BRAINGATE
THE NURAL INTERFACE
The BrainGate™ Neural Interface System is an investigational medical device that is being developed to improve the quality of life for physically disabled people by allowing them to quickly and reliably control a wide range of devices by thought, including computers, environmental controls, robotics and medical devices. In the future, the BrainGate System may enable those with severe motor disabilities to use their own arms and hands again. Cyberkinetics is also developing products to allow for robotic control, such as a thought-controlled wheelchair. Next generation products may be able to provide an individual with the ability to control devices that allow 2005 breathing, bladder and bowel movements.
JUST BY THINKING OF IT.
MEET DR. DONOOGHUE AND
HIS
PATIENT ‘NAGLE’
THE MOTION OF ROBOTIC-HAND BY THOUGHTS ALONE
WHAT IS BRAINGATE?
“NEURO MOTOR PROSTHESIS”

AN INVESTIGATIONAL DEVICE COMPRISED OF INTERNAL AND EXTERNAL SENSORS.

THE INTERNAL SENSORS DETECTS THE BRAIN SIGNAL ACTIVITY AND EXTERNAL SENSORS DIGITISES THE SIGNAL TO FEED INTO THE COMPUTER.
THE ARRANGEMENT OF INTERNAL SENSORS

THE INTERNAL SENSORS CONSISTS OF A CHIP OF SIZE (4X4) MM X MM WITH 100 ELECTRODES EACH OF LENGTH 1MM.
THE ARRAY BEING CONNECTED TO THE MOTOR CORTEX IS ATTACHED BY OPTICAL FIBRES TO THE PEDESTAL ON THE TOP OF THE SKULL.
HOW BRAINGATE IS CONNECTED TO THE COMPUTER?

THIS IN TURN IS CONNECTED TO THE COMPUTER VIA A DIGITAL CONVERTER.
NOW THE COMPUTER IS CONNECTED TO VARIOUS EXTERNAL DEVICES LIKE T.V, INTERNET, WHEEL CHAIR, EXTERNAL HAND ETC.
WHY TO CONNECT THE MOTOR CORTEX?
● This is how it was discovered that every part of the body has a particular region of the primary motor cortex that controls its movement.

• The area 6 of the motor cortex decides which set of muscle is to be contracted.

• The area 4 activates those muscles through motor neurons by calling various other part of brain (such as cerebellum).
In 1870 Hitzig and Fritsch stimulated various parts of dog’s motor cortex.

They observed that depending on what part of the cortex they stimulated, a different part of body contracted.

Moreover, they found that when they destroyed the same area of the cortex the corresponding area of body became paralyzed.
Inside the cortex

We know that different areas of the cortex control different parts of the body. Scientists can say how much of the cortex relates to each part of the body, as this exhibit shows.

'Cortex man' (representational models)

This is what a man would look like, if each part of his body grew in relation to the area of the cortex that controls it.
HOW INFORMATION IS TRANSMITTED THROUGH NERVE FIBRE?

- EVERY THING THE BRAIN DOES FROM ADDING A ROW OF NUMBERS TO DIRECTING THE ARM TO SWAT A FLY CREATES A POTENTIAL DIFFERENCE IN THE BRAIN.

- THE INFORMATION IS TRANSMITTED FROM THE CELL TO THE MOTOR CORTEX BY MEANS OF ACTION POTENTIAL ONLY.

- LET’S SEE HOW THIS POTENTIAL DIFFERENCE IS CREATED. BUT BEFORE THAT LET US KNOW THE CONSTITUTION OF CELLS.
THE PLASMA MEMBRANE:

✓ INSIDE THE CELLS PLASMA MEMBRANE IS PRESENT.

✓ THE OUTER PART OF WHICH IS DIPPED IN ECF (EXTRACELLULAR CELLULAR FLUID) & THE INNER PART IS DIPPED IN ICF (INTRA CELLULAR FLUID).

✓ THERE ARE ACTUALLY THREE STAGES OF THE PLASMA MEMBRANE:

1. POLARISATION (OR RESTING STATE)
2. DEPOLARISATION
3. REPOLARISATION
RESTING STATE OF PLASMA MEMBRANE

IN A RESTING STATE Na+ IONS PREDOMINATE IN EXTRACELLULAR FLUID (ECF) AND K+ IONS PREDOMINATE IN INTRA CELLULAR FLUID (ICF).

Polarization

\[ \text{Na}^+ \text{K}^+ \]
WHEN STIMULUS IS GIVEN TO THE NERVE FIBRE:
WHEN AN EXTERNAL STIMULUS IS GIVEN TO THE NERVE FIBRE A DISTURBANCE IS CREATED.

