การประชุมสัมมนาวิชาการด้านวิทยาศาสตร์การแพทย์ เรื่อง "การพัฒนายุทธศาสตร์งานวิจัยเกี่ยวกับสมอง จิตใจ และพฤติกรรม" (Development of Research Strategies for Brain Mind and Behaviour)

จัดโดย สาขาวิทยาศาสตร์การแพทย์ สำนักงานคณะกรรมการวิจัยแห่งชาติ (วช.) ร่วมกับ สถาบันวิจัยระบบสาธารณสุข (สวรส.) วันที่ 21 – 23 กรกฎาคม 2557 ณ ห้องประชุมจูปิเตอร์ (Jupiter) ชั้น 3 โรงแรมมิราเคิลแกรนด์ คอนเวนชั่น กรุงเทพฯ

Neuroscience: Scientific Bases of Brain-Mind-Behavior and Development of Neuroscience Research and Education for Thailand

รศ. ดร. นัยพินิจ คชภักดี

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อาจารย์พิเศษศูนย์วิจัยประสาทวิทยาศาสตร์
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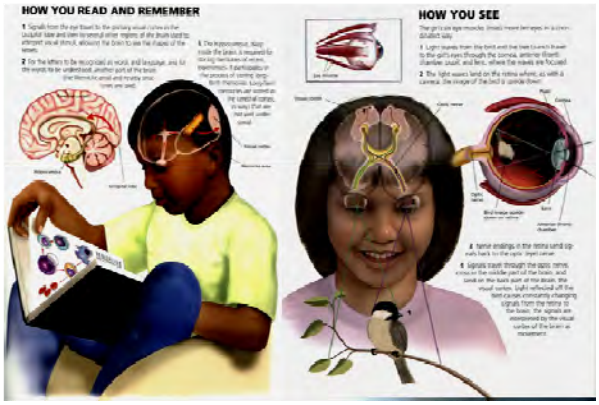
What is Neuroscience?

Neuroscience is one of the most important and rapidly developing multidisciplinary fields of scientific researches and clinical investigations. (Society for Neuroscience: www.sfn.org)

Neuroscience represents the entire range of scientific research endeavors aimed at understanding the brain, the entire nervous system, neurobiological mechanisms underlying various behaviors in both health and diseases, and translating this knowledge to the treatment and prevention of nervous system and mental disorders.

It fosters the broad interdisciplinary fields that use multiple approaches "Multi-omics" (e.g., genetic, molecular, cellular, anatomical, neurophysiological, neurochemical, neuropharmacological, system, comparative and evolutionary, computational, and behavioral neuroscience) to study the nervous system of organisms ranging from invertebrates to humans across various stages of development, maturation, and aging.

สมองมีบทบาทสำคัญที่สุดในการรับรู้ประสบการณ์เรียนรู้ เก็บความทรงจำ คิดค้นหาเหตุผล ตัดสินใจ และแก้ปัญหาต่างๆในชีวิต



What is learning or cognition?

กระบวนการเรียนรู้--คิด (Learning or Cognition)

In science, cognition is a group of mental processes that includes:

attention,
memory,
producing and understanding language,
learning,
reasoning,
problem solving,
and decision making.

In psychology and **cognitive science and cognitive neuroscience**, **"cognition"** usually refers to an information processing view of an individual's psychological functions. It is also used in a branch of social psychology called social cognition to explain attitudes, attribution, and groups dynamics. In cognitive psychology and cognitive engineering, **cognition is typically assumed to be information processing in a participant's or operator's mind or brain.**

Cognition is a faculty for the processing of information, applying knowledge, and changing preferences. Cognition, or cognitive processes, can be natural or artificial, conscious or unconscious. the concept of cognition is closely related to abstract concepts such as mind, intelligence. It encompasses the mental functions, mental processes (**thoughts**), and **states of intelligent** entities.

Cognitive science is the interdisciplinary scientific study of the mind and its processes. It examines what **cognition** is, what it does and how it works. It includes research on intelligence and behavior, especially focusing on how information is represented, processed, and transformed (in faculties such as perception, language, memory, reasoning, and emotion) within nervous systems (human or other animal) and machines (e.g. computers). Cognitive science consists of multiple research disciplines, including psychology, artificial intelligence, philosophy, neuroscience, linguistics, anthropology, sociology, and education.

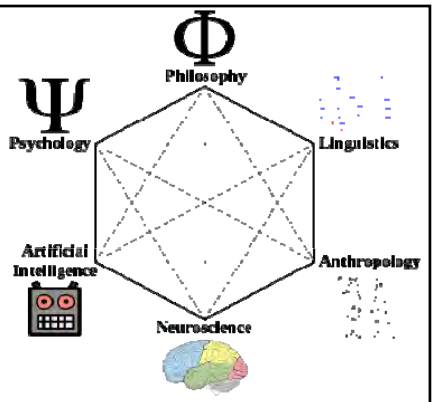
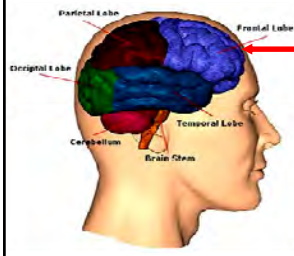


Figure illustrating the fields that contributed to the **birth of cognitive science**, including linguistics, neuroscience, artificial Intelligence, philosophy, anthropology, and psychology. Adapted from Miller, George A (2003). "The cognitive revolution: a historical perspective". *TRENDS in Cognitive Sciences*

The Frontal Lobes Executive Functions



"Executive Functions"

- Governing emotions
- Judgment
- Planning
- Organization
- Problem Solving
- Impulse Inhibition
- Abstraction
- Analysis/synthesis
- Self-awareness*
- Self-concept*
- Identity and Personality and
- Spirituality

***Self- "everything"**

What can neuroscience do for our country (Thailand)?

การวิจัยในช่วงสองทศวรรษที่ผ่านมาทำให้มีหลักฐานที่ชัดเจนว่า สมองและระบบประสาทยังมีความเกี่ยวข้องโดยตรงกับปัญหาต่างๆ ที่มีความสำคัญทางด้านการแพทย์และสุขภาพของประชาชน อาทิเช่น

(1) สมองเกี่ยวข้องโดยตรงกับพฤติกรรมการเสพย์ติด (Addiction Behaviour) บุหรี่ สุรา แอลกอฮอลล์ ยาเสพย์ติดชนิดต่างๆ ที่เป็นปัญหาสำคัญในวาระระดับชาติ (National Priority) มีการค้นพบบริเวณของสมองและกลไกระบบประสาทของการเสพย์ติด ทำให้การป้องกัน และบำบัดการเสพย์ติด มีหลักการและประสิทธิภาพมากขึ้น

(2) ความผิดปกติในพัฒนาการของโครงสร้าง และสารเคมีที่ทำหน้าที่สื่อสารในระบบประสาททำให้เกิดปัญหาพัฒนาการล่าช้า ผิดปกติ จนเกิดอาการสมาธิสั้นและอยู่ไม่นิ่ง (Attention deficit/Hyperactivity: AD/HD) อาการออทิสซึม (Autistic Spectrum Disorders: ASDs) ความบกพร่องผิดปกติในการเรียนรู้ (Learning Disorders: LD) การรับรู้ ประมวลข้อมูล การรู้-คิดและความเข้าใจ การพูด การอ่าน การเขียน การคำนวณ (Perceptual, Sensory Processing and Cognitive Disorders, Aphasia, Dyslexia, Agraphia, Acalculia) ซึ่งทำให้เด็กไทยจำนวนมากมีปัญหาในการศึกษา และไม่สามารถพัฒนาสติ-เชาวน์ปัญญา ความรู้ความสามารถได้อย่างเต็มศักยภาพ

INFLUENTIAL PUBLICATION | April 01, 2003

Addiction Is a Brain Disease, and It Matters

Alan I. Leshner, Ph.D.

FOCUS 2003;1:190-193.

Alan I. Leshner

Scientific advances over the past 20 years have shown that

1. **drug addiction is a chronic, relapsing disease that results from the prolonged effects of drugs on the brain**.
2. As with many other brain diseases, addiction has embedded behavioral and social-context aspects that are important parts of the disorder itself.
3. **Therefore, the most effective treatment approaches will include biological, behavioral, and social-context components.**
4. **Recognizing addiction as a chronic, relapsing brain disorder characterized by compulsive drug seeking and use can impact society's overall health and social policy strategies and help diminish the health and social costs associated with drug abuse and addiction.**

FRONTIERS IN NEUROSCIENCE: THE SCIENCE OF SUBSTANCE ABUSE

Addiction Is a Brain Disease, and It Matters

Alan I. Leshner

Scientific advances over the past 20 years have shown that drug addiction is a chronic, relapsing disease that results from the prolonged effects of drugs on the brain. As with many other brain diseases, addiction has embedded behavioral and social-context aspects that are important parts of the disorder itself. Therefore, the most effective treatment approaches will include biological, behavioral, and social-context components. Recognizing addiction as a chronic, relapsing brain disorder characterized by compulsive drug seeking and use can impact society's overall health and social policy strategies and help diminish the health and social costs associated with drug abuse and addiction.

Dramatic advances over the past two decades in both the neurosciences and the behavioral sciences have revolutionized our understanding of drug abuse and addiction. ... drug use is, more, an addict. The most ... victims of their societal situation. However, ... the most common view is that drug addicts ... affects both the health of the individual and the health of the public. The use of drugs ... has well-known and severe negative consequences for health, both mental and physical. But drug abuse and addiction also have tremendous implications for the health of the public, because drug use, directly or indirectly, is now a major vector for the transmission of many serious infectious diseases—particularly acquired immunodeficiency syndrome (AIDS), hepatitis, and tuberculosis—as well as violence. Because addiction is such a complex and pervasive health issue, we must include in our overall strategies a committed public health approach, including extensive education and

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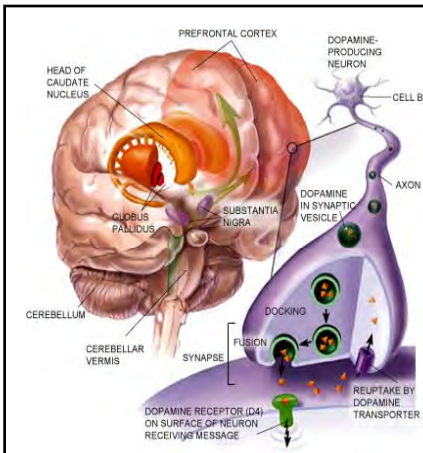
เด็กสมาธิสั้น ชน พฤติกรรมไม่เหมาะสมกับกาลเทศะ

(Attention Deficit/Hyperactivity: AD/HD)

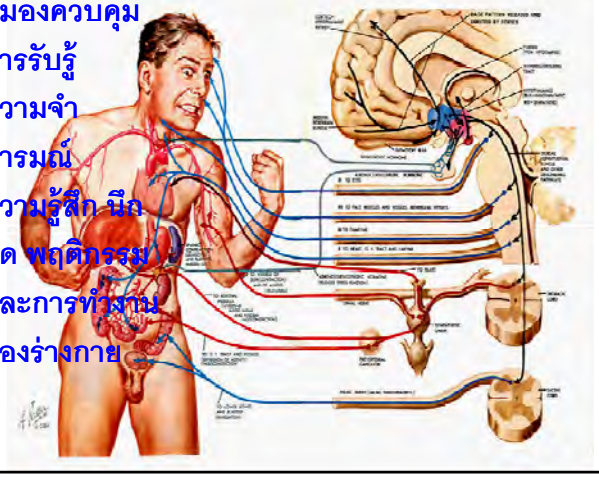


ระบบประสาทสมองในเด็กสมาธิสั้น ชุกชน ไม่อยู่นิ่ง และมีพฤติกรรมที่ไม่เหมาะสมกับกาละเทศะ

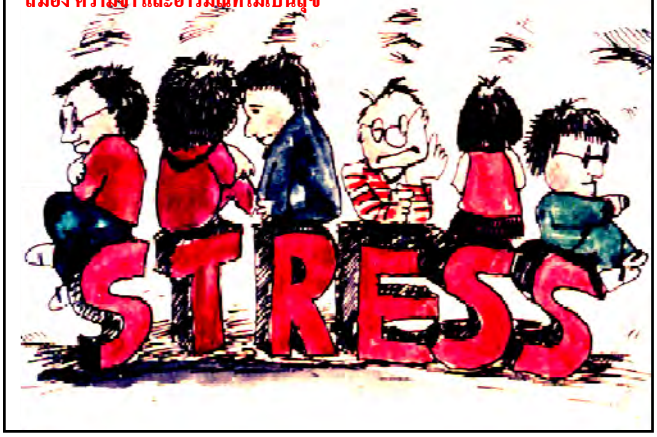
มีความผิดปกติของสารเคมีสื่อประสาทโดปามีน (Dopamine) ในสมองส่วนหน้า

(3) สมองเกี่ยวข้องปัญหาความเครียดทั้งด้านร่างกายและจิตใจ ทำให้เกิดปัญหาสุขภาพมากมายที่เกี่ยวข้องกับความเครียด อาทิเช่น ความดันโลหิตสูง โรคหลอดเลือดหัวใจ และหลอดเลือดสมอง อาการนอนไม่หลับ หงุดหงิด วิตกกังวล อาการเซ็ง ซึมเศร้า (Depression) ความผิดปกติทางเมตาบอลิซึม (Metabolic Syndromes) ภูมิต้านทานบกพร่อง ที่เป็นปัจจัยสำคัญนำไปสู่กลุ่มโรคและอาการโรคต่างๆที่ไม่ติดต่อโดยเชื้อโรค (Non-Communicable Diseases: NCDs)
(4)ปัญหาโรคที่เกิดจากการชราภาพ (Aging) ความเสื่อมของสมองและระบบประสาท (Neurodegenerative disorders) อาทิเช่น โรคสมองและความจำเสื่อมเสื่อม และโรคอัลไซเมอร์ (Senile Dementia, Amnesia and Alzheimer's disease) โรคพาร์กินสัน และความบกพร่องในการเคลื่อนไหว (Parkinson's disease and Movement Disorders) อาการหลงลืม เพ้อคลั่ง และซึมเศร้าในคนชรา (Senile Delirium and Depression) จะเป็นปัญหาสำคัญในอนาคตอันใกล้จากการมีแนวโน้มเพิ่มขึ้นของประชากรผู้สูงอายุ

สมองควบคุม
การรับรู้
ความจำ
อารมณ์
ความรู้สึก นึก
คิด พฤติกรรม
และการทำงาน
ของร่างกาย



ความเครียด และวิตกกังวลอย่างรุนแรง ยาวนานเรื้อรัง บั่นทอนกาทำงานของสมอง ความจำ และอารมณ์ที่ไม่เป็นสุข



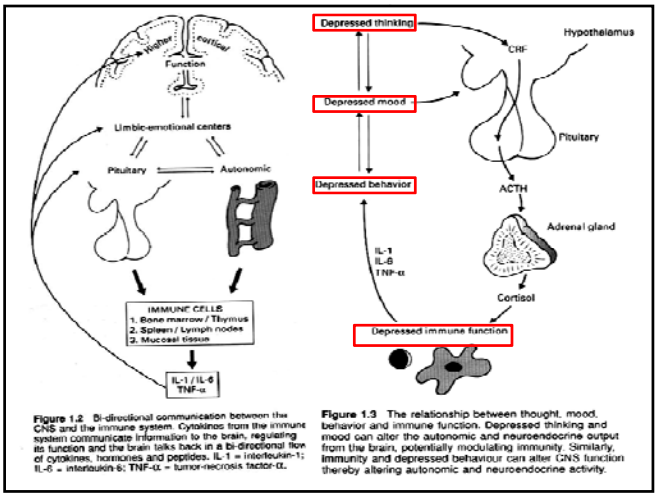
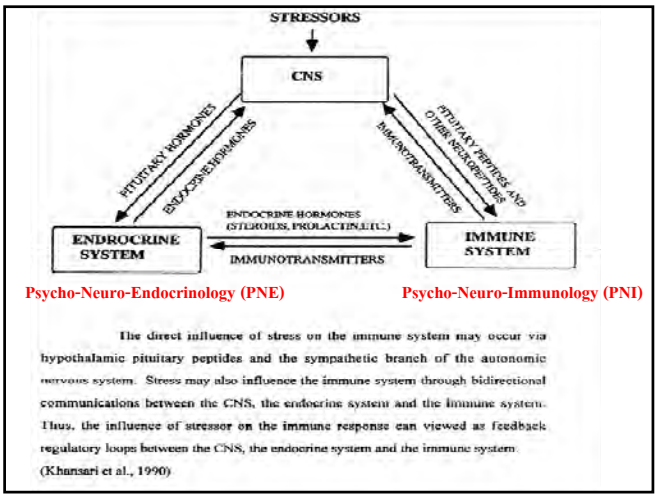


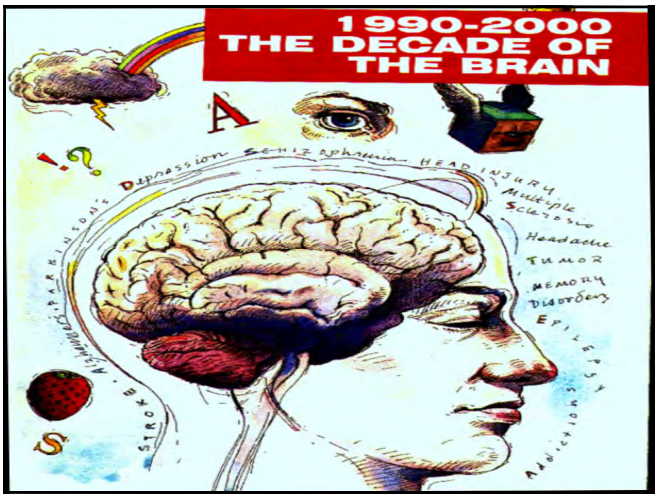
Figure 1.2 Bi-directional communication between the CNS and the immune system. Cytokines from the immune system communicate information to the brain, regulating its function and the brain talks back in a bi-directional flow of cytokines, hormones and peptides. IL-1 = interleukin-1; IL-6 = interleukin-6; TNF-α = tumor-necrosis factor-α.

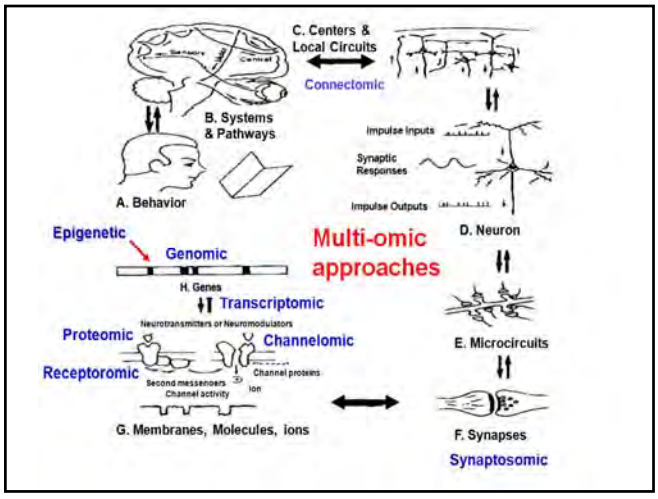
Figure 1.3 The relationship between thought, mood, behavior and immune function. Depressed thinking and mood can alter the autonomic and neuroendocrine output from the brain, potentially modulating immunity. Similarly, immunity and depressed behaviour can alter CNS function thereby altering autonomic and neuroendocrine activity.



New links to stress:

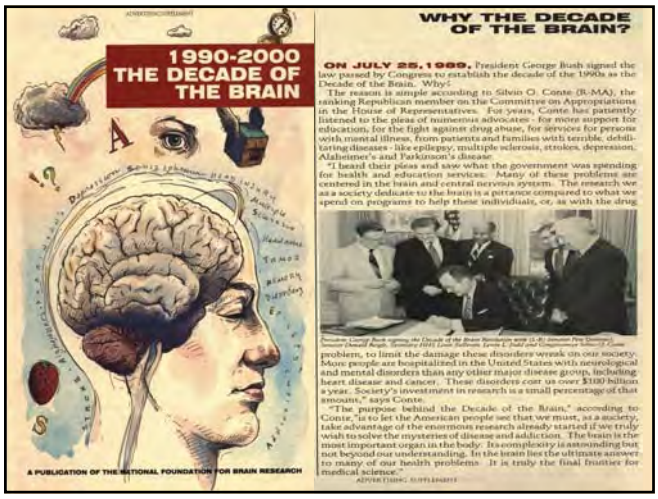
-Type 2 Diabetes mellitus
-Metabolic syndromes
-Sleep Apnea and Sleep disorders
-Obesity
-Cancer
-Auto-immune disorders e.g. SLE
-Allergies
-Many skin disorders
-Mental health problems e.g. depression, aggression, violence, homicide and suicide etc..

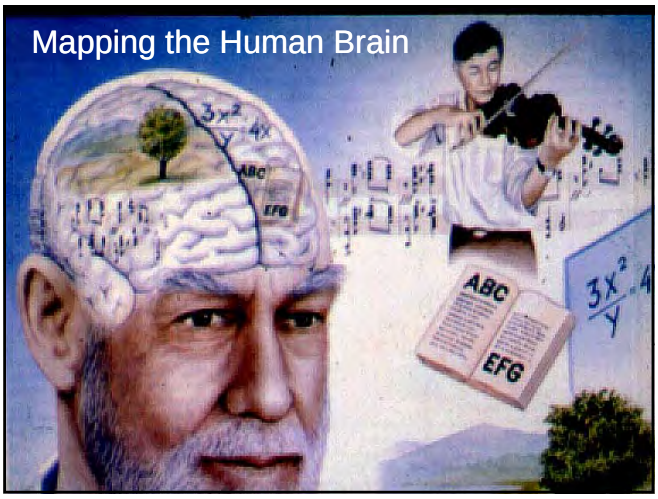


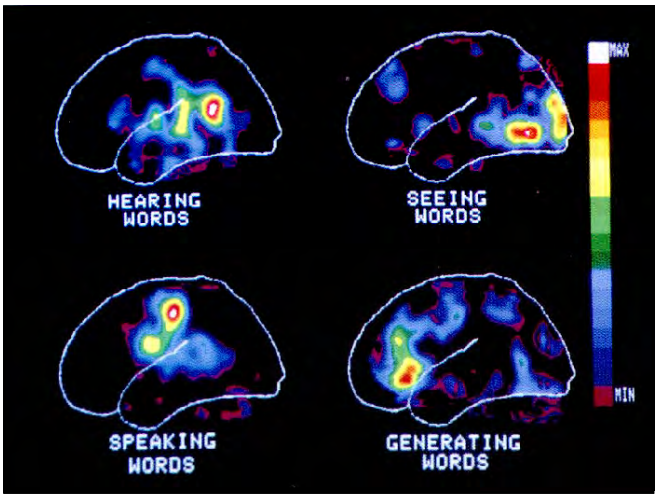


Prevalence and Economic Impact of the Major Neurological and Communicative Disorders

Disorder	Estimated Cases[1]	Cost of Illness[2]	NINDS Approp. Research Dollars FY07 Estimate
Traumatic head and spinal cord injury	1,000,000	$ 4.68 billion[3]	$ 47.871 million
Stroke[4]	1,900,000	11.3 billion[5]	57.909 million
Epilepsy	2,000,000	3.0 billion	33.663 million
Hearing and Speech:			
Deafness	1,800,000	1.8 billion	44.956 million
Partial Deafness	11,600,000	11.6 billion	
Speech	8,375,000	9.0 billion	14.770 million
Language	6,600,000	7.53 billion	6.972 million
Infectious disorders of the nervous system	25,000[6]	25 million	14.991 million
Neuro-AIDS	20,000	Unavailable	2.413 million
Parkinson disease, Huntington disease, and other movement disorders	500,000	2.5 billion	15.625 million
Alzheimer disease and related dementias	3,000,000	50.0 billion[7]	13.774 million
Demyelinating and atrophic disorders:			
Multiple sclerosis	131,000[8]	1.12 billion[9]	33.707 million
Amyotrophic lateral sclerosis	14,000	300 million	
Disorders of early life (cerebral palsy, perinatal injuries, retardation, etc.)	750,000	3.75 billion	42.924 million
Neuromuscular disorders	1,000,000	5.0 billion	24.360 million
Peripheral neuropathy (diabetic, other)	1,000,000	1.0 billion	8.486 million
Other neurological disorders	6,000,000	8.6 billion	55.218 million
Fundamental neurosciences research[7]	—	—	83.127 million
Total	64,715,000	$420.6 billion	$490.227 million

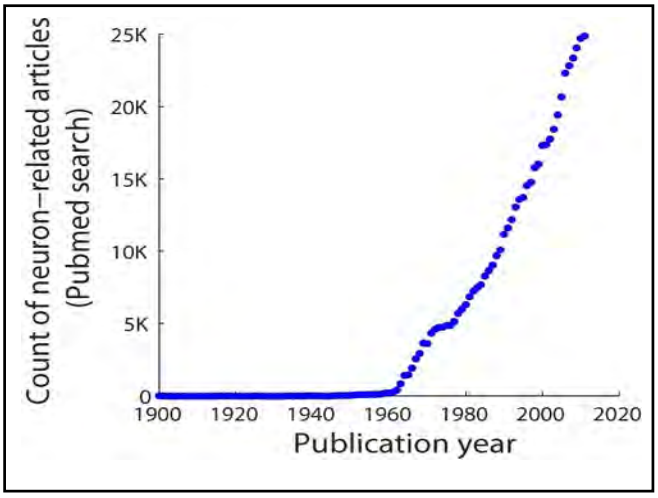


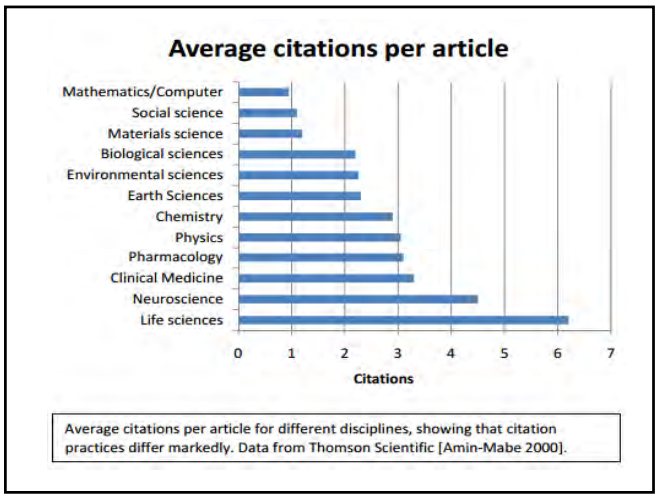




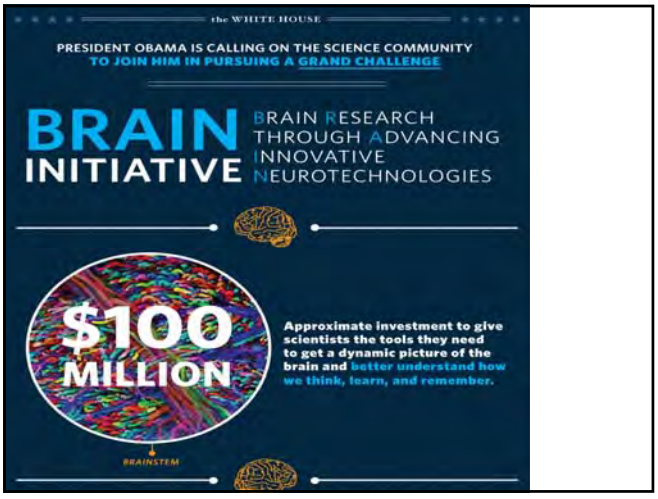
Neuroscience is Exploding!

- We've learned more about the brain in the last 10 years than in the previous 100 years!
- Over 255 brain journals now published!
- 37,000 scientists from 62 countries produce countless studies daily
- Have you noticed the news?





Average citations per article for different disciplines, showing that citation practices differ markedly. Data from Thomson Scientific [Amin-Mabe 2000].



The Human Brain Project is a ten-year project, consisting of a thirty-month ramp-up phase, funded under FP7, with support from a special flagship ERANET, and a ninety-month operational phase, to be funded under Horizon 2020. The project, which will have a total budget of over Euro 1 billion, is European-led with a strong element of international cooperation. The goal of the project is to build a completely new ICT infrastructure for neuroscience, and for brain-related research in medicine and computing, catalyzing a global collaborative effort to understand the human brain and its diseases and ultimately to emulate its computational capabilities. https://www.humanbrainproject.eu/

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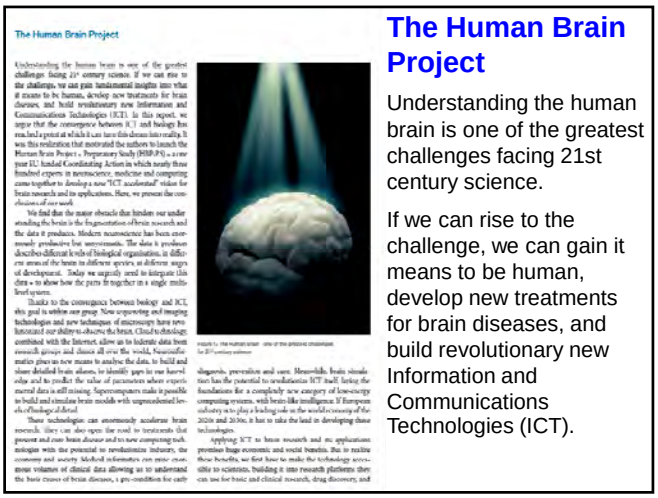


The Human Brain Project

Understanding the human brain is one of the greatest challenges facing 21st century science.

If we can rise to the challenge, we can gain it means to be human, develop new treatments for brain diseases, and build revolutionary new Information and Communications Technologies (ICT).

Foundation of the First modern Hospital:

1886: Siriraj Hospital was established by H.M. King Rama V to be the first permanent modern hospital. While the committee was working on plans for the hospital, His Royal Highness Prince Siriraj Kakuta Bhandu, His Majesty's beloved son, died from dysentery. The hospital, a wooden structure with accommodation for just 44 patients, was completed and opened to the public in 1888. In accordance with His Majesty's wishes, the hospital provided health care and services for everyone without discrimination. Free medical care and treatment was available to patients from all walks of life. They were able to receive treatment by traditional medicine, or by modern western medicine, whichever they chose.

In 1916, King Rama VI founded the first university in Thailand, Chulalongkorn University. The Royal Medical School was then renamed the Faculty of Medicine Chulalongkorn University.
In 1918, the Royal Medical College was amalgamated with Chulalongkorn University and became the Faculty of Medicine and Siriraj Hospital, the premedical part of the course being taught at Chulalongkorn University.


Chulalongkorn University in 1918


Faculty of Medicine at Siriraj

Prince Mahidol Songkhla, M.D. cum laude (Harvard), Dr. P.H. (Harvard)

Father of Medicine and Public Health in Thailand

Father of the Present H.M. King of Thailand

Teaching of Human Gross Anatomy by dissection for the first time by Dr. T. Hayward Hays, M.D. in 1889

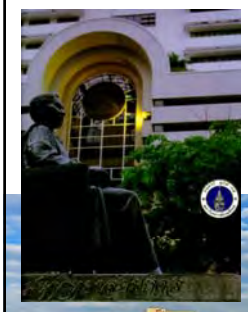
In 1890 a medical school was established for the first time in the country because of the urgent need to recruit resident physicians for the newly-built hospital. In addition, those who practiced traditional medicine were not inclined to work and cooperate with others. The School was originally named 'Pathayakorn School', that is the 'school for medical practitioners', and was given the title of 'Royal Medical College' in 1901. The first class of 9 students graduated in 1893. The course of instruction was 3 years until 1903, and this was gradually extended to 6 years by 1915.


John D. Rockefeller, Founder of the Rockefeller Foundation


H.R.H. Prince Mahidol Songkla, M.D., Dr. P.H., Founder of modern medicine in Thailand


In 1923 Professor Dr. A.G. Ellis M.D., M.Sc. , Dean and Director of Siriraj Hospital, and the new concrete building at Siriraj in 1923

Through the generosity of His Royal Highness Prince Mahidol Songkla (His Majesty the present King's father) and the assistance of the Rockefeller Foundation, a period of reorganization began in 1923 to bring the medical school up to international standard. Admission requirements were raised and students had to have completed the government secondary school. Two years of premedical studies included mathematics, psychology, physics, chemistry, biology and English. A four year curriculum of 4,620 hours was adopted. At the same time, an ongoing program of construction began at Siriraj Hospital. New laboratories were built to house modern equipment and many old wooden structures were replaced by concrete buildings. The medical curriculum was updated periodically in keeping with the progress of medical science in the West.



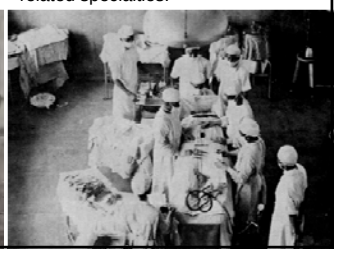
Prince Mahidol Songkla statue at Siriraj Hospital Medical School, Mahidol University

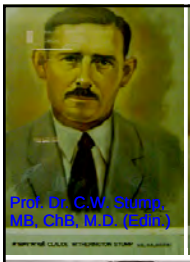


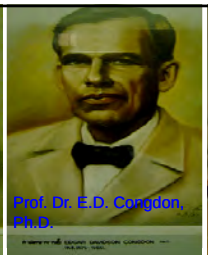
In 1943, the School was transferred to the University of Medical Sciences under the auspices of the Ministry of Health. In 1959, the University of Medical Sciences was placed under the jurisdiction of the Office of the Prime Minister, and later, the Thai Government established 5 new medical schools, at Chulalongkorn Hospital, Nakorn Chiang Mai Hospital, Ramathibodi Hospital, Khon kaen University and Prince of Songkhla University. Then, in 1969, the University of Medical Sciences was awarded the new name of 'Mahidol University' after the name of the present King's father. This was done in recognition of Prince Mahidol's important contributions to medicine in Thailand.

In 1969, Mahidol University established a second medical school, known as the 'Faculty of Medicine at Ramathibodi Hospital'. This medical school is completely separate from that of the Faculty of Medicine Siriraj Hospital.

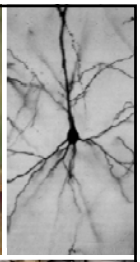
Neuroscience in Thailand developed after the Second World War at Siriraj Hospital, Faculty of Medicine when Thai doctors, who have studied abroad in Germany, UK and USA brought back their knowledge in Neuroanatomy, Neurophysiology, Neurology, Neurosurgery and Psychiatry to teach medical students and residents in related specialties.


Prof. Dr. C.W. Sturge, MB, ChB, M.D. (Edin.)


Prof. Dr. E.D. Congdon, Ph.D.


First Compound Microscope




Old Anatomy Building and the Congdon Anatomical Museum

Thai neuro-anatomists were fortunate to have studied with the late Prof. Dr. Elizabeth Crosby, Ph.D. in Ann Arbor, Michigan. Her support enabled them to conduct and published some classical studies using degenerative techniques and the development of excellent anatomical museum at Siriraj Medical School.

Professor Dr. Sud Sangvichien, M.D., Dr. Med. taught neuroanatomy and histology to medical students at Siriraj

การศึกษาด้านประสาทวิทยา เริ่มมาตั้งแต่คณะแพทยศาสตร์ศิริราชพยาบาล แห่งจุฬาลงกรณ์มหาวิทยาลัย เมื่อ 50 ปีก่อน โดย ศ. นพ. สุด แสงวิเชียร ได้นำความรู้เรื่องประสาทกายวิภาคศาสตร์มาบรรยาย ทำให้เกิดความสนใจในการทำงานของสมองเกี่ยวกับการเคลื่อนไหวของร่างกาย โดยประสานกับ ศ. นพ. อวย เกตุสิงห์ ซึ่งบรรยายเรื่องประสาทสรีรวิทยา เป็นที่น่าสนใจ เกี่ยวกับกลไกของระบบประสาทกับอวัยวะภายในร่างกายและด้านอารมณ์ ส่วนในทางด้านคลินิกมี ศ. นพ. จิตต์ ตู้จินดา เป็นผู้บรรยายเกี่ยวกับโรคของสมอง และระบบประสาทต่อมาทางศัลยกรรมได้ศึกษาเกี่ยวกับเนื้องอกของสมองจนได้มีการผ่าตัดสมองโดย นพ. บรรจง กรลักษณ์


ศ.นพ. สุด แสงวิเชียร

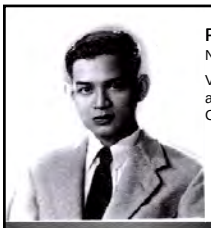

ศ.นพ. อวย เกตุสิงห์

Neuroanatomical teaching specimen in Congdon Anatomical Museum at Department of Anatomy, Siriraj Medical School

Prof. Dr. Udom Poshakrisana, M.D., Dr. Med., Dr.Med.Dent.., Facharzt für Chirurgie

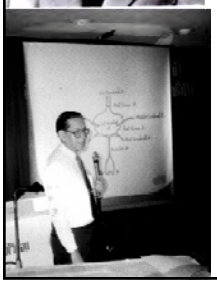
Founder of Neurosurgery in Thailand, former Head of Surgery Department, Dean of Faculty of Medicine and Siriraj Hospital; and Former Minister of Public Health

การก่อตั้ง และพัฒนา
ประสาทศัลยศาสตร์
ศิริราชฯ



Prof. Dr. Bhuket Vachanonda, M.D., Ph.D.
Neuroanatomist studied at University of Michigan, Ann arbor

Vachanonda B: The major spinal efferent system of cerebellum and the cerebellar corticonuclear connection in Macaca mulatta. J Comp Neurol 1959: 112, 202-232.



Prof. Dr. Chusak Vejbaesya, M.D., Ph.D.
Neurophysiologist studied visual pathways and their responses in the thalamus at University of Edinburgh, Scotland, later became director of the Biomedical Instrumentation Center.

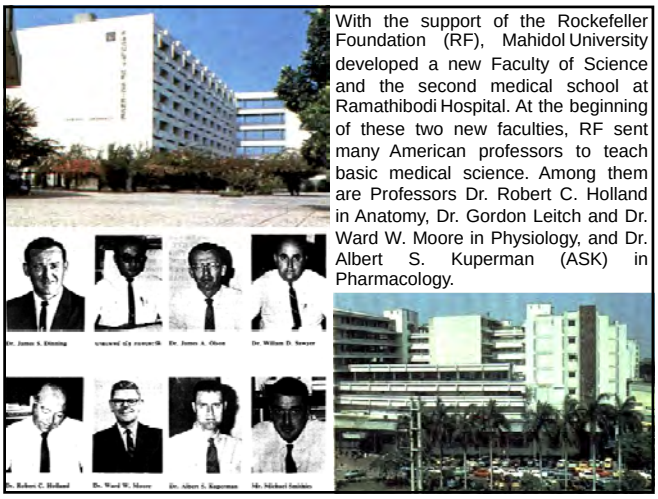
ใน พ.ศ. 2499 **ศ. นพ. ประสพ รัตนากร** ได้ก่อตั้งโรงพยาบาลประสาทพญาไท เพื่อเป็นโรงพยาบาลทางระบบประสาท หรือประสาทวิทยา โดยเฉพาะจึงมีการร่วมใจกันในการช่วยงานทั้งด้านคลีนิค และด้านวิชาการ จนเป็นศูนย์รวมของคณะผู้ทำงานด้านประสาทวิทยา และศัลยกรรมประสาท โรงพยาบาลประสาท พญาไท ได้รับพระมหากรุณาธิคุณจากสมเด็จพระเจ้าอยู่หัวพระราชทานทุน จัดสร้าง ตึกวิจัยประสาท ขึ้น เพื่อศึกษาในทางประสาทวิทยาศาสตร์ โดยกว้างขวาง รวมไปถึงประสาทพยาธิวิทยา ประสาทชีวเคมี ประสาทสรีรวิทยาและการติดเชื้อของระบบประสาท

เมื่อได้มีการจัดตั้งคณะแพทยศาสตร์ ที่จุฬาลงกรณ์มหาวิทยาลัยขึ้น ได้มีการเริ่มงานทางด้านประสาทกายวิภาคศาสตร์ และการสอนทางประสาทวิทยา โดย **ศ. นพ. บุญเลี้ยง ตามไท** กับคณะ และ **ศ. นพ. จรัส สุวรรณเวลา** กลับจากสหรัฐอเมริกา ได้เป็นกำลังสำคัญทางด้านศัลยกรรมประสาท

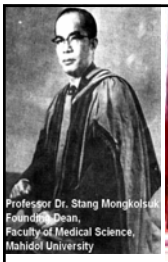
และ **ศ. นพ. อรรถสิทธิ์ เวชชาชีวะ** ทางด้านประสาทวิทยา ที่คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี

สมาคมประสาทวิทยาแห่งประเทศไทย
Thai Neurological Society of Thailand.

