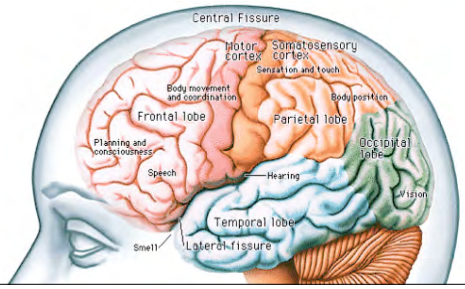
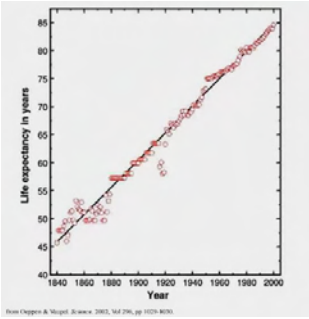
Stockholm Brain Institute

Center for
Cognitive and Computational Neuroscience

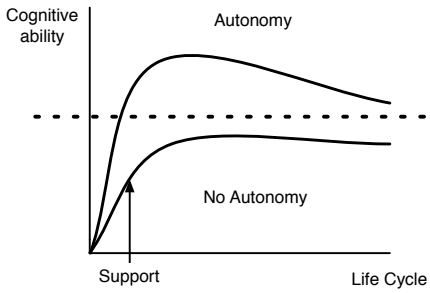


Research

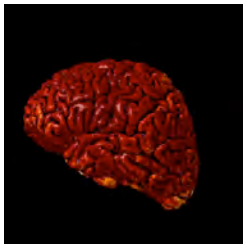
3 months per year



AUTONOMY (WHO)



Cognitive & Computational Neuroscience



Cognitive functions

- Attention
- Memory
- Learning
- Language

What: Behavioral level

Intra and interindividual differences

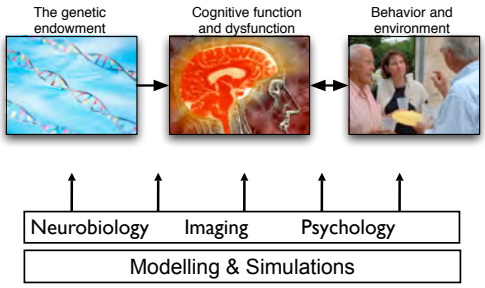
Why: Information processing level

Working memory, episodic memory
attention, processing speed
Simulations based on models

How: Neurobiological level

Functional neuroanatomy
Detailed neuronal curcuits, neuromodualtion
Simulations based on models

Cognitive & computational neuroscience

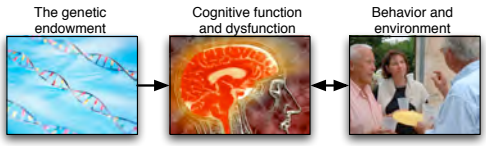


Attention
Memory
Learning
Language
Action
Perception

Neurobiology Imaging Psychology

Modelling & Simulations

Cognitive dysfunctions leads to:



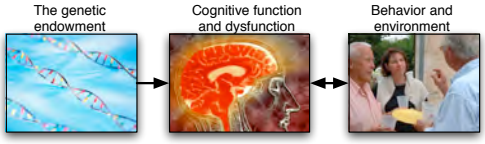
Attention
Memory
Learning
Language
Action
Perception

Neurodevelopmental disorders: ADHD, autism, learning disorders

Psychiatric disorders: Schizophrenia, depression, anxiety disorders

Dementia and neurodegenerative disorders: Alzheimer, Parkinson

Cognitive dysfunctions leads to:



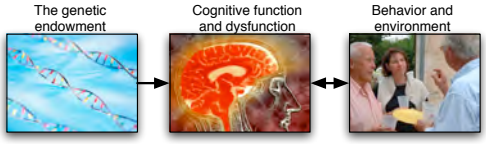
Attention
Memory
Learning
Language
Action
Perception

Burden of diseases:

In EU 127 (of 466 million) suffer from brain disorders

Total annual cost €386 billion

Cognitive dysfunctions leads to:



