancient Greece to apply electrical (brain) stimulation for pain relief

recent technological developments enable far more sophisticated approaches



Disruption of Broca's Area

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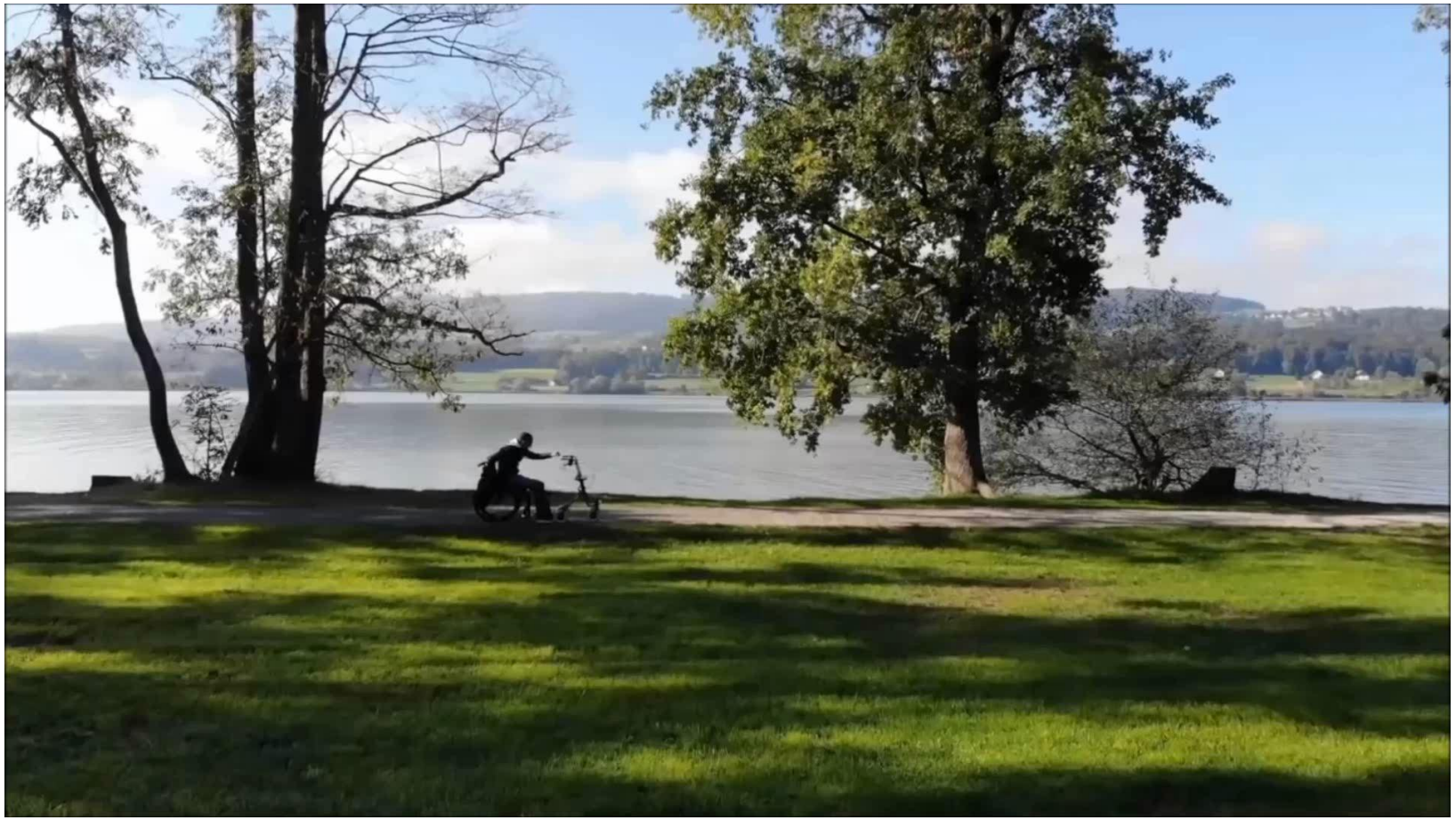
Treatment After Spinal Cord Injury



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Go the extra mile

Current Neuromodulation Approaches

Invasive Techniques

- Deep Brain Stimulation
- Spinal Cord Stimulation
- Vagal Nerve Stimulation
- Sacral Nerve Stimulation

Non-Invasive Techniques

- Transcranial Magnetic Stimulation
- Transcranial Direct Current Stimulation
- Transcranial Alternating Current Stimulation

+ exciting developments such as:
optogentics
transcranial focused ultrasound stimulation

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Go the extra mile

Specialization in Neuromodulation

First of its kind programme starting next year!

Maastricht has a strong tradition in neuromodulation research and application across various departments

A unique specialization that is truly interdisciplinary

State-of-the art training with a strong focus on research

Maastricht University

Go the extra mile

Two Core Courses on Neuromodulation

- Fundamental Neuromodulation

- provides essential knowledge about neuroanatomy and neurophysiology
- detailed explanation of basic principles of current neuromodulation techniques
- Particular focus on...
  - deep brain stimulation
  - spinal and sacral neuromodulation
  - transcranial magnetic stimulation

- Translational Neuromodulation

- showcases clinical applications of various neuromodulation techniques in neurology, neuro-rehabilitation, and psychiatry
- provides a conceptual and technological framework that allows translating state-of-the-art understanding of the central nervous system into novel treatment approaches

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Go the extra mile

Practicals and Internships

experience clinical neuromodulation practices in several departments

extensive lab tours and hands-on training

opportunity to get in contact with research groups at MUMC+

a 10-months Master thesis internship

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Go the extra mile

Target Group & Carreer Opportunities

Prospective students should have a first degree in biology, biochemistry, biotechnology, biomedical sciences, medicine,
or any other related field

This program offers a unique opportunity for students who wish to pursue careers in neuroscience. The integrated curriculum provides students a specialization in neuromodulation that is not easily achievable in any individual Master program, which is highly demanded in academia, but also in the pharmaceutical industry.