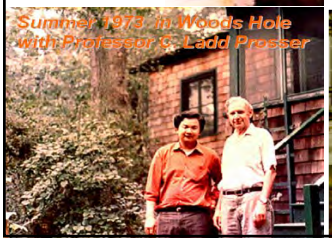
พ.ศ. 2503 แพทย์ทางประสาทวิทยาได้จัดตั้งสมาคมซึ่งในตอนแรก เรียกว่า **"สมาคมประสาทแพทย์แห่งประเทศไทย"** โดยมีผู้เริ่มการคือ ศ. นพ. จิตต์ ตู้จินดา, ศ. นพ. บุญเลี้ยง ตามไท, ศ. นพ. ประสพ รัตนากร เป็นกรรมการผู้ก่อตั้ง และได้รับอนุญาตเมื่อ 8 กุมภาพันธ์ 2503 มีสำนักงาน ณ โรงพยาบาลประสาทพญาไท และกรรมการผู้เริ่มงานก็มี ศ. นพ. สมบัติ สุคนธพันธ์, ศ. นพ. จรัส สุวรรณเวลา ศ. นพ. วิชัย บำรุงผล, ศ. นพ. ทองจันทร์ หงส์ลดารมย์, ศ. นพ. รุ่งธรรม ลัดพลี, นพ. หทัย ชิตานนท์ เป็นต้น โดยมีวัตถุประสงค์ ดังนี้ 1. บำรุงและส่งเสริมการแพทย์ทางโรคประสาท ในประเทศไทย ตลอดจนการศึกษาป้องกัน การวิจัย และรักษาโรคประสาทให้ก้าวหน้าไปตามหลักวิทยาการแพทย์ 2. เผยแพร่ และโฆษณาความรู้ในวิชาการแพทย์ทางโรคประสาท และการป้องกันตนเองจากโรคนี้แก่ประชาชน 3. ร่วมมือโดยใกล้ชิดกับแพทยสมาคมแห่งประเทศไทย และสมาคมสาขาการแพทย์ อื่น ๆ แห่งประเทศไทย 4. ให้การอบรมศึกษาแก่แพทย์ที่สนใจทางโรคประสาท 5. ร่วมมือ และแลกเปลี่ยนความรู้กับสมาคมแพทย์โรคประสาทในต่างประเทศ และหน่วยงานองค์การอนามัยของนานาชาติทางด้านโรคประสาท6.ไม่เกี่ยวกับการเมือง



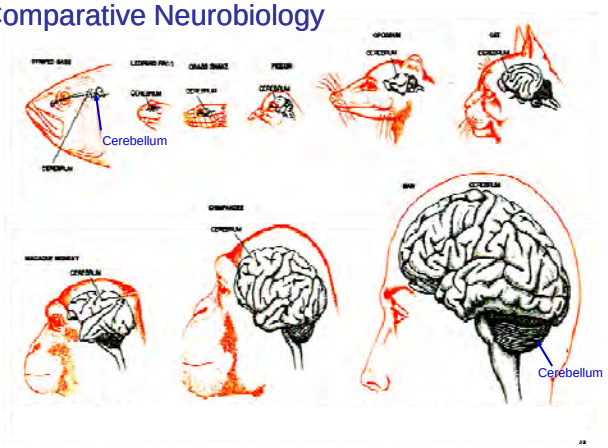
With the support of the Rockefeller Foundation (RF), Mahidol University developed a new Faculty of Science and the second medical school at Ramathibodi Hospital. At the beginning of these two new faculties, RF sent many American professors to teach basic medical science. Among them are Professors Dr. Robert C. Holland in Anatomy, Dr. Gordon Leitch and Dr. Ward W. Moore in Physiology, and Dr. Albert S. Kuperman (ASK) in Pharmacology.



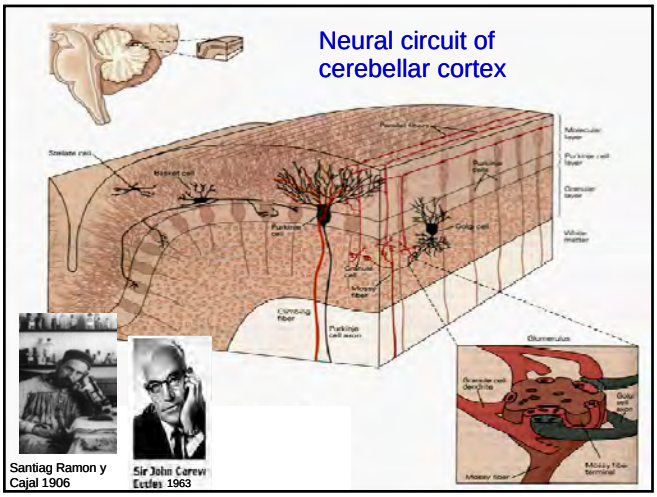
To establish sustainable development, Professor Dr. Stang Mongkolsuk, Dean of Faculty of Science, sent many Thai medical scholars on Rockefeller Foundation fellowships to study for doctoral degrees abroad including Naiphinich Kotchabhakdi (NK) who studied Neuro-Behavioral Biology at the University of Illinois in Urbana-Champaign under Professor Dr. C. Ladd Prosser (CLP), 1970 - 1973.



Comparative Neurobiology



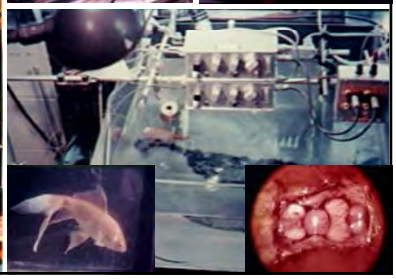
Neural circuit of cerebellar cortex

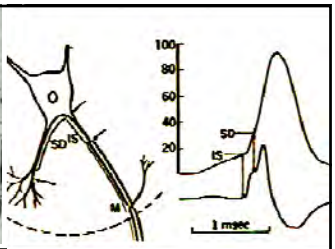


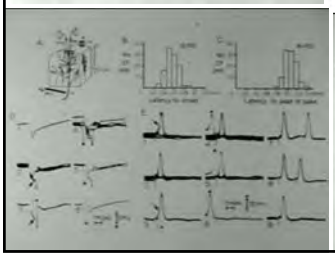
Santiag Ramon y Cajal 1906

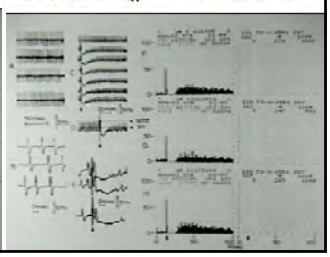
Sir John Carew Eccles 1963

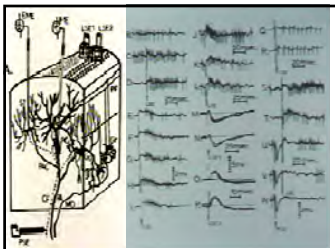
NK returned to Mahidol University and developed laboratory of Neurobiology with generous support from CL Prosser and A S Kuperman.

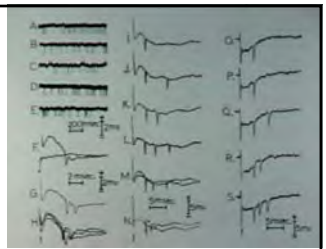


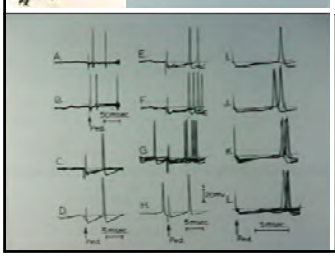


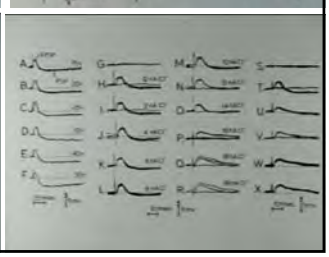












During his residency training in surgery at Siriraj Hospital, Roongtam was selected by H.E. **Professor Dr. Udom Poshakritsana**, the Founder of Neurosurgery in Thailand and the Former Dean of the Faculty of Medicine and Former Minister of Health, as the chief resident for neurosurgery.

Paul Bucy (1904-1992)

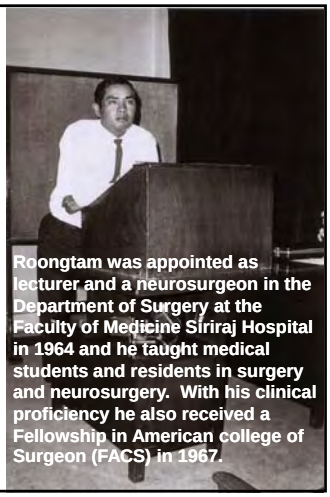
Professor Udom introduced Roongtam to **Professor Dr. Paul C. Bucy**, the world famous neurosurgeon of North Western University in Chicago, and sent Roongtam for further training in USA. In 1959 Roongtam was accepted for neurosurgical training program and Professor Bucy sent him to do basic research work in the Neurophysiology Laboratory of **Professor Dr. Clinton N. Woolsey** at the University of Wisconsin in Madison, Wisconsin.

The University of Wisconsin (Madison)

Dr. Clinton N. Woolsey was the founder, director, and first Chairman of the Laboratory (and then Department) of Neurophysiology in the Medical School of the University of Wisconsin in Madison, Wisconsin.

Roongtam had the opportunities to learn Stereotaxic and electrophysiological techniques and published some classic work with Professor Woolsey on the organization of the pre- and post-central leg areas and the representation of the visual fields in the visual areas I and II of the cat's cerebral cortex. He also worked and published together with Professor G. H. Wang on spontaneous variations of skin potentials in footpads of normal, striatal and spinal cats (J Neurophysiol. 1960 July; 23:448-52.), and on Galvanic skin reactions of chronic spinal cats (Am J Phys Med. 1962 Feb; 41:15-22.).

Returning to work with Professor Bucy at North Western University in Chicago, Roongtam completed his clinical work and received his American Board of Neurological Surgery in 1963. He also published two important classical works with Professor Bucy (**Bucy PC, and Ladpli R: Recoverable paraplegia. JAMA. 185:685 691; 1963 and Bucy PC, Ladpli R, Ehrlich A. Destruction of the pyramidal tract in the monkey: The effects of bilateral section of the cerebral peduncles. J. Neurosurgery 25, 1-23, 1966**). Before returning to Thailand, Roongtam had further training in pediatric neurosurgery at the Children Memorial Hospital in Chicago and in neuropathology at the Montefiorre Hospital and Columbia University in New York.



Roongtam was appointed as lecturer and a neurosurgeon in the Department of Surgery at the Faculty of Medicine Siriraj Hospital in 1964 and he taught medical students and residents in surgery and neurosurgery. With his clinical proficiency he also received a Fellowship in American college of Surgeon (FACS) in 1967.

In 1965, Dr. Roongtam Ladpli, a young Thai neurosurgeon, had an opportunity to meet with the world famous neuro-anatomist **Professor Dr. Alf Brodal from the University of Oslo in Norway** during a conference in London.

Professor Brodal invited Roongtam to do a Postdoctoral research in Norway with the support of **NORAD** (Norwegian Agency for International Development). Roongtam used his neurosurgical skills to solve difficult experimental approaches to study the reticular and vestibular commissural connections in the brainstem. He published a much referred classical paper in the Journal "Brain Research" with Alf Brodal

Ladpli, R., Brodal, A.: Experimental studies of commissural and reticular formation projections from the vestibular nuclei in the cat. Brain Res. 8, 65-96, 1968.

Alf Brodal (b. 1910, Oslo, Norway) is professor of anatomy at the University of Oslo. His neuroanatomical researches have dealt particularly with the structural-functional relationships between various parts of the brain. Dr. Brodal has received the Bárány Medal (for vestibular research) and the Jahre Prize (for outstanding medical research in the Nordic countries).

Professor Dr. Med Alf Brodal

Very fortunately Roongtam had an opportunity to meet with the world famous neuro-anatomist Professor Dr. Alf Brodal from the University of Oslo in Norway during a conference in London. Professor Brodal invited Roongtam to do a Postdoctoral research in Norway with the support of NORAD (Norwegian Agency for International Development). Roongtam used his neurosurgical skills to solve difficult experimental approaches to study the reticular and vestibular commissural connections in the brainstem of cats.

Anatomical Institute, University of Oslo, Norway

Experimental studies of commissural and reticular formation projections from the vestibular nuclei in the cat, Brain Research, Volume 8, Issue 1, April 1968, Pages 65-96
Ladpli, R; Brodal, A

He published a much referred classical paper with Alf Brodal (Ladpli, R., Brodal, A.: Experimental studies of commissural and reticular formation projections from the vestibular nuclei in the cat. Brain Res. 8, 65-96, 1968.).

Together with Professors Alf Brodal, Fred Walberg and Eric Rinvik, Roongtam initiated a long-term collaboration between the University of Oslo and Mahidol University with the support of NORAD.

In 1975 Roongtam introduced Naiphinich Kotchabhakdi to Professor Dr. Fred Walberg from University of Oslo, Norway and Naiphinich was invited to Oslo on NORAD postdoctoral fellowship to study with Fred Walberg, Eric Rinvik and Alf Brodal in 1976.

Professor Dr. Fred Walberg visited the Faculty of science, Mahidol University in 1975

And the Initiation of long-term collaboration between Mahidol University and the University of Oslo under the auspices of NORAD

Professor Dr. Fred Walberg taught for 45 years at the Anatomical Institute, Faculty of Medicine, University of Oslo, Norway.
He taught Gross and Comparative Anatomy, Cytology, Histology and Neuroanatomy.

With support from senior neurosurgeon, **Dr. Roongtam Ladpli**, NK met with **Prof. Dr. Fred Walberg** (FW) from U. of Oslo, Norway and went to Oslo on NORAD postdoctoral fellowship to study with FW, **Eric Rinvik** and **Prof. Alf Brodal**. Returning from Oslo with generous support from FW and NORAD, NK established collaborative research program with U of Oslo, and many Thai graduates received postdoctoral training in Norway.

Professor Dr. Med. Alf Brodal, Former Dean of Faculty of Medicine, University of Oslo

Professor Dr. Med. Fred Walberg, Director, Anatomical Institute, Faculty of Medicine, University of Oslo

Professor Dr. Roongtam Ladpli, Former Chief of Neurosurgery, Faculty of Medicine Siriraj Hospital, Mahidol University

Professors Natth Bhamarapravati, Fred Walberg, and Eric Rinvik

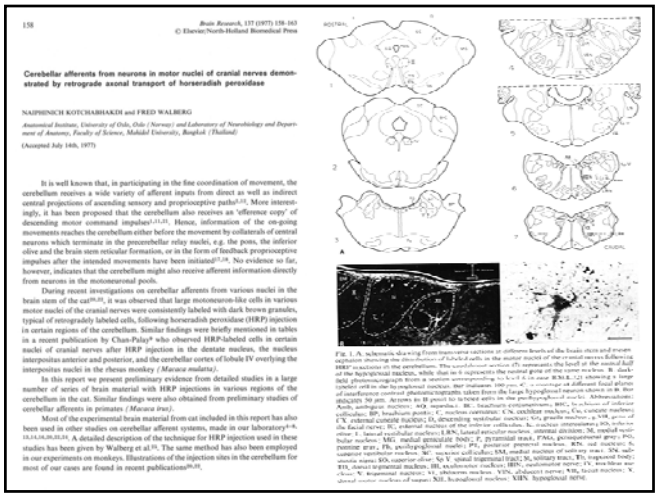
Salaya Campus site 1982

Oslo-LNB Collaboration

1976-1988

Laboratory of Neurobiology,
Faculty of Science,
Mahidol University 1978

Returning from Oslo with generous supports for basic and research equipment, chemicals and laboratory supplies from Fred Walberg and NORAD, Naiphinich established collaborative research program with University of Oslo and by now 19 Thai scientists received pre- and post-doctoral training in Norway.



158

Brain Research, 137 (1977) 158–163
© Elsevier/North-Holland Biomedical Press

Cerebellar afferents from neurons in motor nuclei of cranial nerves demonstrated by retrograde axonal transport of horseradish peroxidase

NAIPHINICH KOTCHABHAKDI and FRED WALBERG

Anatomical Institute, University of Oslo, Oslo 1 (Norway) and Laboratory of Neurobiology and Department of Anatomy, Faculty of Science, Mahidol University, Bangkok (Thailand)

(Accepted July 14th, 1977)

It is well known that, in participating in the fine coordination of movement, the cerebellum receives a wide variety of afferent inputs from direct as well as indirect central projections of ascending sensory and proprioceptive paths[2,33]. More interestingly, it has been proposed that the cerebellum also receives an 'efference copy' of descending motor command impulses[1,7,11,31]. Hence, information of the on-going movements reaches the cerebellum either before the movement by collaterals of central neurons which terminate in the precerebellar relay nuclei, e.g. the pons, the inferior olive and the brain stem reticular formation, or in the form of feedback proprioceptive impulses after the intended movements have been initiated[17,18]. No evidence so far, however, indicates that the cerebellum might also receive afferent information directly from neurons in the motoneuronal pools.

During recent investigations on cerebellar afferents from various nuclei in the brain stem of the cat[30,33], it was observed that large motoneuron-like cells in various motor nuclei of the cranial nerves were consistently labeled with dark brown granules, typical of retrogradely labeled cells, following horseradish peroxidase (HRP) injection in certain regions of the cerebellum. Similar findings were briefly mentioned in tables in a recent publication by Chan-Palay[9] who observed HRP-labeled cells in certain nuclei of cranial nerves after HRP injection in the dentate nucleus, the nucleus interpositus anterior and posterior, and the cerebellar cortex of lobule IV overlying the interpositus nuclei in the rhesus monkey (*Macaca mulatta*).

In this report we present preliminary evidence from detailed studies in a large number of series of brain material with HRP injections in various regions of the cerebellum in the cat. Similar findings were also obtained from preliminary studies of cerebellar afferents in primates (*Macaca irus*).

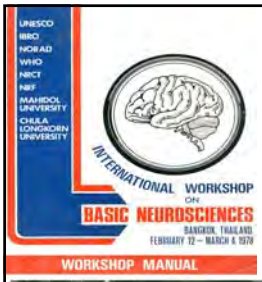
Most of the experimental brain material from cat included in this report has also been used in other studies on cerebellar afferent systems, made in our laboratory[4–6, 13,14,18,30,33,35]. A detailed description of the technique for HRP injection used in these studies has been given by Walberg et al.[35]. The same method has also been employed in our experiments on monkeys. Illustrations of the injection sites in the cerebellum for most of our cases are found in recent publications[30,33].

Wipawan Irena Grofova NK Ole Petter

Oslo 1980

Mahidol University Faculty Members who received NORAD Fellowship to Norway

Fellows	Norwegian Mentors
1. Roongtam Ladpli	Alf Bordal
2. Naiphinich Kotchabhakdi & Nittaya Kotchabhakdi	Fred Walberg, Eric Rinvic and Alf Brodal
3. Amara Siddhichai	Eric Rinvik
4. Reon Somana	Fred Walberg
5. Wanna Chindadoungratn	Eric Rinvik
6. Chittin Chindadoungratn	Holger Ursin (Bergen)
7. Wipawan Thangnipon	Jon Storm-Mathisen
8. Piyarat Govitrapong	Jon Storm-Mathisen
9. Kanoknart Yingchareon	Eric Rinvik



In 1978, with supports from IBRO, NORAD and WHO, the first International Workshop on Basic Neuroscience was organized at Mahidol University in Bangkok with 65 participants from local and 35 participants from all over Asia, Africa and Latin America.

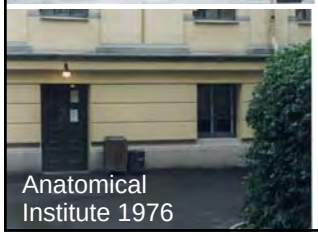
IBRO –NORAD Workshop February 12, 1978

BNS 1978

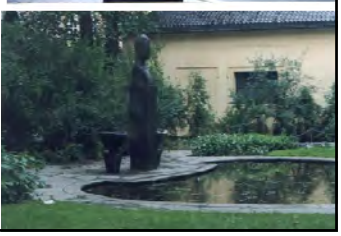
Mahidol University Salaya

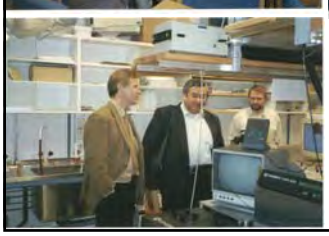
Salaya 1978

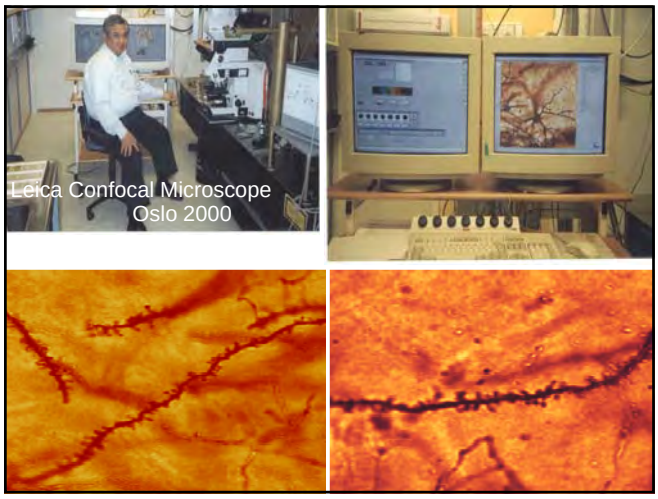
LNB Salaya 1982



Anatomical Institute 1976





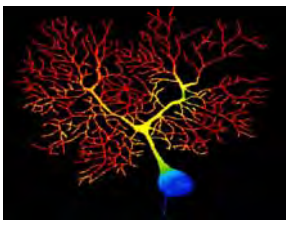


Mahidol University

Neuro-Behavioural Biology Center,

ศูนย์วิจัยชีววิทยาระบบประสาทและพฤติกรรม

สถาบันวิจัยชีววิทยาศาสตร์โมเลกุล



Neuro-Behavioural Biology Center, and International Graduate Program in Neuroscience, Institute of Molecular Biosciences, Mahidol University, Salaya, Nakornpathom 73170 Thailand

Mission

Teaching and Learning

The Neuro-Behavioural Biology Center

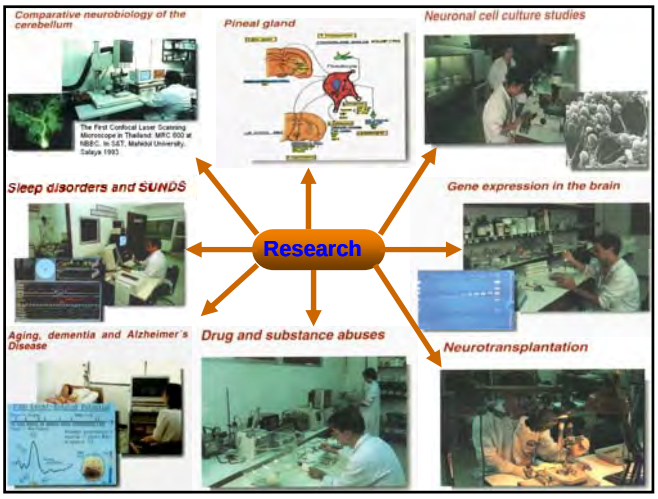
Research

Academic Service

Teaching

วิทยาศาสตรมหาบัณฑิต สาขาประสาทวิทยาศาสตร์ (หลักสูตรนานาชาติ)

ปรัชญาดุษฎีบัณฑิต สาขาประสาทวิทยาศาสตร์ (หลักสูตรนานาชาติ)



On October 30, 1984 with a strong encouragement from Roongtam to Professor Dr. Natth Bhamarapravati, the former President of Mahidol University, the University established the Neuro-Behavioural Biology Center (NBBC) in 1982 and developed an International Graduate Program in Neuroscience (M.Sc. in 1987 and Ph.D. in 1988) at the new Salaya Campus.

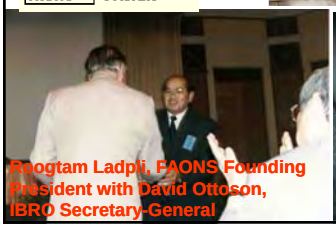
On October 30, 1984 Mahidol University established the Neuro-Behavioural Biology Center (NBBC) at the Salaya Campus, and International Graduate Program in Neuroscience (M.Sc. in 1987 and Ph.D. in 1988). By 2008, 90 students (60 M.Sc.'s, and 30 Ph.D.'s) have graduated from the Neuroscience program at NBBC.

Thai Neuroscience Society (TNS) was established in 1985 and we now have more than 150 full and student members. In 1988, TNS organizes another IBRO workshop in Asia at Chulalongkorn University in Bangkok.

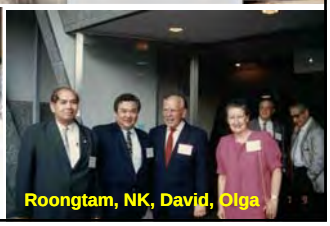
In 1996, the Thai Neuroscience Society (TNS) organized the first Asian Congress of Neuroscience and this led to the establishment of the Federation of Asian and Oceanean Neuroscience Societies (FAONS).

Federation of Asian - Oceanian Neuroscience Societies

FAONS



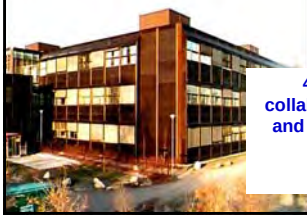
Roogtam Ladpli, FAONS Founding President with David Ottoson, IBRO Secretary-General



Roongtam, NK, David, Olga

CENTRE FOR MOLECULAR BIOLOGY AND NEUROSCIENCE

Mahidol University
Neuro-Behavioural Biology Center



45th Anniversary of the research collaboration between Mahidol University and the University of Oslo in the field of brain research (Neuroscience)

1965 - 2010

6th January 2010

Background of Collaboration

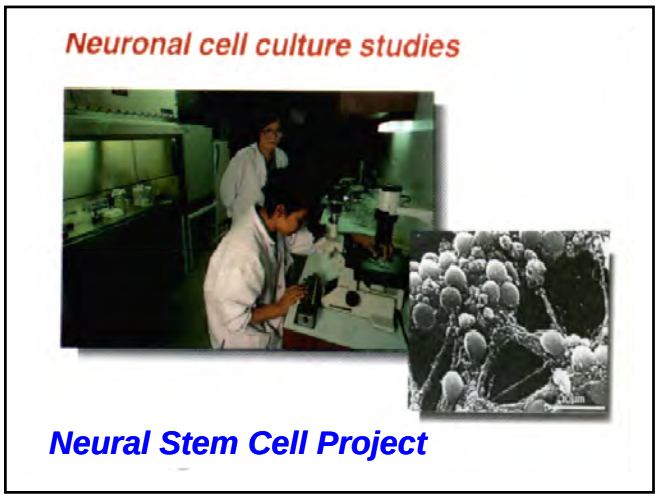
The collaboration between **Mahidol University** and **University of Oslo** started in 1965 in the field of "**Brain Research**" (or "**Neuroscience**") and has progressively extended for the last 45 years (1965 to 2010) involving with 4 generations of collaborators between the two universities.

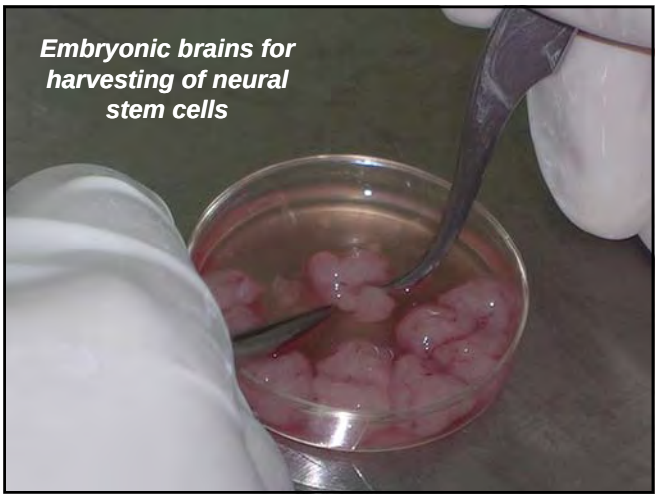
The First Generation with Professor Dr. Roongtam Ladpli and Professor Dr. Alf Brodal (1960's)

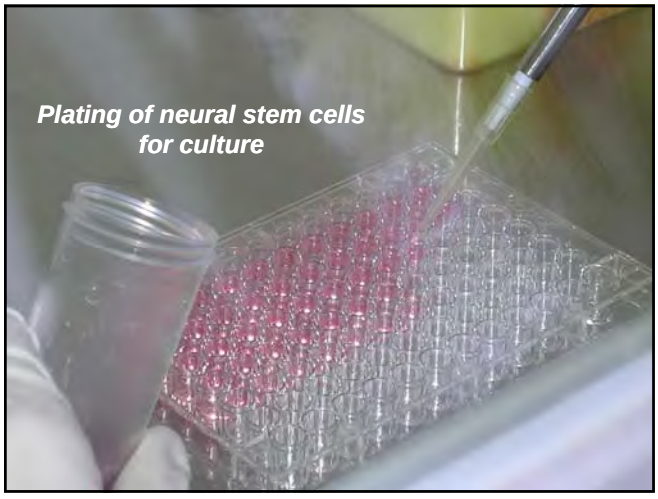
The Second Generation with Dr. Naiphinich Kotchabhakdi, Prof. Dr. Reon Somana, Asst. Prof. Dr. Chittin and Assoc. Prof. Wanna Chindadoungratn and Professors Dr. Fred Walberg and Eric Rinvik (1970's and 1980's)

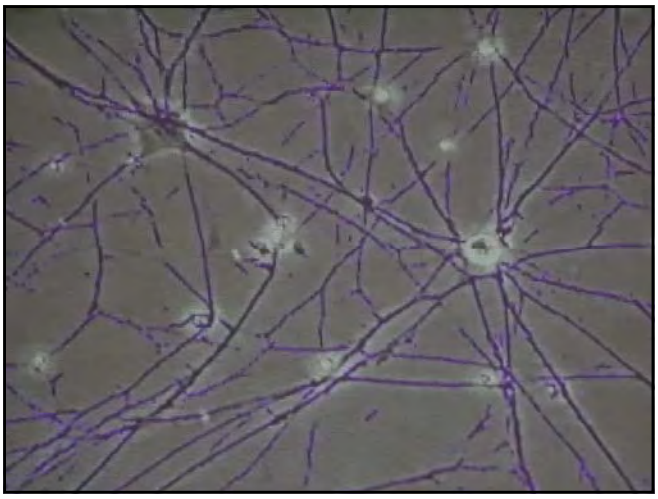
The Third Generation with Dr. Wipawan Thangnipon, Dr. Piyarat Govitrapong, Dr. Kanoknart Yingchareon and Professor Dr. Jon Storm-Mathisen and Eric Rinvik (1990's)

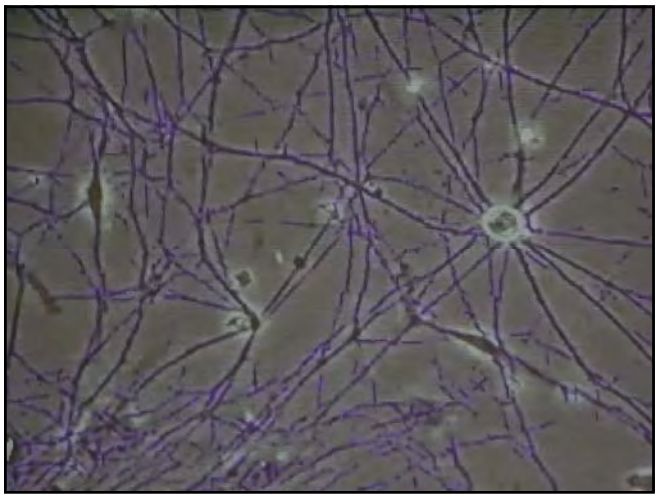
The Fourth Generation with three doctoral candidates, Dr. Wimolrat Puwarawuttipanit from the Faculty of Nursing at Siriraj Hospital, Dr. Duangjai Buntap, Dr. Paworn Nuntagij, a PhD-MD Student from Faculty of Medicine at Siriraj Hospital and Professor Dr. Ole Petter Ottersen and Dr. Reidun Thorp, Professor Dr. Jon Storm-Mathisen, and Dr. Mahmood Amiry-Moghaddam, (2000's)











Neurotransplantation

Stereotaxic injection of neural stem celss into the brain of experimental animals

DEVELOPMENT OF EMBRYONIC RHOMBENCEPHALON TRANSPLANTED INTO ADULT RAT CEREBELLUM

NUANCHAN KRITSANASRINUAN, NAIPHINICH KOTCHABHAKDI AND VEERASAK THERAPANCHAREON

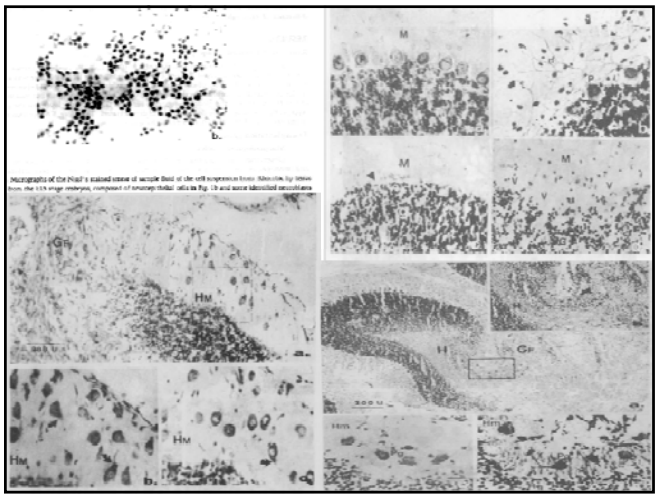
Neuro- and Behavioural Biology Center, Institute of Science and Technology for Research and Development, Mahidol University, Salaya, Nakorn Pathom 73170, Thailand.

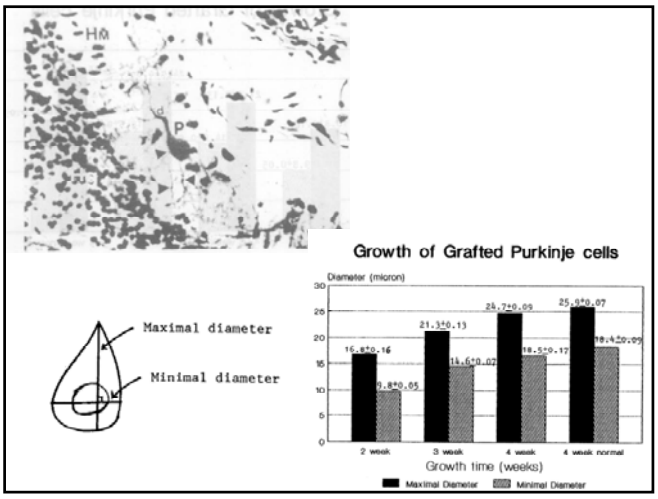
J.Sci.Soc.Thailand,19(1993) 129-142 *(Received August 16, 1993)*

ABSTRACT

The present experiment on neural transplantation is an attempt to investigate the mechanisms of development of embryonic neural tissues which have been grafted into the brain of adult animals. The main objectives of the present study are to find out whether grafted embryonic neural cells can survive, grow and differentiate into specific cell or neuronal types, contact with afferent fibers and integrate into host brain environment, especially when the host brain has been freshly lesioned.

Embryonic rhombencephalic cell suspension isolated from E15 stage rat embryos were injected into the cerebellar vermis of adult rats which had been lesioned with Kainic acid (KA) one week before the transplantation. Histological observations were performed at 2, 3 and 4 weeks after transplantation. The results indicated that grafted neural cells did not only grow and differentiate into Purkinje cells (PC's) like those in the adult cerebellar cortex, but also to a certain extent integrated into damaged host brain, to replace the lost neurons. The present evidence indicates that, under freshly lesioned conditions, the host brain may be receptive to the neural grafted cells and provide a sufficiently neuronotrophic environment for further development.





BEHAVIOURAL EFFECTS OF RHOMBENCEPHALIC CELL SUSPENSION TRANSPLANS INTO THE RAT AFTER CEREBELLAR LESIONING WITH KAINIC ACID

NUANCHAN KRITSANASRINUAN, VEERASAK THERAPANCHAREON AND NAIPHINICH KOTCHABHAKDI

Neurobehavioural Biology Center, Institute of Science and Technology for Research and Development, Mahidol University, Salaya, Nakorn Pathom 73170, Thailand.

J.Sci.Soc.Thailand, 24(1998) 81-90 *(Received March 3, 1998)*

ABSTRACT

The embryonic rhombencephalic tissue suspensions isolated from E15 stage rat embryos were injected into the cerebellar vermis of adult rats which had been lesioned with kainic acid 10 nM one week before transplantation. The result from the histological studies indicated that the grafted neural cells grow and differentiate into adult Purkinje cells, migrate into the host molecular layer and organize into a single cell layer to replace the Purkinje cells lost after kainic acid lesioning. The results from the behavioural studies indicated that the transplantation of the rhombencephalic cell suspension into the lesioned area in the cerebellar cortex can improve the motor deficits as shown by a decrease in the frequency of dysmetria and an increase in the frequency of normal rearing behaviour. At 3 months after transplantation, there was no significant difference in the frequencies of dysmetria and normal rearing behaviour between the transplantation and the control groups. However, when observed with neurological tests, the percent of correct response of the transplantation group was larger than the lesioned group, but still had a significance difference ($p<0.05$) from the control group. In summary, the embryonic rhombencephalic cell suspension can be functionally integrated into a host brain and restore the motor deficits caused by the lesioning in the cerebellum, and although this restoration does not reach normal levels, it is significantly different from the lesioned animals. The results from this experiment suggest that the open-field testing and the neurological examination are useful for evaluation of functional recovery as effects of the grafted tissues, with the neurological examination being more sensitive for detecting the functional effects of transplanted tissue than open-field testing.