THE PLASMA MEMBRANE BECOMES PERMEABLE TO

Na⁺ IONS. SUDDENLY HUGE NUMBER OF Na⁺ IONS DIFFUSE INSIDE THE NERVE FIBRE AND THE K⁺ IONS MOVE OUTWARDS BUT IN LESS AMOUNT THAN THE Na⁺ IONS.

HENCE DEPOLARISATION OCCURS. i.e. REVERSAL OF CHARGE IN OUTER AND INNER PART OF MEMBRANE
DEPOLARISATION STATE OF PLASMA MEMBRANE:

HUGE NUMBER OF Na⁺ IONS HAVE ENTERED INSIDE, SO A NET +VE CHARGE IS CREATED IN THE INNERPART OF THE MEMBRANE.
STARTING OF REPOLARISATION
WHEN THE ACTION POTENTIAL CANNOT GENERATE SUFFICIENT VOLTAGE TO STIMULATE THE NEXT AREA OF THE MEMBRANE DEPOLARISATION STOPS AND REPOLARISATION STARTS.

BECAUSE OF THE INCREASE IN Na⁺ ION CONCENTRATION IN THE INNER PART OF THE MEMBRANE, THE MEMBRANE BECOMES LESS PERMEABLE TO THE Na⁺ IONS WHEREAS THE PERMEABILITY OF THE MEMBRANE TO K⁺ IONS INCREASES.

HENCE MORE K⁺ IONS ARE PUMPED INTO THE MEMBRANE AND SOME Na⁺ IONS LEAVE THE MEMBRANE.

THIS IS CALLED “REPOLARISATION”. i.e. THE ORIGINAL STATE OF THE POLARISATION IS REACHED.
DEPOLARISATION TO REPOLARISATION:

This is how the depolarisation is transmitted as a wave in the nerve fibre.

This wave of depolarisation is called “action potential” - the main cause of communication through nerve fibres.
WHAT THE BRAINGATE DOES THEN?
NOW THIS POTENTIAL DIFFERENCE ("ACTION POTENTIAL") IS CAPTURED BY OUR ELECTRODES AND IS TRANSMITTED VIA FIBRE OPTIC TO THE DIGITISER

THE DIGITISER CONVERTS THE SIGNAL INTO SOME 0 S AND 1 S AND THAT IS FED INTO THE COMPUTER.

THUS WE’VE SUCCESSFULLY GIVEN A NEW PATH TO THE PROPAGATION OF BRAIN COMMANDS FROM THE BRAIN TO THE COMPUTER VIA BRAINGATE.

NOW WHEN SOME EXTERNAL DEVICE IS CONNECTED TO THE COMPUTER THEY WORK ACCORDING TO THE THOUGHT PRODUCED IN THE MOTOR CORTEX.
FUTURE IMPLICATIONS:
FUTURE IMPLICATIONS ARE MIND BLOWING. WE CAN HAVE A ROBOT COMPLETELY CONTROLLED BY THE THOUGHTS WHICH CAN DO ANY WORK AND OBVIOUSLY VERY MUCH EFFECTIVELY.

THERE WON’T BE ANY MASTERMINDS LIKE ASTROPHYSICS “STEPHEN HAWKINGS” PARALYSED.
IT CAN BE A BOON NOT ONLY TO THE PARALYSED PERSONS BUT ALSO TO THE ENTIRE HUMANITY.
BRAIN
FINGER
PRINTING
IT CAN GIVE A NEW LIGHT TO “BRAIN FINGER PRINTING”.

ALL THE INFORMATION IS STORED IN CEREBRAL CORTEX OF THE BRAIN AS MEMORY.

NOW WHEN WE FEED THE RELEVANT SOUNDS, PICTURES ETC AS STIMULII TO THE BRAIN, IF IT MATCH WITH THE INFORMATION PRESENT IN THE BRAIN THEN THE WAVES COINCIDE AS SHOWN IN FIG. 1:

**FIG. 1**
Otherwise the waves won’t concide as shown in Fig. 2.
ORIGIN OF BRAINGATE

BRAINGATE IS A CULMINATION OF 10 YEARS OF RESEARCH OF DR. JHON DONOHUE WHO IS THE CHAIRMAN OF THE “NEUROSCIENCE DEPARTMENT” AT BROWN UNIVERSITY AND CHIEF SCIENTIFIC OFFICER FOR CYBERKINETICS.

THE NEUROSURGEON DR. GERHARD FREIGHS HELPED HIM BY EXPERIMENTING ON MONKEYS TO CONTROL THE CURSOR BY THOUGHTS ALONE.

THESE RESEARCHERS CO-FOUNDED CYBERKINETICS. INC. IN FOXBORO, MASSACHUSETTS. THE COMPANY BEARS ALL THE EXPENSES REQUIRED FOR THE STUDY. NOW IT IS PURELY EXPERIMENTAL.
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