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Go the extra mile

Neuromodulation Research at MUMC+

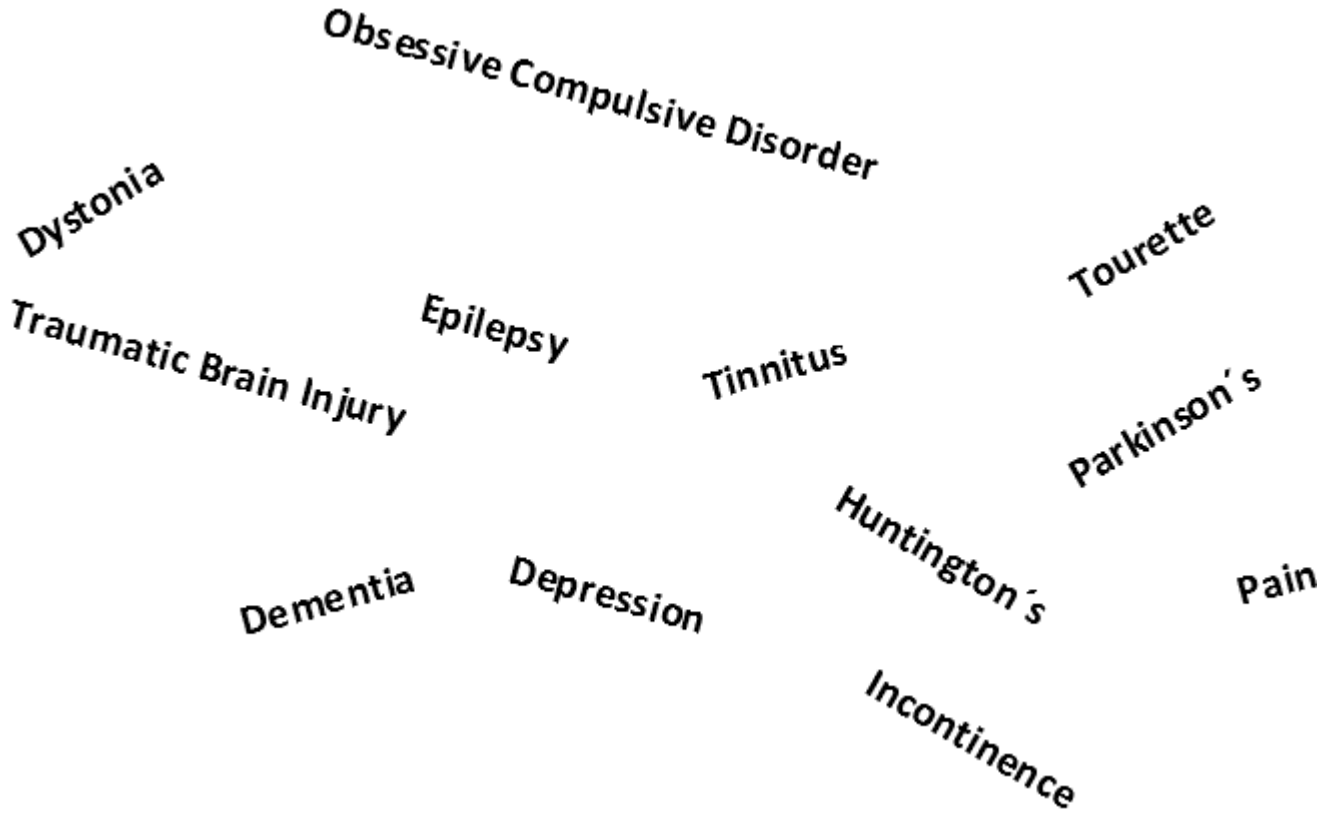
fundamental

↓

pre-clinical

↓

clinical



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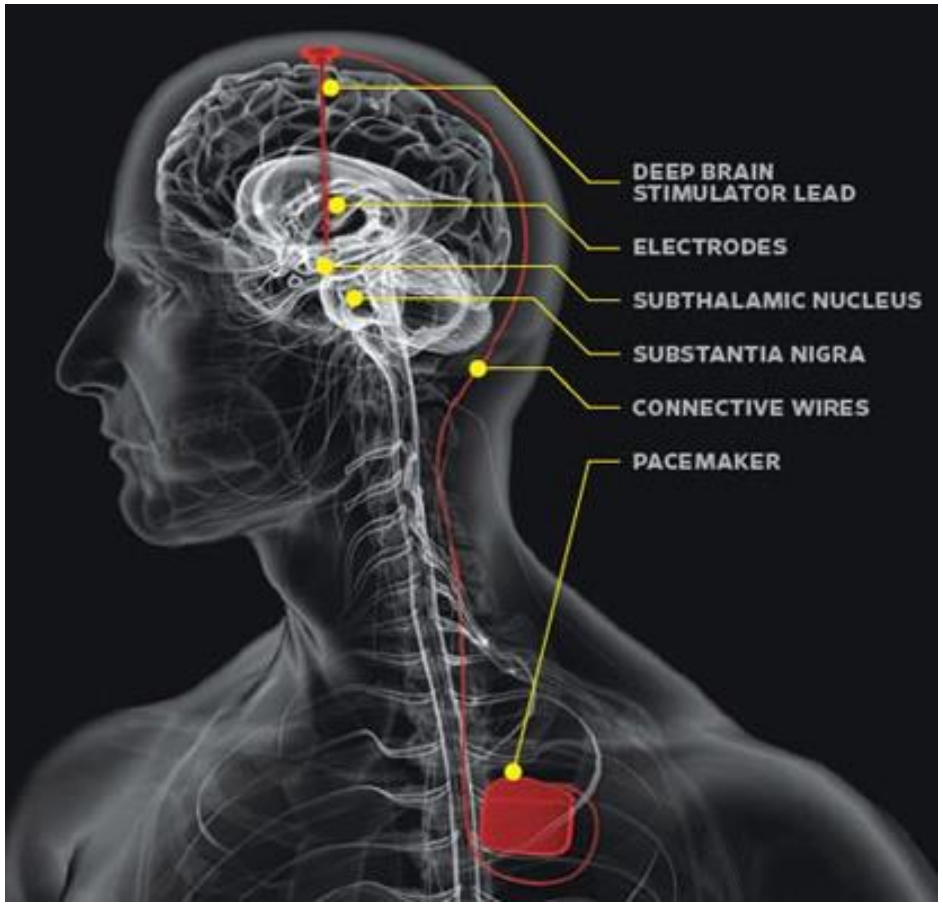
Go the extra mile

Deep Brain Stimulation

The most famous and successful neuromodulation approach

Involves the placement of an electrode inside the brain, with a wire pulse generator

Used to treat Parkinson's disease and number of other disorders



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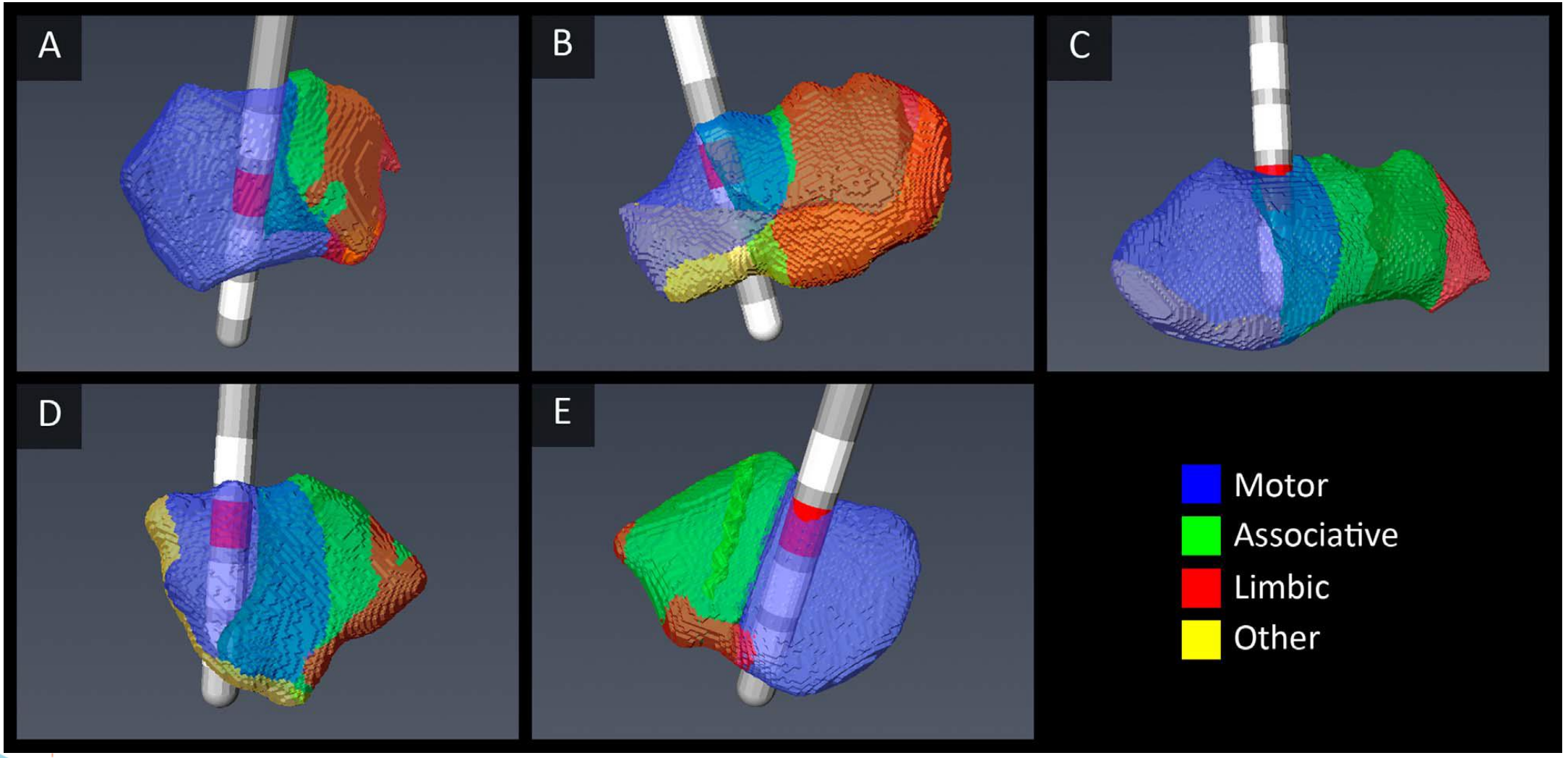
Go the extra mile

Deep Brain Stimulation



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Go the extra mile

Ultra-high field scanners at MUMC+

3.0, 7.0, and 9.4 Tesla!