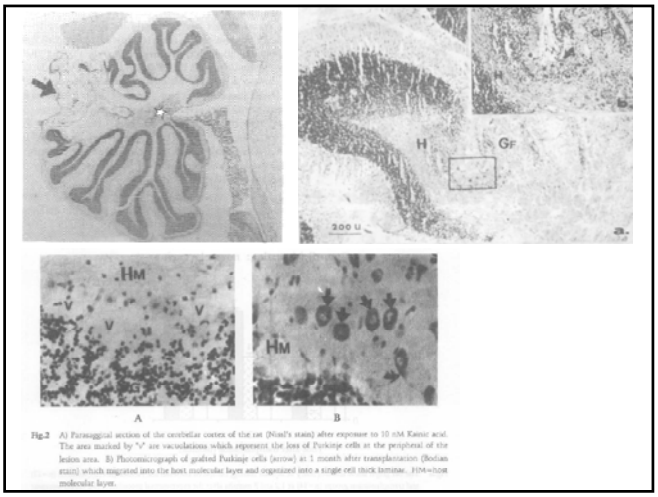


Fig.2 A) Paraoggical section of the cerebellar cortex of the rat (Nissl's stain) after exposure to 10 nM Kainic acid. The area marked by "V" are vacuolations which represent the loss of Purkinje cells at the peripheral of the lesion area. B) Photomicrograph of grafted Purkinje cells (arrow) at 1 month after transplantation (Bodian stain) which migrated into the host molecular layer and organized into a single cell thick laminae. HM=host molecular layer.

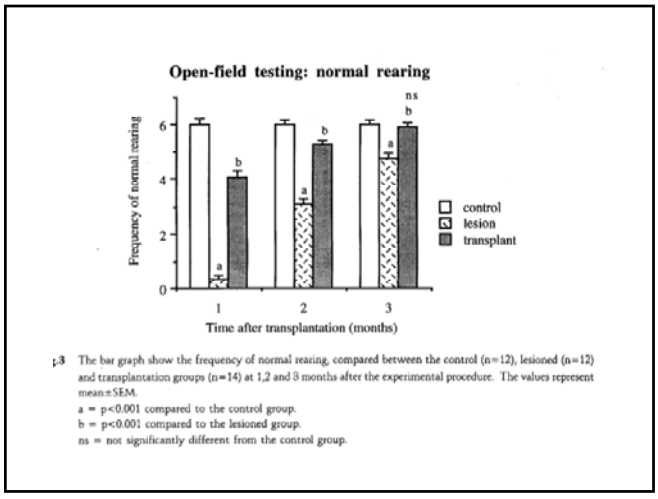
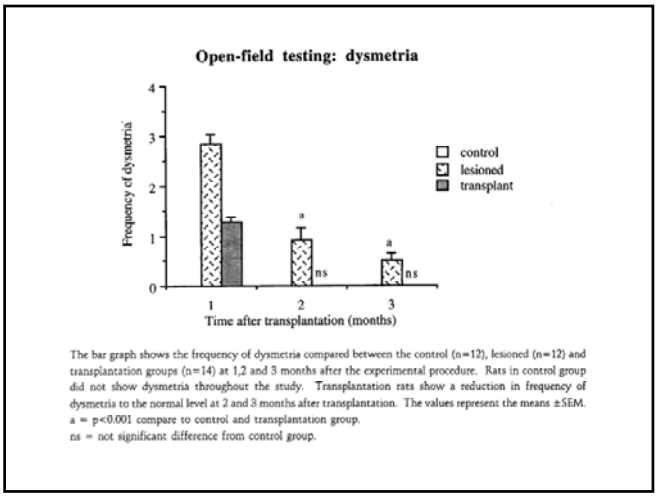
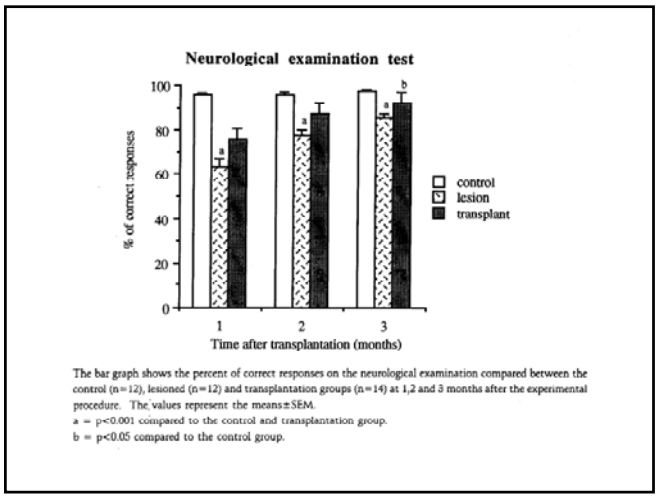
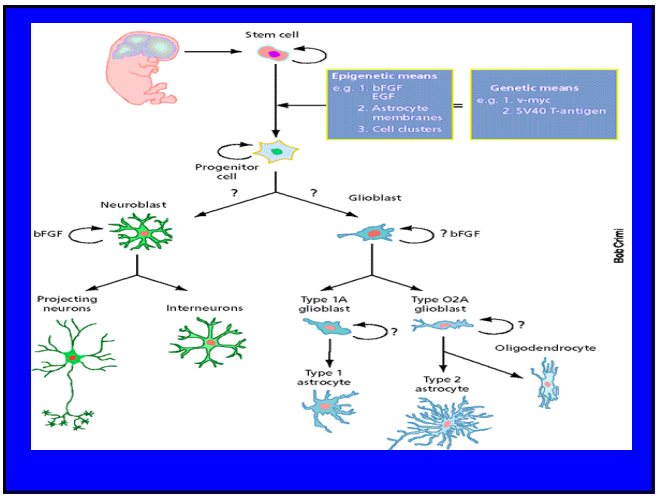


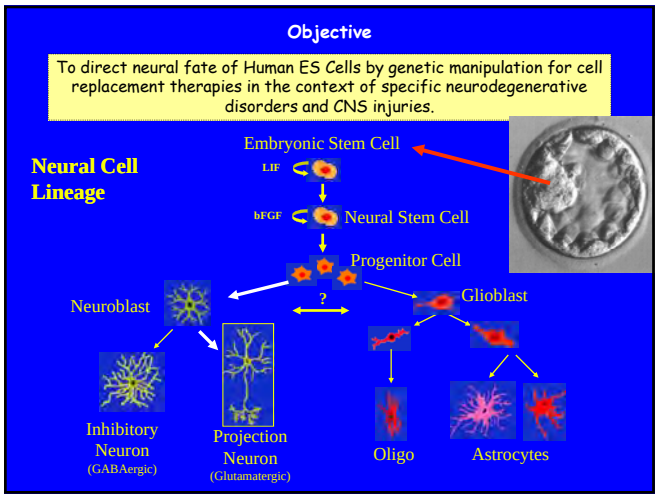
Fig.3 The bar graph show the frequency of normal rearing, compared between the control (n=12), lesioned (n=12) and transplantation groups (n=14) at 1,2 and 3 months after the experimental procedure. The values represent mean±SEM.
a = p<0.001 compared to the control group.
b = p<0.001 compared to the lesioned group.
ns = not significantly different from the control group.

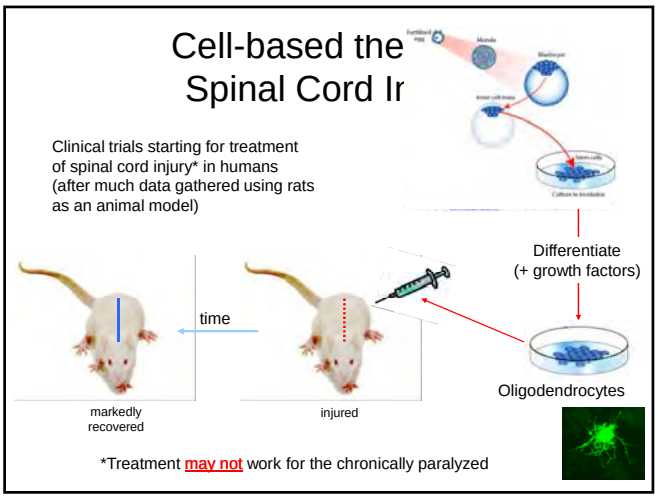


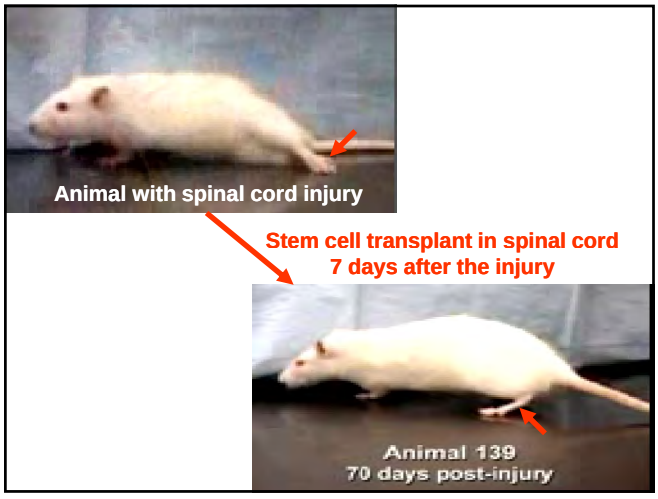
The bar graph shows the frequency of dysmetria compared between the control (n=12), lesioned (n=12) and transplantation groups (n=14) at 1,2 and 3 months after the experimental procedure. Rats in control group did not show dysmetria throughout the study. Transplantation rats show a reduction in frequency of dysmetria to the normal level at 2 and 3 months after transplantation. The values represent the means ±SEM.
a = p<0.001 compare to control and transplantation group.
ns = not significant difference from control group.

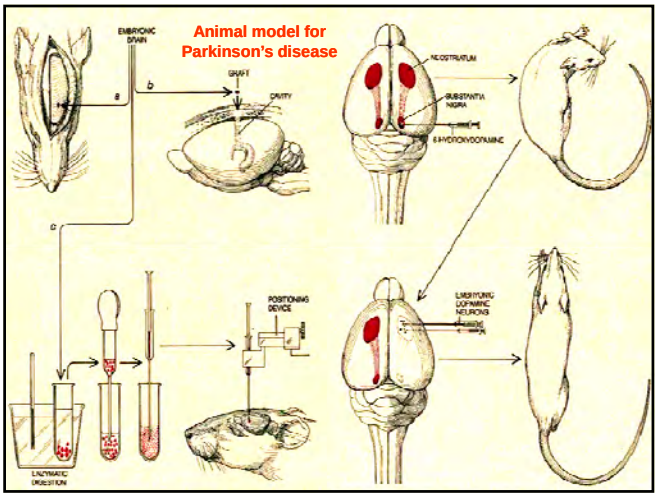

Neurological examination test
% of correct responses
100
80
60
40
20
0
control
lesion
transplant
1
2
3
Time after transplantation (months)
The bar graph shows the percent of correct responses on the neurological examination compared between the control (n=12), lesioned (n=12) and transplantation groups (n=14) at 1,2 and 3 months after the experimental procedure. The values represent the means±SEM.
a = p<0.001 compared to the control and transplantation group.
b = p<0.05 compared to the control group.

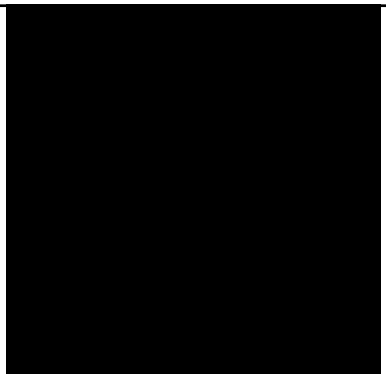

Stem cell
Epigenetic means
e.g. 1. bFGF
EGF
2. Astrocyte membranes
3. Cell clusters
=
Genetic means
e.g. 1. v-myc
2. SV40 T-antigen
Progenitor cell
Neuroblast
Glioblast
bFGF
? bFGF
Projecting neurons
Interneurons
Type 1A glioblast
Type O2A glioblast
Oligodendrocyte
Type 1 astrocyte
Type 2 astrocyte


Objective
To direct neural fate of Human ES Cells by genetic manipulation for cell replacement therapies in the context of specific neurodegenerative disorders and CNS injuries.
Neural Cell Lineage
Embryonic Stem Cell
LIF
bFGF
Neural Stem Cell
Progenitor Cell
Neuroblast
Glioblast
Inhibitory Neuron
(GABAergic)
Projection Neuron
(Glutamatergic)
Oligo
Astrocytes


Cell-based the
Spinal Cord Ir
Clinical trials starting for treatment of spinal cord injury* in humans (after much data gathered using rats as an animal model)
Differentiate
(+ growth factors)
Oligodendrocytes
time
markedly recovered
injured
*Treatment may not work for the chronically paralyzed

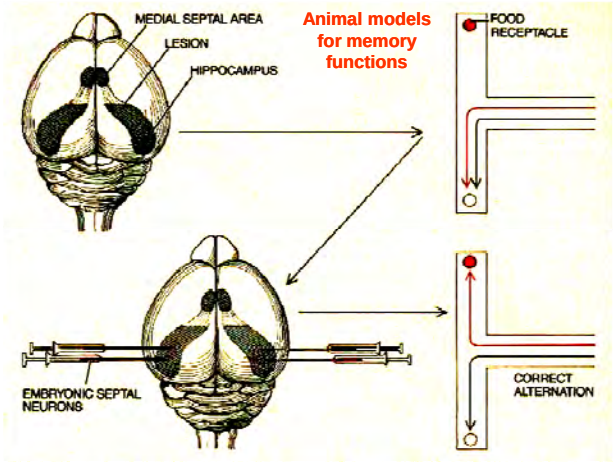

Animal with spinal cord injury
Stem cell transplant in spinal cord
7 days after the injury
Animal 139
70 days post-injury

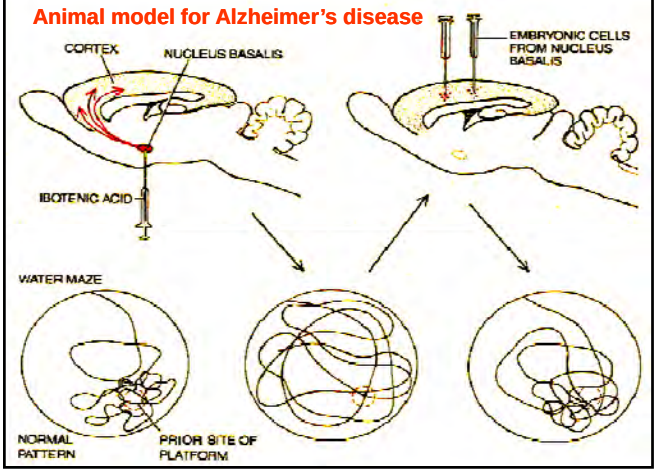

Animal model for Parkinson's disease



Parkinson's patient before and 10 months after autologous neural transplant into the head of caudate nucleus 1998

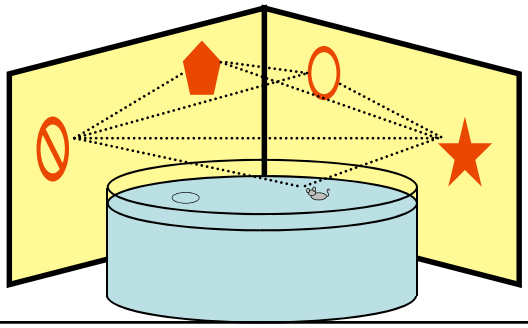
Neurosurgeons: Professor Dr. Sira Bunyaratvej, and Dr. Veerasak Theeraphancharoen

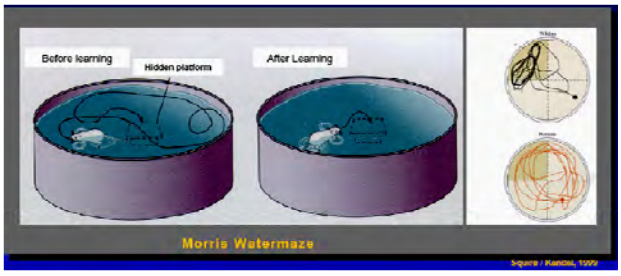




Behavior Test: Morris's Water Swimming Maze

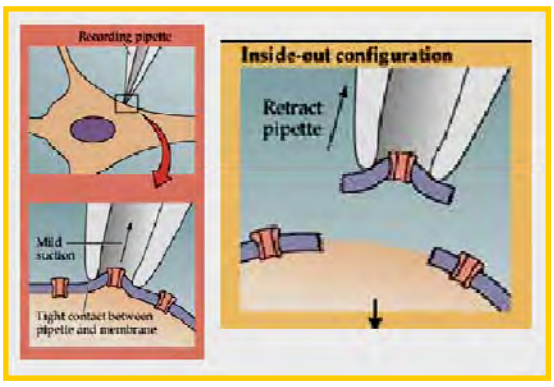
Water maze - Hidden platform
Hippocampal dependent spatial (Declarative memory) task

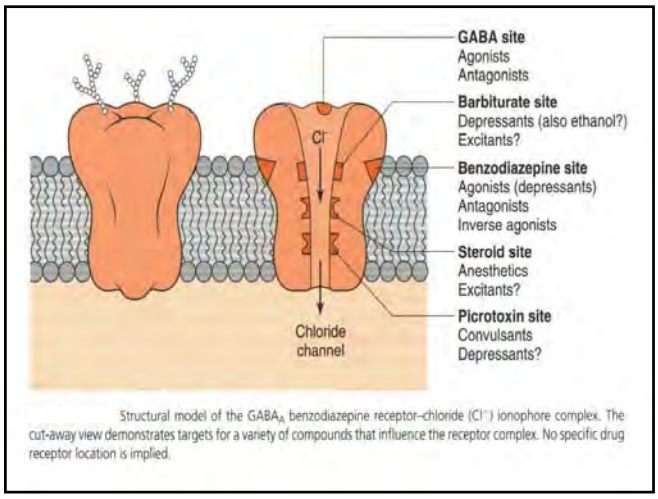




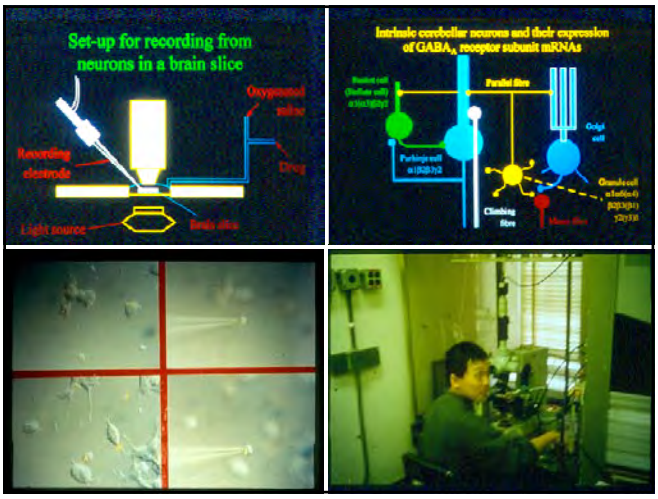
Day 1 D2	Day 3 D7 D12	Day 13 D17
Visible PF Visual acuity Procedural aspect Swim deficits?	Hidden PF Hippocampal-dependent spatial learning	Transfer Behavioral flexibility

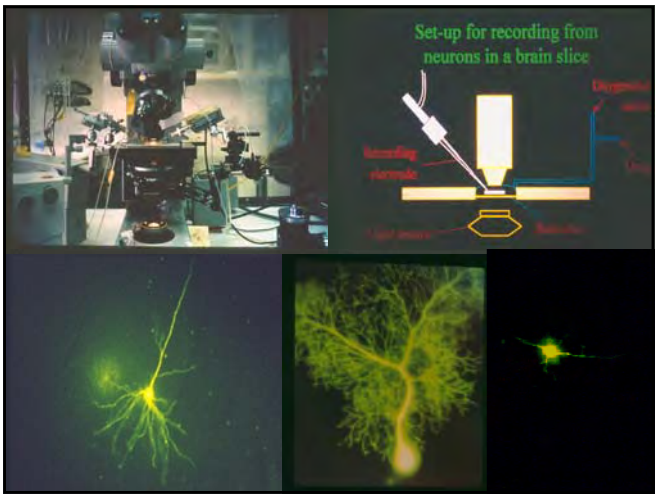
Measuring individual ion channel opening

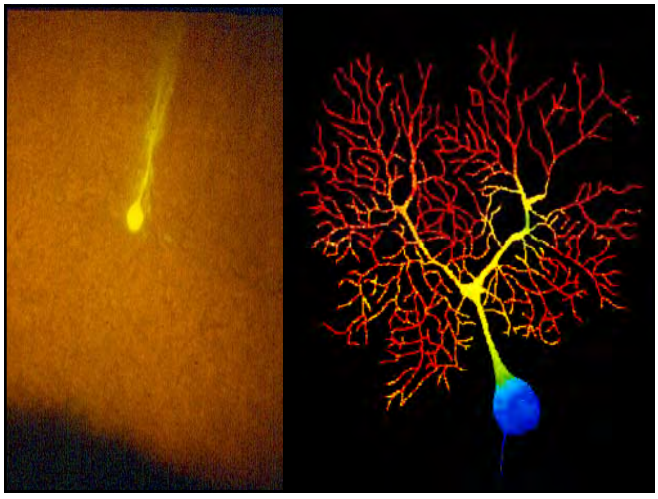


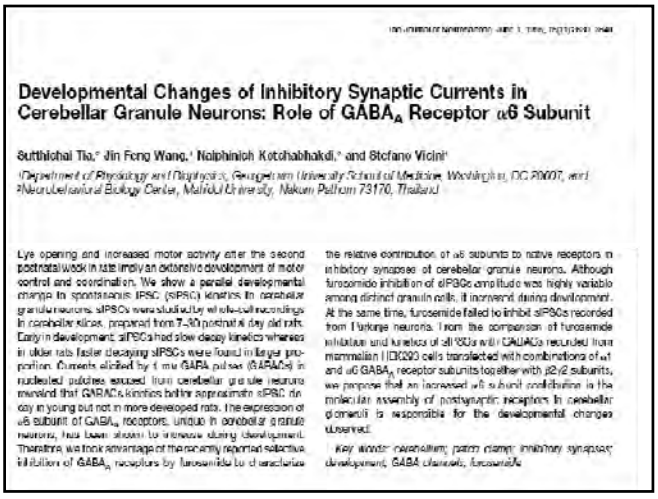


Structural model of the $GABA_A$ benzodiazepine receptor-chloride (Cl^-) ionophore complex. The cut-away view demonstrates targets for a variety of compounds that influence the receptor complex. No specific drug receptor location is implied.









Developmental Changes of Inhibitory Synaptic Currents in Cerebellar Granule Neurons: Role of $GABA_A$ Receptor α6 Subunit

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Eye opening and increased motor activity after the second postnatal week in rats imply an extensive development of motor control and coordination. We show a parallel developmental change in spontaneous IPSC (sIPSC) kinetics in cerebellar granule neurons. sIPSCs were studied by whole-cell recordings in cerebellar slices, prepared from 7–30 postnatal day old rats. Early in development, sIPSCs had slow decay kinetics whereas in older rats faster decaying sIPSCs were found in larger proportion. Currents elicited by 1 ms GABA pulses (GABAA) in nucleated patches excised from cerebellar granule neurons revealed that GABAA kinetics define approximate sIPSC decay in young but not in more developed rats. The expression of α6 subunit of $GABA_A$ receptors, unique in cerebellar granule neurons, has been shown to increase during development. Therefore, we took advantage of the recently reported selective inhibition of $GABA_A$ receptors by furosemide to characterize the relative contribution of α6 subunits to native receptors in inhibitory synapses of cerebellar granule neurons. Although furosemide inhibition of sIPSC amplitude was highly variable among distinct granule cells, it increased during development. At the same time, furosemide failed to inhibit sIPSCs recorded from Purkinje neurons. From the comparison of furosemide inhibition and kinetics of all sIPSCs with GABAA recorded from mammalian HEK293 cells transfected with combinations of α1 and α6 $GABA_A$ receptor subunits together with β2/γ2 subunits, we propose that an increased α6 subunit contribution to the molecular assembly of postsynaptic receptors in cerebellar glomeruli is responsible for the developmental changes observed.

Key words: cerebellum; patch clamp; inhibitory synapses; development; GABA channels; furosemide


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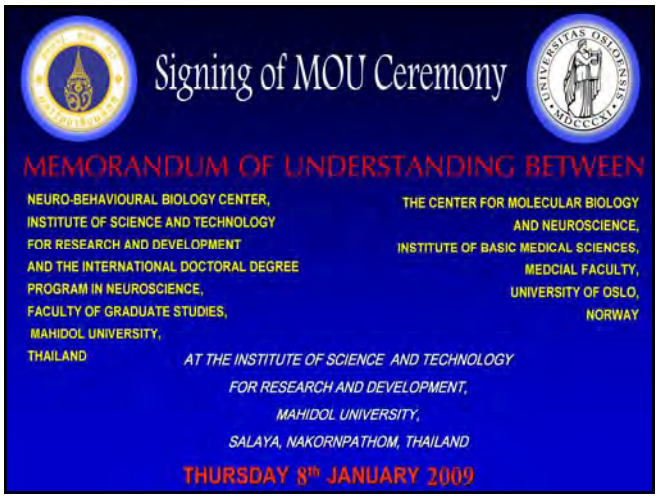
Signing of MOU Ceremony
MEMORANDUM OF UNDERSTANDING BETWEEN
NEURO-BEHAVIOURAL BIOLOGY CENTER,
INSTITUTE OF SCIENCE AND TECHNOLOGY
FOR RESEARCH AND DEVELOPMENT
AND THE INTERNATIONAL DOCTORAL DEGREE
PROGRAM IN NEUROSCIENCE,
FACULTY OF GRADUATE STUDIES,
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THAILAND
THE CENTER FOR MOLECULAR BIOLOGY
AND NEUROSCIENCE,
INSTITUTE OF BASIC MEDICAL SCIENCES,
MEDCIAL FACULTY,
UNIVERSITY OF OSLO,
NORWAY
AT THE INSTITUTE OF SCIENCE AND TECHNOLOGY
FOR RESEARCH AND DEVELOPMENT,
MAHIDOL UNIVERSITY,
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THURSDAY 8th JANUARY 2009


Signing of MOU Ceremony
8 1 2009

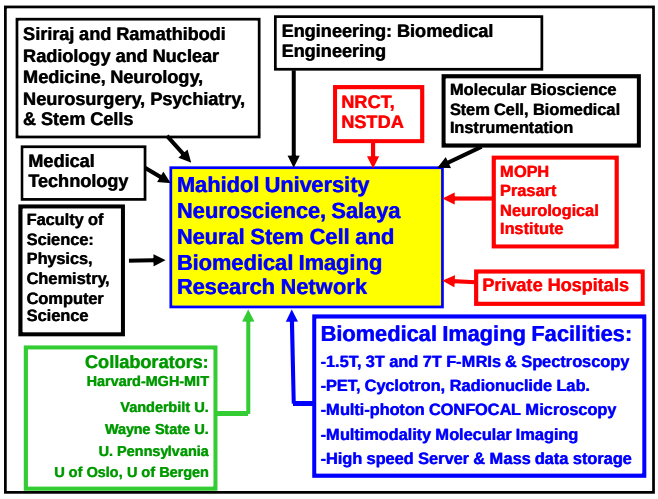

GENERAL AGREEMENT FOR ACADEMIC EXCHANGE
BETWEEN
MAHIDOL UNIVERSITY
AND
UNIVERSITY OF OSLO

The future of Neuroscience:

1. Provide solutions to most common neurological and mental health problems e.g. CVA-Stroke, Alzheimer's disease, Parkinson disease, Dystonia, brain and spinal cord injuries, tumors, schizophrenia, depression, AD/HD, Autistic Spectrum Disorders (ASD) etc..
2. Provide understanding and solution to behavioural and conduct disorders, abnormal aggression and violence, addiction and dependence on drugs, substance abuse, gambling and criminal behaviour
3. Improvement or enhancement of cognitive and learning abilities
4. Reverse engineering of neuro-informatics data base to create large-scale real-time computer simulation of the human brain in both normal and disease conditions: **"The Human Brain Project".**

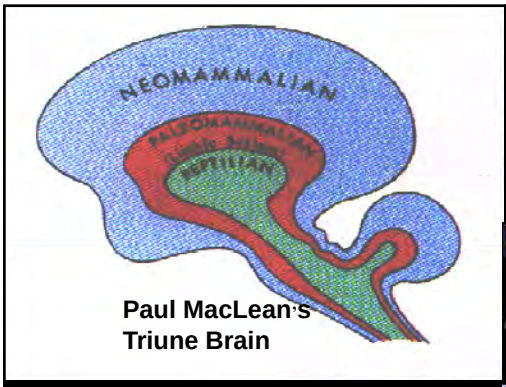
The future of Neuroscience:

5. Development of Brian-Machine Interface Technology and understanding of "Neural Coding and Processing Systems"
6. Better understanding of higher executive brain functions e.g. "Theory of mind", "Social Brain, Moral and Spiritual Brain"
7. Better understanding and utilization of "Mind-Body Medicine" i.e., Psycho-Neuro-Endocrinology (PNE) and Psycho-Neuro-Immunology (PNI)
8. "Information-based Medicine" from "Multi-omics approaches"
9. Ultimate life with "Promotion of Healthy Brian and Happiness"



สมองสามระบบ หรือสามระดับ (Triune Brain) ในมนุษย์?

สมองของมนุษย์เราประกอบด้วยสมองสามระบบ ที่มีวิวัฒนาการ และพัฒนาการมารวมกัน มีนายแพทย์นักวิชาการคนหนึ่งชื่อ นายแพทย์พอล แมคลีน (Dr. Paul MacLean) ได้ศึกษา **สมองสามระบบ** ที่เขาเรียกว่า **Triune Brain** นั่นก็คือ สมองของมนุษย์เรานั้นเหมือนมีสามระบบ หรือสามส่วนประกอบกันทั้งในด้านวิวัฒนาการ (Phylogenic Evolution) และในด้านการเจริญเติบโต พัฒนาการตามวัย (Ontogenic Evolution)



Paul MacLean
M.D.

The Reptilian Brain : Core brainstem
The Paleomammalian Brain : the limbic system
The Neomammalian Brain : neocortex and neocerebellum

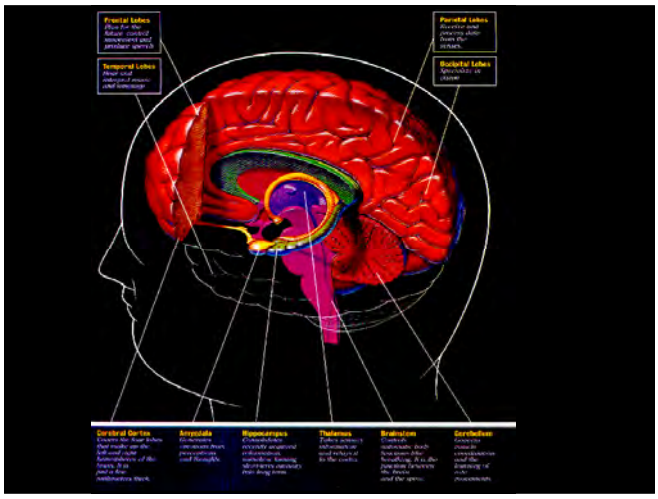
สมองส่วนแรก คือ สมองของสัตว์เลื้อยคลาน (Reptilian Brain) เป็นสมองที่มนุษย์เราได้รับมรดกตกทอดมาจากสัตว์เลื้อยคลานยุคดึกดำบรรพ์ อยู่ภายใต้อิทธิพลของพันธุกรรม 90 – 95 % และเจริญเติบโตในระหว่างที่อยู่ในครรภ์มารดาเป็นส่วนใหญ่ เมื่อเกิดมาแล้วสิ่งแวดล้อมมีอิทธิพลต่อสมองส่วนนี้น้อยมาก มันจะถูกปิดจัยทางพันธุกรรมกำหนดมาเลยว่าเป็นสมองคน หรือสมองสัตว์และมีโครงสร้างและการทำงานอย่างไร สมองส่วนนี้ควบคุมการทำงานของอวัยวะต่างในร่างกายโดยอัตโนมัติ และพฤติกรรมที่เป็นสัญชาติญาณของสิ่งมีชีวิตที่มีมาโดยกำเนิดโดยการกำหนดของพันธุกรรมได้มรดกโดยตรงมาจากพ่อแม่ พ่อแม่เป็นอย่างไรลูกจะได้มรดกตกทอดมาเป็นอย่างนั้นเลย **Reptilian Brain** มีลักษณะเป็นแกนอยู่ตอนในสุดของสมองเป็นส่วนของก้านสมองและสมองตอนกลาง **สมองส่วนที่หนึ่งนี้เป็นสมองส่วนที่ทำให้มนุษย์มีสัญชาติญาณของการอยู่รอด การกิน การขับถ่าย การสืบพันธุ์** เริ่มสร้างขึ้นตั้งแต่ขณะที่ทารกอยู่ในครรภ์มารดา ในวันที่คลอดนั้นสมองส่วนนี้สามารถทำงานได้ราว 99 % และเติบโตสมบูรณ์พร้อมทำงานเต็มที่ในช่วงขวบปีแรก ถ้าสมองส่วนแรกนี้ไม่สามารถทำงานได้ดีทารกก็ไม่อาจมีชีวิตอยู่รอดได้ เพราะมันไป**ควบคุมการเต้นของหัวใจ การหายใจ ระบบขับถ่าย การกินการอยู่ การตื่น การนอนหลับทุกอย่างหมดเลย ในช่วงสองขวบปีแรก พ่อแม่ และผู้เลี้ยงดูเด็กจะสอนเด็กให้สามารถควบคุมร่างกาย ควบคุมการกินอยู่ ควบคุมการขับถ่าย และสร้างนิสัยต่างๆที่เหมาะสมกับการอยู่รอดในสังคม**

สมองส่วนที่สอง คือ สมองสัตว์เลี้ยงลูกด้วยนมยุคโบราณ (Paleomammalian Brain หรือ Limbic System) เป็นสมองส่วนที่มนุษย์เราได้รับมรดกตกทอดมาจากสัตว์เลี้ยงลูกด้วยนมยุคโบราณ สมองส่วนนี้จะเริ่มสร้างและเจริญเติบโตเมื่อทารกอยู่ในครรภ์มารดาได้ราว ๆ หกเดือน Limbic Systemจะมีลักษณะคล้ายวงแหวนที่หุ้มรอบๆสมองส่วนแรกซึ่งมีลักษณะเป็นแกนเอาไว้ หน้าที่ของสมองส่วนนี้ก็คือ **ทำให้ทารกเกิดความจำเกี่ยวกับเหตุการณ์และสถานที่ (Episodic or Spatiotemporal Memory)** โดยเฉพาะความจำที่เกี่ยวกับใบหน้าแม่ จำกลิ่นแม่ได้ **ทำให้มนุษย์รู้จักตัวเอง ("Self")** และ**พัฒนาให้มีความรู้สึก(Feeling)และการแสดงออกทางอารมณ์ต่าง ๆ** มันจะเป็นตัวที่ทำให้ทารกร้องไห้โยเยเรียกร้องความสนใจ แสดงอารมณ์ความรู้สึกเวลา ดีใจ-เสียใจ ชอบ-ไม่ชอบ พอใจ-ไม่พอใจ สมองส่วนที่สองนี้ทำให้มนุษย์เราแตกต่างจากสัตว์เลื้อยคลาน เช่น จิ้งจก กิ้งก่า เต่า ซึ่งมีเพียงแค่สัญชาติญาณแต่ปราศจากความรู้สึก และอารมณ์ อย่างไรก็ตามตอนที่ทารกคลอดออกมาสมองส่วนนี้เพิ่งสร้างเสร็จไปเพียง 50 % เท่านั้น มันจะเจริญเติบโตต่อไปโดยเฉพาะในช่วงสี่ขวบปีแรกของชีวิต

สมองส่วนที่สองจะได้รับอิทธิพลจากพันธุกรรมประมาณ 50 % ส่วนอีก 50 % ที่เหลือนั้นพัฒนาตามสภาพแวดล้อม ประสบการณ์และการเรียนรู้โดยเฉพาะช่วงตั้งแต่แรกเกิด ขวบปีแรกจนถึงปฐมวัย (0 – 8 ปี) สมองส่วนนี้สำคัญมากตรงที่ เป็นตัวกำหนด **พื้นอารมณ์** (Temperament) ควบคุมการแสดงออกของอารมณ์ให้เหมาะกับเหตุการณ์ และสถานการณ์ ซึ่งเป็นรากฐานของ**บุคลิกภาพของปัจเจกคน (Individual Personality)**ที่ทำให้เราทุกคนแตกต่างกัน การที่เด็กจะเติบโตเป็นคนที่**ฉลาดทางอารมณ์ (Emotional Intelligence)** มีมนุษยสัมพันธ์ดีหรือไม่ขึ้นอยู่กับการเลี้ยงดูในช่วงปฐมวัย และการพัฒนาของสมองส่วนนี้เป็นสำคัญ

สมองส่วนที่สาม คือ สมองของสัตว์เลี้ยงลูกด้วยนมยุคใหม่ และเปลือกหุ้มสมองใหม่ (Neo-Mammalianหรือ Neo-Cortex Brain) คือ สมองที่พบได้เฉพาะในสัตว์ชั้นสูงที่มีเปลือกหุ้มสมองใหญ่เท่านั้น เช่น มนุษย์ ปลาโลมาและสัตว์ประเภทวานร ลิง (Primates)เป็นต้น สมองส่วนที่สามนี้จะมีลักษณะคล้ายเปลือกหุ้มสมอง หุ้มสมองส่วนที่หนึ่งและส่วนที่สองเอาไว้ ตอนที่ทารกคลอดออกมาใหม่ ๆ สมองส่วนนี้ยังไม่พัฒนามากเลย มันจะเริ่มก่อร่างสร้างตัวและเจริญเติบโตอย่างรวดเร็วมากในช่วงสามปีแรกของชีวิต จนกระทั่งเมื่อเด็กอายุได้หกขวบจึงเจริญเติบโตราว 80 % ตอนเก้าขวบจะเติบโตราว 90 % และจะเจริญเติบโตเรื่อยต่อไปกระทั่งอายุ 25 ปี สมองส่วนที่สามจะได้รับอิทธิพลจากพันธุกรรมน้อยมาก แทบจะเรียกได้ว่าพันธุกรรมควบคุมมัน 10-20 % เท่านั้น เพราะมันมาเจริญเติบโตหลังคลอด **พัฒนาการของสมองส่วนนี้จึงได้รับอิทธิพลมาจากสิ่งแวดล้อมเป็นส่วนใหญ่ และต้องการการกระตุ้นจากสิ่งแวดล้อมให้สามารถพัฒนาได้เต็มที่ตามศักยภาพที่มีมากับตัวของเด็ก**

สมองส่วนที่สาม มีความยืดหยุ่นค่อนข้างมาก มีบทบาทเปรียบได้กับหน้าต่างของโอกาส (Windows of opportunities)ที่จะส่งเสริมให้เด็กฉลาดโดยการกระตุ้นการรับรู้ และกิจกรรมต่างๆจากประสบการณ์การเรียนรู้ต่างๆ การได้รับอาหารที่มีครบทุกหมู่อาหารในปริมาณที่เหมาะสม และคุณภาพที่ดีจำเป็นมากต่อการเจริญเติบโตของสมองส่วนนี้ การสัมผัสและการกระตุ้นประสาทสัมผัสต่างๆอย่างเหมาะสมเป็นความจำเป็นอย่างยิ่งที่จะทำให้สมองส่วนนี้พัฒนาก้าวหน้า และสามารถเรียนรู้ประสบการณ์ต่างๆ ที่ทำให้อย่างเต็มที่ เพราะฉะนั้นเรื่องการเลี้ยงดูเด็กในช่วงสามขวบปีแรกจึงเป็นเรื่องสำคัญมาก เพราะในช่วงนี้สมองส่วนนี้จะเจริญเติบโตจากที่ไม่มีอะไรมากเลย คือ ประมาณ 25% ของผู้ใหญ่ตอนแรกเกิด จนกระทั่งเติบโตได้ถึง 80 % ตอนอายุ 3 ขวบปีแรก **สมองส่วนนี้ทำให้เด็กสามารถเรียนรู้ สร้างโลกทัศน์ของการรับรู้ และความเข้าใจเกี่ยวกับจักรวาลรอบตัว มีทักษะต่างๆในการเคลื่อนไหว เรียนรู้ภาษาที่ใช้ในการสื่อสาร ทั้งภาษาพูด ภาษาเขียน การคำนวณ การคิดหาเหตุผล คณิตศาสตร์ และตรรกวิทยา (Logic thinking) รวมทั้งการเรียนรู้วิชาการต่างๆ และจินตนาการทางศิลปะ**



ช่วงอายุของการพัฒนาสมอง สามระบบ หรือสามระดับ (Triune Brain) ในมนุษย์?

