NEUROETHICS AND HOMELAND SECURITY

September 29th, 2006
Tufts University

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TUFTS UNIVERSITY

Organized by Dr Turhan Canli, PhD.
Department of Psychology, Stony Brook University

Workshop Presenters:

Dr. Guven Guzeldere, Associate Professor, Philosophy Department, Duk University.

Don DuRousseau, CEO, Human Bionics, an early-stage neurotechnology company.

Dr. Turhan Canli, Graduate Program in Genetics and Department of Psychology, Stony Brook University; Co-Founder and Executive Board Member of the Neuroethics Society.

Dr. Charles Morgan, Associate Clinical Professor of Psychiatry and Research Affiliate, History of Medicine, Yale University School of Medicine.

Dr. Alvaro Pascual-Leone, Professor of Neurology, Harvard Medical School and Director of the Laboratory for Magnetic Brain Stimulation.

Dr. Hank Greely, Deane F. and Kate Edelman Johnson Professor, Stanfo University.

Dr William Casabeer, Major, USAF, Chief of Eurasian Intelligence Analysis, NATO Military Headquarters.

Dr Susan Brandon, Behavioral and Social Science Principal, Mitre, a nonprofit corporation providing systems engineering, research and development, and information technology support to the government.

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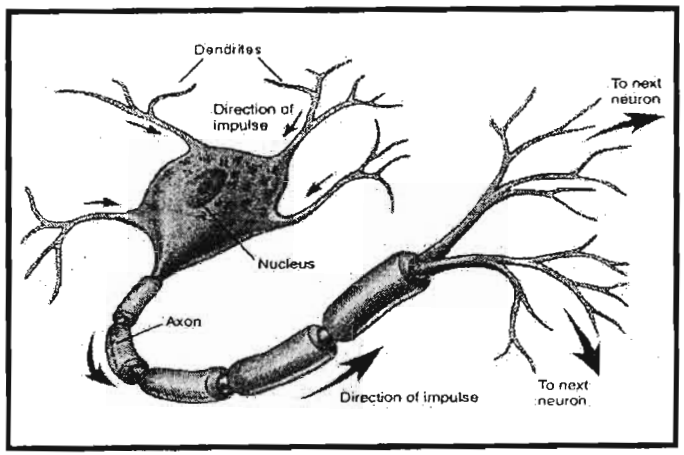
P.J Crowley, Senior Fellow and Director of National Defense and Homeland Security, Center for American Progress.

NEURONS:
-The 100 billion building blocks of the human brain-



Neuron Anatomy:
A Unique Cytoarchitechture

Cell Body (houses DNA and protein synthesis machinery)
Axon (Sends signals to other neurons)
Dendrites (Receives input from other neurons)

Neuronal Communication:
The delicate balance of electrical and chemical signals:

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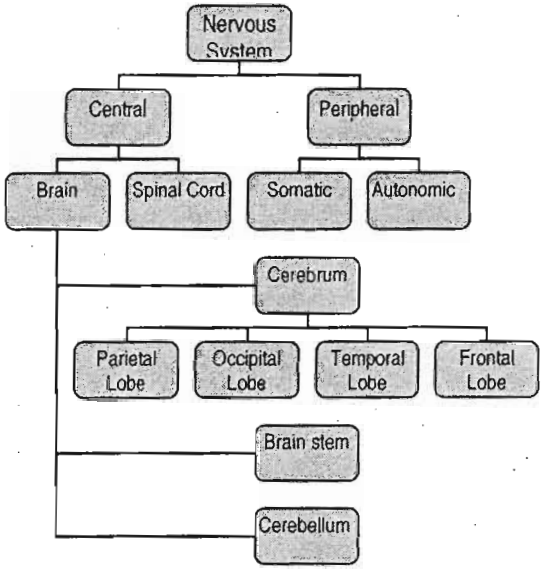
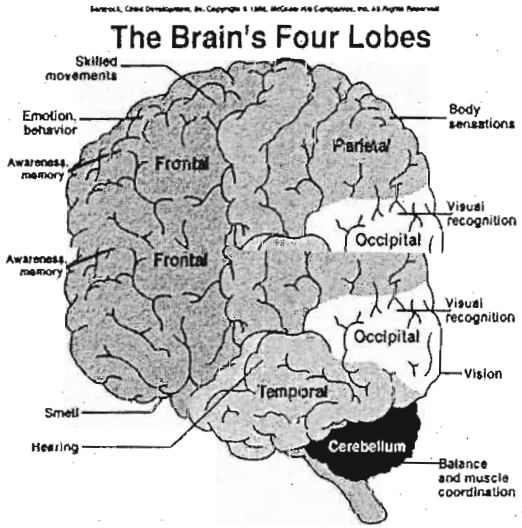
The delicate balance of electrical and chemical signals:

Within neurons: *the Action Potential*→ selective movement of charged ions across the cell membrane allows a neuron to convert incoming information to outgoing signals.
In between Neurons: *the Synapse*→ the space in between neurons where relevant information, in the form of chemical transmitters, is sent from one neuron to another.