Structural imaging

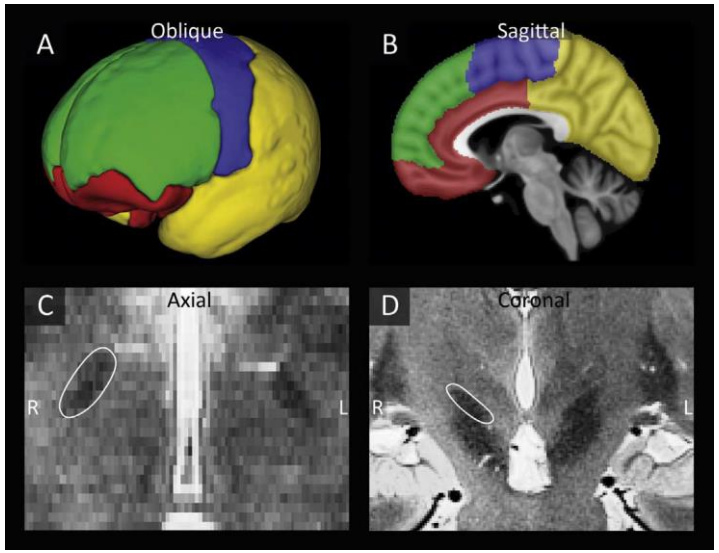
Functional imaging

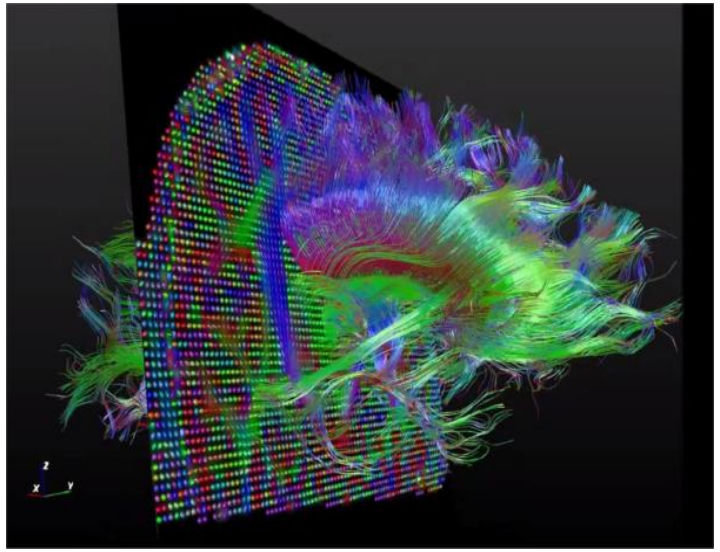
Quantitative imaging

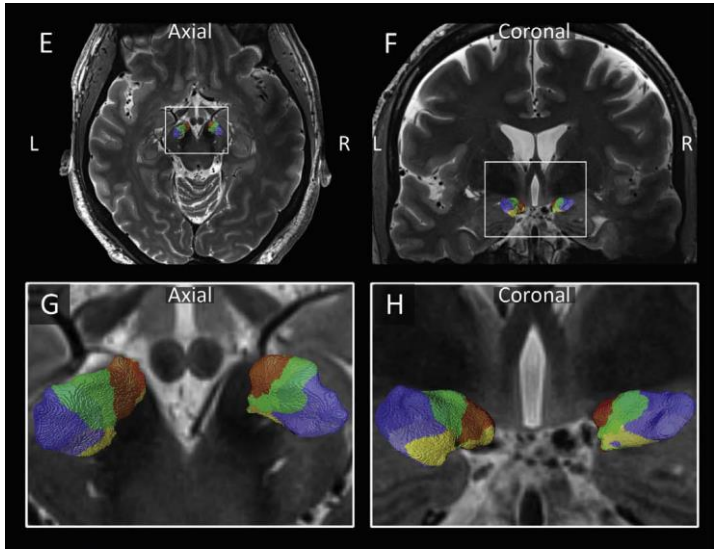
Diffusion imaging

Arterial Spin Labelling

MR-spectroscopy







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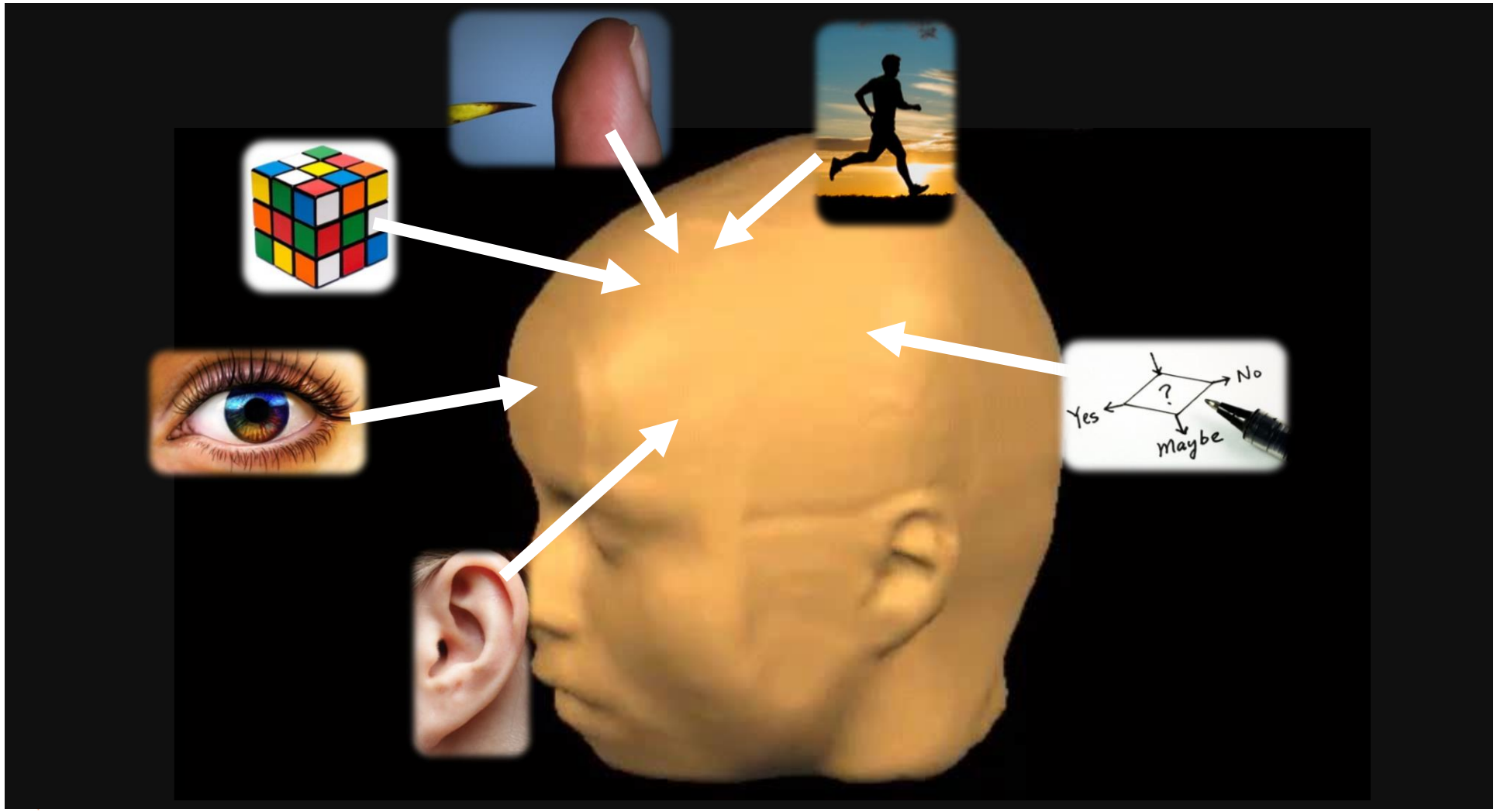
The Human Brain

Go the extra mile



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Brain Damage = Loss of Function

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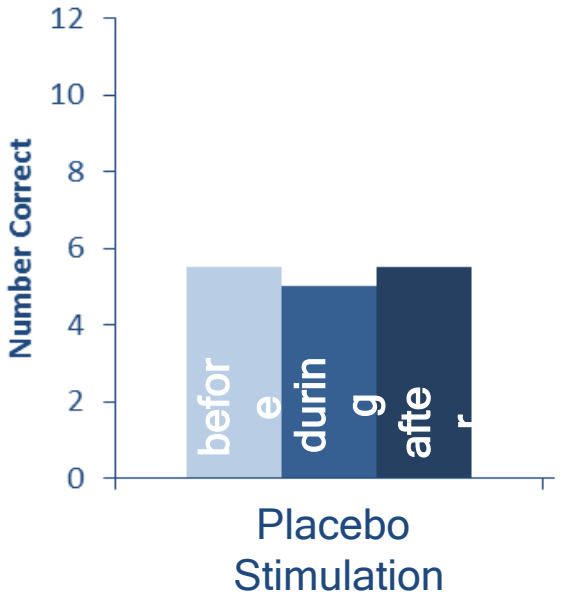
Translate findings to stroke patients for recovery

Correct Detection Bilateral



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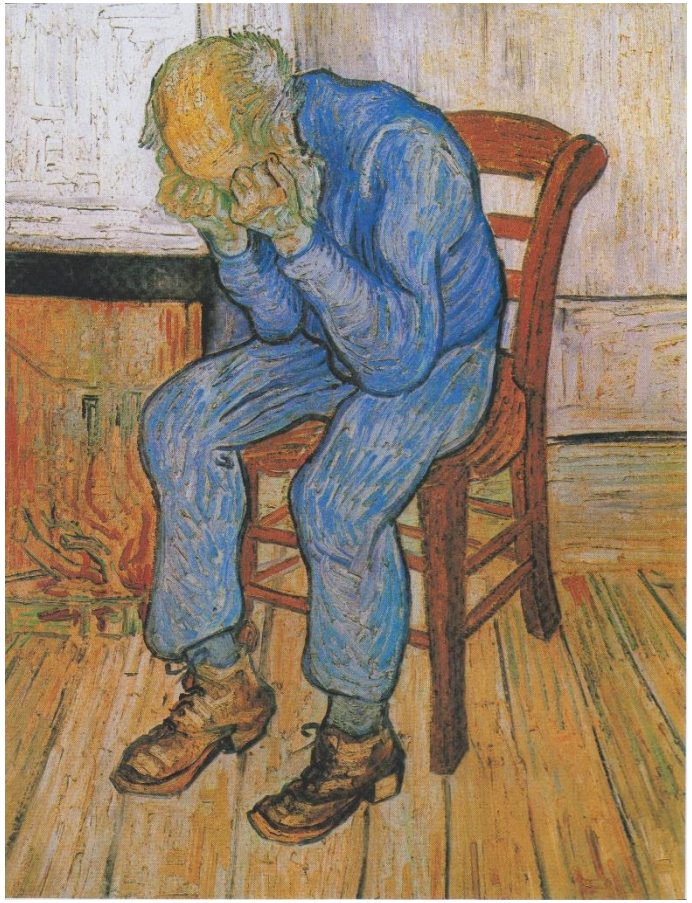
Go the extra mile