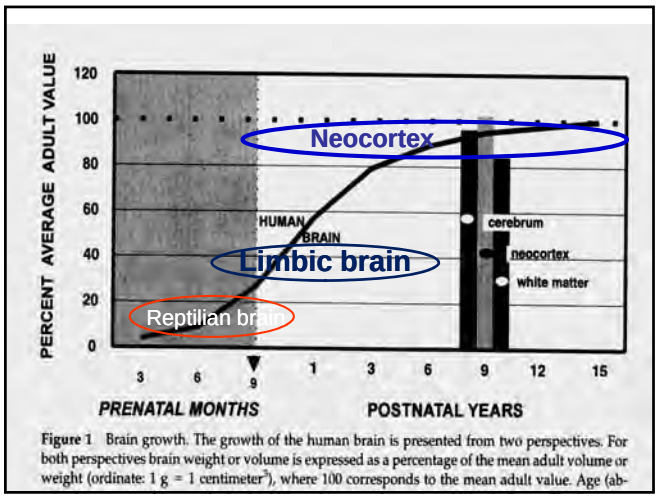


Figure 1 Brain growth. The growth of the human brain is presented from two perspectives. For both perspectives brain weight or volume is expressed as a percentage of the mean adult volume or weight (ordinate: 1 g = 1 centimeter^3), where 100 corresponds to the mean adult value. Age (ab-

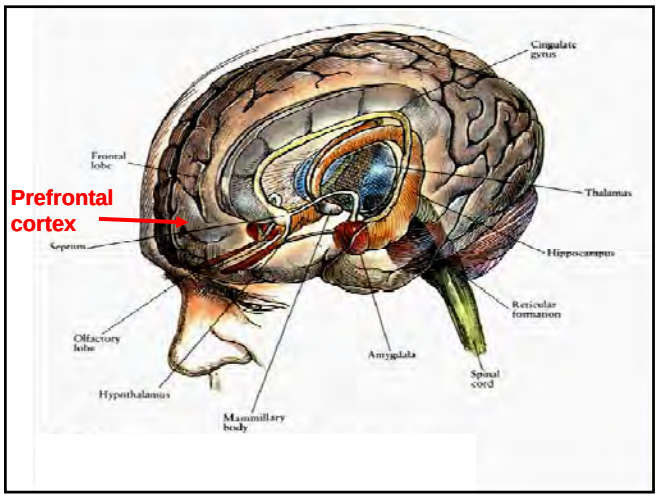
สมองส่วนไหนคือ “นายของสมอง (CEO of the brain)” และ “จิต (Mind)” ในมนุษย์?

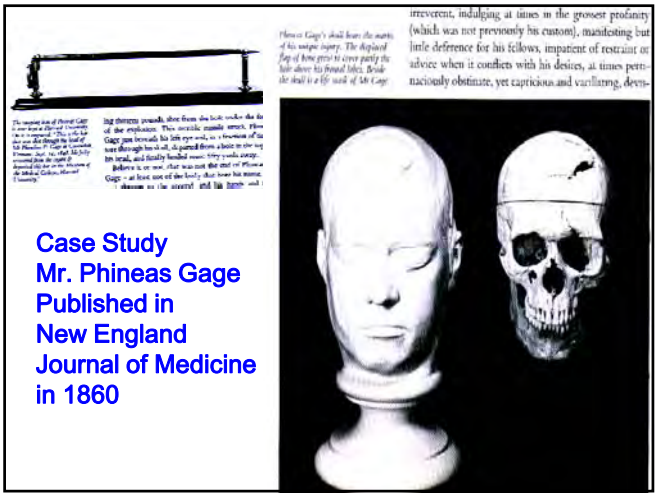
What are Executive Functions?

- The concept of ‘executive functions’ refers to the higher order control processes necessary to guide behaviour in a constantly changing environment (Jurado & Rosselli, 2007).
- The concept includes abilities such as planning, working memory, mental flexibility, response initiation, response inhibition, impulse control and monitoring of action (Roberts, Robbins, & Weiskrantz, 1998; Stuss & Knight, 2002).
- Behavioural and neuropsychological studies originally linked executive functions to the frontal lobes, in particular, the pre-frontal cortex (Baddeley & Wilson, 1988; Stuss & Benson, 1986).
- However, more recent neuroimaging studies have shown that executive functions are associated with different regions of the frontal lobes, with links between frontal and posterior areas, as well as subcortical and thalamic pathways (Monchi, Petrides, Strafella, Worsley, & Doyon, 2006; Stuss &

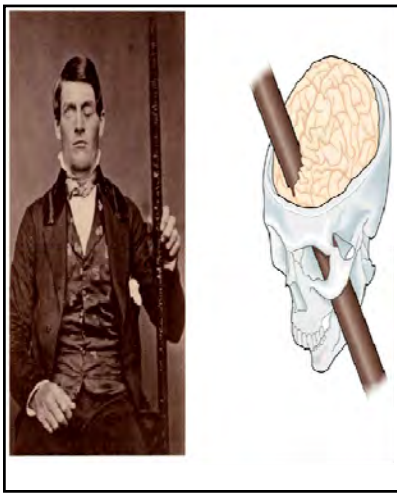
Prefrontal Cortex

front view. Lateral view. Medial view.





Case Study
Mr. Phineas Gage
Published in
New England
Journal of Medicine
in 1860



19th century case revealing the dependence of personality on pre-frontal cortex.

Left: Phineas Gage with the 3-foot long tamping iron that was driven through his head by an explosion.

Right: A computer reconstruction of a drawing of the passage of the tamping iron through Gage's brain.
This injury resulted in severe personality changes that added to our understanding of the function of the frontal lobes.

Phineas Gage: A changed man

"He is fitful, irreverent, indulging at times in the grossest profanity, impatient of restraint or advice when it conflicts with his desires; at times pertinaciuously obstinate yet capricious and vascillating. His friends and acquaintances said he was no longer Gage"

Harlow, 1868

Why Are Executive Functions Important?

Executive Function Skills important for:

- **School readiness** more than are IQ or entry-level reading or math. *(Blair, 2002, 2003, Blair and Razza, 2007, Normandeau and Guay, 1998)*
- **School Success:** Working Memory and inhibitory control each independently predict both math and reading competence throughout the school years. *(Adele Diamond, 2012)*
- **Job Success**: Poor EF Skills lead to poor productivity and difficulty finding and keeping a job.

Executive Function skills are critical for cognitive, social and psychological development.

Executive Functions and Mental Health

- **Increase in drug addictions, ADHD, ASD, Bipolar and major depression, conduct disorder, and schizophrenia are associated with impaired executive functions.**
- **Children with less self-control (more impulsive, less persistent, poor attention regulation) have worse health, earn less and commit more crimes as adults 30 years later** *(Terri Moffitt et all , 2011, National Academy of Sciences)*

Executive Functions and Early Childhood

- 46% of kindergarten teachers, in a survey by Robert Pianta and others from UVA, reported that at least half of the children in their classrooms have problems following directions.
- **Head Start teachers**, in another study, reported that more than a quarter of their students exhibited serious self-control-related negative behaviors.

How to and What Can Support Executive Functions

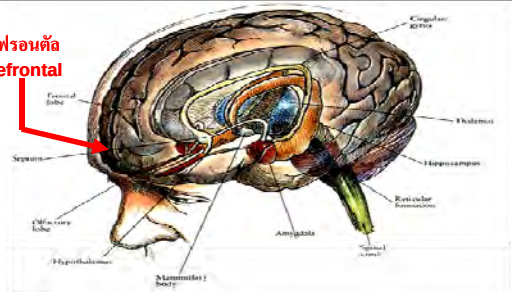
Research has shown that diverse activities can improve children's executive functions, including:

- **Computer games**
- **Aerobics, martial arts and yoga,**
- **Mindfulness**
- **Playing a musical instruments**
- **School curricula that support creative thinking and hands-on learning.**

Who are the students who have difficulties in these areas?

- Autism Spectrum Disorder
- ADHD, both Hyperactive-type and Inattentive-type
- Specific Learning Disabilities
- Expressive and/or Receptive Language disorders
- ELL, "it's hard enough just learning a second language. You want me to be organized too???"

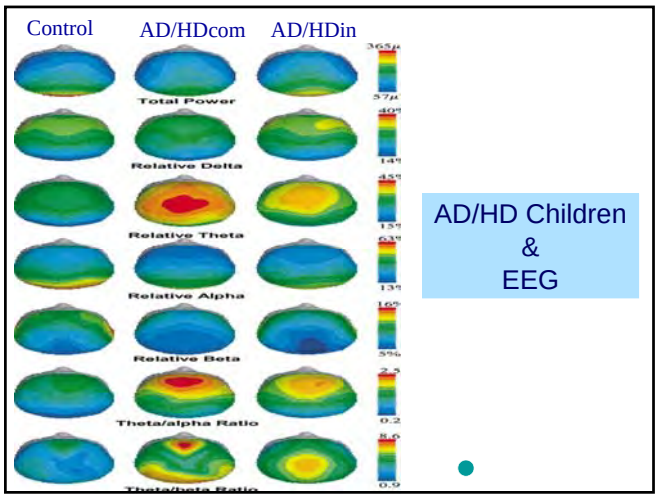
ในสมอง ส่วนที่สำคัญที่สุด ในด้านการพัฒนาสมอง คือ สมองส่วนหน้า (Frontal lobe) ที่อยู่ด้านหลังหน้าผากของมนุษย์ หรือ **สมองส่วนปรีฟรอนตัล (Prefrontal Cortex)** เป็นสมองส่วนที่อยู่ในสมองส่วนที่สาม สาเหตุที่ทำให้สมองส่วนนี้มีความสำคัญมาก เพราะมันมีหน้าที่ความสำคัญเปรียบได้กับเป็น **"นายของสมอง" (Chief Executive Officer หรือCEO ของสมองทั้งหมด)** เพราะเป็นสมองส่วนที่เกิดทีหลังสุด ในช่วงสองขวบปีแรกเพิ่งเริ่มสร้างเท่านั้นเอง ทำหน้าที่เชื่อมโยงกับสมองที่ที่สร้างก่อนมาทั้งหมด สมองส่วนนี้จะได้รับเส้นประสาทมาจากสมองส่วนต่างๆ เมื่อเจริญเติบโตเต็มที่ในช่วงที่ย่างเข้าสู่วัยรุ่น จะเป็นส่วนที่ควบคุมร่างกายและจิตใจทั้งหมด ทำให้เราเหมือนมีจิตใจเป็นหนึ่งเดียว มีเจ้านายคนเดียวสั่งงาน สังเกตดูจะเห็นว่าช่วงวัยเด็กเล็ก เด็ก ๆ จะวิ่งเล่นตามประสา สะเปะสะปะไปตามสิ่งเร้า สิ่งกระตุ้น เหมือนไม่มีการควบคุมการสั่งงาน แต่พอเราโตขึ้นชีวิตเริ่มมีการวางแผน สมองส่วนนี้นี่เองที่จะคอยควบคุมกำหนดให้มนุษย์มีการวางแผนงานล่วงหน้า มีความรับผิดชอบ มีสมาธิ



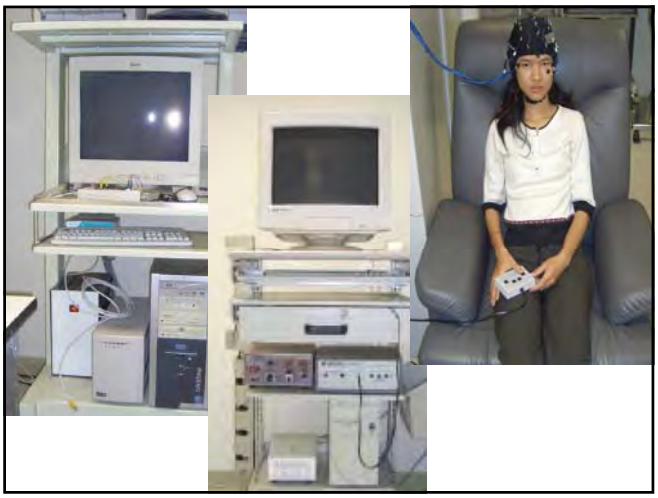
ภาพสมองคนแสดง สมองสามระบบ (Triune brain) สมองระบบแรก Reptilian brain ควบคุมสมดุลของการมีชีวิตและการอยู่รอด (Homeostasis and survival) อยู่ในบริเวณก้านของสมอง และสมองส่วนเล็กที่อยู่ใจกลางภายในของสมอง ระบบที่สอง ส่วนของสมองลิมบิค (Limbic brain structures) หุ้มห่อสมองระบบแรกที่อยู่ภายใน ซึ่งทำหน้าที่เกี่ยวกับพัฒนาการของอารมณ์ ความสัมพันธ์และสังคมกับคนอื่นๆ และกับจิตใจกับความประพฤติของตัวเราเอง ระบบที่สาม นีโอคอร์เท็กซ์ (Neocortex) เป็นส่วนเปลือกที่หุ้มห่อภายนอกของสมองใหญ่ ทั้ง Cerebrum and cerebellum ควบคุมการรับรู้ การเรียนรู้ และทักษะความชำนาญ และความเฉลียวฉลาด รวมทั้งบริเวณ ปรีฟรอนตัล (Prefrontal) ที่เป็นนายหรือ CEO ของสมอง

ทีมงานวิจัยของมหาวิทยาลัยไอโอวานำโดยประสาทแพทย์ชื่อ ดร. อันโตนิโอ ดามาสซิโอ (Dr. Antonio Damassio) **และภรรยา ดร.ฮันนา ดามาสซิโอ** (Dr. Hanna Damassio) ได้ทำการวิจัยติดตามเด็กเล็กที่เมื่ออายุประมาณขวบหรือขวบครึ่งเคยได้รับบาดเจ็บจากอุบัติเหตุ เช่น หกล้มไปข้างหน้าแล้วศีรษะส่วนหน้าผากฟาดพื้น ทำให้สมองบริเวณนั้นเกิดอาการช้ำ ทีมงานวิจัยติดตามเด็กกลุ่มนี้ไปจนกระทั่งวัยรุ่นแล้วพบว่า เด็กกลุ่มนี้จะมีอาการทางประสาทที่จิตแพทย์เรียกว่า **สมองส่วนหน้าพิการ** (Frontal lobe syndrome) คือ เด็กที่สมองส่วนหน้าทำงานไม่สมบูรณ์ ทำให้ประสบปัญหาเรื่องการเรียน และพฤติกรรม แม้ว่าบางคนจะมีไอคิว (IQ) สูงก็ตาม เนื่องจาก**มีสมาธิสั้น** (Attention Deficit หรือ AD)) **ไม่สามารถควบคุมตัวเองให้สงบนิ่ง ที่จะทำอะไรนิ่งๆ อยู่กับที่นาน ๆ ได้พอ ไม่มีการวางแผนที่ดี ขาดความรับผิดชอบ และมีปัญหาในการเรียน และการเข้าสมาคมกับคนอื่นๆ เด็กวัยรุ่นที่มาจากครอบครัวที่ดีแต่ตัวเด็กกลับมีพฤติกรรมไม่เหมาะสม และเป็นอันธพาลชอบต่อต้านกฎระเบียบต่างๆ ต่อต้านสังคม และบางครั้งชอบใช้ความก้าวร้าวและพฤติกรรมรุนแรง** นั้น เมื่อศึกษาลึกลงไป จะพบว่ามีสาเหตุเกี่ยวกับความพิการของสมองส่วนนี้เข้ามาเกี่ยวข้องได้เสมอ ดังนั้น จึงควรดูแลป้องกันระมัดระวังไม่ให้ศีรษะส่วนนี้ของเด็กทารกได้รับบาดเจ็บ

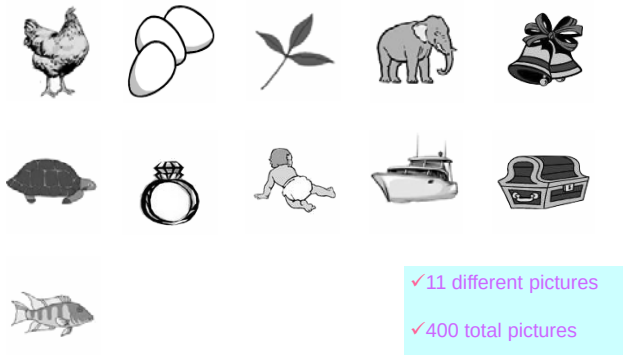
เด็กสมาธิสั้น ซน พฤติกรรมไม่เหมาะสมกับกาลเทศะ
(Attention Deficit/Hyperactivity: AD/HD)



AD/HD Children
&
EEG

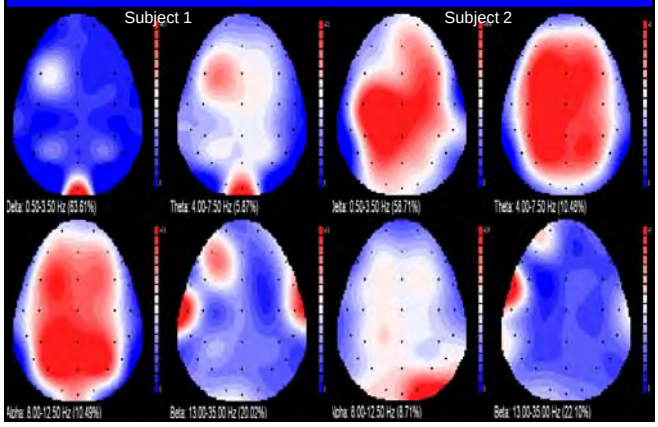


CPT - The Stimuli

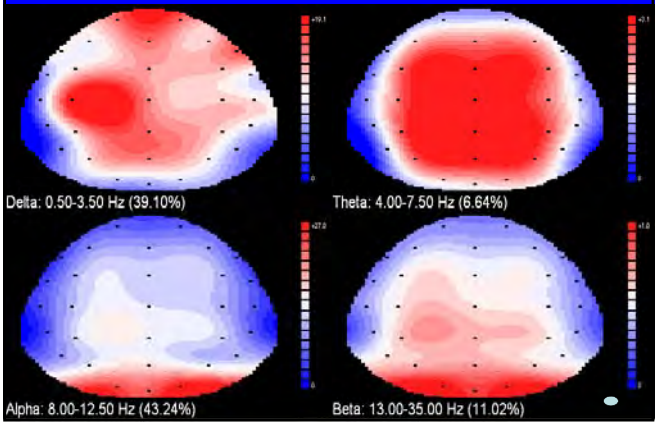


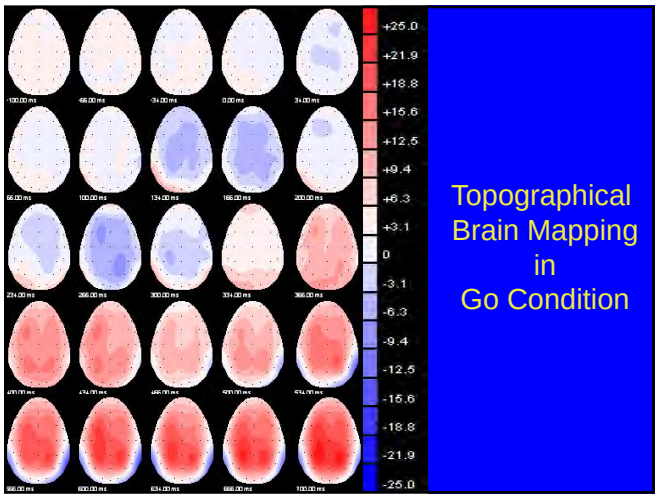
- ✓11 different pictures
- ✓400 total pictures
- ✓4 X 4.5 cm

Eyes-opened condition (relative power; uV^2)

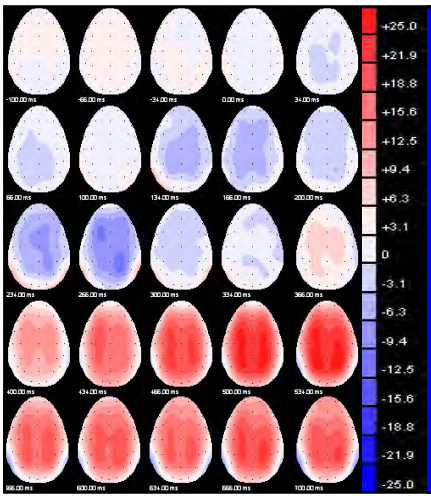


Eyes-closed condition (relative power; uV^2)

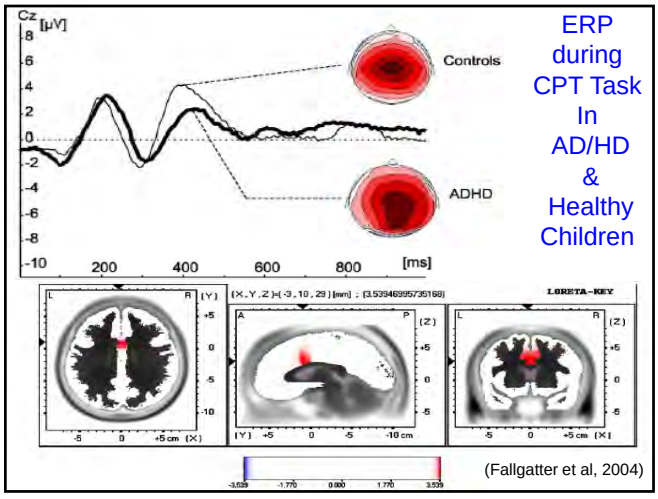




Topographical Brain Mapping in Go Condition



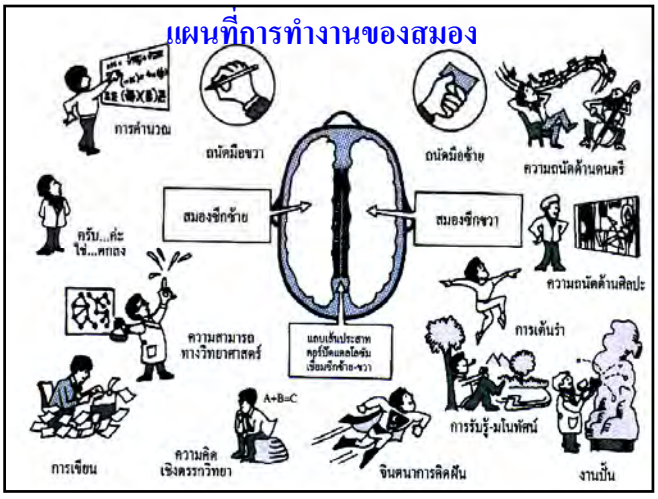
Topographical Brain Mapping In Nogo Condition

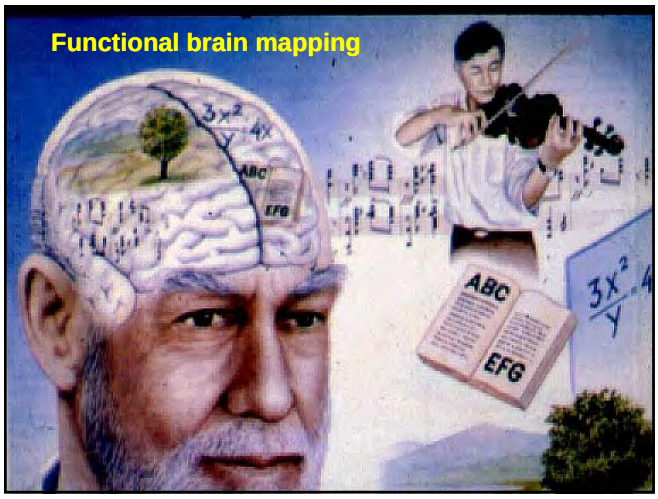


ERP during CPT Task In AD/HD & Healthy Children

(Fallgatter et al, 2004)

แผนที่การทำงานของสมอง

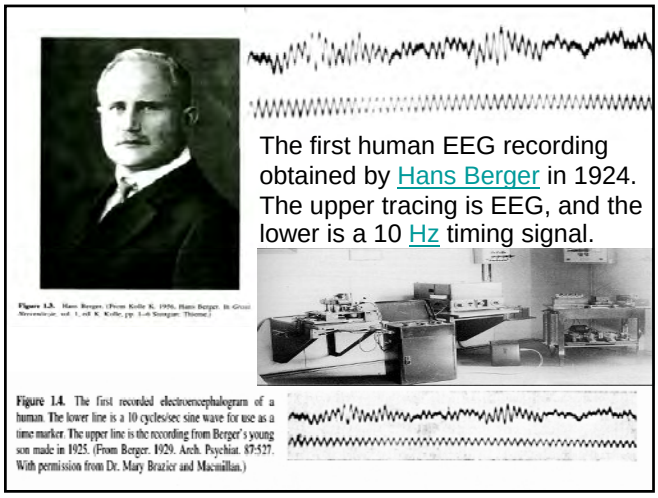




Research use of EEG

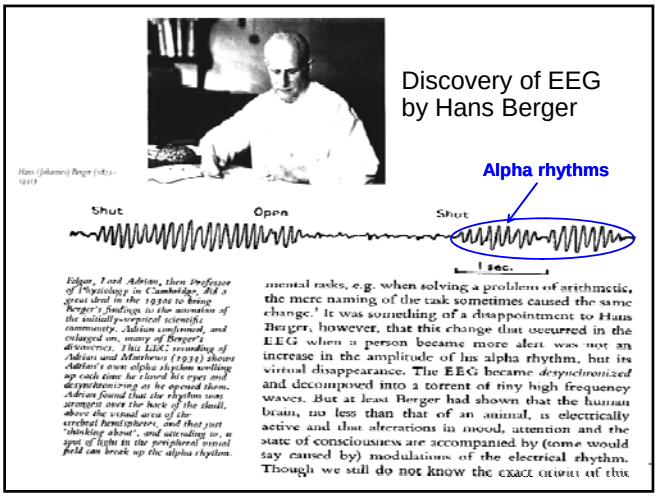
EEG, and the related study of Evoked Potentials (EP) and Event Related Potentails (ERPs) are used extensively in neuroscience, cognitive science, cognitive psychology, neurolinguistics and psychophysiological research.

Many EEG techniques used in research are not standardized sufficiently for clinical use.



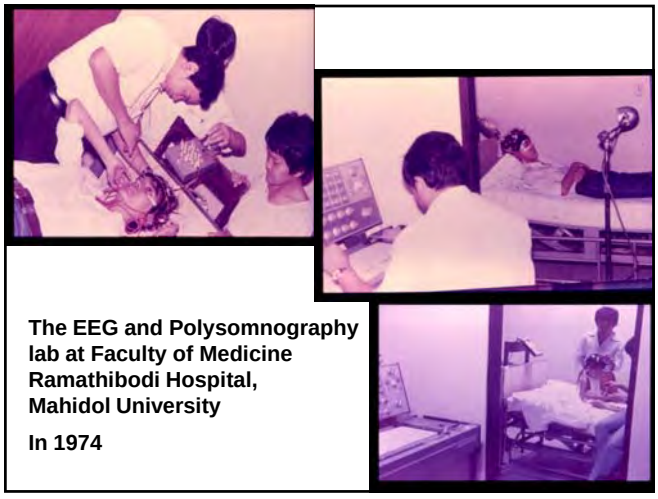
The first human EEG recording obtained by Hans Berger in 1924. The upper tracing is EEG, and the lower is a 10 Hz timing signal.

Figure 1.4. The first recorded electroencephalogram of a human. The lower line is a 10 cycles/sec sine wave for use as a time marker. The upper line is the recording from Berger's young son made in 1925. (From Berger. 1929. Arch. Psychiat. 87:527. With permission from Dr. Mary Brazier and Macmillan.)



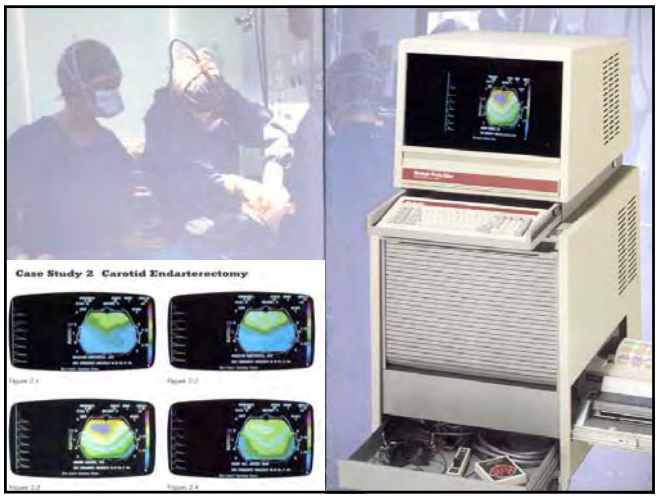
Edgar, Lord Adrian, then Professor of Physiology in Cambridge, did a great deal in the 1930s to bring Berger's findings to the attention of the initially sceptical scientific community. Adrian confirmed, and enlarged on, many of Berger's discoveries. His EEG recording of Adrian and Matthews (1934) shows Adrian's own alpha rhythm welling up each time he closed his eyes and desynchronizing as he opened them. Adrian found that the rhythm was strongest over the back of the skull, above the visual area of the cerebral hemispheres, and that just 'thinking about', and attending to, a spot of light in the peripheral visual field can break up the alpha rhythm.

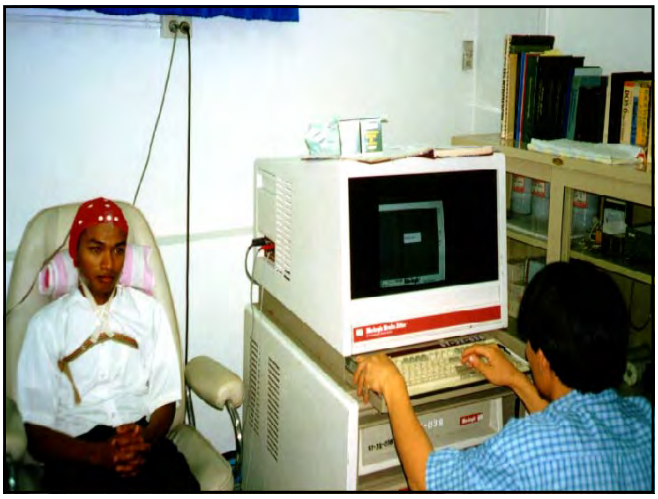
mental tasks, e.g. when solving a problem of arithmetic, the mere naming of the task sometimes caused the same change.' It was something of a disappointment to Hans Berger, however, that this change that occurred in the EEG when a person became more alert was not an increase in the amplitude of his alpha rhythm, but its virtual disappearance. The EEG became *desynchronized* and decomposed into a torrent of tiny high frequency waves. But at least Berger had shown that the human brain, no less than that of an animal, is electrically active and that alterations in mood, attention and the state of consciousness are accompanied by (some would say caused by) modulations of the electrical rhythm. Though we still do not know the exact origin of this



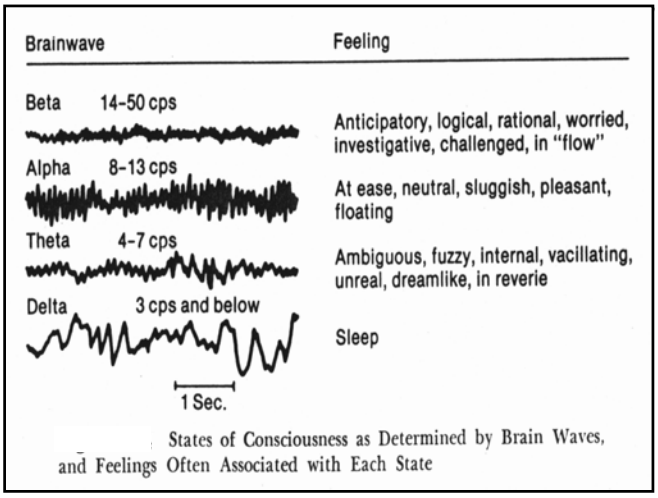
The EEG and Polysomnography lab at Faculty of Medicine Ramathibodi Hospital, Mahidol University

In 1974

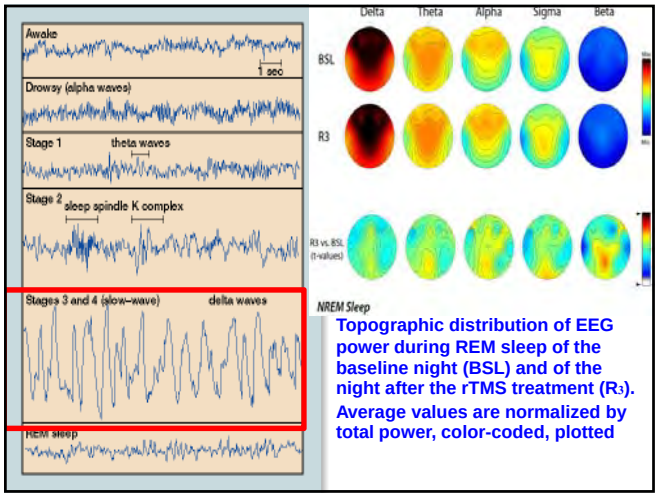




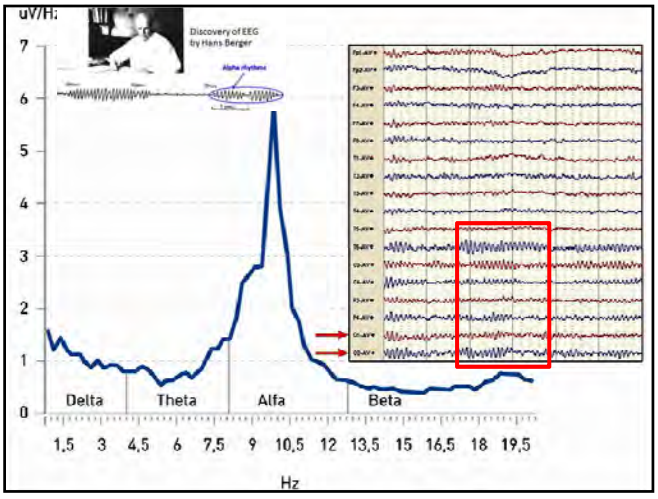
SALAYA EEG & SLEEP LABORATORY

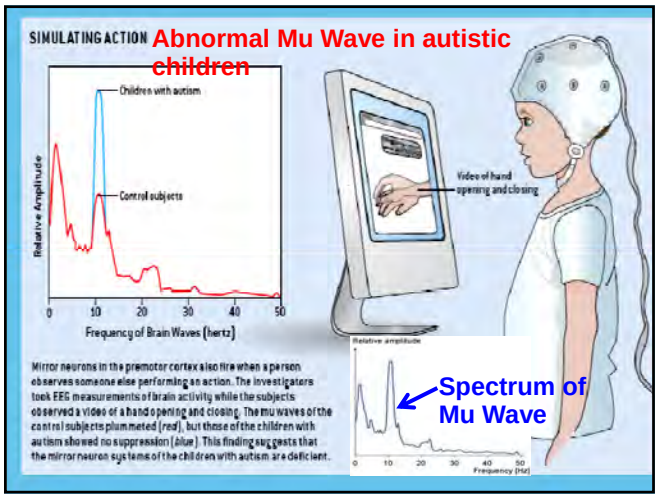


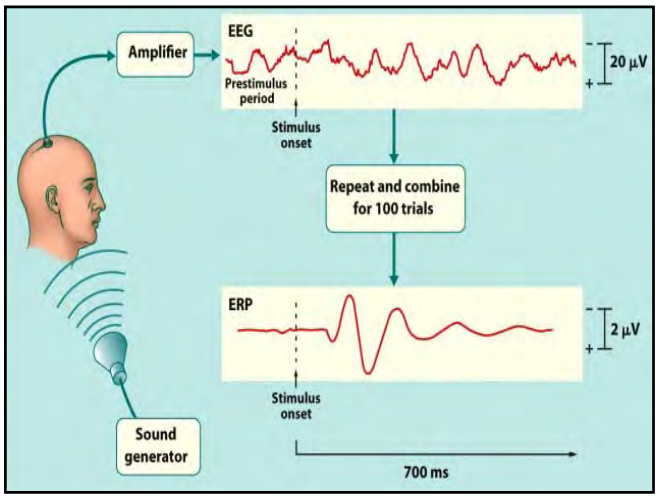
States of Consciousness as Determined by Brain Waves, and Feelings Often Associated with Each State



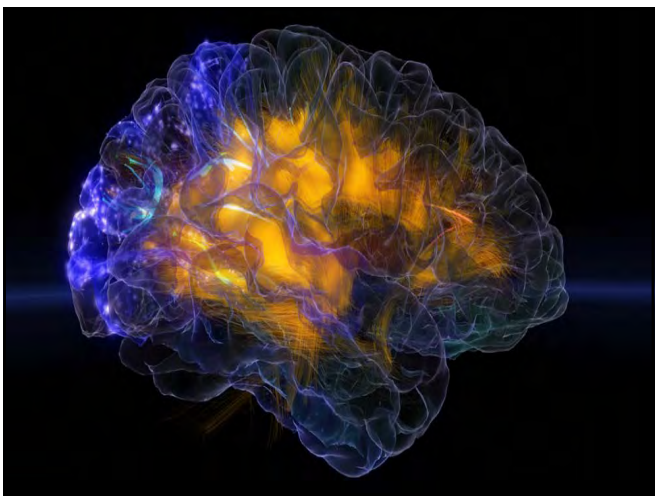
Topographic distribution of EEG power during REM sleep of the baseline night (BSL) and of the night after the rTMS treatment (R_3). Average values are normalized by total power, color-coded, plotted

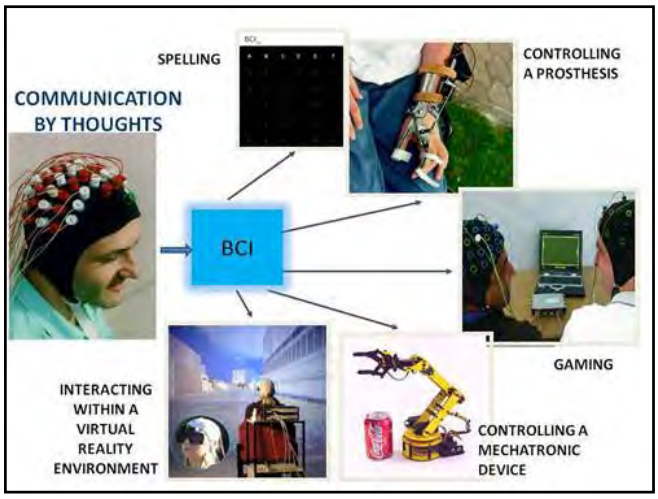




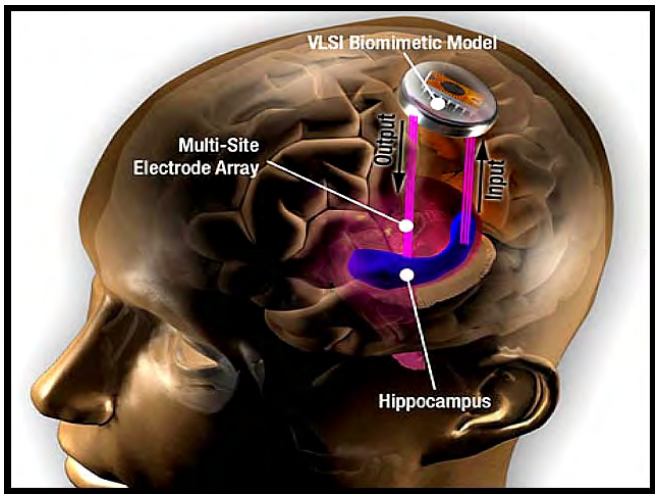


Scientists say they can predict who will improve most on an unfamiliar video game by looking at their brain waves using an EEG.