KEY BRAIN ANATOMY:





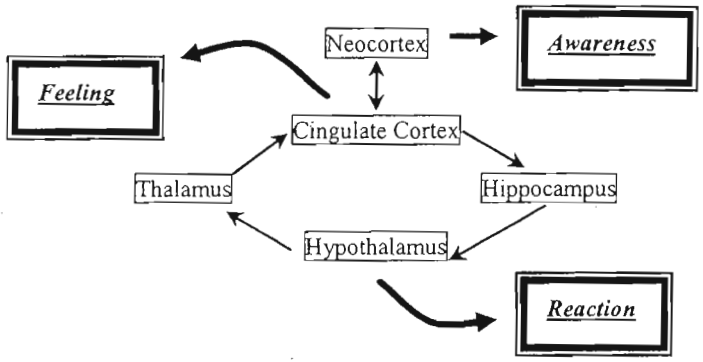
Neural Perspectives on Emotion:

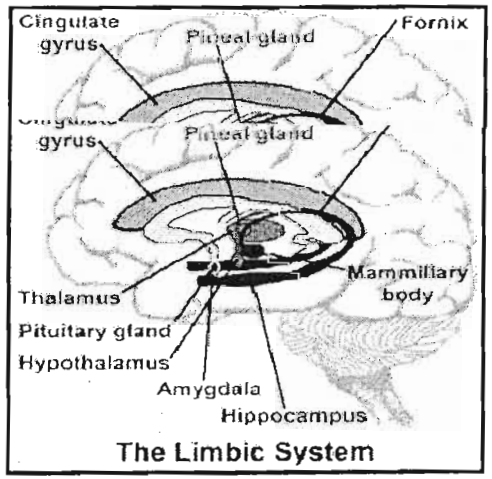
The Limbic Lobe and the Papez Circuit:

1. Sensory systems send information about outside world to the brain.
2. Brain interprets input and assigns it an emotional quality + value.
3. Brain devises and orchestrates the appropriate behavioral response.

1878: Paul Broca collectively referred to a group of related cortical ons bordering the brain stem as the **Limbic Lobe.**

1930s: James Papez implicated the limbic lobe in emotional processing suggested the **Papez Circuit** as a proposed pathway by which emotions related physiological changes are produced.





THE BIOLOGY OF AGRESSION:

(1) Anatomical Regions Associated with Aggressive Behavior:

a. Amygdala:
   i. Electrical stimulation of this region produces visib agitation and aggression in animals.
   ii. Studies of Rhesus Monkeys show that the amgyda necessary for the aggressive behavior required to establish and maintain dominant positions in socia hierarchies.

b. Hypothalamus:
   i. Posterior region of hypothalamus is important in t expression of anger- normally it is inhibited by hi cortical areas. Studies show that disrupting this connection between the cortex and hypothalamus lead to inappropriate rage - **"sham rage".**
   ii. Sends signals to 2 key brain stem regions which h trigger the physiological manifestations of anger:
      1. Ventral Tegmental Area
      2. Periaqueductal Gray Matter

(2) Chemical Compounds Associated with Aggressive Behavior:

a. Androgens:
   i. Male hormones, such as testosterone, are positive correlated with levels of experienced aggression.
   ii. Castrated animals show lower levels of aggressio

b. Serotonin:
   i. Low levels of serotonin have been associated wit increased aggression.
   ii. Drugs that block serotonin activity have been see

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   iii. Drugs that enhance serotonin activity have been s to decrease aggression.

THE BIOLOGY OF FEAR:

Detection, Perception, and Reaction: the Amygdala and Beyond

(1) Perception of Fear:

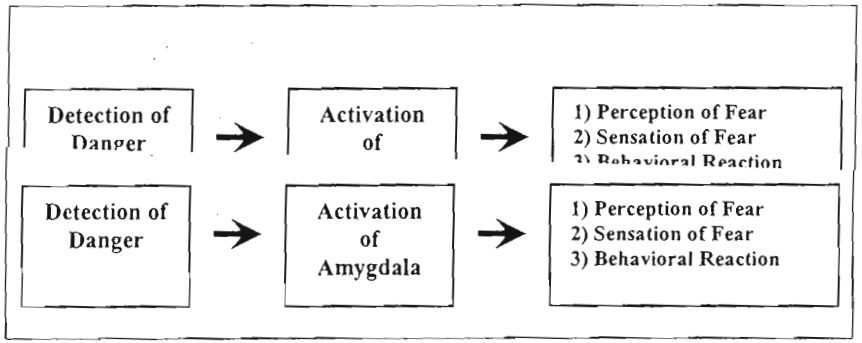
a. Visual system detects fearful stimuli
b. Detection leads to the activation of the *amygalda*.
c. The amygdala sends the information to the cerebral cortex resulting in the sensation of fear.