Depression

In NL approximately 1 million patients suffer from depression

Lifetime Prevalence of 10-20 %

Second most years lived with disability



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Go the extra mile

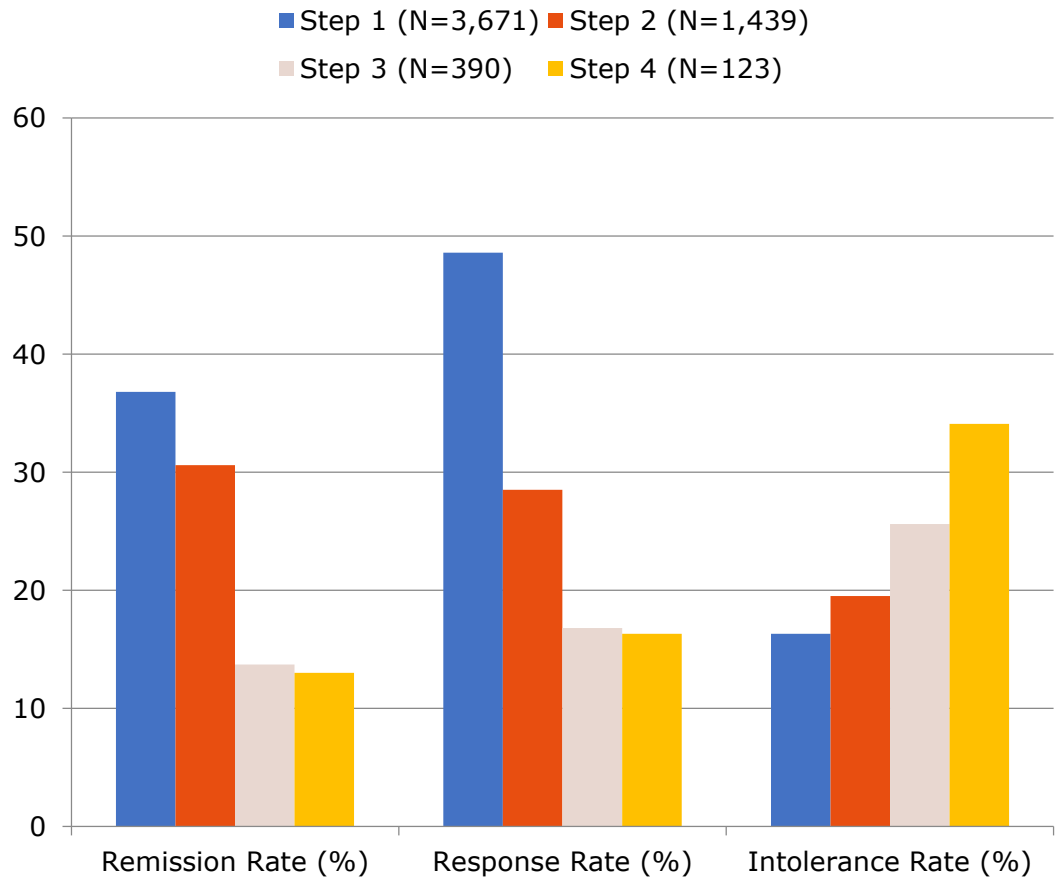
Depression: Current Treatment Efficacy

cumulative remission rate: 67%

probability of remission decreases dramatically after two treatment attempts

about 25% of patients do not tolerate and/or stop treatment

about 30% are treatment resistent



Rush et al. (2006)

DE VOLKSKRANT

45

WETENSCHAP

Pulsen, als praten en pillen falen

Neurologie

Een behandeling waarbij met magneten de hersenen worden gestimuleerd biedt een alternatief voor ernstig depressieve patiënten bij wie praten en pillen niets uithalen.

Morgen gaat ze met vakantie, naar Frankrijk. Vandaag krijgt ze op de valreep een 'onderhoudsbeurt' in de kelder van de Universiteit Maastricht. Routineus schuift Hanneke (65) een soort badmuts met gaatjes erin over haar hoofd. Maatje 58. Een technicus controleert met een meetlint of het kapje de schedel goed bedekt. Haar stoel wordt in de ligstand gezet, benen omhoog.

van de patiënten is hiermee, al dan niet tijdelijk, geholpen. 40 procent helemaal niet. Die groep is aangewezen op elektroconvulsietherapie, ect. Maar elektroshocks, zoals ze vroeger genoemd werden toen de behandeling zonder narcose werd gedaan, is voor veel patiënten een brug te ver en wordt weinig toegepast.

Daarom is de wetenschap op zoek naar een alternatieve behandelmethode met een minder hoge

spoel, een soort douchekop, op haar schedel en de technicus stelt de sterkte van het signaal in – met een blik op haar rechterduim. Als die onwillekeurige bewegingen gaat maken, in reactie op de puls, is duidelijk hoe prikkelgevoelig Hanneke vandaag is en wordt de kracht van het signaal daarop afgestemd. De behandeling kan beginnen.

Trillende duimen en hersencellen wakker schudden door een

Onderzoeker Alexander Sack demonstreert een TMS-behandeling met een medewerker van de Universiteit Maastricht.

Terwijl wij zitten te praten, vuren er hersencellen in ons brein. Dat is de manier waarop hersennetwerken communiceren. Je kunt die neuronen ook van buitenaf met elkaar laten vuren. Dat is pure wetenschap. Nul tovenarij.'

Sack gebruikt TMS voor fundamenteel onderzoek naar de relatie tussen gedrag en brein. Hij wil bijvoorbeeld weten: welk deel van ons brein onthoudt dat telefoonnummer van vijf cijfers? MRI-scans laten slechts zien welke hersendelen actief zijn bij geheugentaken. Daarmee weet je nog niet welke gebieden onontbeerlijk zijn om dat telefoonnummer te onthouden. Met TMS lukt dat wel.

Sack laat gezonde proefpersonen geheugentaakjes doen terwijl hij hun brein een 'boost' geeft met magnetische pulsen. Zodra het geheugen van de proefpersoon verbetert, heeft Sack spijkerhard bewijs voor de exacte locatie van het werkgeheugen. Vervolgens gaat hij kijken met wat voor soort pulsen hij de beste resultaten bereikt. En in welke frequentie cellen binnen bepaalde hersennetwerken communiceren.

De effecten van de magnetische pulsen die Sack door de schedel jaagt (transcranieel betekent: door de schedel) zijn zeer tijdelijk. Zodra de spoel van het hoofd is, functioneert je werkgeheugen weer even beroerd of soepel als altijd. Maar wat als je de behandeling vaak herhaalt? Kun je dan breinfuncties herstellen die door een beroerte zijn aangetast? Sack denkt van wel. Hij doet onderzoek met patiënten met hersenletsel, als gevolg van een beroerte. Met als doel verstoorde breinfuncties (deels) te herstellen.

Een belangrijke inspiratiebron voor Sack is het onderzoek naar

koop. Bijwerk
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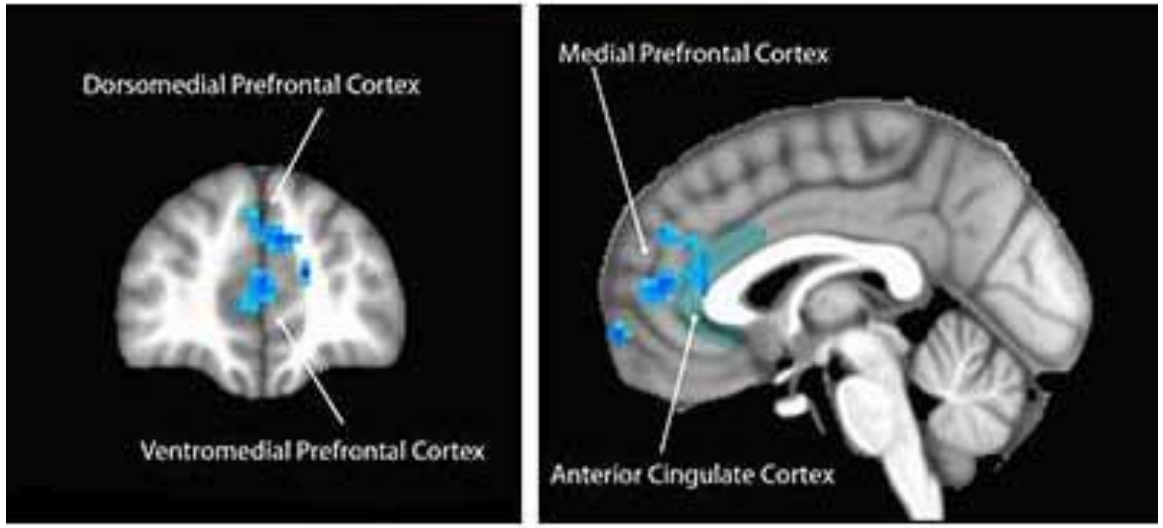
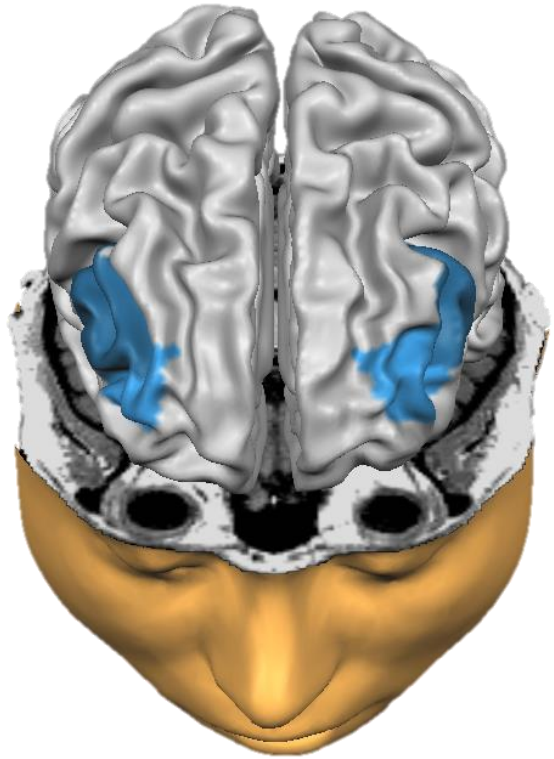
Depression: A Network Imbalance