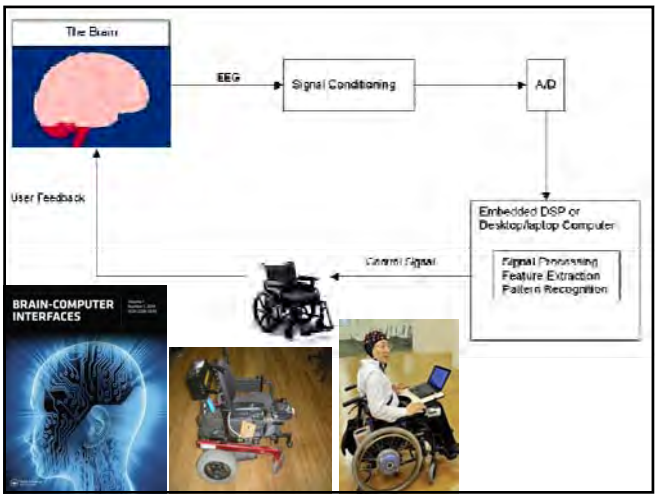


Man wearing the B-Alert X24 Wireless EEG System to monitor his physiology and brain. Single-Trial ERPs are the neural indicators of target detection on computer sceen

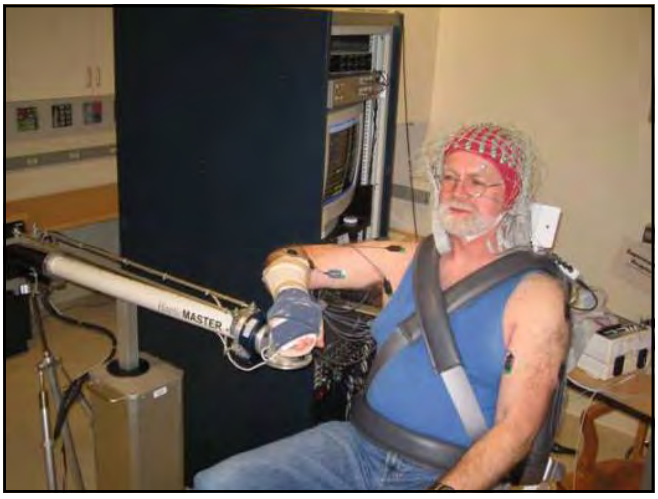

VLSI Biomimetic Model
Multi-Site
Electrode Array
Output
Input
Hippocampus

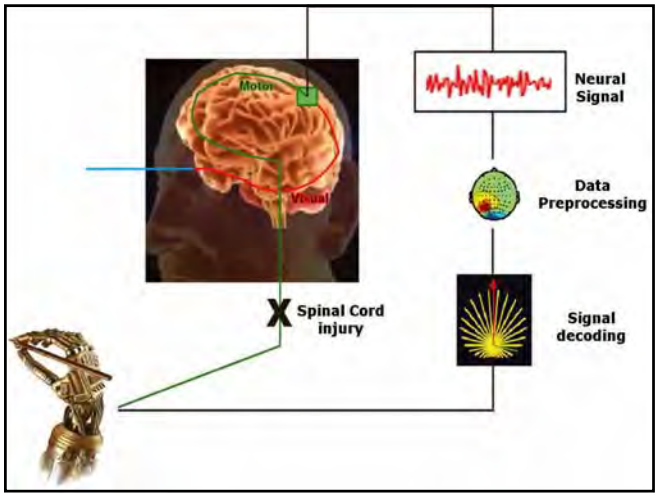

EEG Electrodes
gtec. Amplifier
Wheelchair


Moving wheel-chair by Brain-Computer Interface (BCI)


The Brain
EEG
Signal Conditioning
A/D
User Feedback
Embedded DSP or
Desktop/laptop Computer
Feature Extraction
Pattern Recognition
BRAIN-COMPUTER
INTERFACES

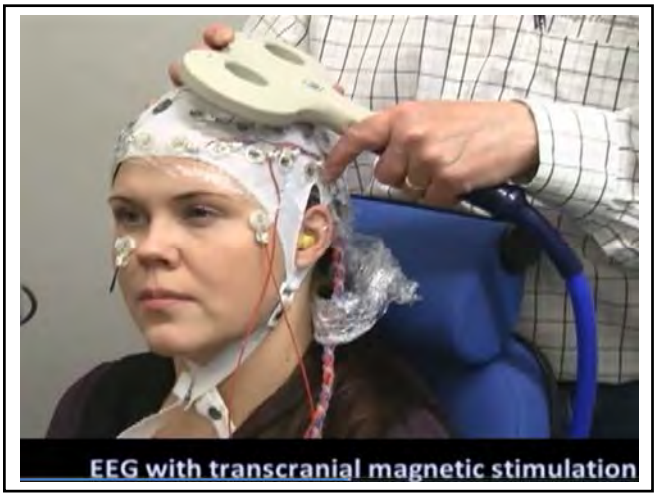

Brain Computer Interface (BCI) for controlling of wheel-chair for disable people

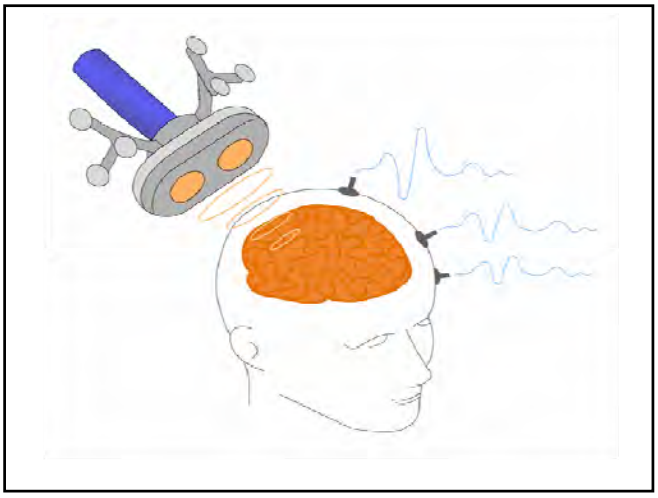



Motor
Visual
Neural Signal
Data Preprocessing
Spinal Cord injury
Signal decoding


Alpha band activation is projected on to a 3D brain model, here showing increased bilateral prefrontal activation.


brainwave entrainment
There was made a discovery that these brainwave frequencies could be changed at will by the use of sound waves acting upon them in a certain special way even though they fell below the human audible range, i.e., 20 cycles per second.
Website: http://www.BrainwaveSynchronization.net/binauralbeats
Alina Janssen

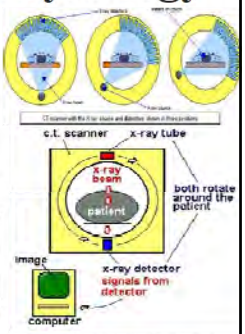




The Nobel Prize in Physiology or Medicine 1979

Allan M. Cormack

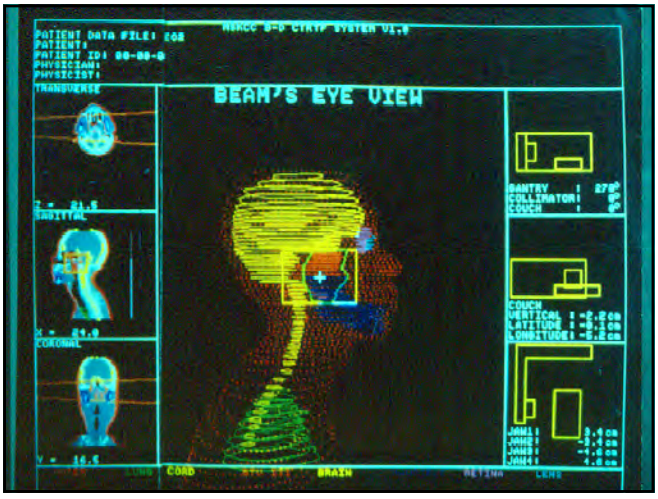
Godfrey N. Hounsfield

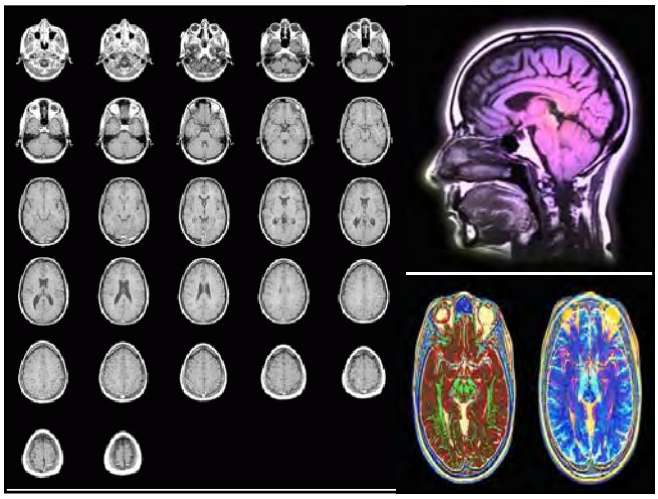


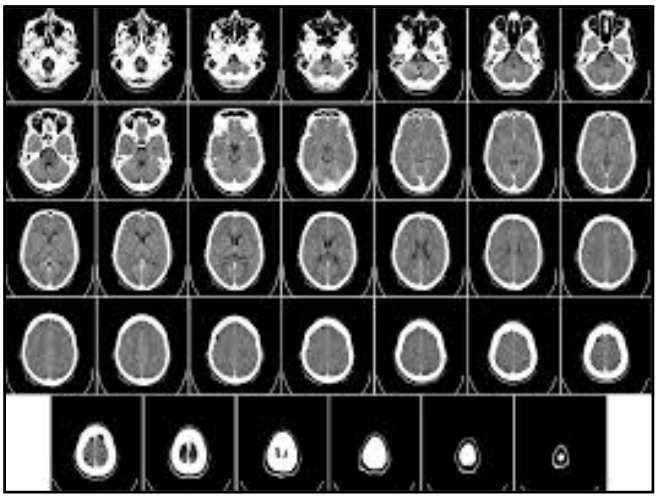
The Nobel Prize in Physiology or Medicine 1979 was awarded jointly to Allan M. Cormack and Godfrey N. Hounsfield *"for the development of computer assisted tomography"*

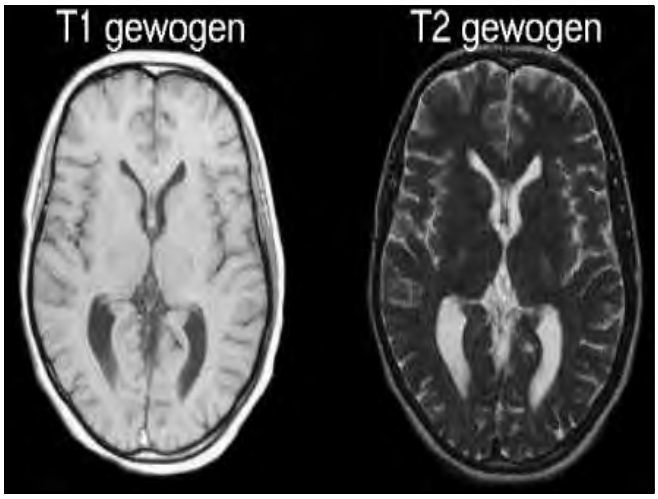
Computerized Tomography (CT) or Computerized Axial Tomography (CAT)

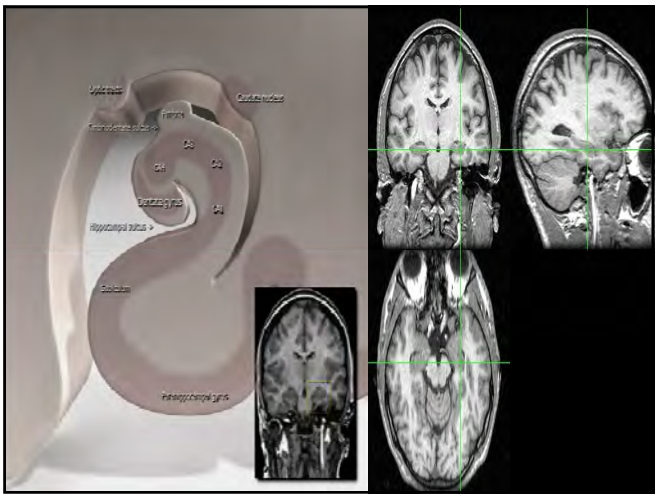
The four images at the right were created using four different techniques for imaging a slice of the brain. Starting at 9 o'clock and moving clockwise, the four techniques are standard photography, x-ray CT, positron emission tomography (most often created in color), and magnetic resonance imaging.

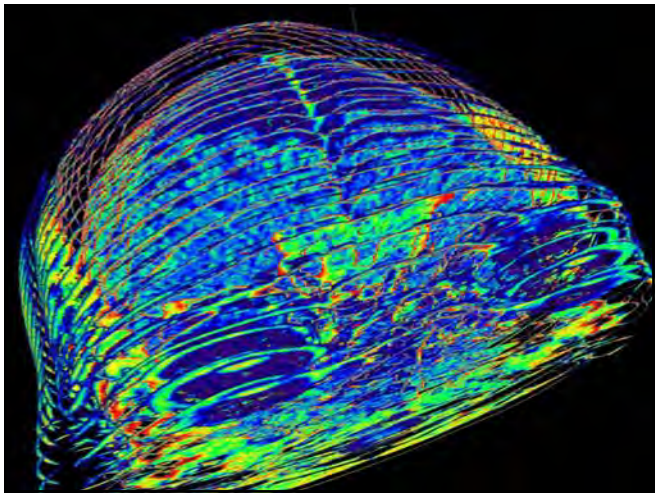


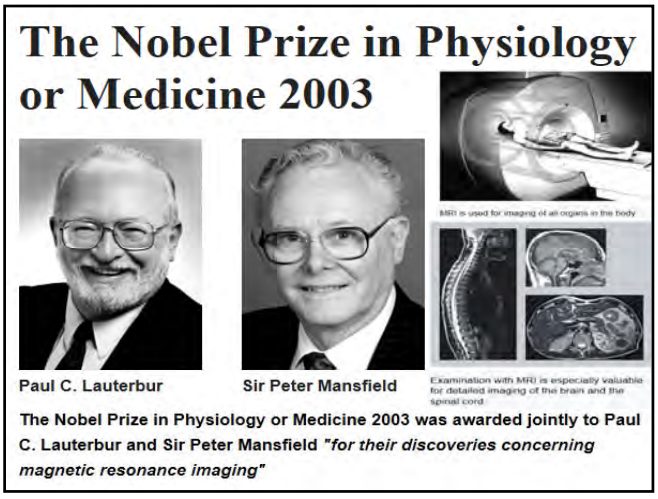


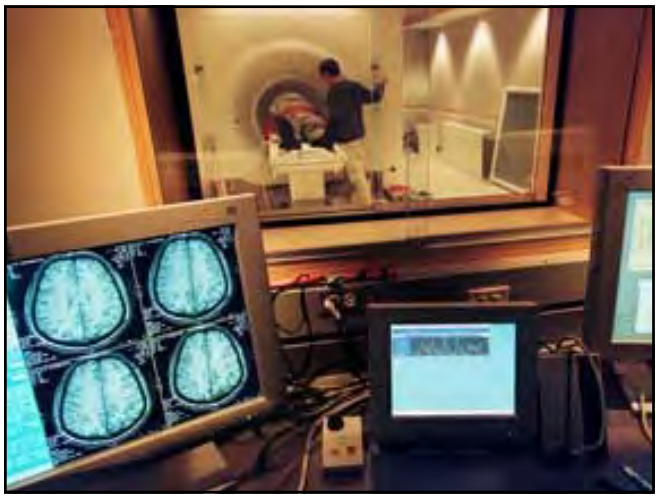


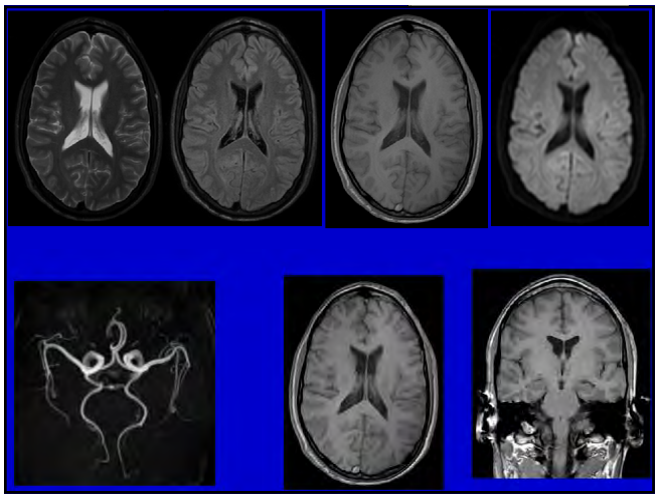

T1 gewogen
T2 gewogen

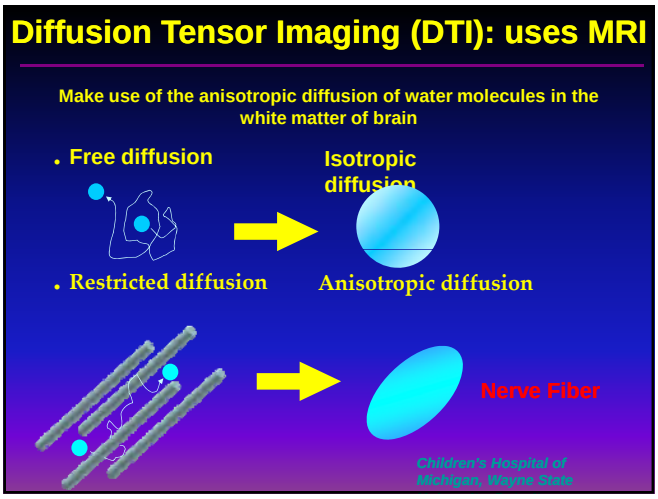


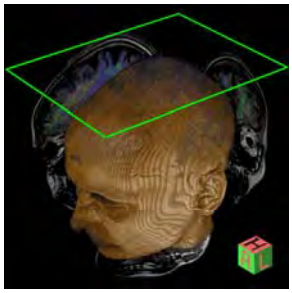



The Nobel Prize in Physiology or Medicine 2003
Paul C. Lauterbur
Sir Peter Mansfield
MRI is used for imaging of all organs in the body
Examination with MRI is especially valuable for detailed imaging of the brain and the spinal cord
The Nobel Prize in Physiology or Medicine 2003 was awarded jointly to Paul C. Lauterbur and Sir Peter Mansfield "for their discoveries concerning magnetic resonance imaging"









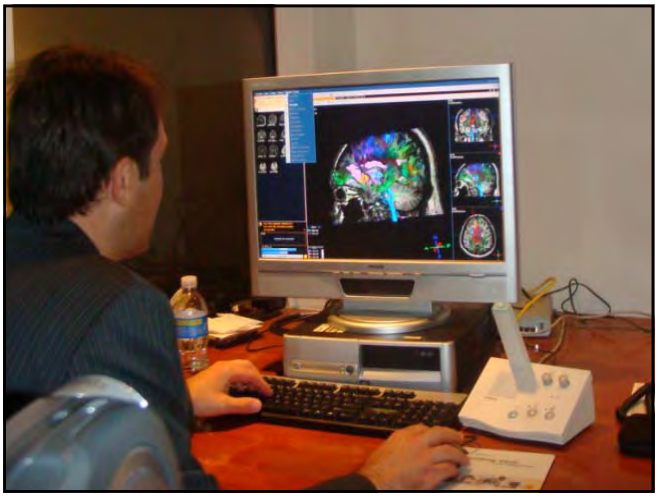
30-direction, 128 matrix DTI EPI showing fiber-tracks fused with 3D MPRAGE, 3D colored FA and motor cortex fMRI data

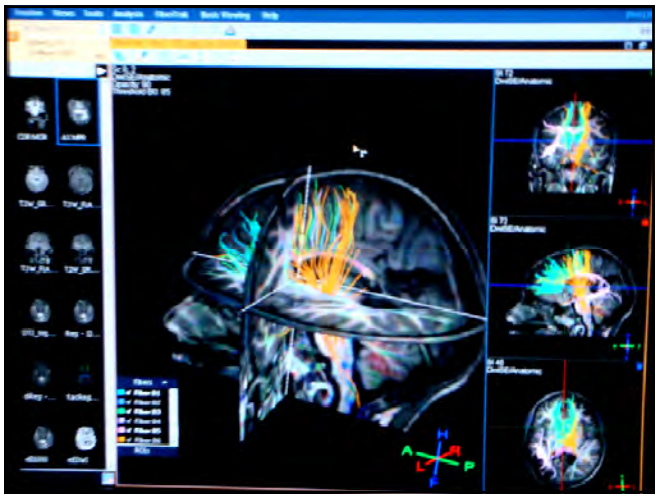
MRI -DTI (Diffusion Tensor Imaging)

Capture better visualizations of brain connectivity.

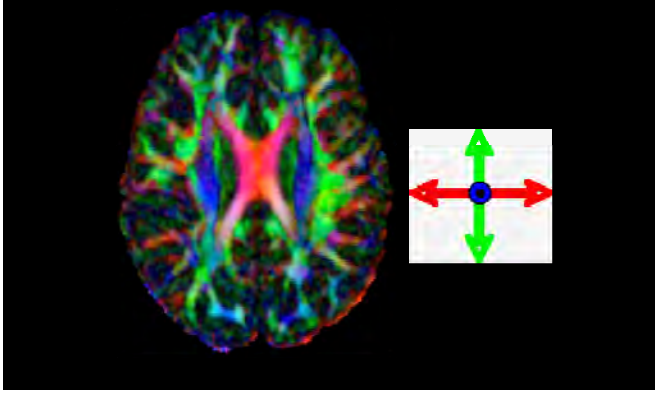
One or two clicks reveal full 3D fiber-views.

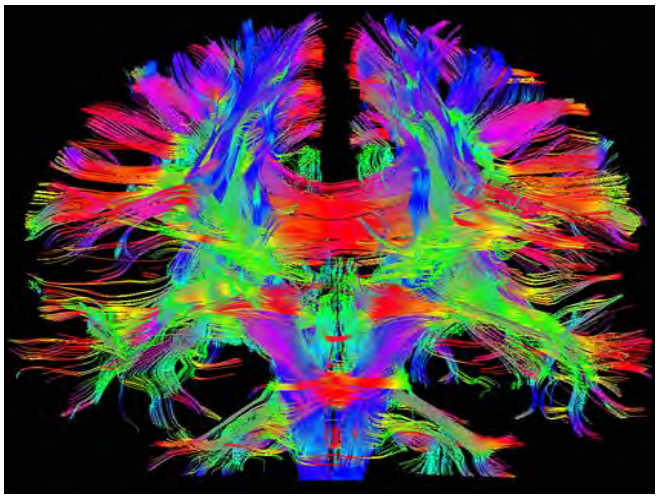
Up to 256 diffusion directions

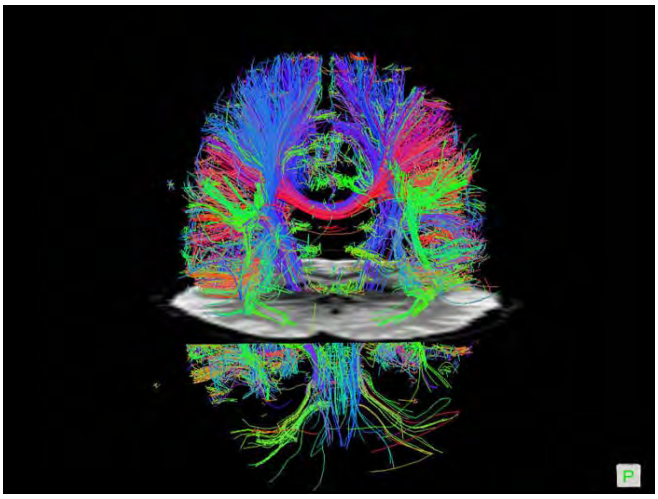




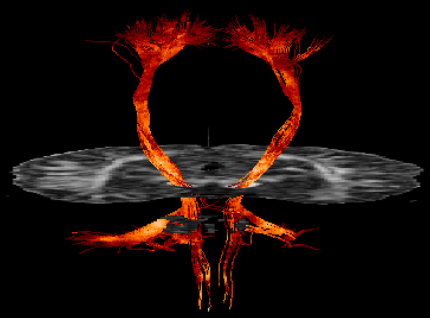
DTI: Direction Encoded Color Map



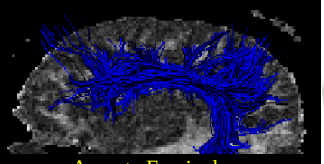




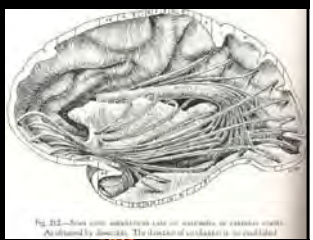
Cortico-spinal Tract

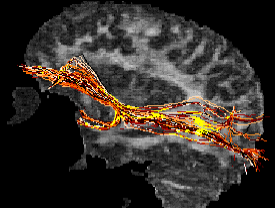


Longitudinal Association WM

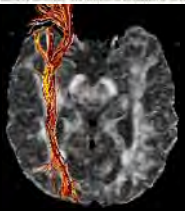


Arcuate Fasciculus

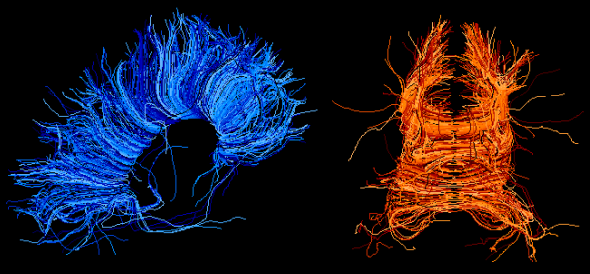


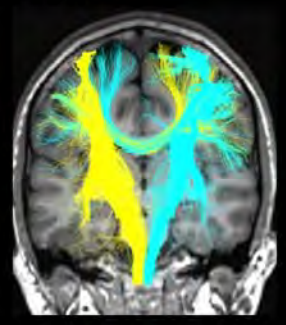


Occipitofrontal & Uniculate F

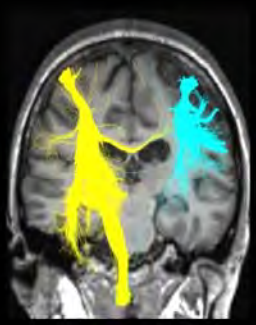


Corpus Callosum



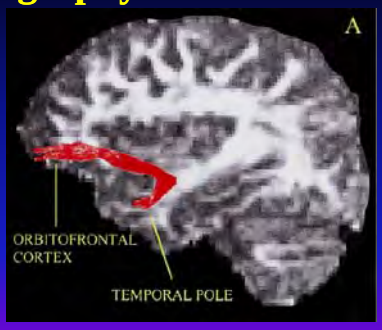


Fibre tract imaging of a healthy brain.

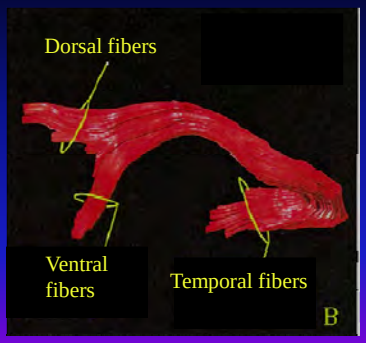


Melbourne woman Karen Bayley's brain, following a massive stroke.

Tractography of Uncinate fasciculus



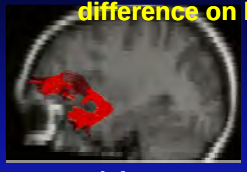
Tractography of Uncinate fasciculus



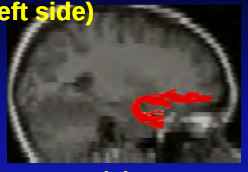
DTI Fiber Tracking: Uncinate Fasciulus

Normal child vs. socially deprived child (marked difference on left side)

Normal

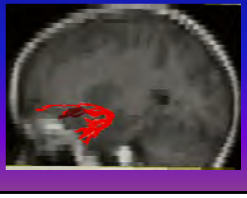


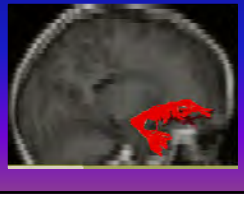
left



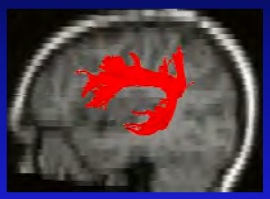
right

Socially deprived

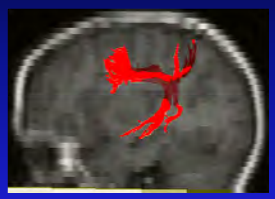




DTI Fiber Tracking: Left Arcuate fasciculus

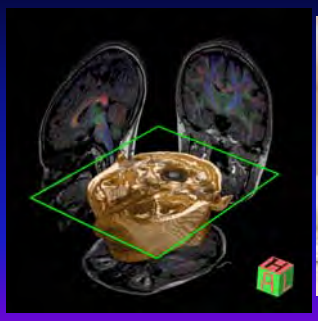


Healthy child



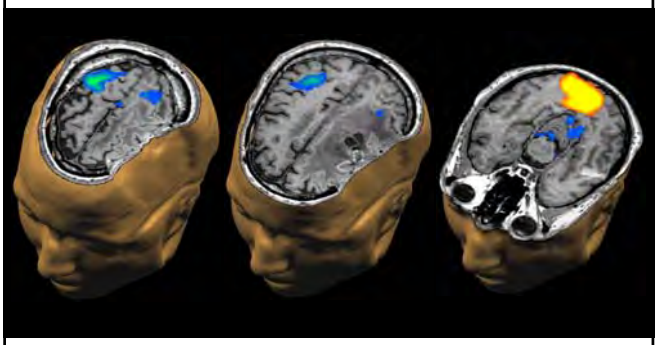
Socially deprived child

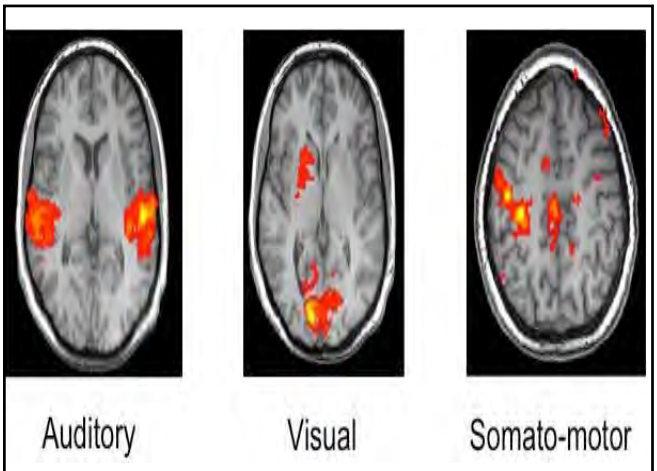
Functional MRI (f-MRI)

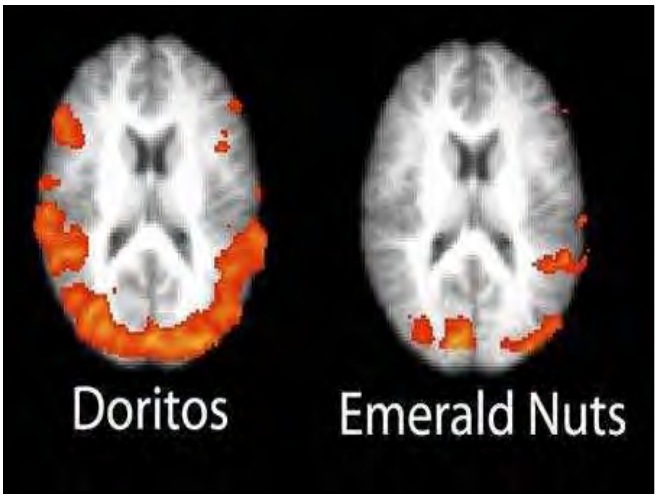


128 matrix BOLD EPI showing motor cortex activation fused with 3D MPRAGE and 30-direction diffusion EPI colored FA 3D dataset

Advanced fMRI: post-processing







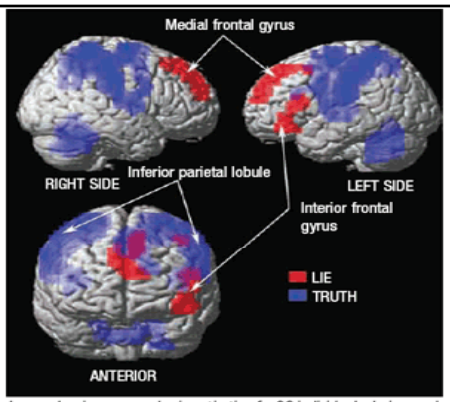
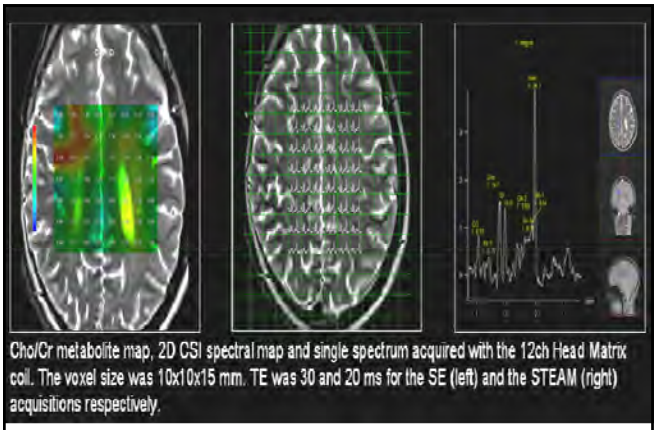


Image showing average brain activation for 22 individuals during modified Guilty Knowledge Test. Red areas represent brain regions more active during lie condition and blue areas represent brain regions more active during truth condition. (Provided by K. Ruparel and D. Langleben, University of Pennsylvania)

MR spectroscopy

- **MR spectroscopy provides a measure of "brain chemistry"**
- **The most common nuclei that are used are ^{1}H (proton), ^{23}Na and ^{31}P**



Cho/Cr metabolite map, 2D CSI spectral map and single spectrum acquired with the 12ch Head Matrix coil. The voxel size was 10x10x15 mm. TE was 30 and 20 ms for the SE (left) and the STEAM (right) acquisitions respectively.