(2) Physiological Response to Fear:

a. Central Nucleus of the Amygdala sends information to the Hypothalamus
b. Hypothalamus produces a sympathetic, autonomic response by activating other structures (i.e. the pituitary).
   i. Release of Adrenaline (Epinephrine) into circulation
   ii. Accelerated heart rate
   iii. Vasoconstriction (increases blood pressure)
   iv. Increased glucose release into blood etc.

(3) Learning Fear:

a. Fear is a way of learning how to avoid danger.
b. Proposed Brain circuitry for learned fear:
   i. Fearful stimulus activates the basolateral region of the amygdala.
   ii. Cells of basolateral region send corresponding information to central nucleus of amgydala.
   iii. The cells of the central nucleus send the information to the Periaqueductal Gray Matter in the brain stem.

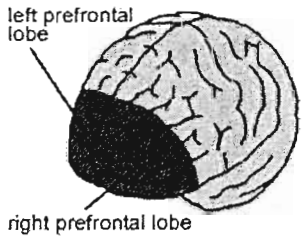


The Executive Brain:

The Decision-Making Process:
Associated with the **Prefrontal Cortex**→ 2 regions in specific:

a. **Orbitofrontal Cortex**: thought to evaluate and assess the social/emotional context that contributes to the decision being made.
b. **Anterior Cingulate Cortex**: thought to select the behavioral response required to execute the decision, in addition to keeping track of any such incorrect responses.

Self Control
Damage to the prefrontal lobe, which is associated with behavioral and higher order processing, can cause the loss of self control associated with criminal/amoral behavior.



Lie Detection

- Deception may be related to changes in regional blood flow to areas such as the **anterior cingulate nucleus** and the **superior frontal gyrus.**
- Techniques to detect acts of deception are currently being areas such as the **anterior cingulate nucleus** and the **superior frontal gyrus.**
- Techniques to detect acts of deception are currently being researched, for example thermal scanning methods that reflect changes in peripheral blood flow patterns.

Relevant Technologies for the Advancement of Neuroscience Research:

-Technologies that Provide Information about Gross Anatomic/Structural Features:

→**Computed Tomography (CT)**: An X-ray source is rotated around one side of the patient's head within the plane of the cross section that needs to be viewed. On the other side of the patient's head, the X-ray beams are picked up by electronic sensors, allowing for a digital reconstruction of the brain based on relative amounts of radiopaque material.

→**Magnetic Resonance Imaging (MRI)**: A magnetic field is applied and sensors detect the electromagnetic signals that hydrogen atoms within the brain consequently emit. A computer then reconstructs images of the brain.

-Technologies that Provide Information about Levels of Brain Activity:

→**Functional Magnetic Resonance Imaging (fMRI):** Detects activity by measuring the ratio between oxyhemoglobin and deoxyhemoglobin in various brain regions. Active tissues require higher levels of blood flow and oxygen, allowing for comparison of levels of activity in different regions.

→ **Positron Emission Tomography (PET):** A radioactive solution with positron emitting atoms is injected into the bloodstream. The positrons can then emit photons, which are then
→ **Positron Emission Tomography (PET):** A radioactive solution with positron emitting atoms is injected into the bloodstream. The positrons can then emit photons, which are then detected by specialized sensors. Higher levels of positron emission in a given brain region signify larger amounts of blood flow, hence increased brain activity.

Suggested Further Reading:

Neuroethics: Defining the Issues in Theory, Practice and Policy. Editor Judy Illes. Oxford University Press 2005.

Neuroethics: Mapping the Field. Editor: Steven J. MArcus. Dana Press 2004

The Ethical Brain by Michael Gazzaniga. Dana Press 2005.

Hard Science, Hard Choices: Facts, Ethics, and Policies Guiding Brain Science Today (Dana Foundation Series on Neuroethics) by Sandra Ackerman.
Dana Press 2006.

Biology of Personality and Individual Differences. Editor: Turhan Canli.Guilford Press 2006.

Mind Wars: Brain Research and National Defense by Jonathan Moreno. Dana Press 2006.

References:.

Goldberg, E., *The Executive Brain: Frontal Lobes and the Civilized Mind.* Oxford University Press, New York, 2001.

Bear M., Connors B., Paradiso, M. *Neuroscience: Exploring the Brain, 3rd addition,* Lippincott Williams and Wilkins, Baltimore, 2007