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Go the extra mile

Simultaneous rTMS and Psychotherapy

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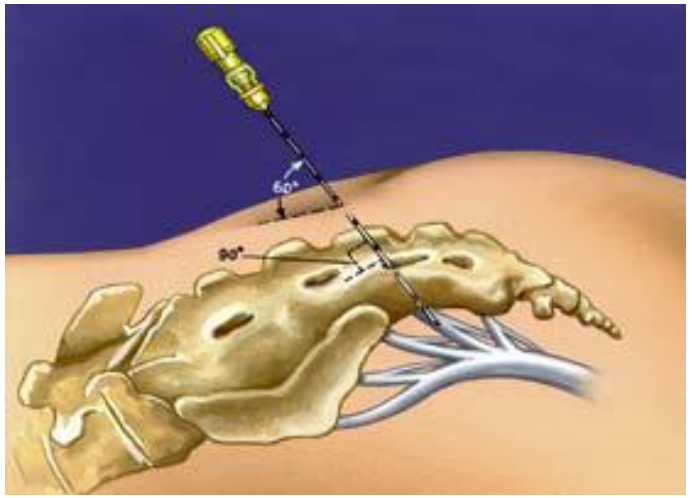
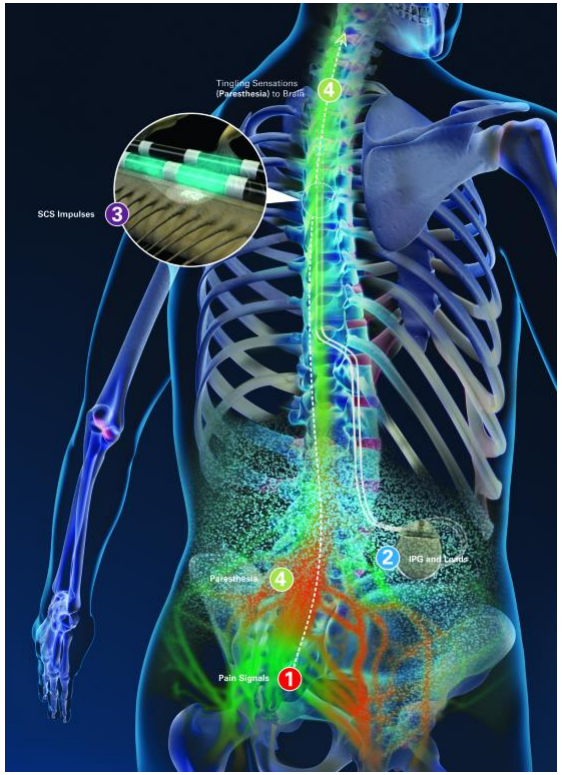
Go the extra mile

Many More Established Approaches

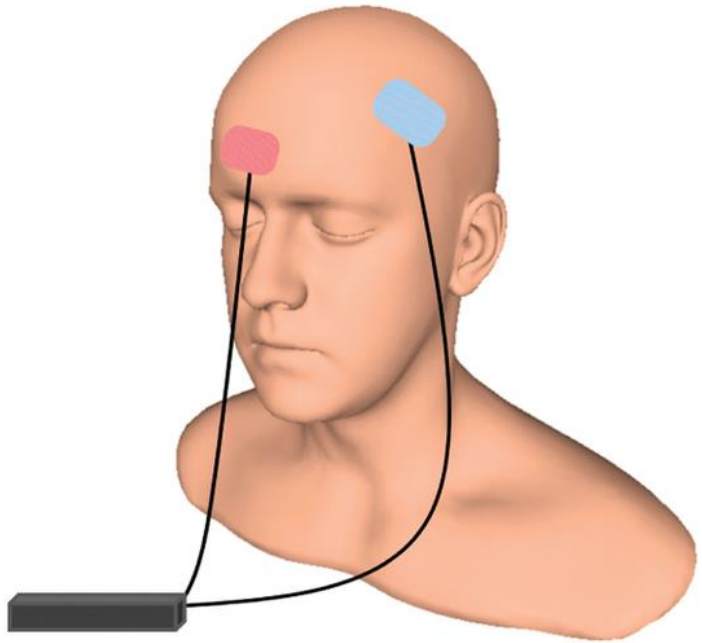


sacral nerve stimulation



spinal cord stimulation

vagus nerve stimulation



Transcranial electrical stimulation

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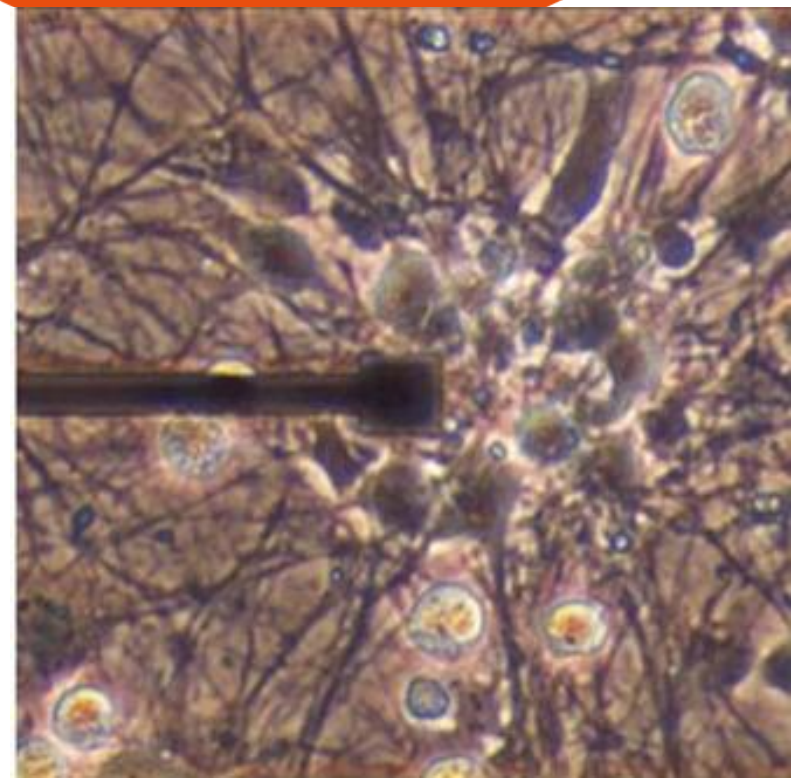
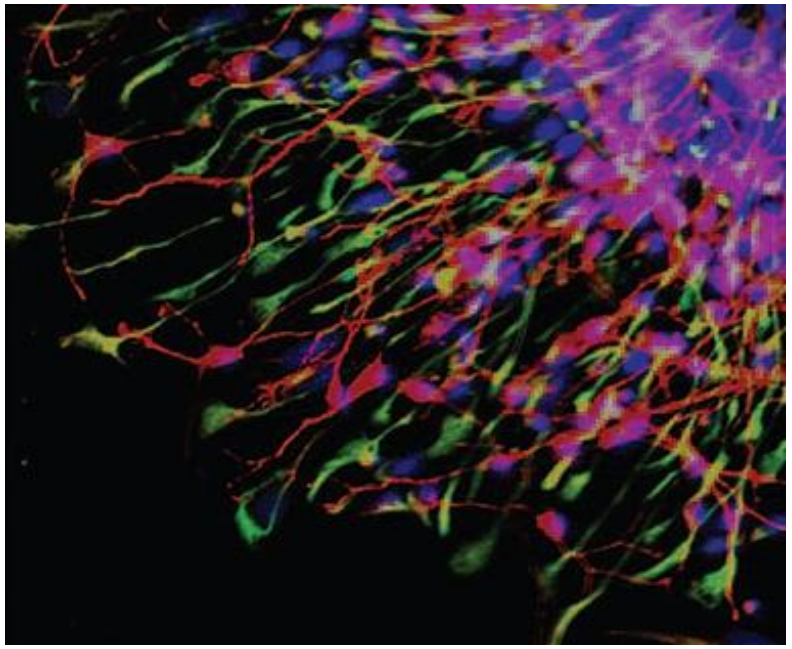
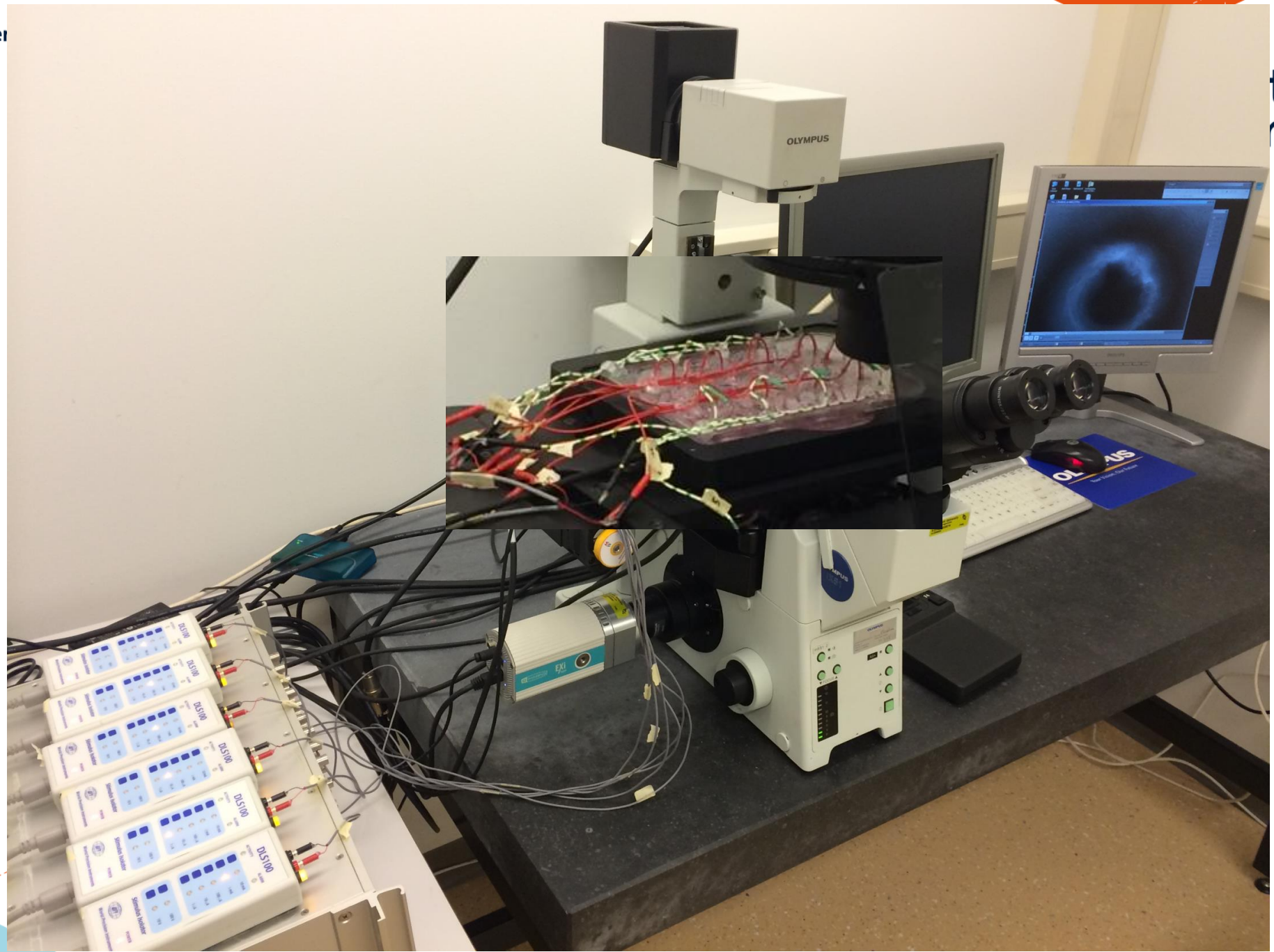
A quickly evolving field...