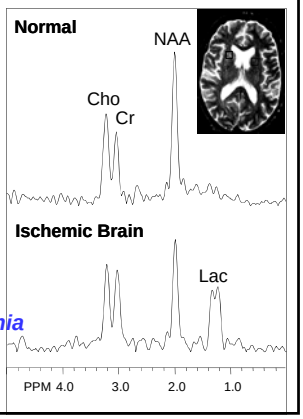
MRI-Spectroscopy

- Other Compounds normally present (if you look closely!)
  - NAAG, Aspartate
  - Taurine, Scyllo-Inositol
  - Betaine, Ethanolamine
  - Purine Nucleotides
  - Histidine
  - Glucose (Glycogen?)
- Compounds observed using "Spectral Editing"
  - GABA
  - Ascorbic acid
  - Glutathione
  - 'Macromolecules'
- Compounds which may be detectable under abnormal/pathological conditions
  - β-Hydroxy-butyrate, acetone
  - Phenylalanine (PKU)
  - Galactitol, Ribitol, Arabitol
  - Succinate, pyruvate
  - Alanine
  - Glycine
  - Valine, leucine, isoleucine
  - Threonine?
- Exogenous Compounds
  - Propan-1,2-diol
  - Mannitol
  - Ethanol
  - MSM - methylsulfonylmethane

Information Content of Proton Brain Spectra

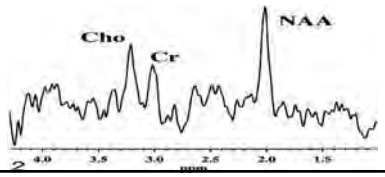
Compounds detectable (at either long or short echo times):

- **N-Acetyl Aspartate (NAA):** ***Axons, neurons, dendrites***
- **Creatine + Phosphocreatine (Cr):** ***Energy metabolites***
- **Cholines (Cho):** ***Glial cells, demyelination***
- **Lactate (Lac):** ***Anaerobic glycolysis, ischemia***



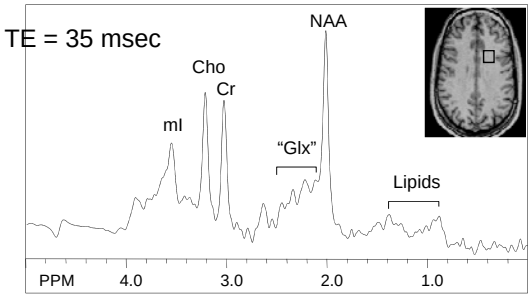
Observable Proton Metabolites

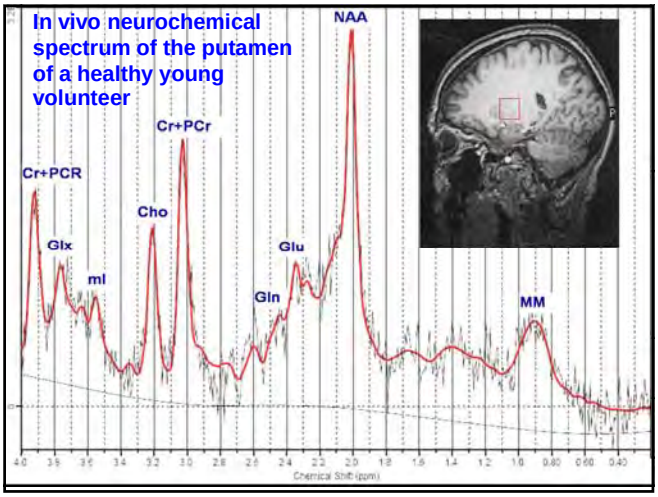
ppm	Metabolite	Properties
0.9-1.4	Lipids	Products of brain destruction
1.3	Lactate	Product of anaerobic glycolysis
2.0	NAA	Neuronal marker
2.2-2.4	Glutamine/GABA	Neurotransmitters
3.0	Creatine	Energy metabolism
3.2	Choline	Cell membrane marker
3.5	*myo*-inositol	Glial cell marker, osmolyte hormone receptor mechanisms
1.2	Ethanol	Triplet
1.48	Alanine	Present in meningiomas
3.4&3.8	Glucose	Increased in diabetes
3.8	Mannitol	Rx for increased ICP

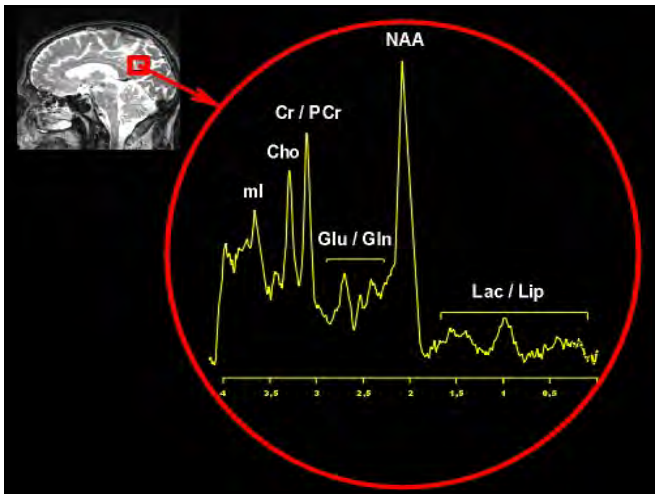


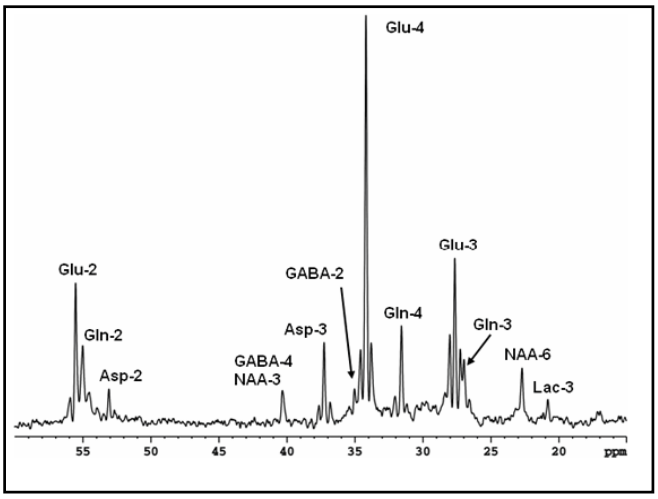
Compounds detectable at short echo times (< ~35 ms)

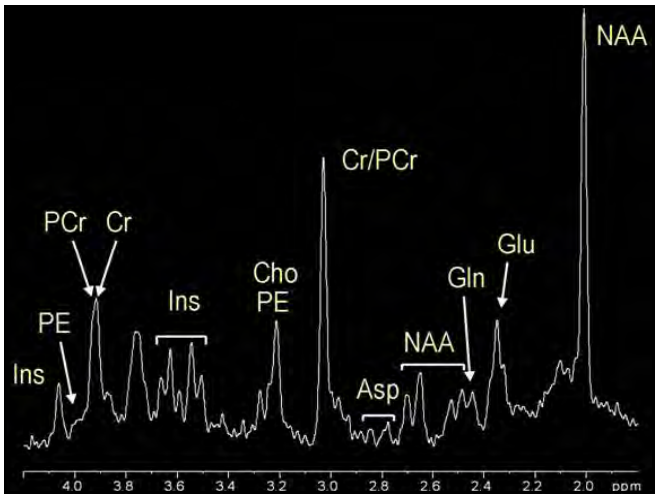
- Myo-inositol (mI) - glial cells, demyelination, osmolyte (?)
- Glutamate + Glutamine (Glx)
- Lipids

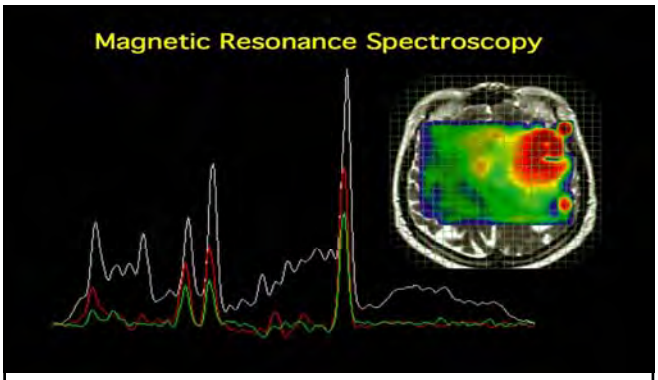




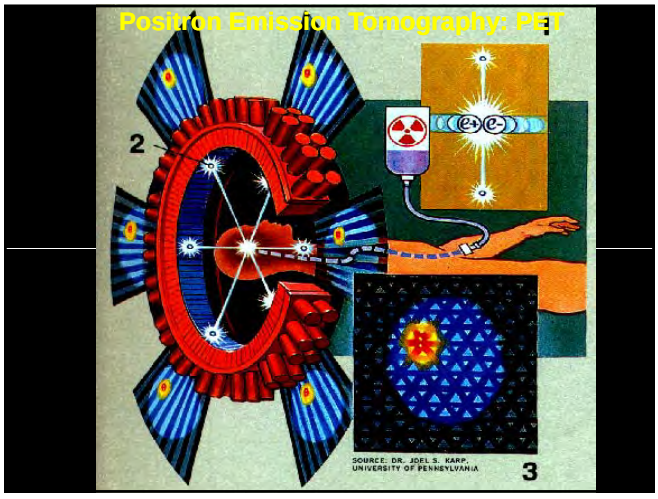


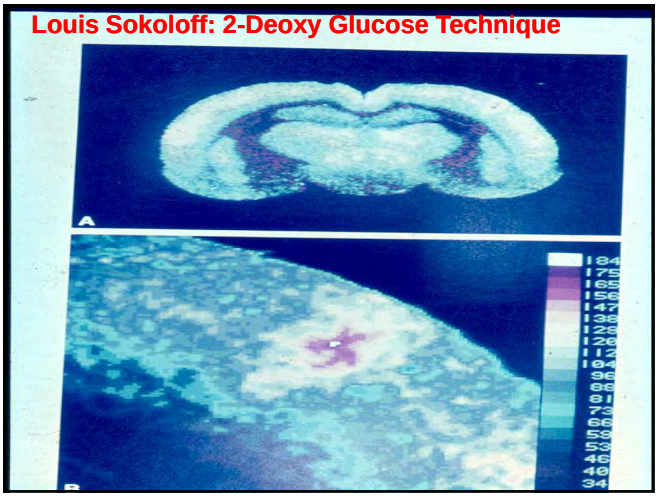






This diagnostic screening, called **magnetic resonance spectroscopy** (MRS), shows a certain gene mutation in gliomas that are considered low or intermediate in their grading. This mutated gene, 2-hydroxyglucarate (2HG), typically occurs in at least 80% of these types of gliomas, and they make enzymes that fuel cancer cells. By looking for the byproduct of this gene, doctors are often able to determine the grade of the tumor. This type of analysis of tumors is performed on a typical MRI machine.

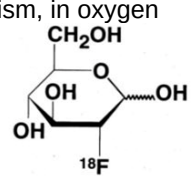


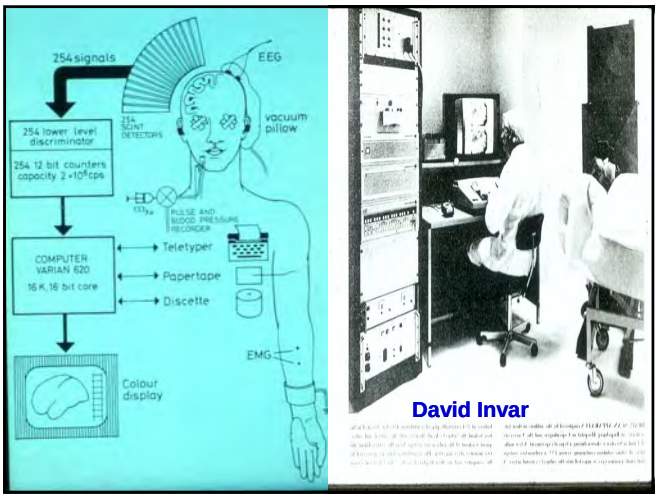


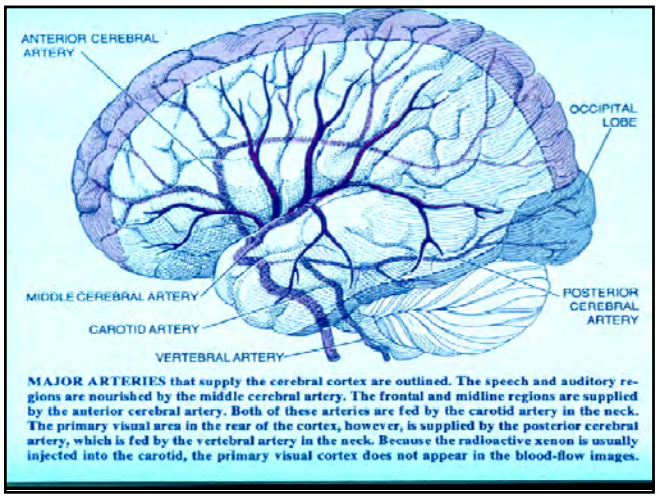
Regional brain activation with PET.

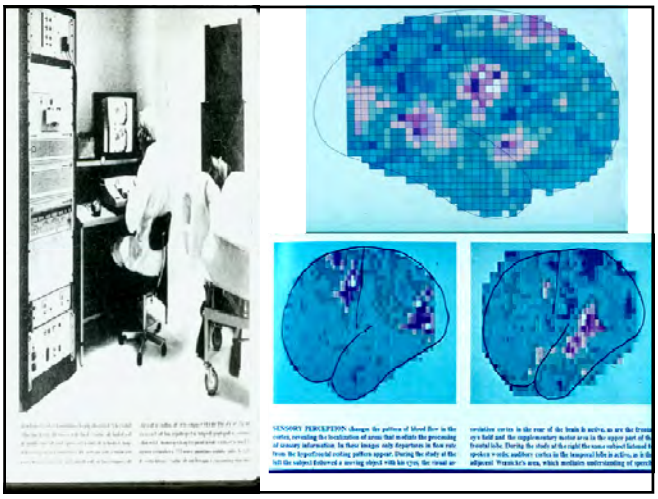
Perhaps the most frequent use of both PET and fMRI is the study of metabolic and vascular changes that accompany changes in neural activity. **With PET, one may separately measure glucose metabolism, oxygen consumption, and regional cerebral blood flow (rCBF).** Each of these techniques allows one to make inferences about the localization of neural activity based on the assumption that neural activity is accompanied by a change in metabolism, in oxygen consumption, or in blood flow.

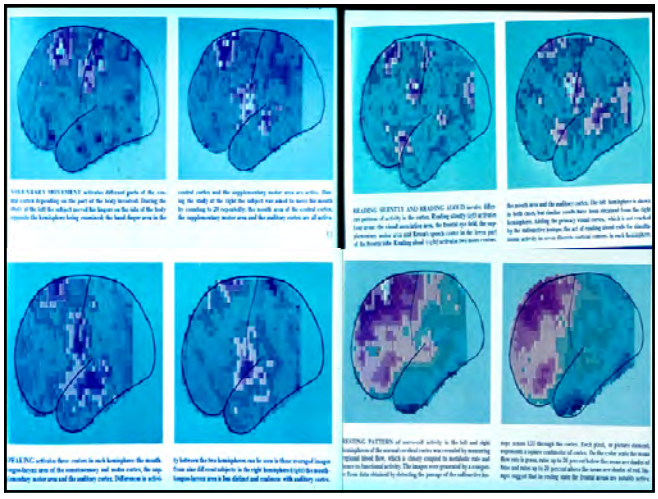
18-Fluoro-deoxy-glucose (FDG)

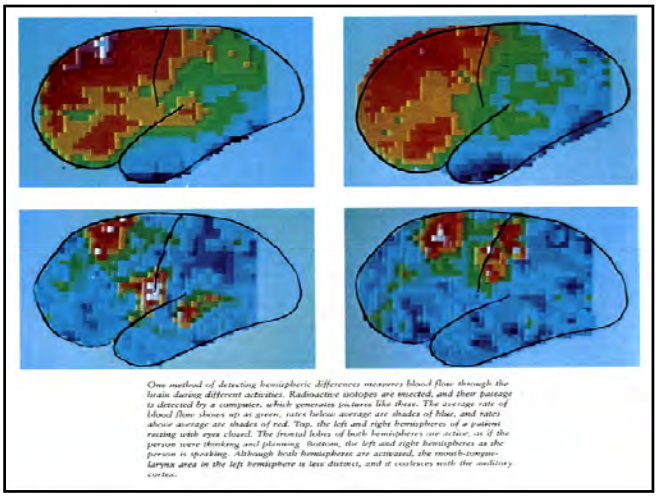


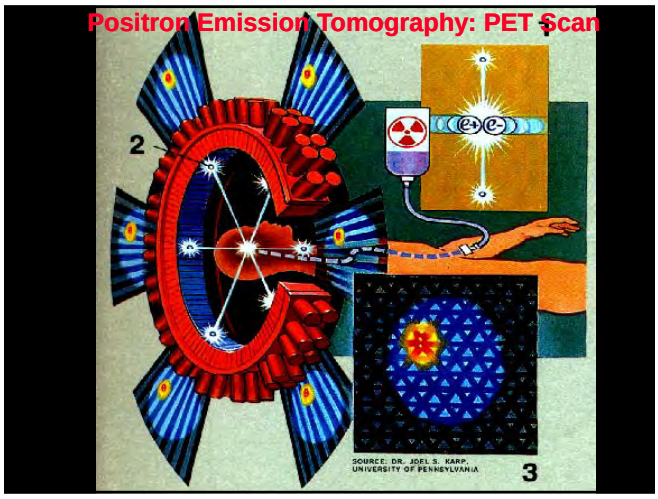


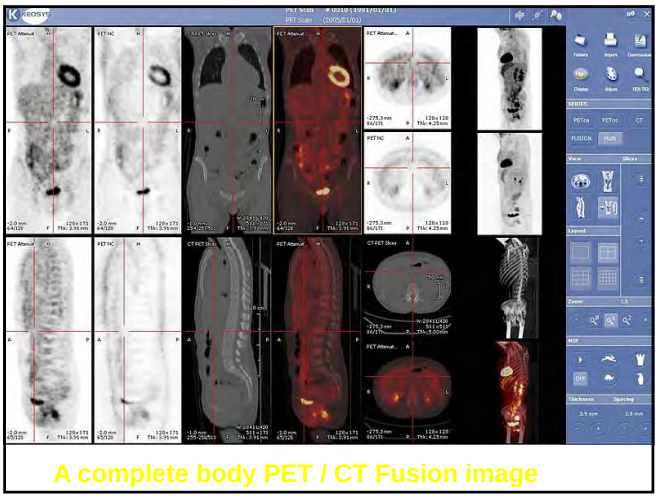


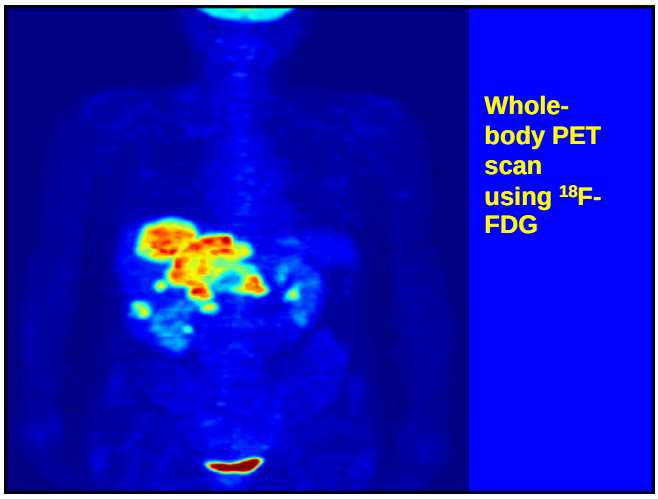







Positron Emission Tomography: PET Scan
2
3
SOURCE: DR. JOEL S. KARP,
UNIVERSITY OF PENNSYLVANIA


A complete body PET / CT Fusion image


Whole-body PET scan using ^{18}F-FDG


Wayne State University, Detroit, MI
PET Lab
Harry Chugani, MD
Pitti Sinsoongsud, PhD-MD student

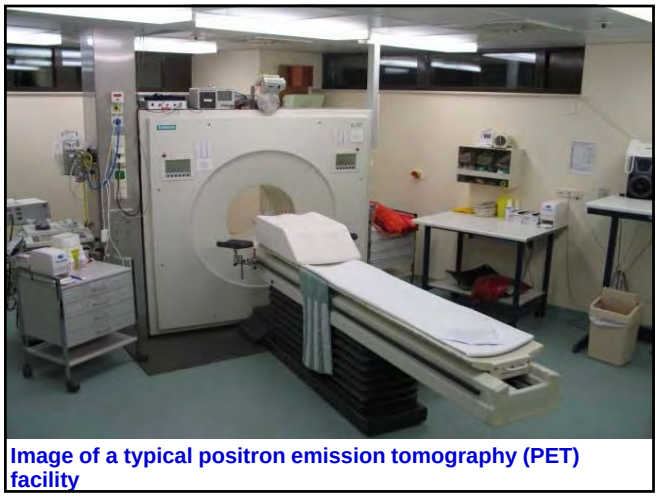
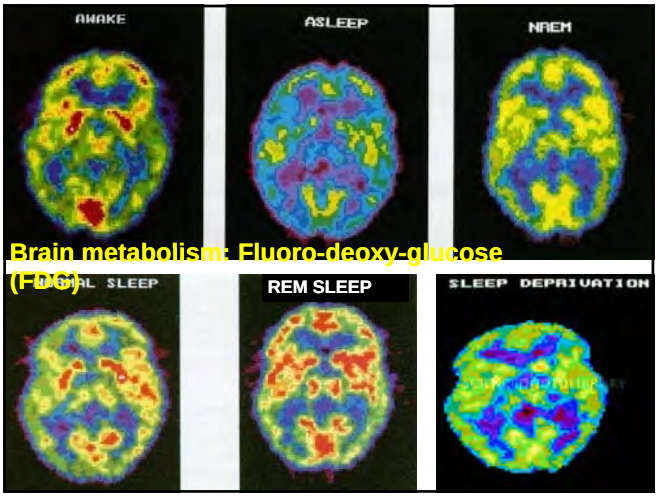
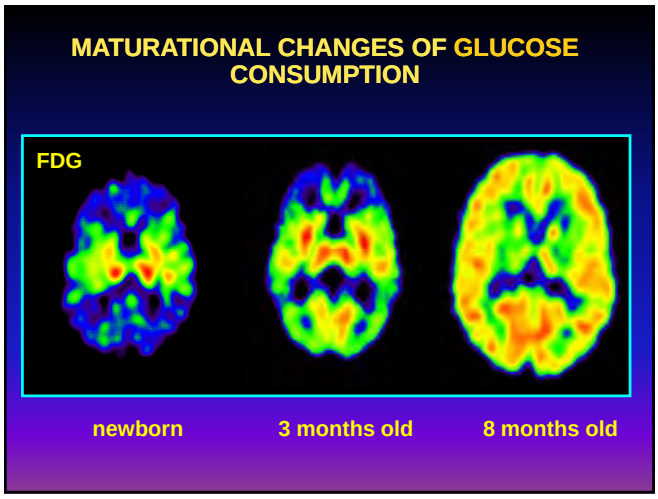
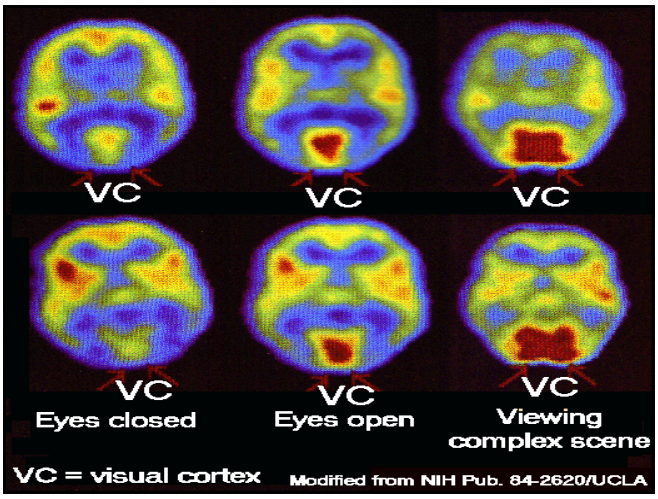
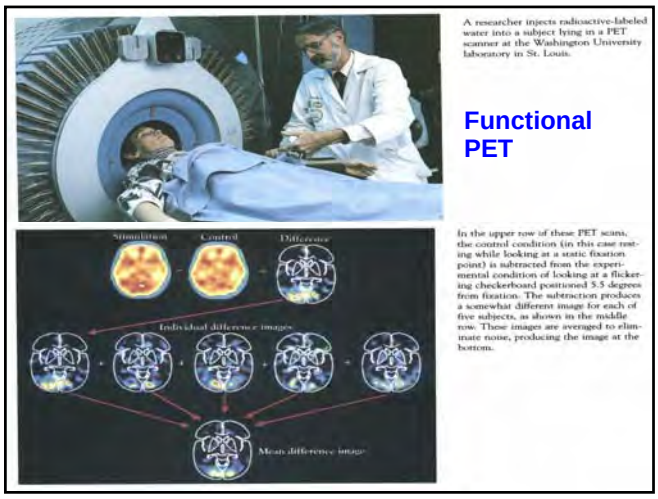


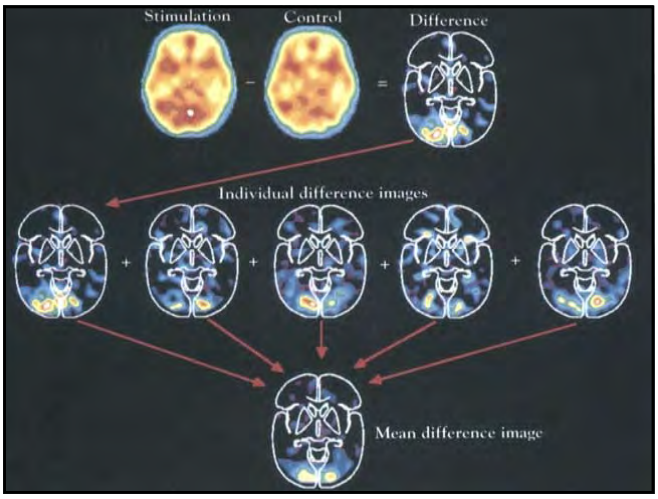
Image of a typical positron emission tomography (PET) facility

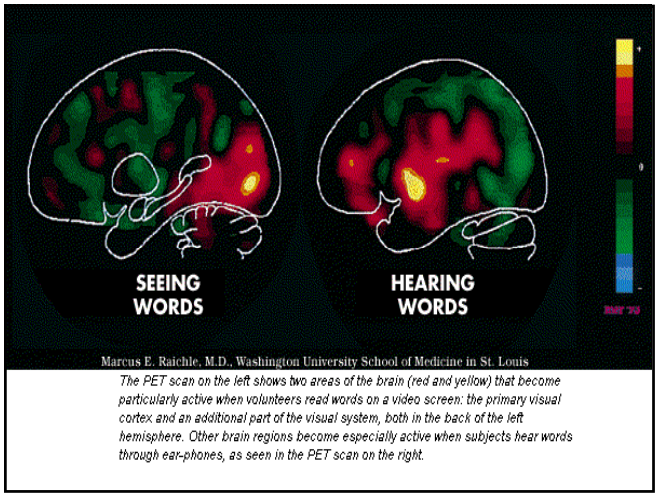

AWAKE
ASLEEP
NREM
REM SLEEP
SLEEP DEPRIVATION
Brain metabolism: Fluoro-deoxy-glucose (FDG)

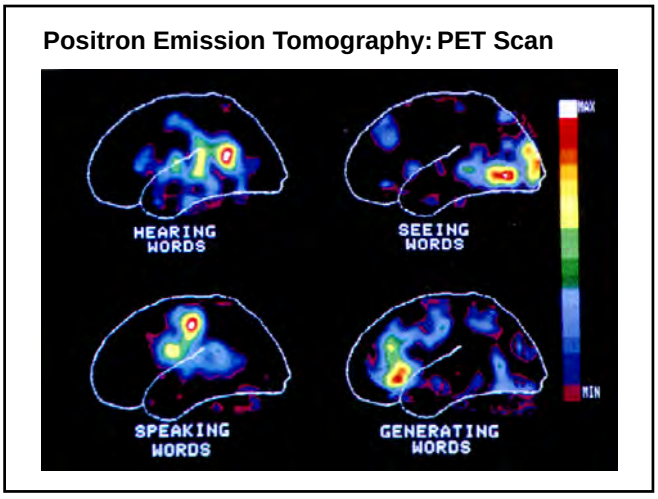

MATURATIONAL CHANGES OF GLUCOSE CONSUMPTION
FDG
newborn
3 months old
8 months old

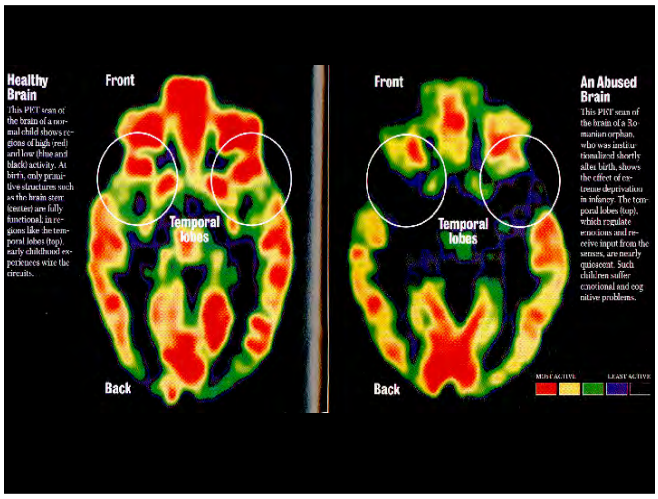

VC
VC
VC
VC
VC
VC
Eyes closed
Eyes open
Viewing complex scene
VC = visual cortex
Modified from NIH Pub. 84-2620/UCLA

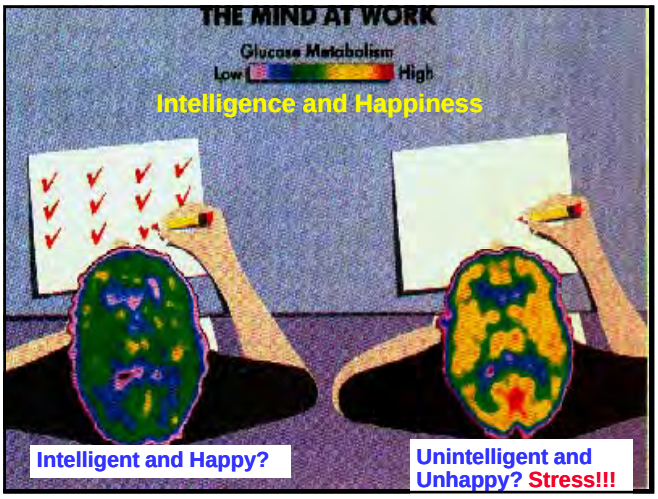

A researcher injects radioactive-labeled water into a subject lying in a PET scanner at the Washington University laboratory in St. Louis.
Functional PET
In the upper row of these PET scans, the control condition (in this case resting while looking at a static fixation point) is subtracted from the experimental condition of looking at a flickering checkerboard positioned 5.5 degrees from fixation. The subtraction produces a somewhat different image for each of five subjects, as shown in the middle row. These images are averaged to eliminate noise, producing the image at the bottom.

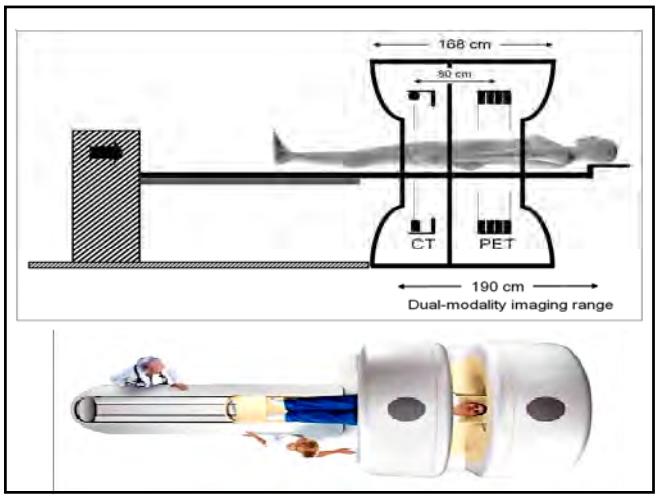

Stimulation
Control
Difference
Individual difference images
Mean difference image

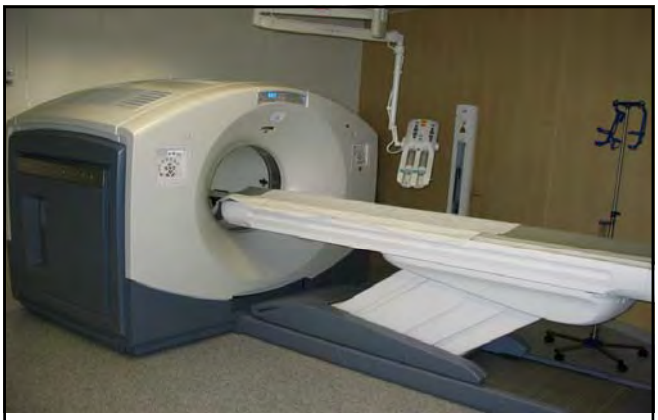

SEEING WORDS
HEARING WORDS
Marcus E. Raichle, M.D., Washington University School of Medicine in St. Louis
The PET scan on the left shows two areas of the brain (red and yellow) that become particularly active when volunteers read words on a video screen: the primary visual cortex and an additional part of the visual system, both in the back of the left hemisphere. Other brain regions become especially active when subjects hear words through ear-phones, as seen in the PET scan on the right.


Positron Emission Tomography: PET Scan
HEARING WORDS
SEEING WORDS
SPEAKING WORDS
GENERATING WORDS
MAX
MIN

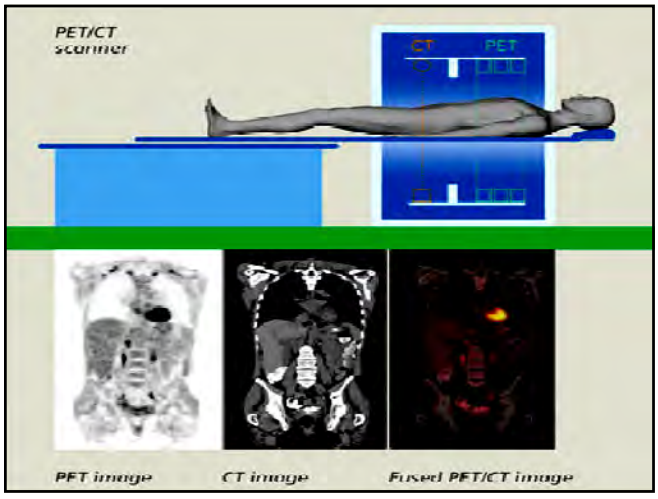


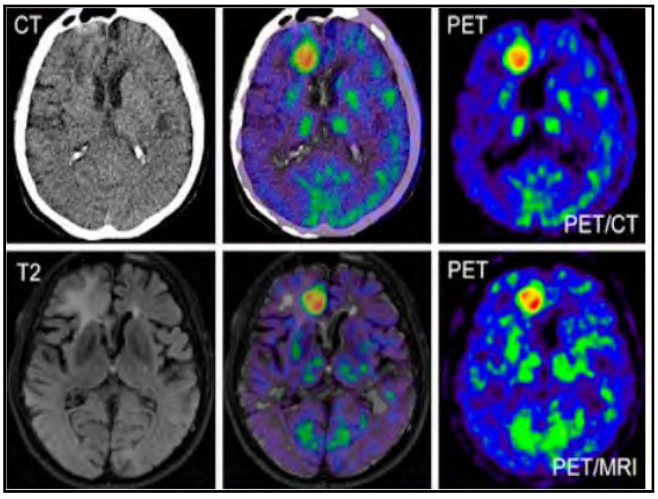


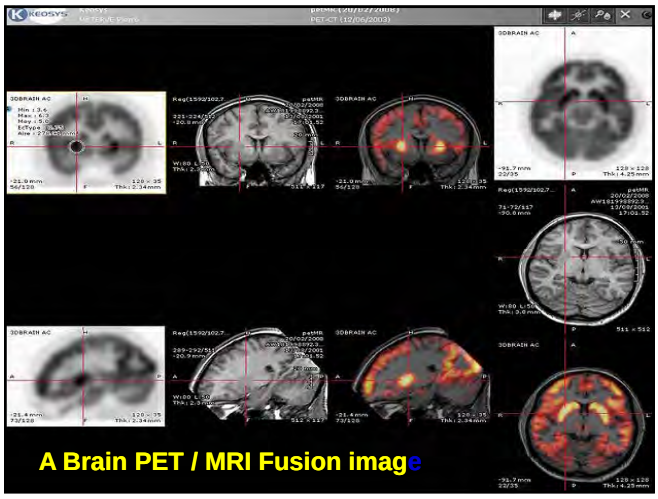




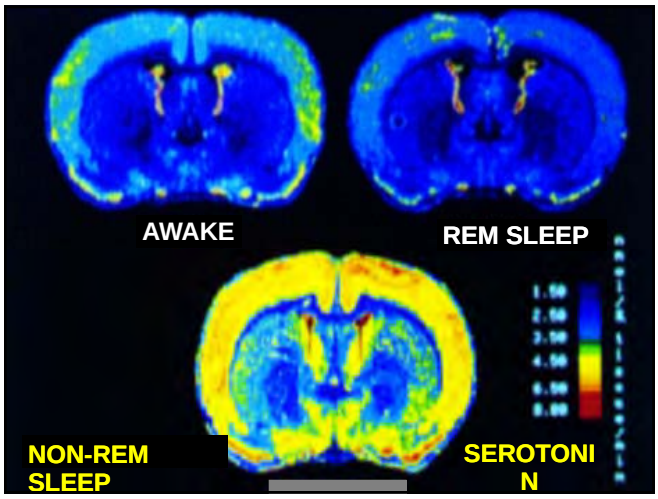
PET/CT-System with 16-slice CT; the ceiling mounted device is an injection pump for CT contrast agent





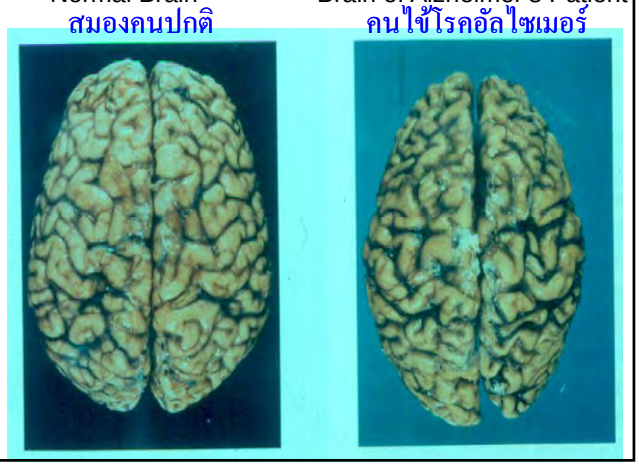


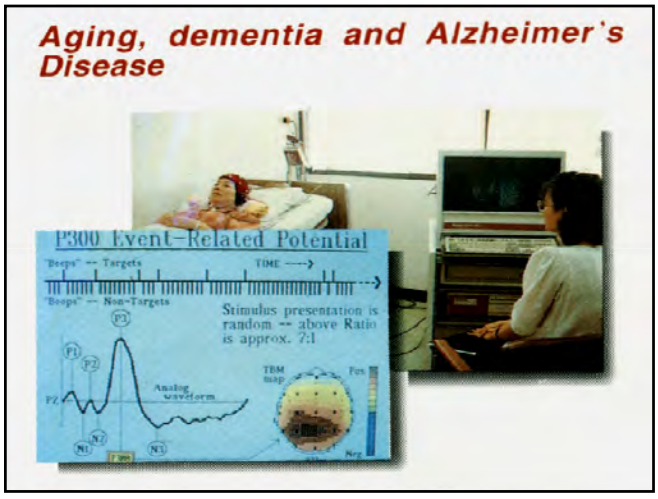
Micropet scanner

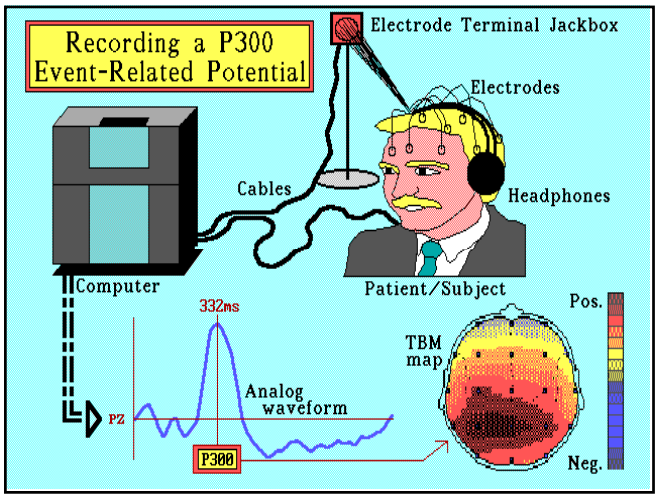


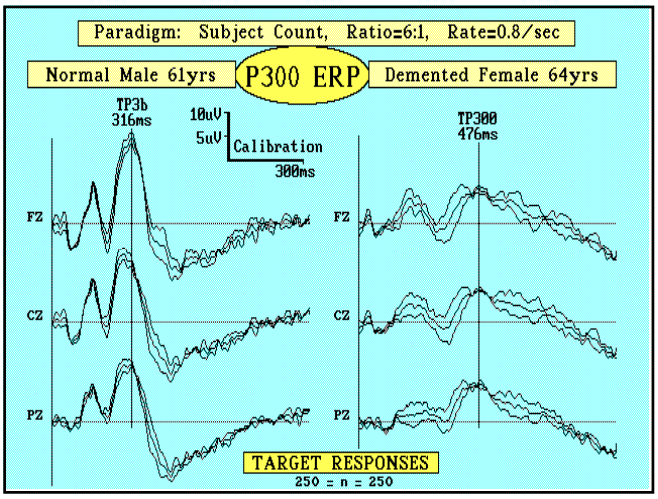
Normal Brain
สมองคนปกติ

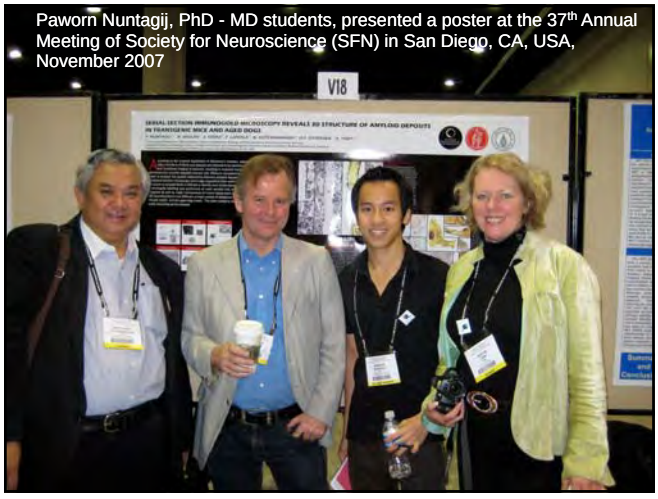
Brain of Alzheimer's Patient
คนไข้โรคอัลไซเมอร์



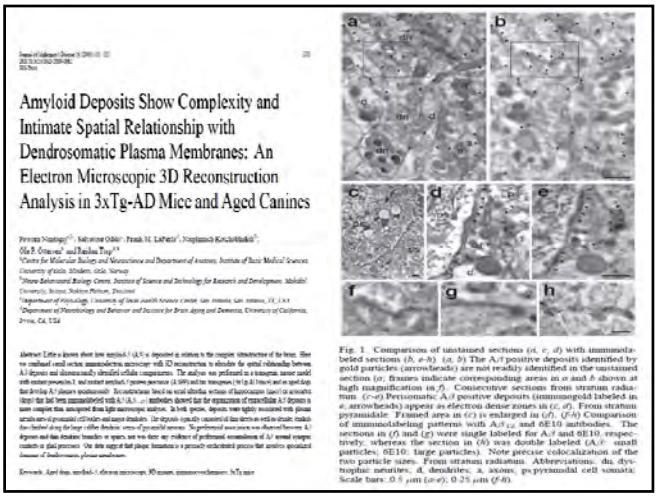








Paworn Nuntagij, PhD - MD students, presented a poster at the 37th Annual Meeting of Society for Neuroscience (SFN) in San Diego, CA, USA, November 2007



Amyloid Deposits Show Complexity and Intimate Spatial Relationship with Dendrosomatic Plasma Membranes: An Electron Microscopic 3D Reconstruction Analysis in 3xTg-AD Mice and Aged Canines

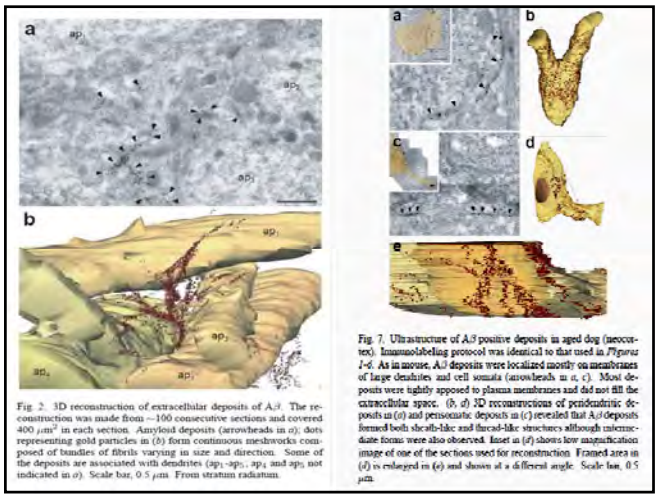


Fig. 2. 3D reconstruction of extracellular deposits of Aβ. The reconstruction was made from ~100 consecutive sections and covered 400 μm^2 in each section. Amyloid deposits (arrowheads in *a*)); dots representing gold particles in (*b*) form continuous meshworks composed of bundles of fibrils varying in size and direction. Some of the deposits are associated with dendrites (ap_1-ap_3, ap_4 and ap_5 not indicated in *a*). Scale bar, 0.5 μm. From stratum radiatum.

