Brain – Computer Interfacing

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Brain-Computer Interfacing (BCI), which is also referred to as neural interfacing or brain-machine interfacing, deals with the direct interaction of an external device to a human or animal brain. As of yet, only one-way BCIs have been successfully implemented in either human or animal brains. One-way BCIs consist of either sending or receiving of brain signals. If the BCI were able to send and receive signals simultaneously, this would be considered a two-way BCI, which as stated before has yet to be successfully implemented therefore we shall only look at one-way BCIs.

Early work in BCI was done by groups led by Schmidt, Fetz and Baker in the 1970's, in which they developed algorithms by using operant conditioning to investigate motor cortex neuron firings.[1] Further work was done in the 1980's by Apostolos Georgopoulos at Johns Hopkins University, where he discovered a relationship between motor cortex neurons and the direction in which a monkey moved its arm.[2]

One of the most major and exciting advances in BCI was done by Yang Dan in 1999. He was able to decode the neuronal firings in a cat to reproduce what it was that the cat was actually seeing. [3]

Since these critical starting points for BCI develop, other major advances have been done in the human world. William Dobelle was a private researcher doing work on vision science, in which the second prototype of his device was used in Jens Neumann in
2002. With this device, Jens Naumann who was blinded in his adulthood was able to see again, though far from perfect.

Other amazing advances were done 1998 by by Philip Kennedy and Roy Bakay at Emory University in Atlanta. They were able to implant a BCI into a patient with no motor abilities and were able to receive strong enough signals so that the patient was able to control a mouse cursor on a computer.[4]

In 2005 Cyberkinetics Neurotechnology's BrainGate was implanted in tetraplegic Matt Nagle's Precentral Gyrus in which he was able to then control a robotic arm, and even a computer cursor, and a television. [5]

The major theme on BCI developments revolves around how the brain adapts to the device. Researchers believe that someday, rather than using a BCI to restore functions of the brain, they may be able to one day actually enhance the functions of the brain.

[1] *Schmidt E M et al. 1978 Fine control of operantly conditioned firing patterns of cortical neurons Exp. Neurol. 61 349–69*

[2] *Georgopoulos AP, Lurito JT, Petrides M, Schwartz AB, Massey JT (1989) Mental rotation of the neuronal population vector. Science 243: 234-236*

[3] *G. B. Stanley, F. F. Li, and Y. Dan. Reconstruction of natural scenes from ensemble responses in the LGN, J. Neurosci., 19(18):8036-8042, 1999*

[4] *Kennedy, P.R., Bakay R.A. (1998) Restoration of neural output from a paralysed patient by a direct brain connection. Neuroreport. June 1;9(8):1707-11*

[5] *Leigh R. Hochberg; Mijail D. Serruya, Gerhard M. Friehs, Jon A. Mukand, Maryam Saleh, Abraham H. Caplan, Almut Branner, David Chen, Richard D. Penn and John P. Donoghue (2006-07-13). "Neuronal ensemble control of prosthetic devices by a human with tetraplegia". Nature 442: 164–171. doi:10.1038/nature04970. Retrieved on 2006-09-10.*