in vitro neuromodulation






OLYMPUS

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A quickly evolving field...

in vitro neuromodulation

in vivo neuromodulation

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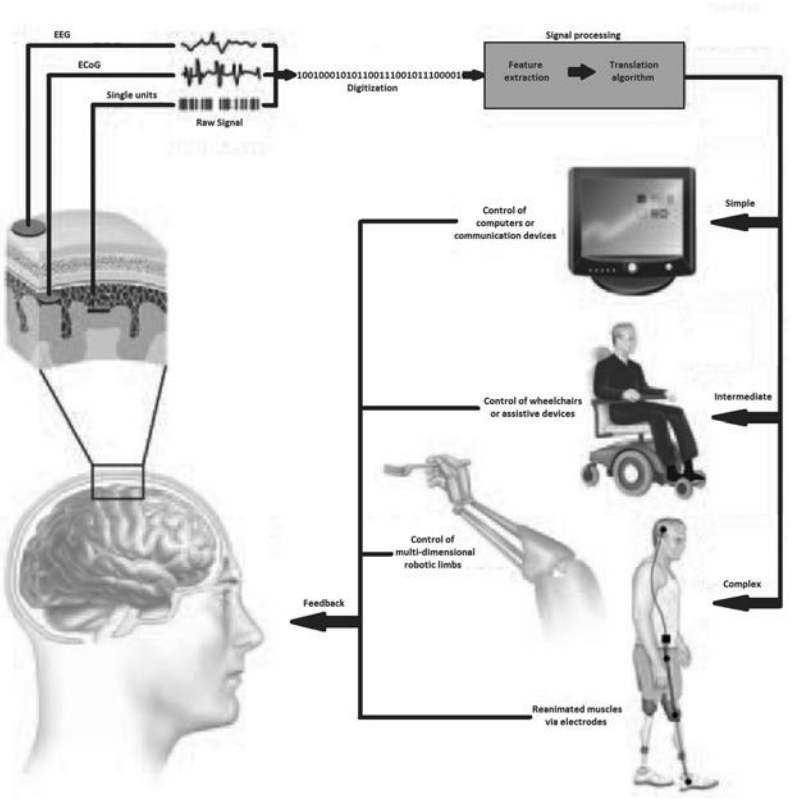
Go the extra mile

Brain-Computer Interfaces

devices that detect intent (typically intended movement) from brain activity, and translate it into an output action, such as control of a cursor on a screen or a robotic arm

1) acquiring a neural signal that can be consciously controlled
2) analyzing that signal to identify an intended motor output
3) executing the intended action



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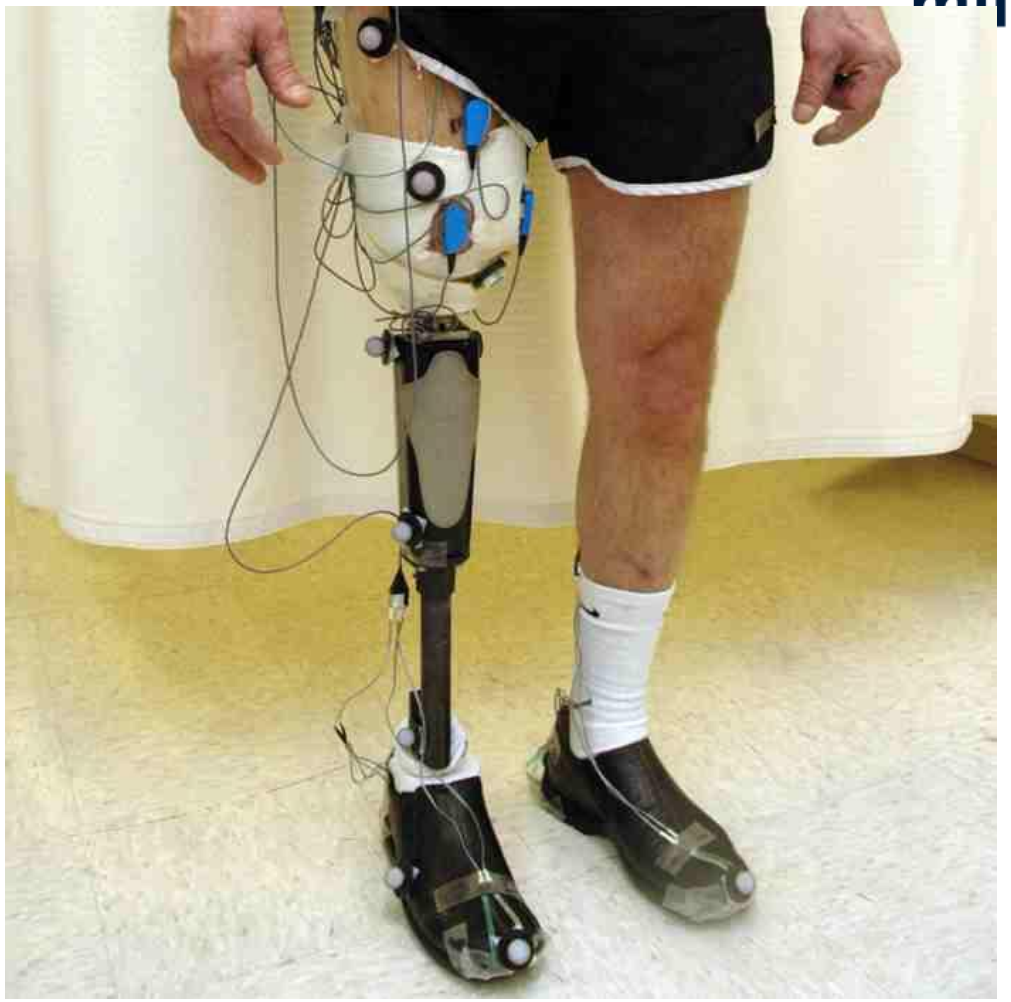
Go the extra mile

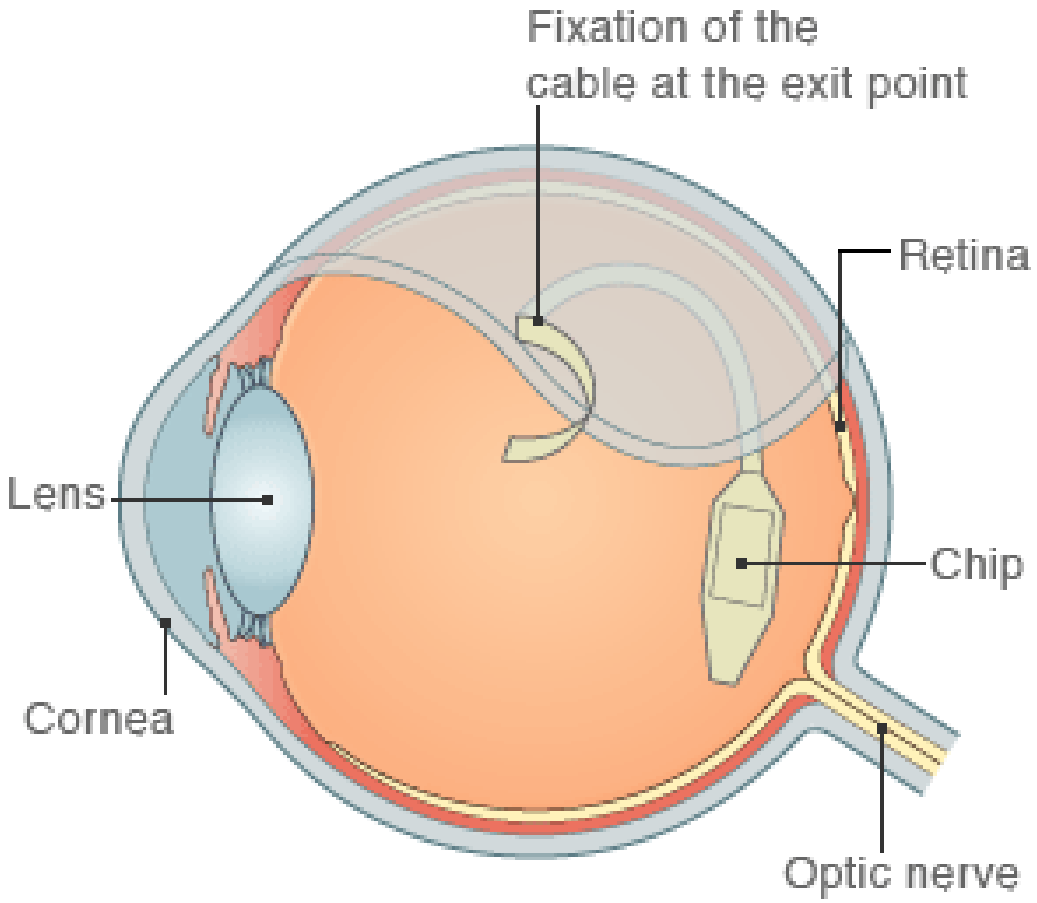
Neural Prostheses and Neural Rehabilitation