Attention
Memory
Learning
Language
Action
Perception

Economic growth CNS-pharma:

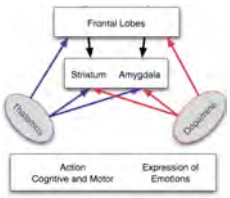
Global market of USD 60 billion

Second fastest growing therapy segment

Account for 20% of total sales

Focus on three specific cognitive functions

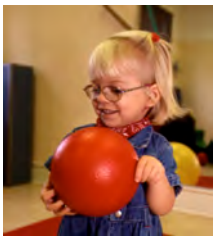
- **Learning & Memory**
- **Emotion/Value**
- **Action - Perception**



Motivation of behavior

From three perspectives

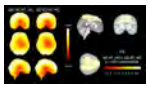
- Development, aging and plasticity
- Gender and sexual differences
- Cognitive dysfunction
  - ADHD
  - Schizophrenia
  - Alzheimer's dementia

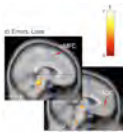


Platform

Stockholm Brain Institute

- **Methodological platforms**
  - **Brain imaging**
    - **Molecular**
    - **Functional**
    - **Structural**

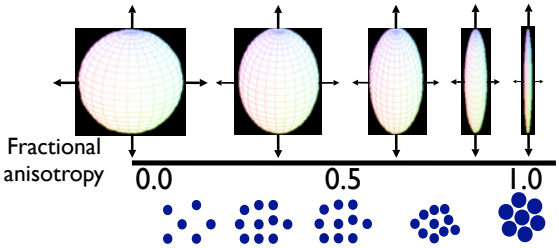




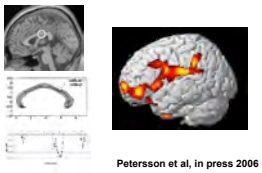
Diffusion Tensor Imaging (DTI)

Method of MRI

- Sensitive to molecular diffusion of water
- Particularly useful for studying white matter

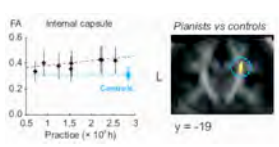


Reading and brain structure/function



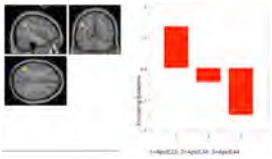
Petersson et al, in press 2006

Early training in professional pianists

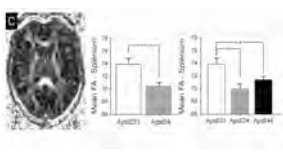


Bengtsson et al, Nature Neurosci 2005

Polymorphism APOE 4 and function - white matter integrity in elderly



Lind et al, Brain 2006



Persson et al, Neurology 2006

Molecular Imaging

DRD2 - 11C Raclopride

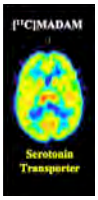
Association between a Promoter Dopamine D_2 Receptor Gene Variant and the Personality Trait Detachment

Erik G. Jönsson, Sven Cichon, J. Petter Gustavsson, Frank Grünhage, Kaj Forslund, Marja Mattila-Evenden, Gunnar Kylander, Marie Åsberg, Lars Farde, Peter Propping, and Markus M. Nöthen

Biological Psychiatry
Volume 53, Issue 7 , 1 April 2003, Pages 577-584

DAT - PE2I

Human PET tracers originating from Karolinska Institutet (1/3 of all)

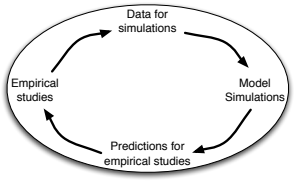


Dopamine D1: [11C]SCH 23390, [11C]NNC 112
D2: [11C]Raclopride (striatal)
D2: [11C]FLB 457 (extrastriatal)
transporter (DAT): [11C]PE2I
Serotonin 5-HT1A: [11C]WAY-100635
5-HT2A: [11C]MDL100907
transporter (SERT): [11C]MADAM
Norepinephrine transporter (NET): [11C]MeNER, [18F]FD2MeNER
GABA/Benzodiazepine: [11C]flumazenil, [18F]flumazenil

