Electric Brains – Mental Music and Robotic Arms

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Project Type: Demonstration
Museum/Venue: MSI (possibly on a small stage, or in the round demonstration room)
Target Audience: Older children and Adults

Big Idea:
This demonstration explores how the brain controls the body. The brain powers the muscles by sending messages back and forth in the form of electric signals. This concept is explained by intercepting the signals in both directions: a) by using electric signals from the brain to power an external device, and b) by using external signals to power human muscles. The "So what?" question is answered by showing how this understanding of the way electric signals from the brain power muscles can aid in creating prosthetic arms for amputees that they control directly from their brain.

The demonstration begins by explaining that the body and the brain have to work together, but the brain needs some way of 'telling' the body what to do. It does so by sending electric impulses along the network of nerves directly to the muscles to make them contract or relax. The demonstrator will then show how we these electric impulses can be intercepted in either direction – we can generate 'fake' electric signals to send to the muscles, or we can use the electric signals from the brain to power something else. There are then two demonstrations of this:

Mental music: Demonstrating that the brain produces electric signals, which in this case are 'visualised' through music. Electrical signals generated by the brain are used to control beats in music.

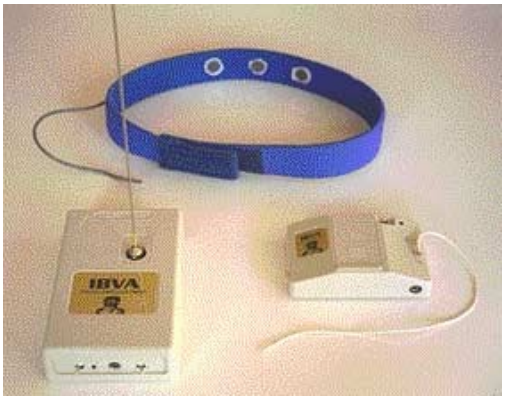
Machine controlled arm: external electric stimulation can move our limbs. Stimulation from an external device is used to move parts of the body without the brain being involved.

After showing these two concepts, the demonstrator then asks the audience if they can think of any way we can use this kind of technology in people's everyday lives? The

demonstrator explains that by 'rewiring' the nervous system that carries these electric impulses, its possible for the brain to control a prosthetic limb. A short video clip of the arm being used can then be shown.

How?

Mental Music. The volunteer wears a head band containing sensors. This is connected to a monitor. Like in Mind Ball, the volunteer is able to control the music (pitch, volume, instrument and channel) using their brain waves. Different members of the audience have to wear the headband to realise what is happening, which may be a disadvantage. However with multiple head bands many people can create an 'orchestra'.

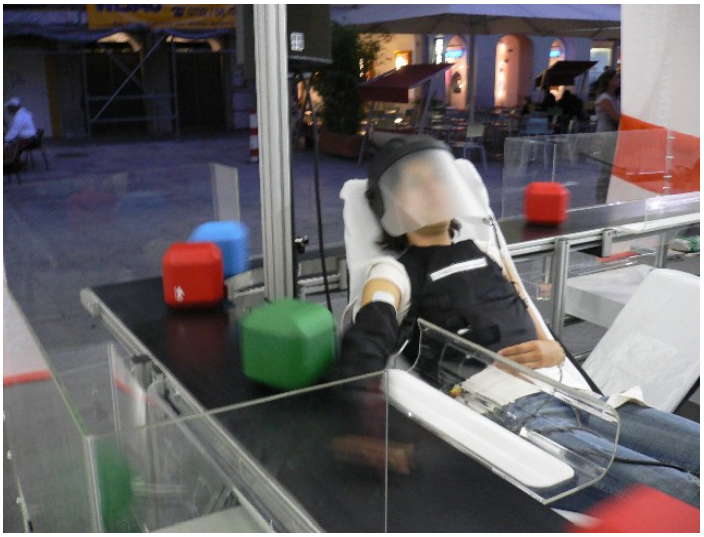


Mental Music equipment (image from ibva.co.uk)

Alternatives: If the Mental Music technology is not available, the Mind Ball could be used, or a version of mind ball that uses alpha waves to change the volume/beat of a musical track. Different members of the audience could control different beats, which then join together.