is used in conjunction with a planned training program to replace or improve function of an impaired nervous system or to provide a better, more controllable prosthesis following loss of a limb.



Retinal Implants

Where the implant is placed



Source: Retina Implant AG

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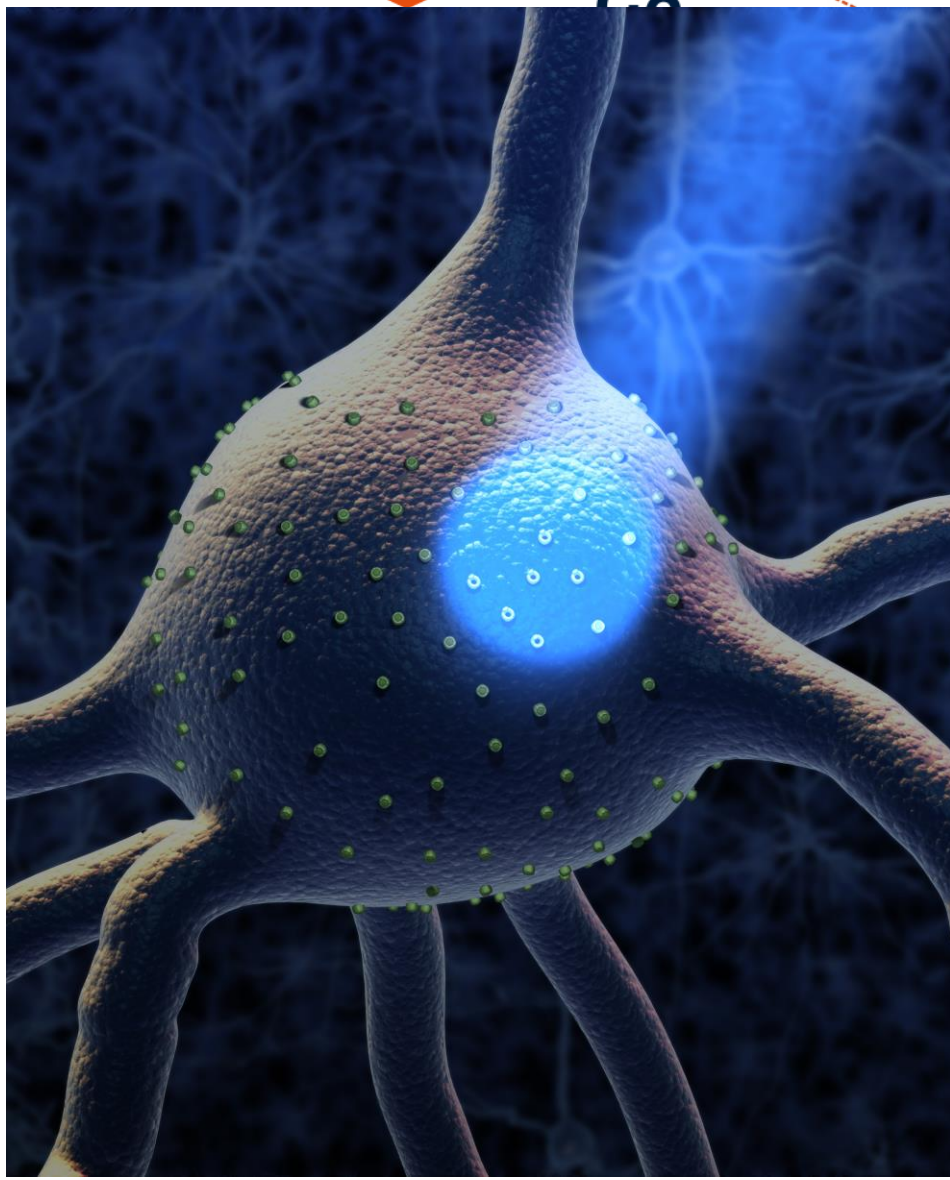
A quickly evolving field...

in vitro neuromodulation

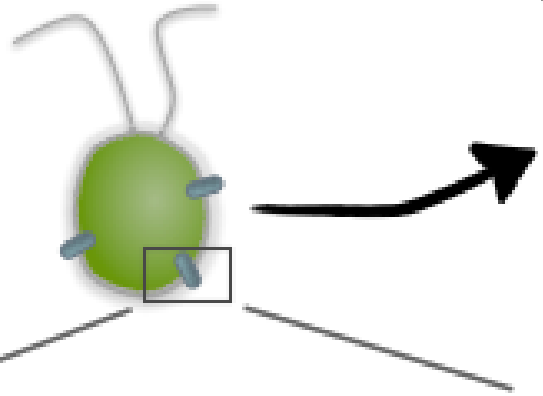
in vivo neuromodulation

optogenetics



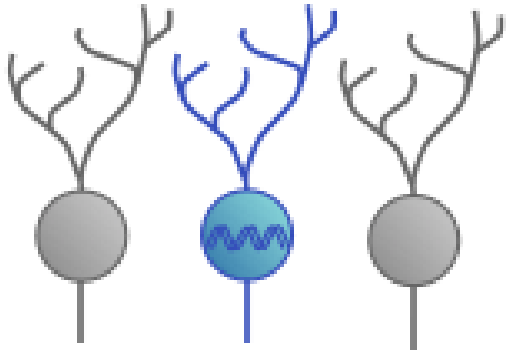
How optogenetics works

A light-sensitive protein from algae

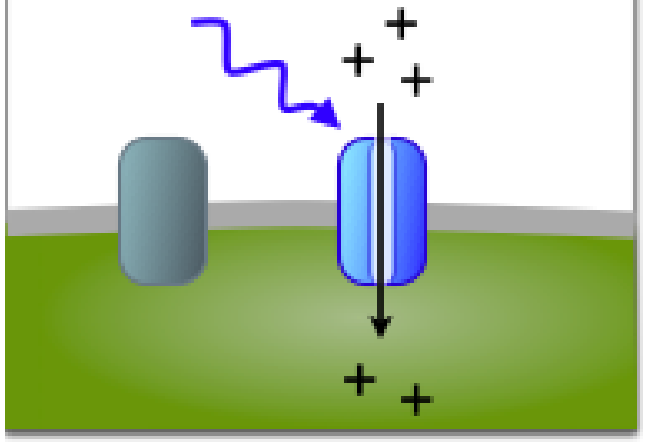


Take the gene for this protein...

... and insert the DNA into specific neurons in the brain

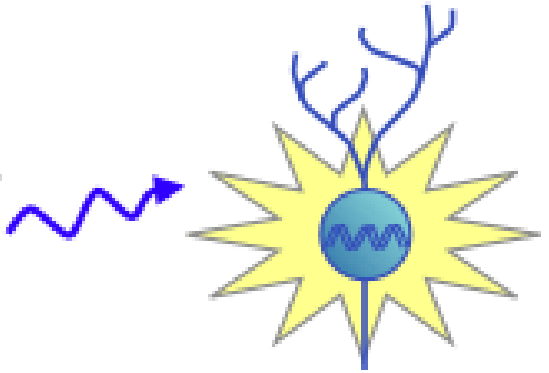


This protein is an ion channel that opens in response to **blue light**



Neurons communicate by "**firing**." This is an electrical signal created by opening & closing ion channels.