Fig. 7. Ultrastructure of Aβ positive deposits in aged dog (neocortex). Immunolabelling protocol was identical to that used in *Figures 1-6*. As in mouse, Aβ deposits were localized mostly on membranes of large dendrites and cell somata (arrowheads in *a*, *c*). Most deposits were tightly apposed to plasma membranes and did not fill the extracellular space. (*b*, *d*) 3D reconstructions of periodendritic deposits in (*a*) and perisomatic deposits in (*c*) revealed that Aβ deposits formed both sheath-like and thread-like structures although intermediate forms were also observed. Inset in (*d*) shows low magnification image of one of the sections used for reconstruction. Framed area in (*d*) is enlarged in (*e*) and shown at a different angle. Scale bar, 0.5 μm.

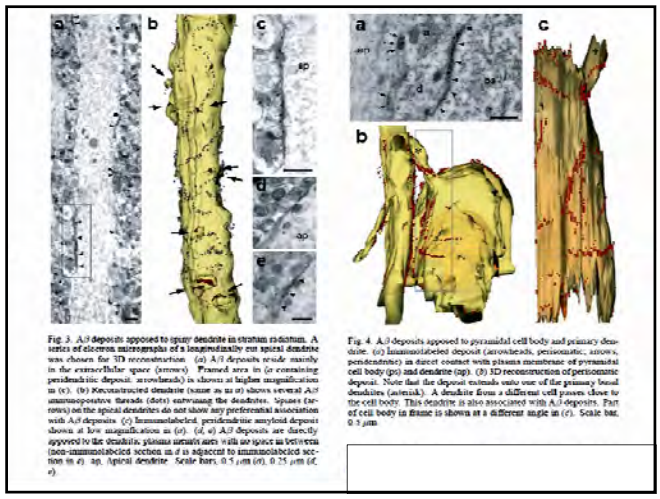


Fig. 3. Aβ deposits apposed to spiny dendrite in stratum radiatum. A series of electron micrographs of a longitudinally cut apical dendrite was chosen for 3D reconstruction. (*a*) Aβ deposits reside mainly in the extracellular space (arrows). Framed area in (*a* containing peridendritic deposit (arrowheads) is shown at higher magnification in (*c*). (*b*) Reconstructed dendrite (same as in *a*) shows several Aβ immunopositive threads (dots) entwining the dendrites. Spines (arrows) on the apical dendrites do not show any preferential association with Aβ deposits. (*c*) Immunolabelled, peridendritic amyloid deposit shown at low magnification in (*a*). (*d*, *e*) Aβ deposits are directly apposed to the dendrite; plasma membranes with no space in between (non-immunolabeled section in *d* is adjacent to immunolabeled section in *e*). ap, Apical dendrite. Scale bars, 0.5 μm (*a*), 0.25 μm (*d*, *e*).

Fig. 4. Aβ deposits apposed to pyramidal cell body and primary dendrite. (*a*) Immunolabeled deposit (arrowheads, perisomatic; arrows, peridendritic) in direct contact with plasma membrane of pyramidal cell body (ps) and dendrite (ap). (*b*) 3D reconstruction of perisomatic deposit. Note that the deposit extends onto one of the primary basal dendrites (asterisk). A dendrite from a different cell passes close to the cell body. This dendrite is also associated with Aβ deposits. Part of cell body in frame is shown at a different angle in (*c*). Scale bar, 0.5 μm.

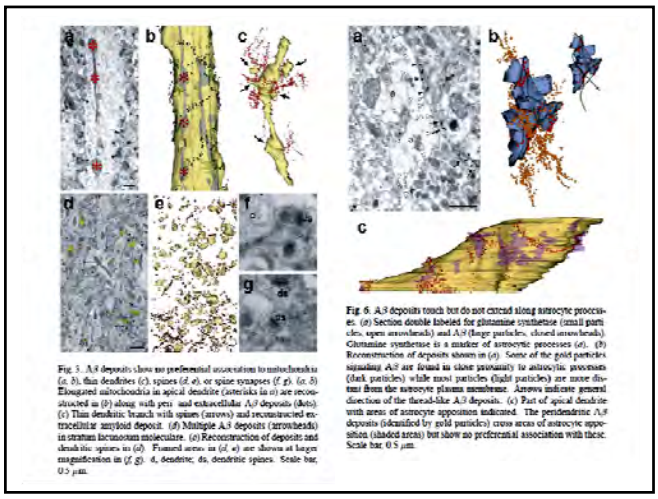
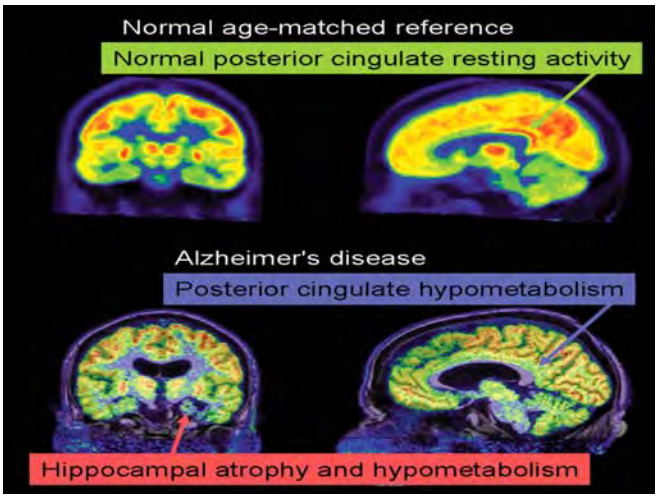
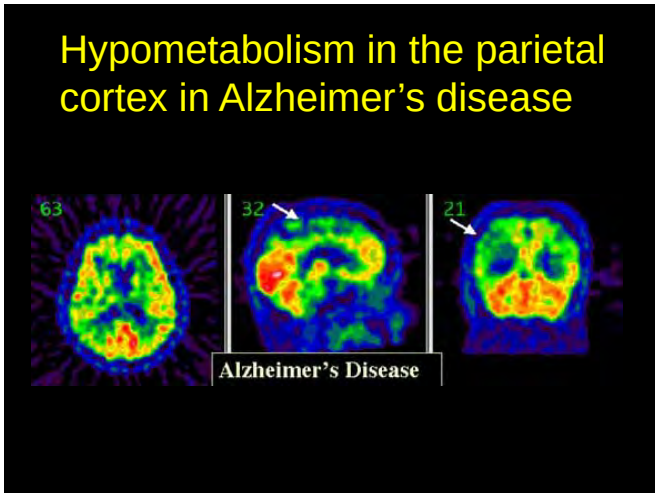
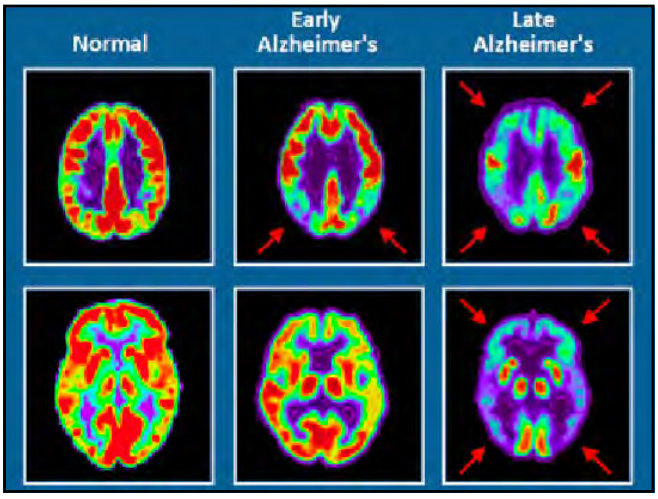


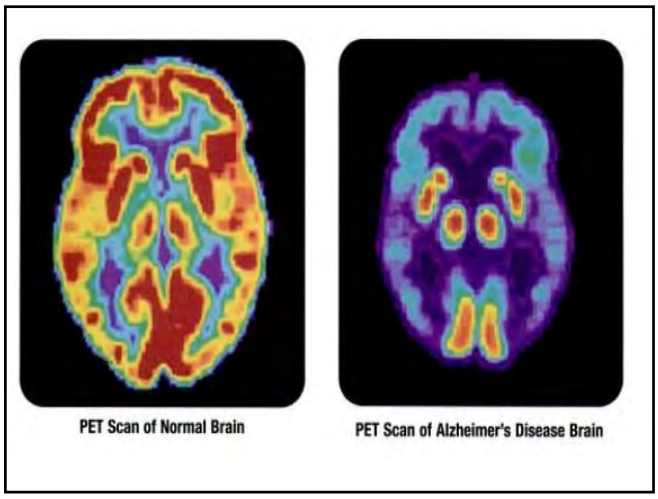
Fig. 5. Aβ deposits show no preferential association to mitochondria (*a*, *b*), thin dendrites (*c*), spines (*d*, *e*), or spine synapses (*f*, *g*). (*a*, *b*) Elongated mitochondria in apical dendrite (asterisks in *a*) are reconstructed in (*b*) along with peri- and extracellular Aβ deposits (dots). (*c*) Thin dendritic branch with spines (arrows) and reconstructed extracellular amyloid deposit. (*d*) Multiple Aβ deposits (arrowheads) in stratum lacunosum moleculare. (*e*) Reconstruction of deposits and dendritic spines in (*d*). Framed areas in (*d*, *e*) are shown at larger magnification in (*f*, *g*). d, dendrite; ds, dendritic spines. Scale bar, 0.5 μm.

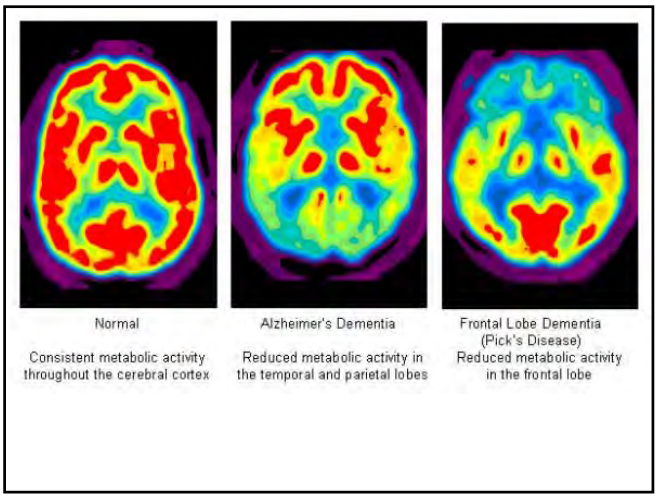
Fig. 6. Aβ deposits touch but do not extend along astrocyte processes. (*a*) Section double labeled for glutamine synthetase (small particles, open arrowheads) and Aβ (large particles, closed arrowheads). Glutamine synthetase is a marker of astrocytic processes (*a*). (*b*) Reconstruction of deposits shown in (*a*). Some of the gold particles signaling Aβ are found in close proximity to astrocytic processes (dark particles) while most particles (light particles) are more distant from the astrocyte plasma membrane. Arrows indicate general direction of the thread-like Aβ deposits. (*c*) Part of apical dendrite with areas of astrocyte apposition indicated. The peridendritic Aβ deposits (identified by gold particles) cross areas of astrocyte apposition (shaded areas) but show no preferential association with these. Scale bar, 0.5 μm.

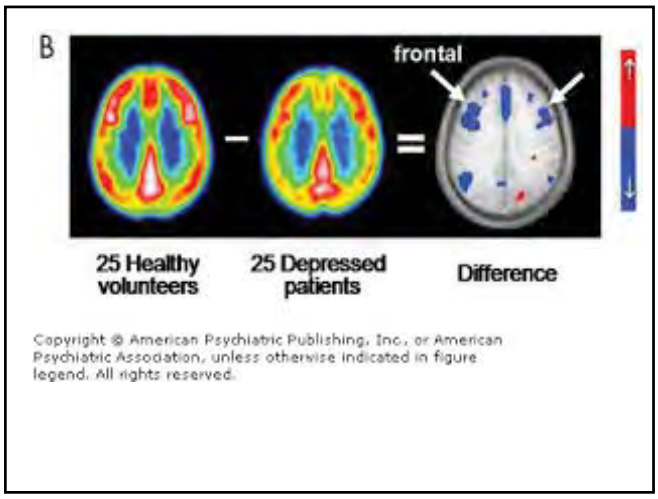







PET Scan of Normal Brain
PET Scan of Alzheimer's Disease Brain


Normal
Consistent metabolic activity throughout the cerebral cortex
Alzheimer's Dementia
Reduced metabolic activity in the temporal and parietal lobes
Frontal Lobe Dementia (Pick's Disease)
Reduced metabolic activity in the frontal lobe


B
frontal
25 Healthy volunteers
25 Depressed patients
Difference
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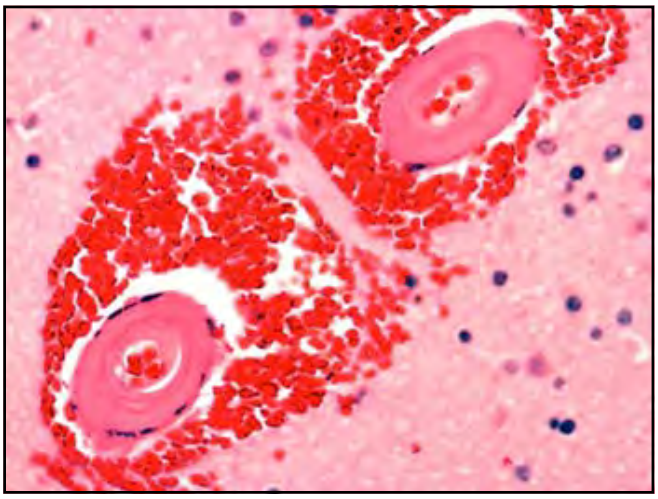
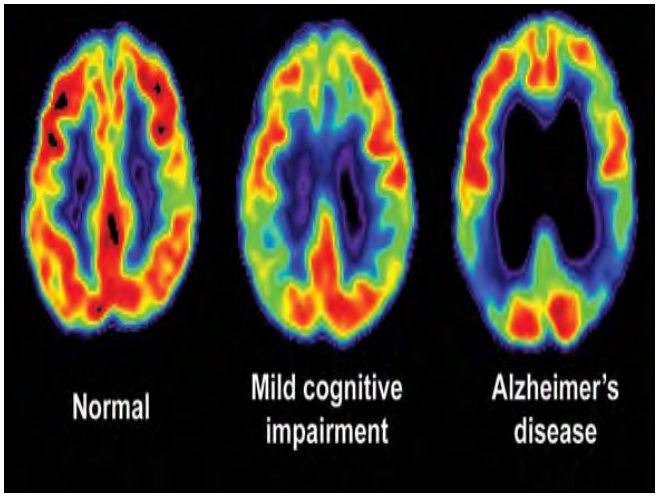
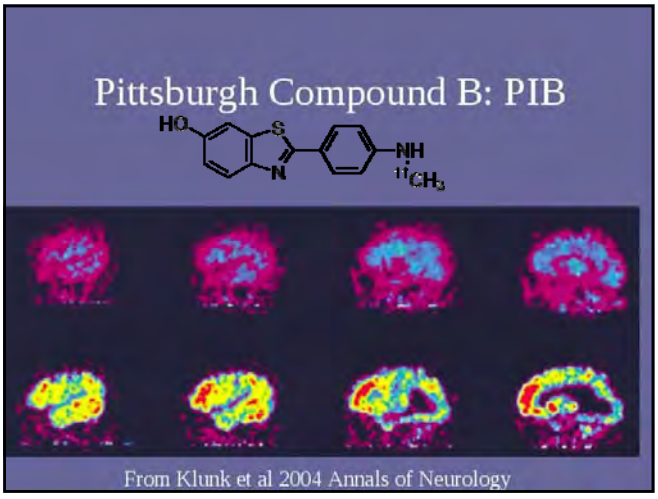
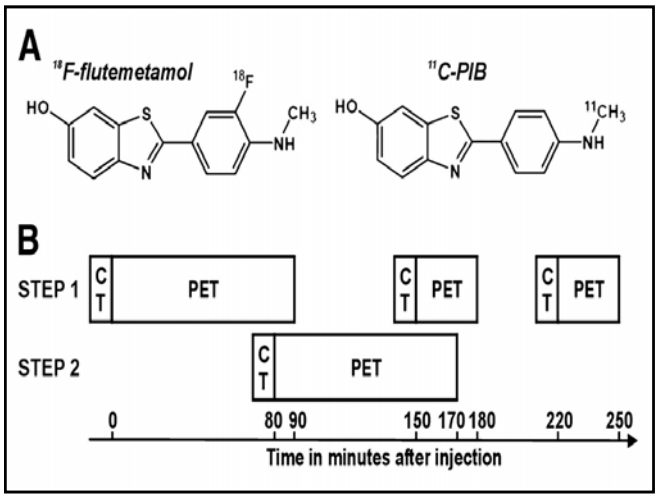
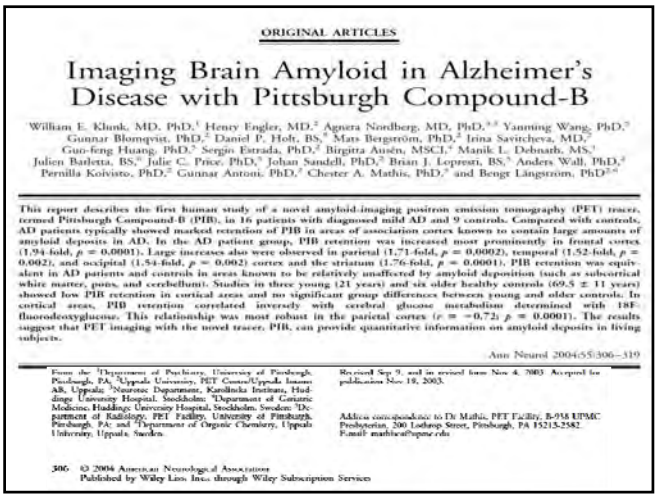



Normal
Mild cognitive impairment
Alzheimer's disease


Pittsburgh Compound B: PIB
HO
S
N
NH
11CH3
From Klunk et al 2004 Annals of Neurology





ORIGINAL ARTICLES

Imaging Brain Amyloid in Alzheimer's Disease with Pittsburgh Compound-B

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This report describes the first human study of a novel amyloid-imaging positron emission tomography (PET) tracer, termed Pittsburgh Compound-B (PIB), in 16 patients with diagnosed mild AD and 9 controls. Compared with controls, AD patients typically showed marked retention of PIB in areas of association cortex known to contain large amounts of amyloid deposits in AD. In the AD patient group, PIB retention was increased most prominently in frontal cortex (1.94-fold, $p = 0.0001$), large increases also were observed in parietal (1.71-fold, $p = 0.0002$), temporal (1.52-fold, $p = 0.002$), and occipital (1.54-fold, $p = 0.002$) cortex and the striatum (1.76-fold, $p = 0.0001$). PIB retention was equivalent in AD patients and controls in areas known to be relatively unaffected by amyloid deposition (such as subcortical white matter, pons, and cerebellum). Studies in three young (21 years) and six older healthy controls (69.5 ± 11 years) showed low PIB retention in cortical areas and no significant group differences between young and older controls. In cortical areas, PIB retention correlated inversely with cerebral glucose metabolism determined with 18F-fluorodeoxyglucose. This relationship was most robust in the parietal cortex ($r = -0.72$; $p = 0.0001$). The results suggest that PET imaging with the novel tracer, PIB, can provide quantitative information on amyloid deposits in living subjects.

Ann Neurol 2004;55:306–319

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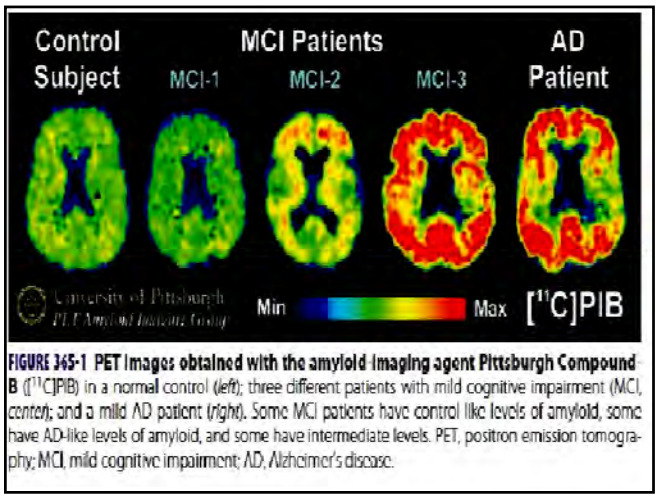
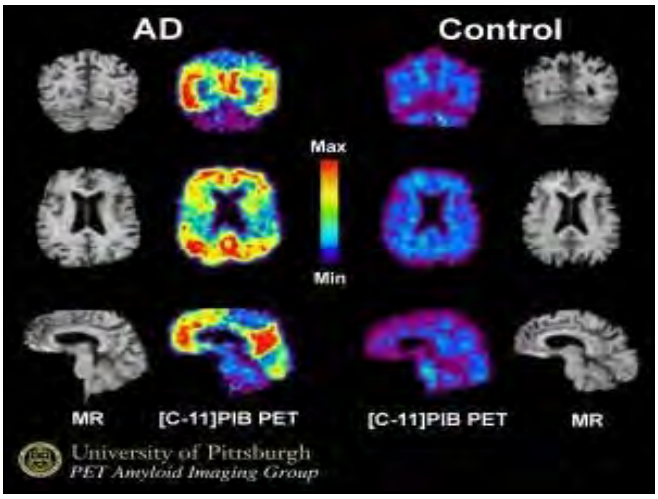
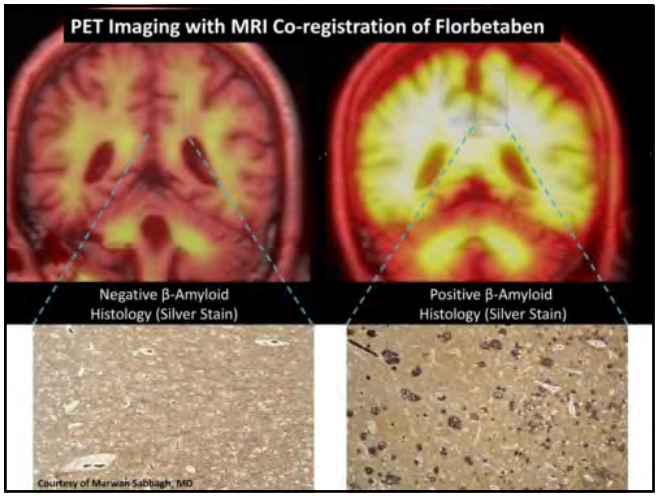
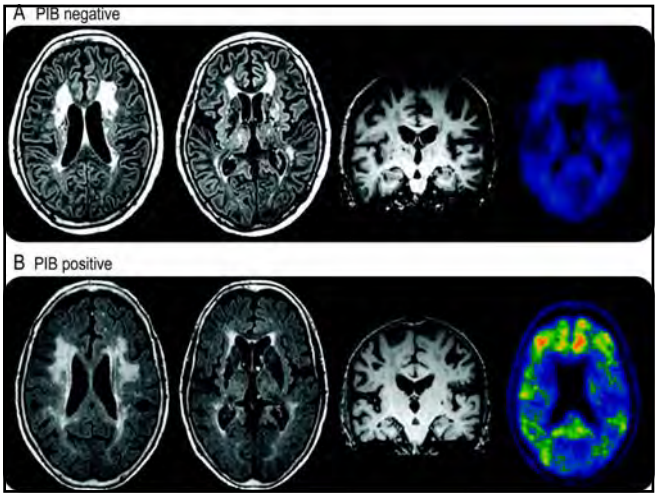
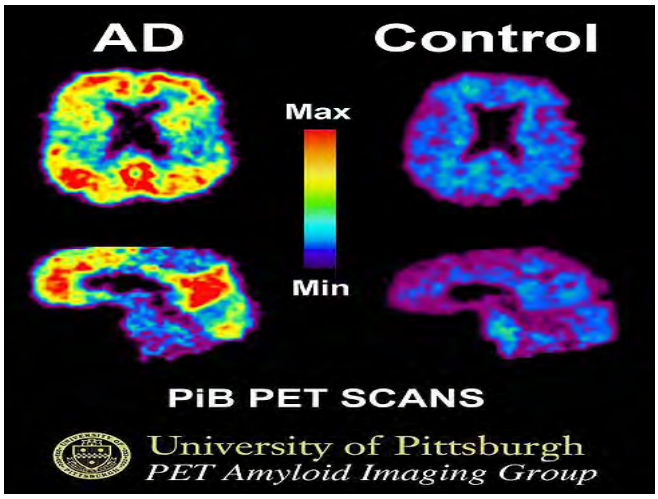


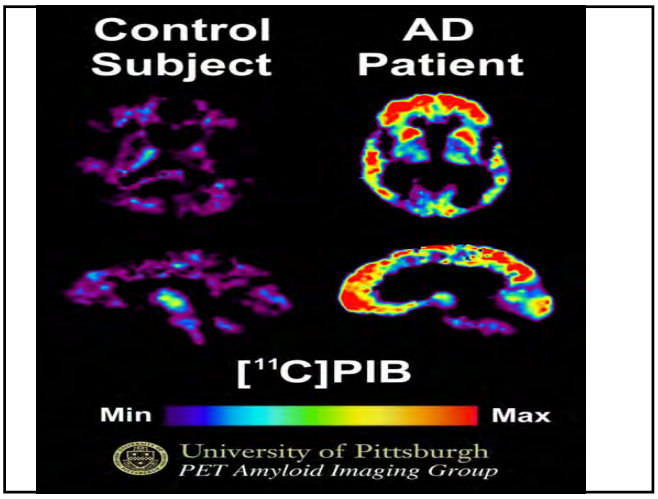
FIGURE 365-1 PET images obtained with the amyloid imaging agent Pittsburgh Compound-B ([11C]PIB) in a normal control (*left*); three different patients with mild cognitive impairment (MCI, *center*); and a mild AD patient (*right*). Some MCI patients have control like levels of amyloid, some have AD-like levels of amyloid, and some have intermediate levels. PET, positron emission tomography; MCI, mild cognitive impairment; AD, Alzheimer's disease.

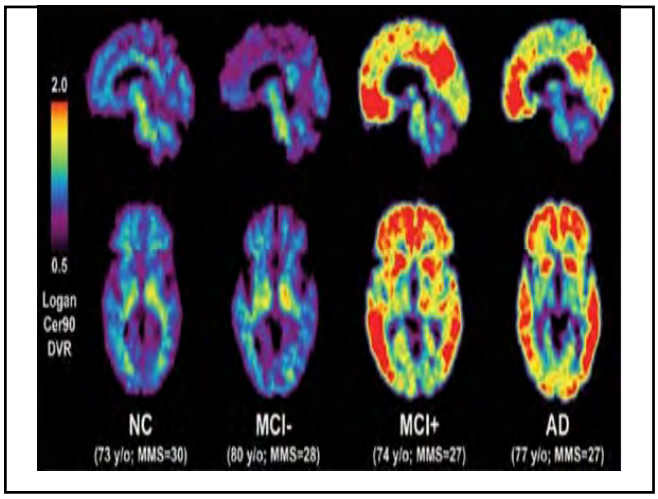


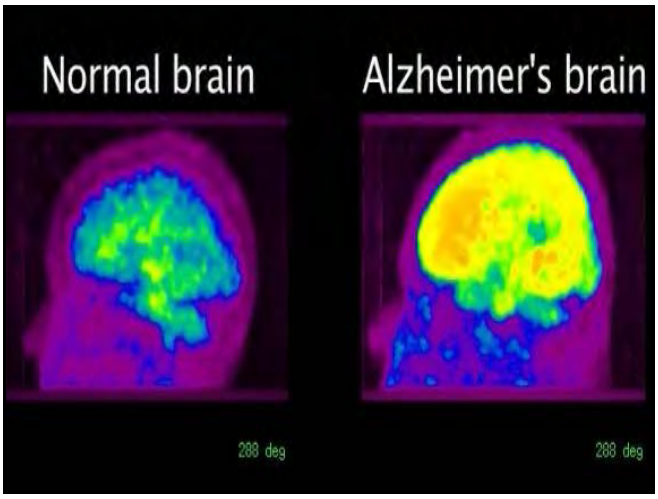


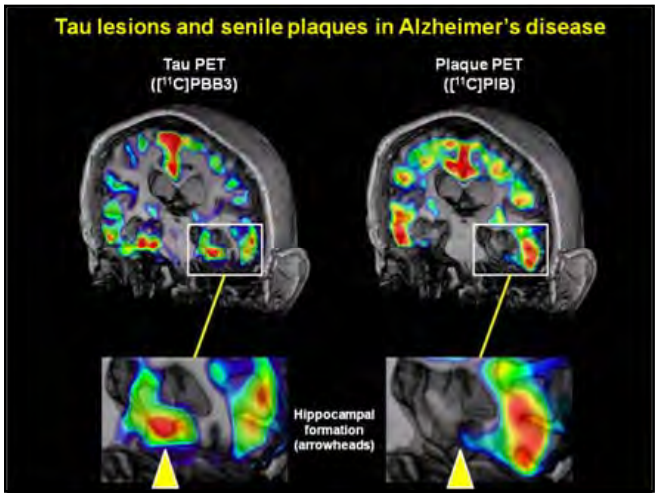


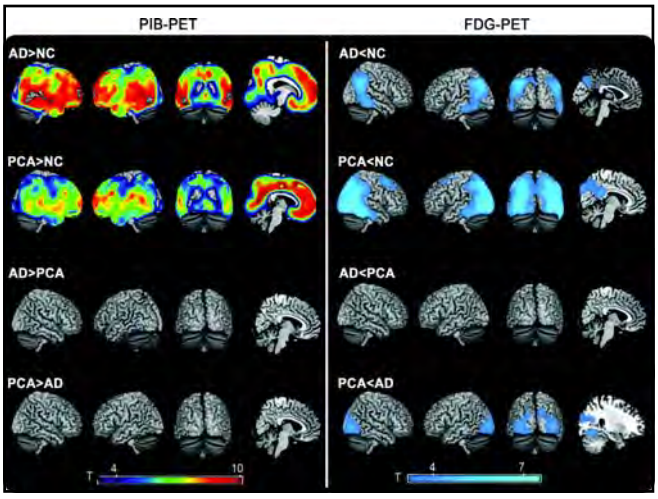

AD
Control
Max
Min
PiB PET SCANS
University of Pittsburgh
PET Amyloid Imaging Group

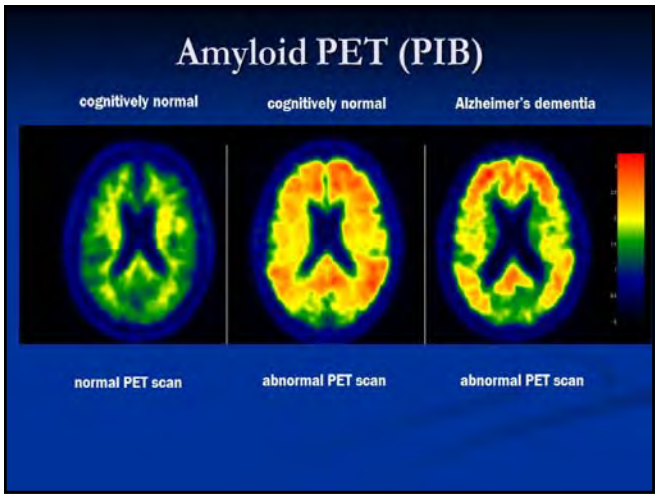

Control Subject
AD Patient
[11C]PIB
Min
Max
University of Pittsburgh
PET Amyloid Imaging Group

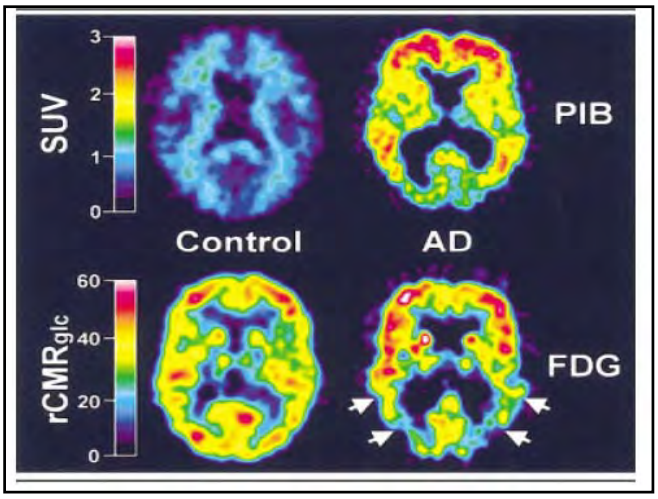

2.0
0.5
Logan Cer90 DVR
NC
(73 y/o; MMS=30)
MCI-
(80 y/o; MMS=28)
MCI+
(74 y/o; MMS=27)
AD
(77 y/o; MMS=27)

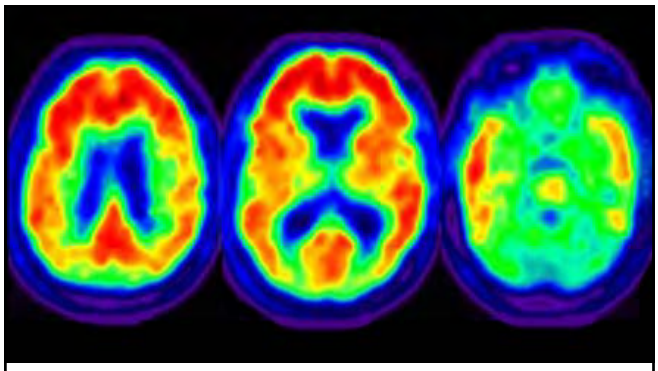

Normal brain
Alzheimer's brain
288 deg
288 deg


Tau lesions and senile plaques in Alzheimer's disease
Tau PET
([11C]PBB3)
Plaque PET
([11C]PIB)
Hippocampal formation (arrowheads)

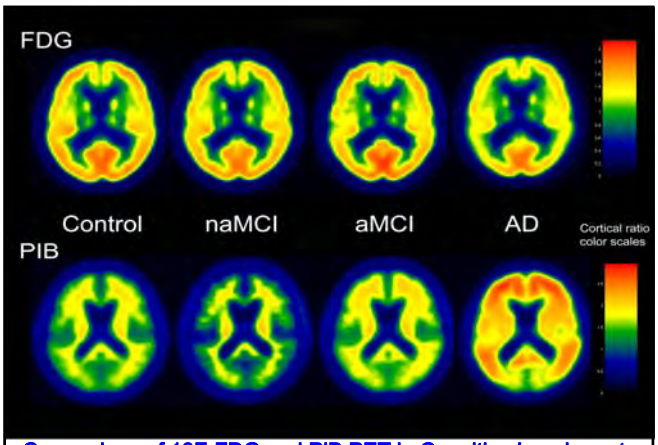

PIB-PET
FDG-PET
AD>NC
AD<NC
PCA>NC
PCA<NC
AD>PCA
AD<PCA
PCA>AD
PCA<AD



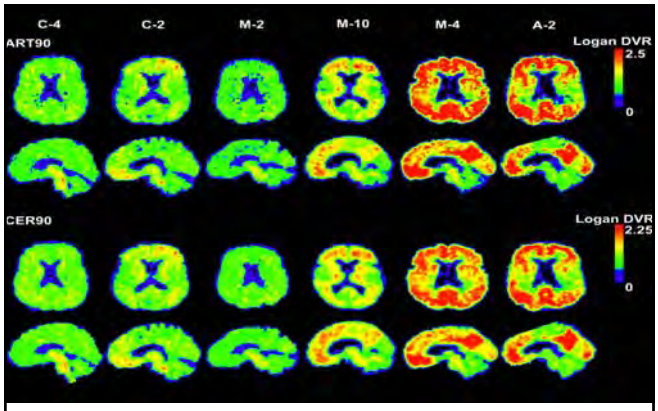




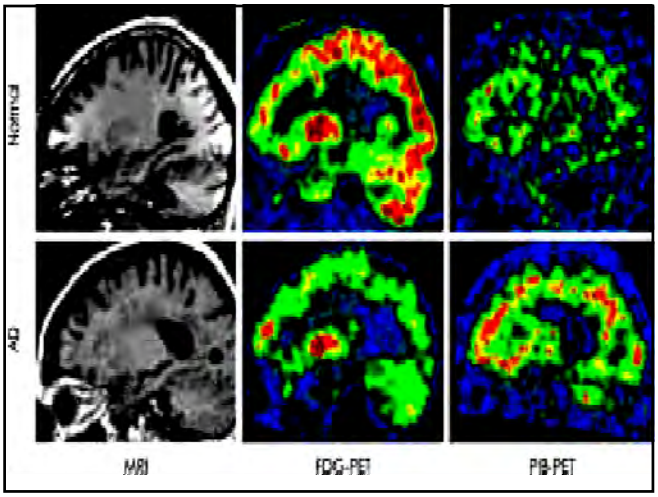
Pittsburgh Compound-B (PIB) is an imaging tracer that binds to amyloid protein and can be detected by a PET scanner for specific diagnosis of Alzheimer's disease.