Machine powered muscles. The Ottobeck Neurostimulator is used to demonstrate how a volunteer's arm can be controlled by electric stimulation from outside the body. The volunteer (Person A) sits in a chair with their arm resting on a table. On the table near their arm are soft balls. Attached to their arm are the sensors from the Neurostimulator. The machine is calibrated to Person A beforehand, to ensure that a safe charge will be applied.

Another volunteer/demonstrator (Person B) controls the Neurostimulator and stands out of sight of Person A, but in sight of the audience. Person B stimulates Person A's muscles using the Neurostimulator, and causes Person A to hit soft balls off the table with their arm.



The Neurostimulator being used at Ars Electronic festival 2006. (photo Brenda Lopez)

Alternatives: If it is not possible to get the Neurostimulator, an 'Electric Muscle Stimulator' (of the type dubiously marketed as a weight loss device) could be used to demonstrate the involentary movement of the muscles.

Prosthetic arms: While it is not likely to be possible to get a prosthetic arm to demonstrate with, a video of a prosthetic limb being used could be shown, along with a description of how it works. There are various film clips from press conferences available.

Technology needed

These demonstrations would involve the use of expensive technology, and as such would probably require donations from the companies involved. So far, we have written to the creators of the IBVA (mental music) and STIWELL med4 (Machine controlled muscles) and are waiting to here back from them for more information on the applicability of using these technologies in a museum setting and more information. If this project were to be developed further we would like to approach these two companies to ask if they would be

interested in helping MSI develop this demonstration, particularly through donating some equipment.

The IBVA costs £1120 ($2200). The STIWELL med4 is not currently available for sale in the US.

Why?

These demonstrations show how the brain gives out electric signals, which control muscle movement. We can see this by substituting either the electric signals (in the case of the Neurotransmitter) or the resulting movement (in the case of the mental music and the prosthetic arm.

Evaluation Process

This demonstration would require the acquisition of the necessary technology, which will then need to be tested for health and safety. Evaluation would focus mainly on safety and comfort of the museum visitors, but would also access how well the concepts behind the technology are being communicated.

Connections to other MSI Exhibits

This demonstration is designed to fit into the Body Human exhibit, and is also similar to (or could include) the Mind Ball demonstration.

References and further information

Prosthetic arms at RIC:

http://www.ric.org/bionic/bionicwoman.php

"To provide the neuro-controlled movement of RIC's Bionic Arm technology, nerves located in the amputee's shoulder, which once went to the amputated arm, are re-routed and connected to healthy muscle in the chest. This surgical process is called targeted muscle reinnervation. The muscle reinnervation procedure allows the re-routed nerves to grow into the chest muscle and direct the signals they once sent to the amputated arm instead to the robotic arm via surface electrodes. Then, when the patient thinks about moving his or her arm, the action is carried out as voluntarily as it would be in a healthy arm allowing for smoother and easier movement of the prosthetic.

In other words, the sensation nerves to the hand have been re-routed to a patch of skin on her chest. Now when Ms. Mitchell is touched on this skin, she feels that her hand is being touched. This will eventually let her 'feel' what she is touching with an artificial hand, as if she were touching it with her own hand."

FAQs on Prosthetic arms:

http://www.popsci.com/popsci/medicine/6123dc8a25076010vgnvcm1000004eecbccdrcrd/2.html

Video of press conference on the Prosthetic arm, showing its use:

http://www.youtube.com/watch?v=UpOdZB0EPs0

Ottobock Neurotransmitter:

http://www.ottobock.com/cps/rde/xchg/SID-3F574DD1-2EFD97B4/ob_com_en/hs.xsl/342.html

"The term neurostimulation describes effecting the nervous system using electric impulses. Stimulation either takes place indirectly via electrodes located on the skin, or directly on the nerve using an implant. The therapy goal is to reestablish motor functions that were impaired due to damage to the brain or spinal cord. The main focus of our efforts is rehabilitation after a stroke or in case of paraplegia."

IBVA "mental music":

http://www.ibva.co.uk/

"With IBVA - pitch, volume, instrument and channel are all controllable with your brainwaves. By assigning specific MIDI notes to correspond with bandwidths of your brainwave's Hertz and power, you can generate notes, chords and play 'phrases'. You may prefer to remix a prearranged composition with a 'live' brain interaction. Using the brainwave frequencies to change the experience for each user."