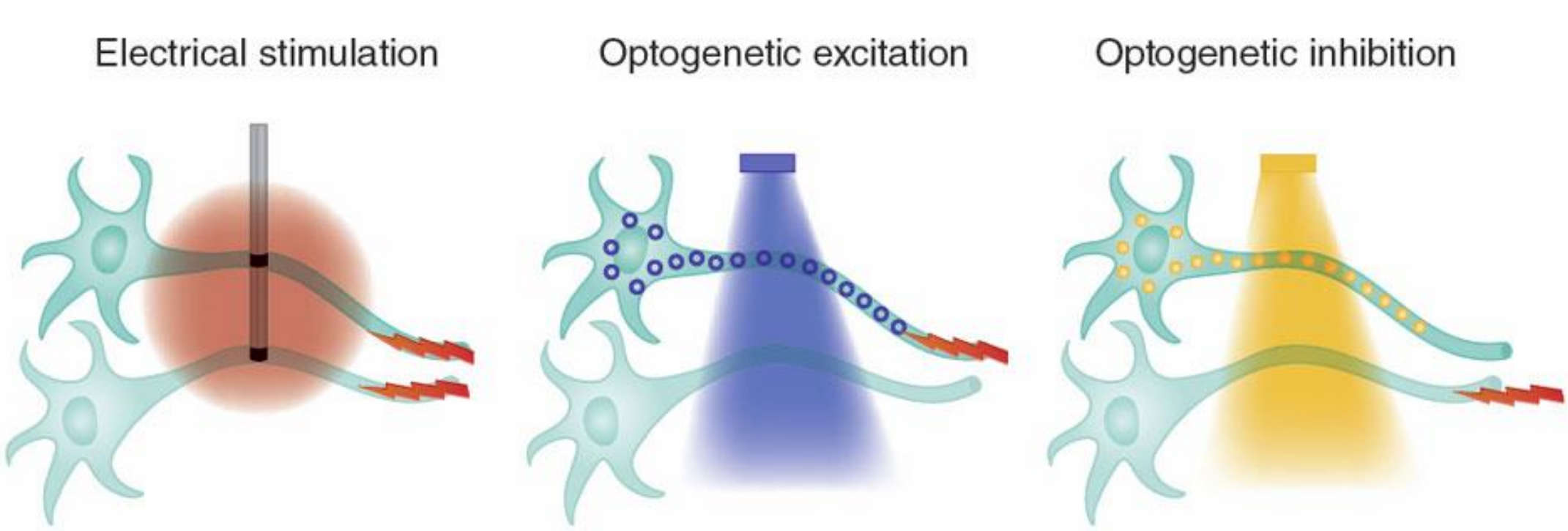
So now you can cause neurons to fire just by flashing **blue light!**



With the right combination of neurons, you can activate an entire brain circuit to control specific behaviors (like movement)

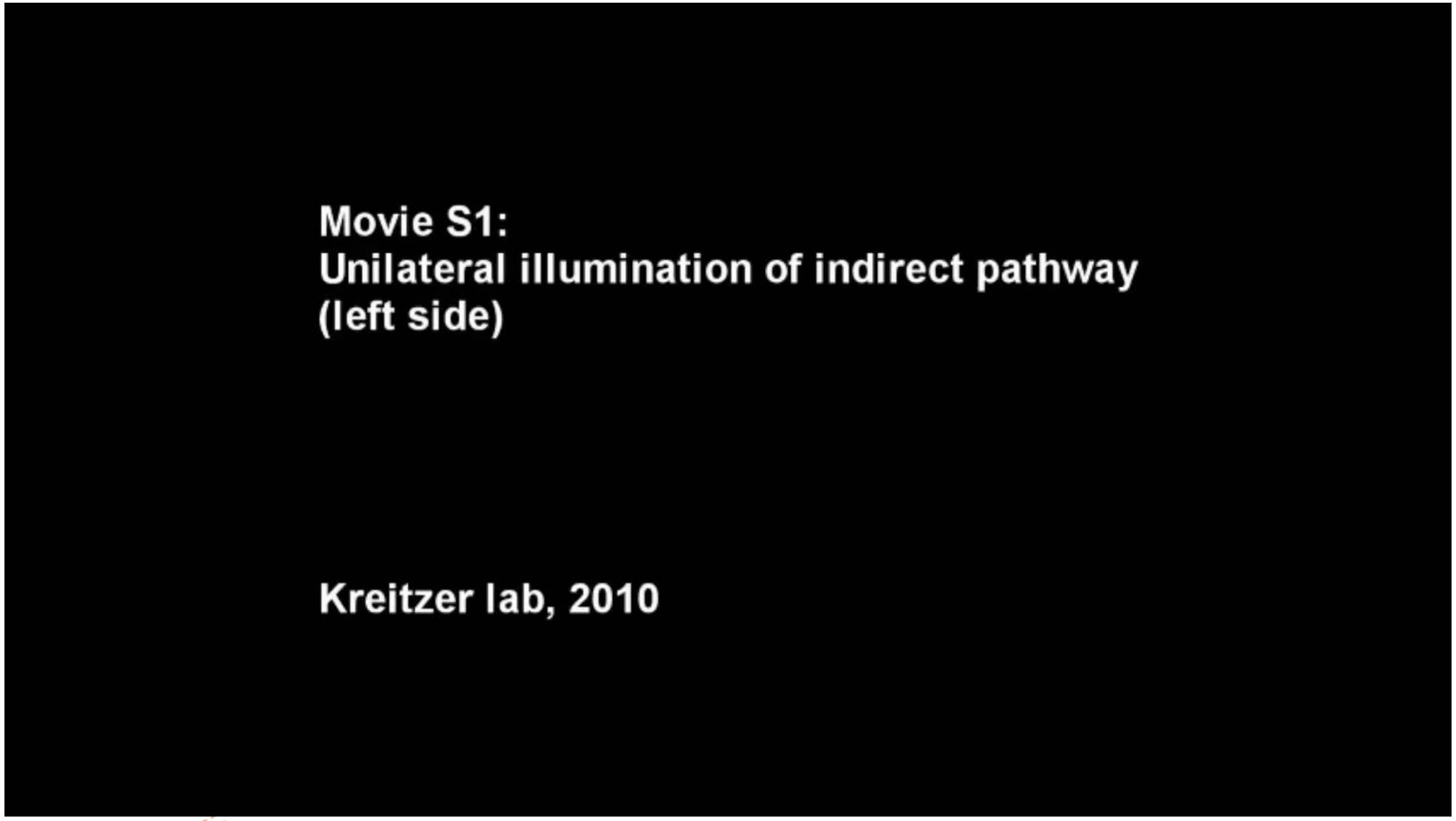
Henderson et al, 2009

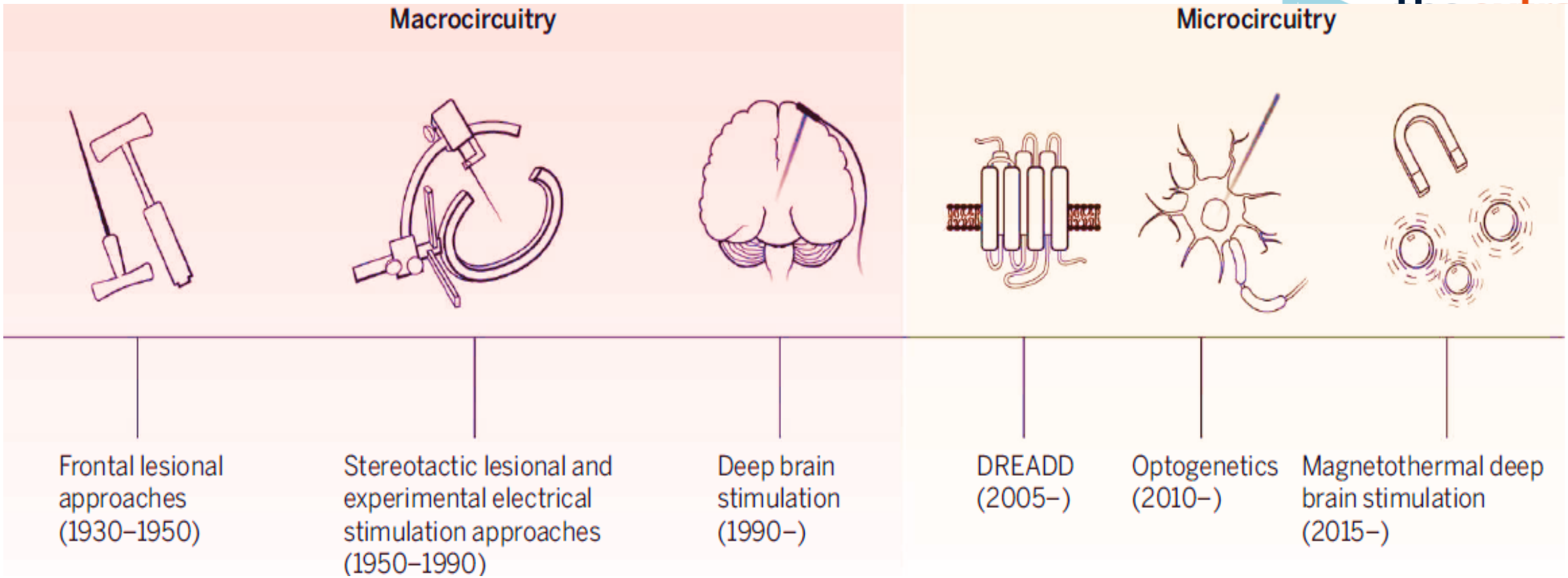
Specificity of the optogenetic neuromodulation technique



Henderson et al, 2009

Optogenetics





Temel and Jahanshahi, Science 2015

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Go the extra mile

Take-Home Message

The specialization in Neuromodulation is a brand-new programme

Ambitious combination of in-depth courses, practicals, and internship

MUMC+ is a unique setting for this research-oriented Master

Carreer prospects in academia, clinical settings, and industry

Maastricht University

Go the extra mile

Application deadlines to start in September 2019

- **Students who apply for a UM-wide scholarship**
  up to and including 1 February 2019
- **Non-EU/EEA-students**
  up to and including 1 May 2019
- **EU/EEA-students**
  up to and including 1 June 2019

Admission related questions?
Please visit the stand from the Board of Admission at the information market for a personal talk with our staff members

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visit

www.maastrichtuniversity.nl

for more information