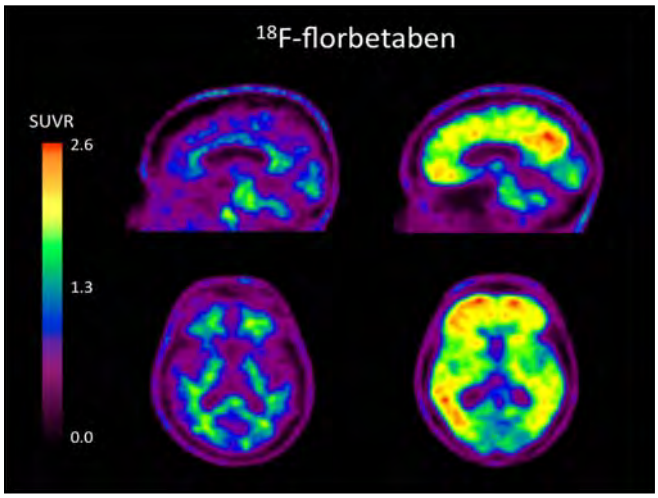


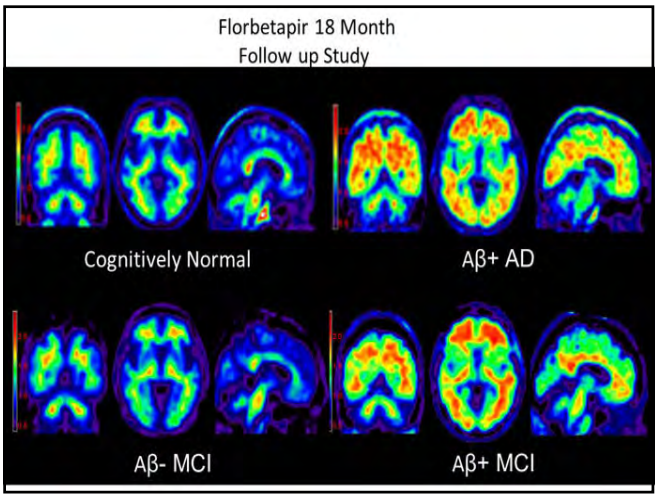
Comparison of 18F-FDG and PiB PET in Cognitive Impairment

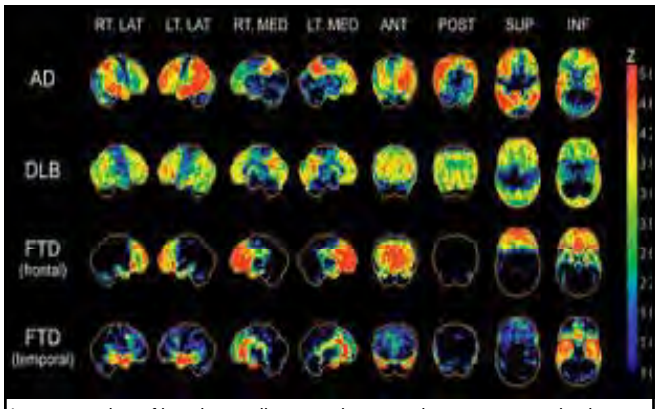


Simplified Quantification of **Pittsburgh Compound B Amyloid Imaging PET Studies**: A Comparative Analysis

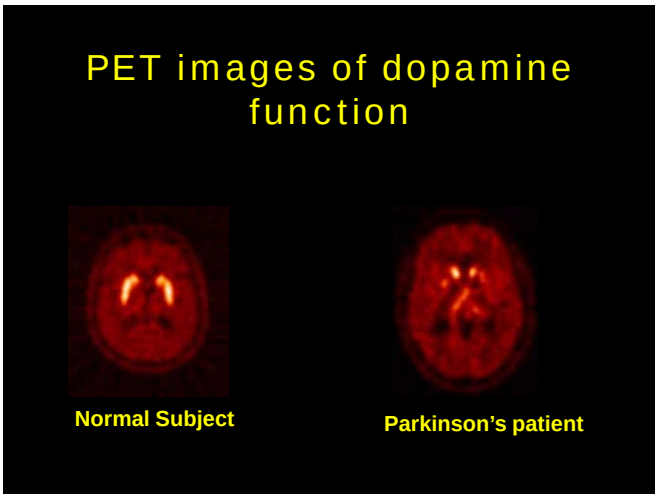


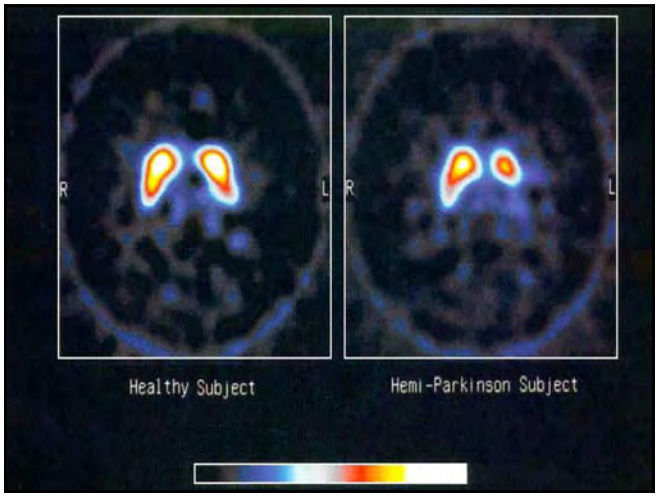


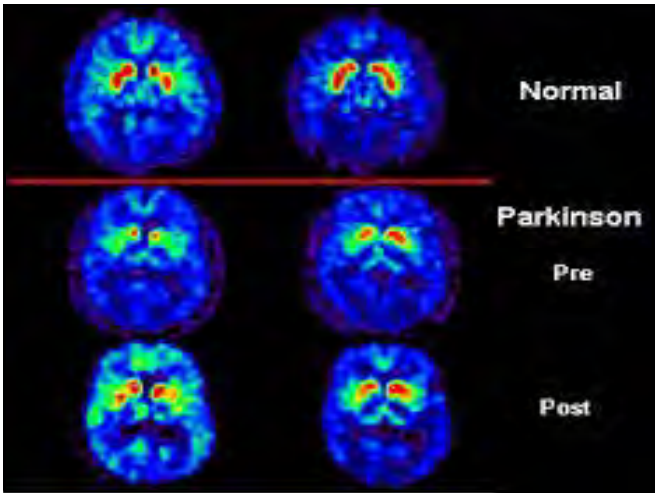




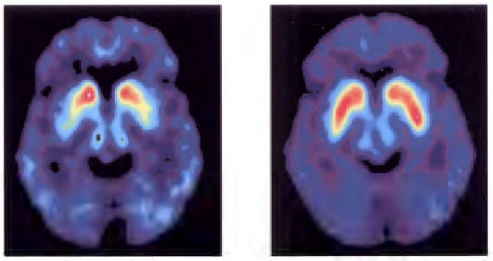
In a new review of imaging studies spanning more than ten years, scientists find that a **method of positron emission tomography (PET) safely and accurately detects dementia, including the most common and devastating form among the elderly, Alzheimer's disease**





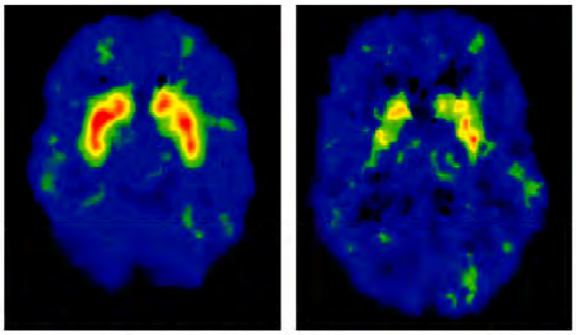


Dopamine-Neuron Transplantation



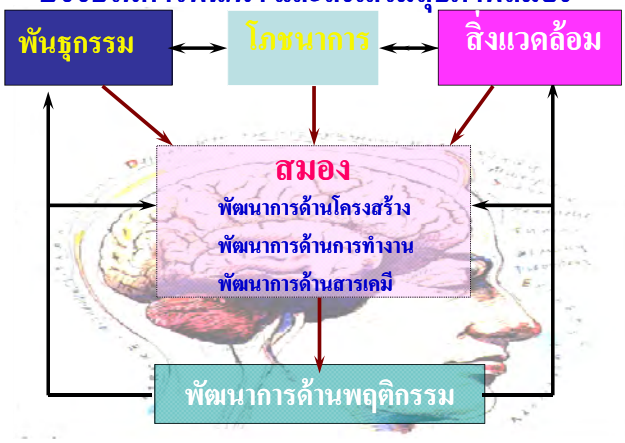
Before Surgery After Surgery

Figure 8.3. Positron Emission Tomography (PET) images from a Parkinson's patient before and after fetal tissue transplantation. The image taken before surgery (left) shows uptake of a radioactive form of dopamine (red) only in the caudate nucleus, indicating that dopamine neurons have degenerated. Twelve months after surgery, an image from the same patient (right) reveals increased dopamine function, especially in the putamen. (Reprinted with permission from N Eng J Med 2001;344 (10) p. 710.)



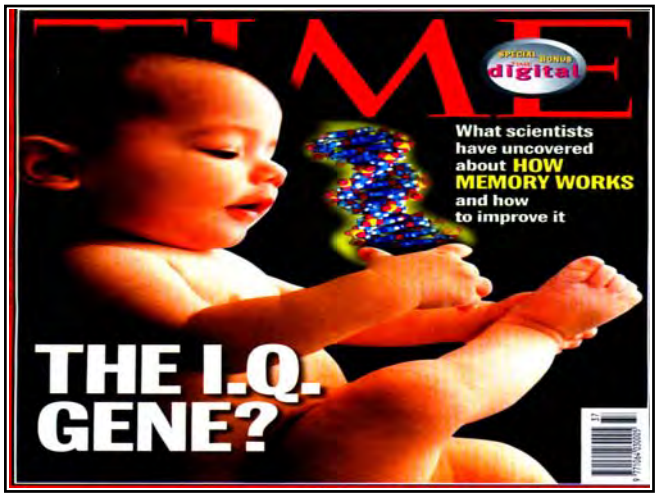
Blown out. Even 80 days after detox, a methamphetamine abuser's dopamine system (right) hasn't recovered to normal levels (left).

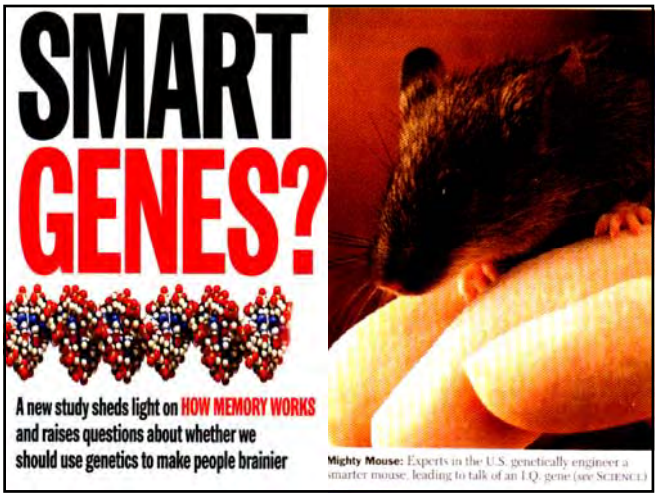
ปัจจัยในการพัฒนา และส่งเสริมสุขภาพสมอง

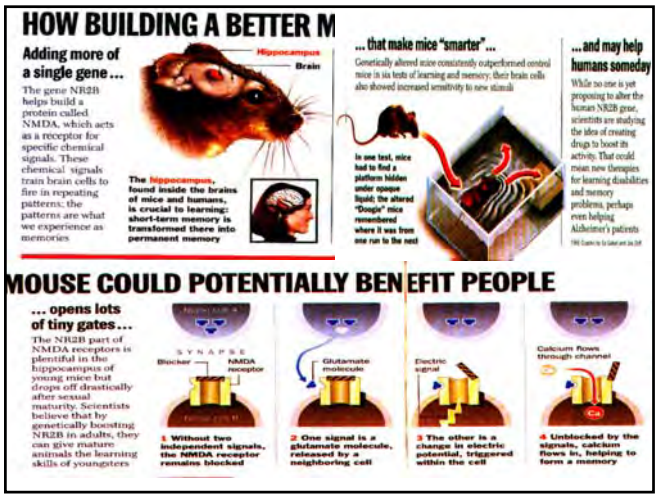


ปัจจัยที่เป็นตัวกำหนดการเติบโต พัฒนาการ และส่งเสริมการทำงานของสมอง

1. **Genetic Endowment** (พันธุกรรม)
2. **Nutrition** (โภชนาการ)
3. **Environment** (สิ่งแวดล้อม)
   - 3.1 สิ่งแวดล้อมด้าน กายภาพ สารเคมี และชีวภาพ
   - 3.2 สิ่งแวดล้อมด้านจิตวิทยา การรับรู้ ความรู้สึก และอารมณ์
   - 3.3 สิ่งแวดล้อม และปฏิสัมพันธ์ทางสังคม และวัฒนธรรม
   - 3.4 การเลี้ยงดู บทบาทของมารดา บิดา
   - 3.5 การเรียนรู้ และประสบการณ์







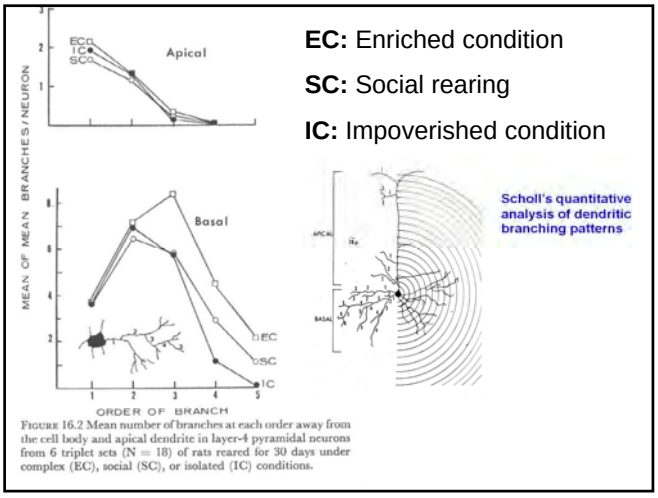


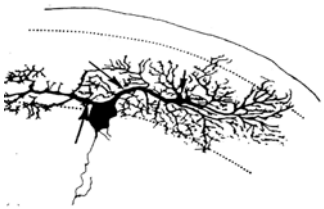
FIGURE 16.2 Mean number of branches at each order away from the cell body and apical dendrite in layer-4 pyramidal neurons from 6 triplet sets (N = 18) of rats reared for 30 days under complex (EC), social (SC), or isolated (IC) conditions.

A. เซลประสาทที่ได้รับสารอาหารสมบูรณ์และการกระตุ้นส่งเสริม

A. Purkinje cell from normal, well nourished and reared in enriched environment

B. เซลประสาทที่ขาดสารอาหารและขาดการกระตุ้นส่งเสริม

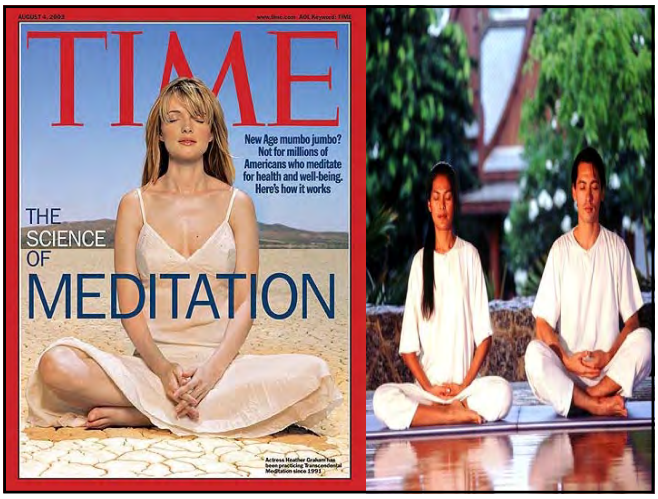
Purkinje cell from malnourished and reared in impoverished environment

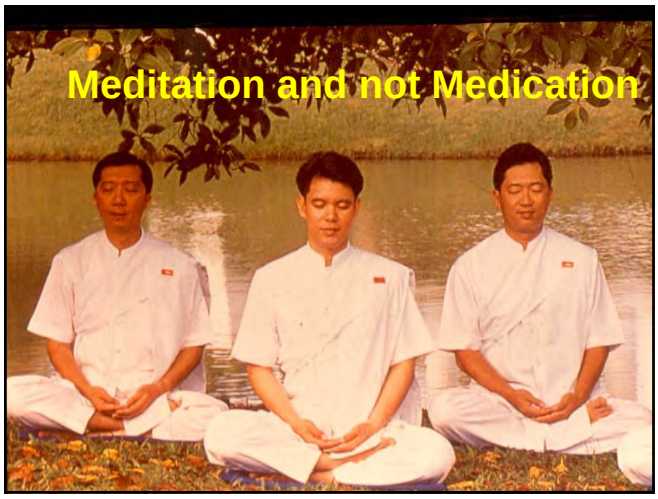


อาหารส่งเสริมพัฒนาการของสมองและสติ-ปัญญา

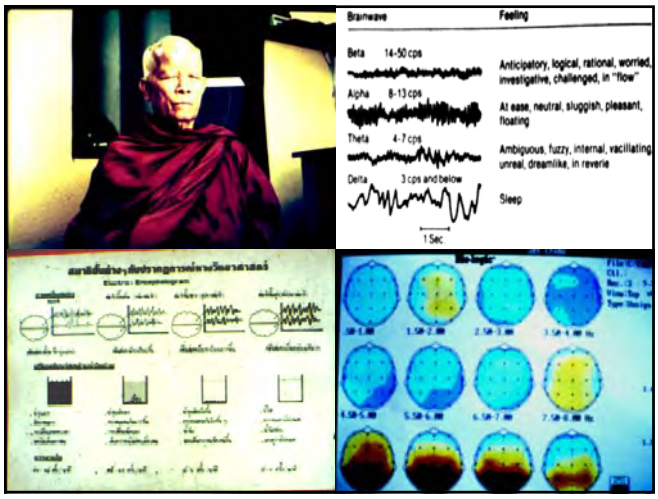
1. "อาหารกาย" คือ การกินสารอาหาร (โภชนาการ) ซึ่งเป็นทั้งโครงสร้าง และ พลังงาน ในการทำงานของสมอง
2. ประสบการณ์ คือ การได้รับประสาทสัมผัสและประสบการณ์จากผู้คนและสิ่งแวดล้อม ที่จำเป็นต่อพัฒนาการของสมอง
3. "อาหารใจ" คือ สภาพแวดล้อม สถานการณ์ที่ทำให้อารมณ์แจ่มใส เบิกบาน มีความรู้สึกดี ต่อตัวเองและปลอดภัย
4. "อาหารปัญญา" คือ ข้อมูล วิธีการคิดและทำอย่างสร้างสรรค์
5. "อาหารธรรม" คือ แบบอย่างการดำรงชีวิตที่ดี มีคุณธรรม

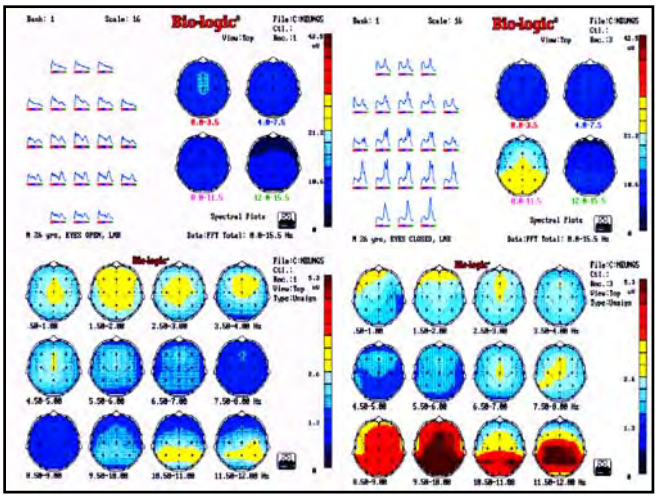

FILIPINO FLIGHT • ASIA'S CURRENCY WARS
Newsweek
The New Science of Mind & Body
HEALTH FOR LIFE
• Forgiveness And Health
• Stress and Infertility
• Rethinking Hypnosis
• Clues to Heart Disease
With Harvard Medical School


TIME
New Age mumbo jumbo? Not for millions of Americans who meditate for health and well-being. Here's how it works
THE SCIENCE OF MEDITATION

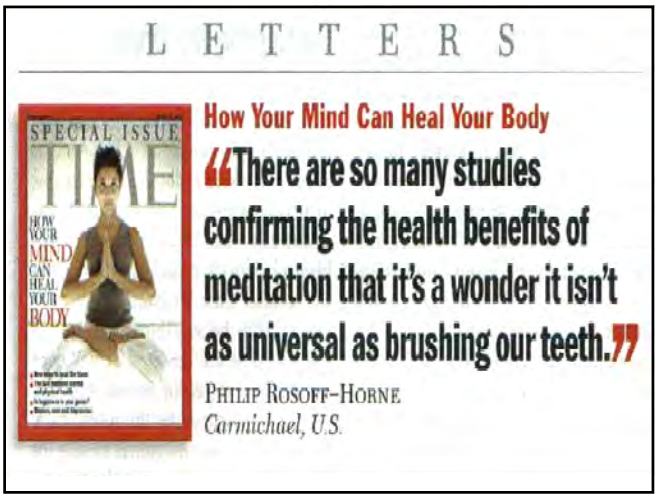

Meditation and not Medication

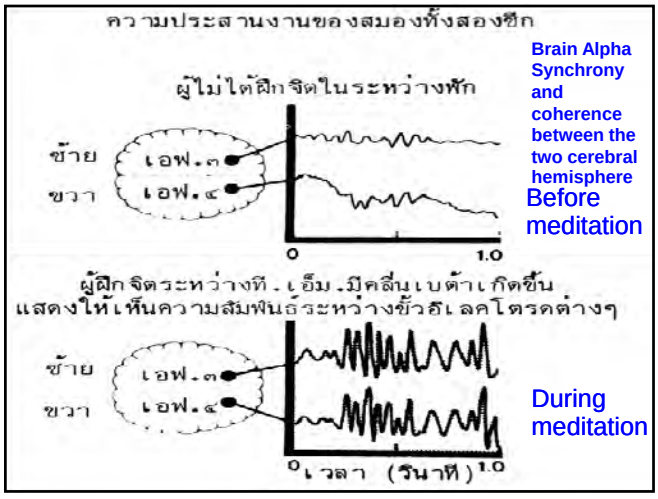

ลดความเครียด วิตกกังวล โดยการพัฒนาจิตใจ ทำสมาธิ
(Meditation





ข้อมูลจากการวิจัยทางวิทยาศาสตร์
การแพทย์เกี่ยวกับกลไกสมอง และ
ประโยชน์ที่เกิดจากการฝึกจิตทำสมาธิ





Brain Alpha Synchrony and coherence between the two cerebral hemisphere

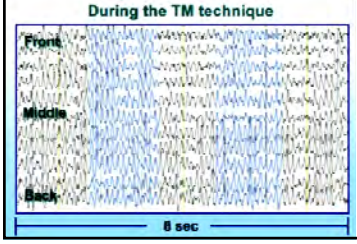
Before meditation

During meditation

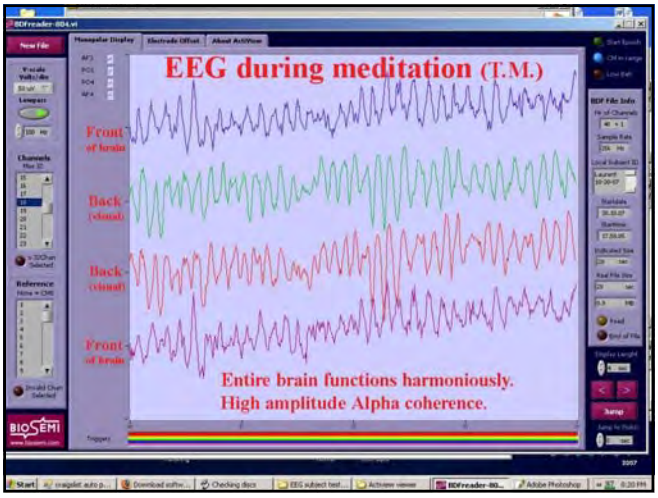
Brainwave Coherence During the Transcendental Meditation technique

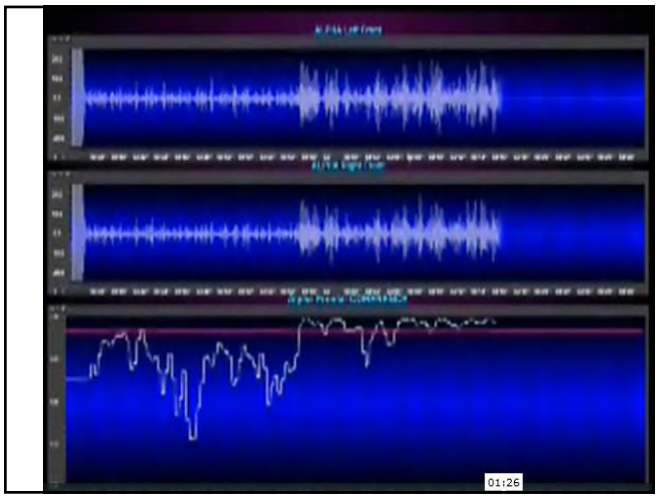
Brain researchers have found that during practice of the Transcendental Meditation technique, the brain becomes more coherent and integrated, and that this heightened efficiency of brain functioning grows over time through twice-daily practice — even outside of meditation — improving mental performance and overall health.

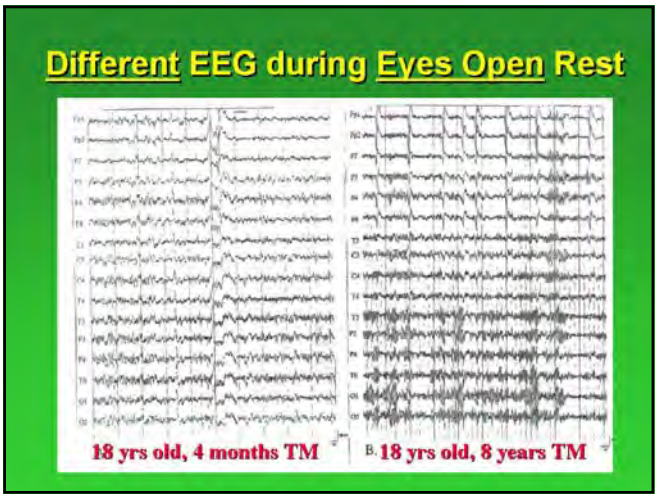
High EEG Coherence During the TM technique



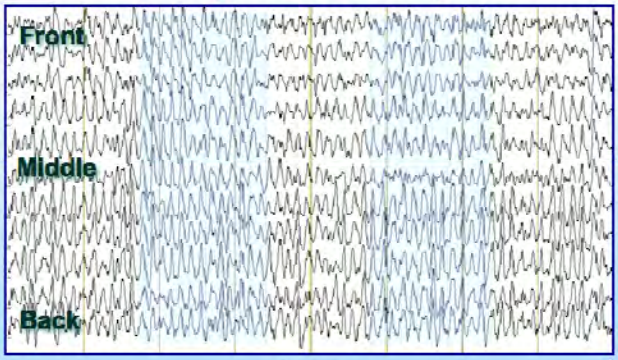
EEG tracings recorded during practice of the TM technique. The lines are moving up and down together — brain waves are no longer scattered but "in phase," indicating that neurons are firing in harmony within the same frequency of alpha2.
Higher coherence is associated with more integrated and effective thinking and behavior, including greater intelligence, creativity, learning ability, emotional stability, ethical and moral reasoning, self-confidence, and

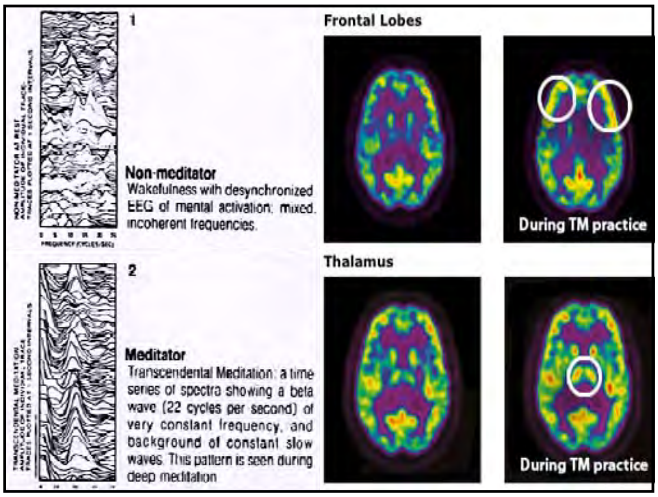


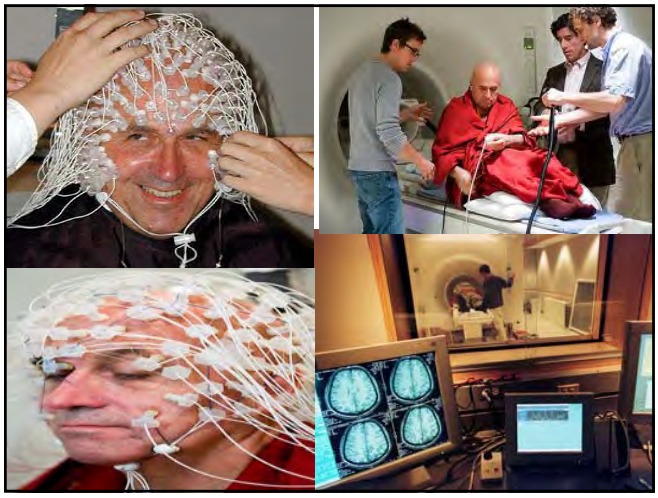




High EEG Coherence During the TM technique

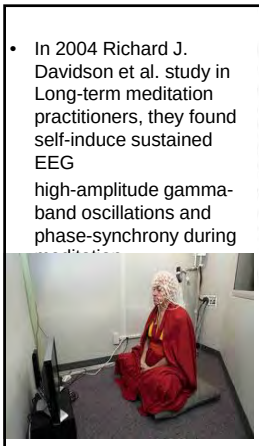


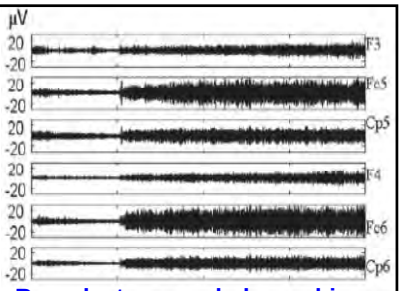




- In 2004 Richard J. Davidson et al. study in Long-term meditation practitioners, they found self-induce sustained EEG

  high-amplitude gamma-band oscillations and phase-synchrony during

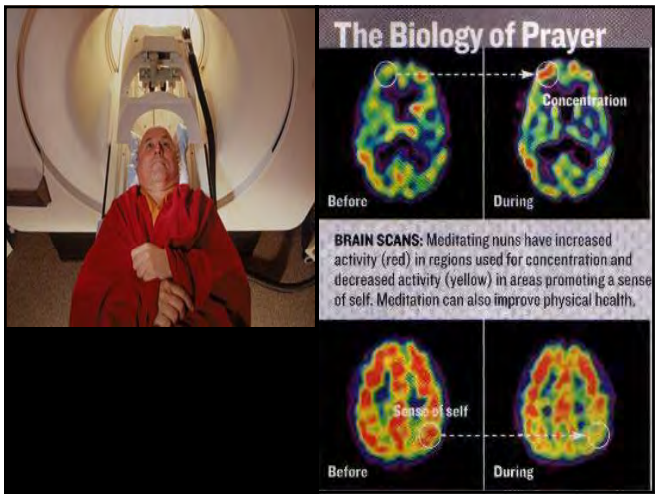




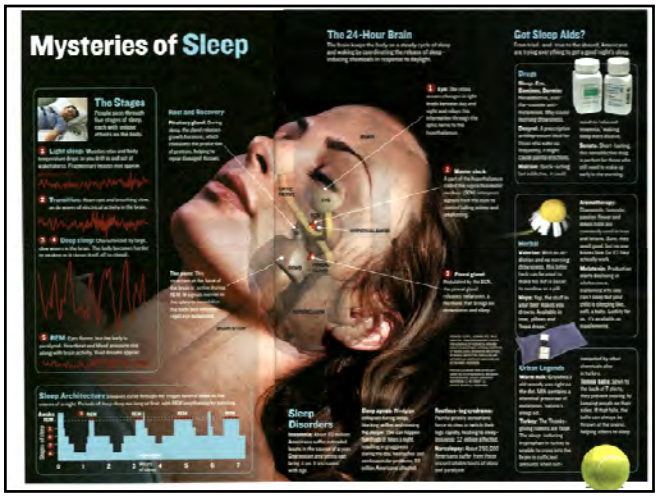
Raw electroencephalographic Signals represent
High-amplitude gamma activity during meditation practice

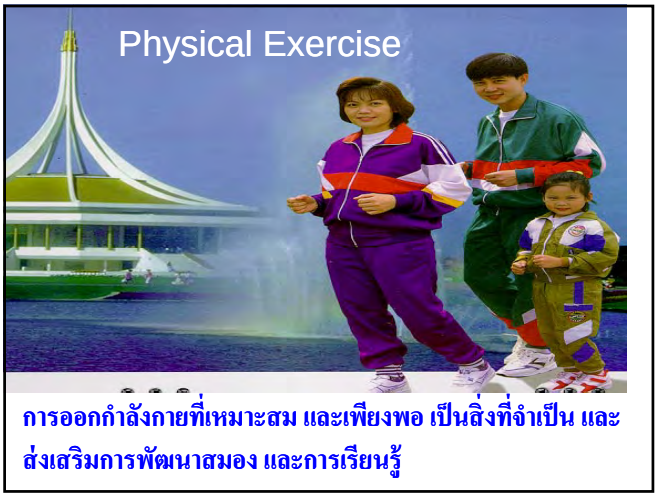
Journal PNAS 2004

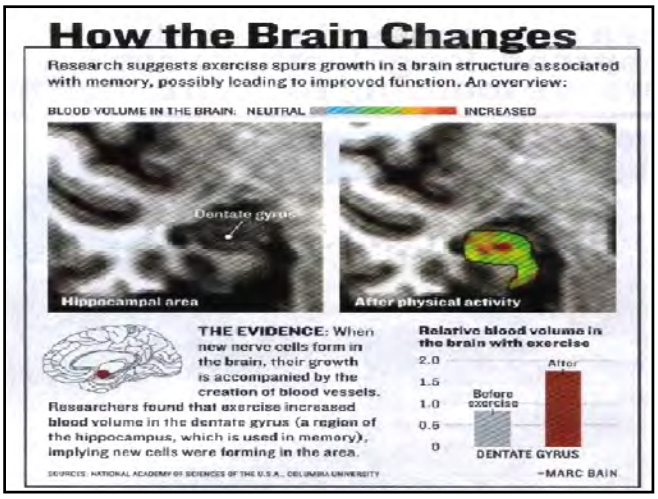
Lutz A., Greischar L.L., Rawlings N.B., Ricard M., Davidson R.J. (2004). "Long-term meditators self-induce high apmlitude gamma synchrony during mental practice". *Proceedings of the National Academy of Sciences USA* 101: 16369–16373



การนอนหลับอย่างดี และเพียงพอ
กับการออกกำลังกายมีความสำคัญ
ต่อ ความจำ และการเรียนรู้







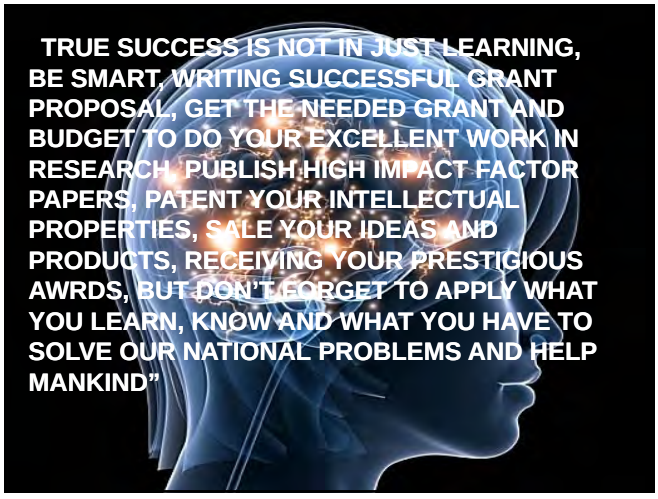
ผลของการฝึกจนชำนาญต่อการทำงานของสมอง PET Scan ในขณะฝึกซ้อมดนตรี

Ref. Trehub, U Toronto- Baby & pleasant vs dissonant music; Pascual-Leone, Lab Mag Brain Stim;Schlaug, Beth Israel Medical Center, Boston- Corpus collosum thickening in piano players

Acknowledgement (กิตติกรรมประกาศ)

ขอบพระคุณ คุณครู ท่านอาจารย์ คนไข้ เพื่อนร่วมงาน นักเรียน ศิษย์ที่รัก Sponsors ผู้ใจดี และผู้คนจำนวนมากมาย ทุกๆท่านที่ให้ความรู้ ประสบการณ์ในการเรียนรู้ การทำงาน ความจำที่ดีๆ ความคิด ปัญญา (Wisdoms) ช่วยเหลือและสนับสนุนให้เราได้ทำงานได้ในทุกวันนี้

ขอบคุณ สาขาวิทยาศาสตร์การแพทย์ สำนักงานคณะกรรมการวิจัยแห่งชาติ (วช.) และ สถาบันวิจัยระบบสาธารณสุข (สวรส.) ที่ให้การสนับสนุนการจัดประชุมในครั้งนี้



Thank you for your attention and participation

With all best wishes,