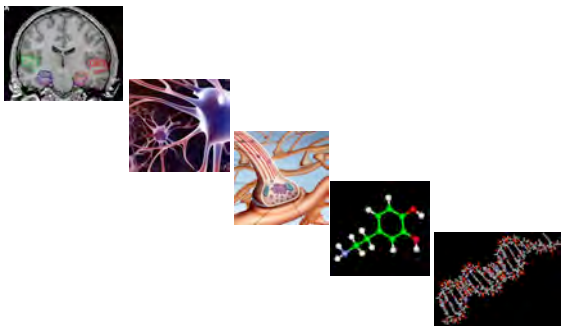
25 PET tracers have been used in humans
>100 different PET tracers developed
Directed towards
Receptor subtypes - Enzymes - Carrier - Proteins

Methodological platform 2

- **Modelling & simulation**
- Quantitative modeling - an enabling tool in neuroscience
- ... at levels from ion channels to brain-scale dynamical network simulations
- Brain models serve as input to brain-inspired IT and computer architectures



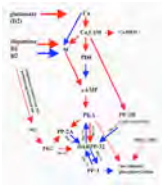
Levels of analysis



Systemförtåelse

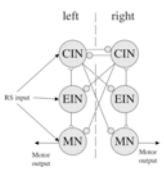
Computational Neuroscience

Learning in a synaptic spine



Neuronal network models of
cortex
basal ganglia
spinal cord

Biomechanical Models

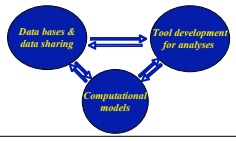


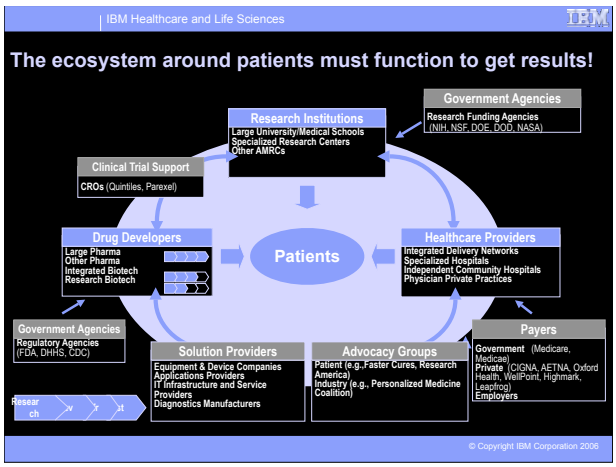
Neuro-modeling can predict effects of neuronal damage

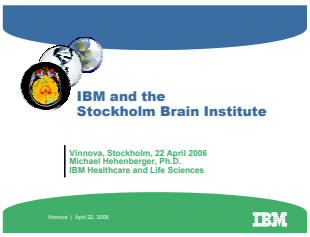
INCF

International Neuroinformatics Coordinating Facility

- OECD
  - Working group for Neuroinformatics
- Brain databases, Modeling, Data analysis infrastructure
- 10+ OECD countries members
- 10 MSEK/yr
- Synergies with SBI







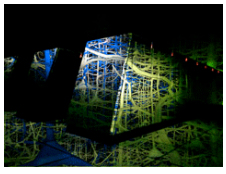
IBM

- Strategic collaboration agreement with Karolinska Institutet and Royal Institute of Technology

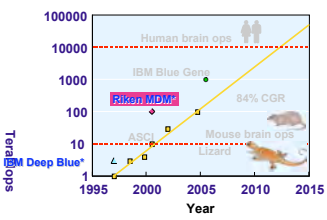
Blue Brain Project

The first objective of the "Blue Brain Project" is to create a cellular level, software replica of the Neocortical Column for real-time simulations.

Blue Brain will search for new insights into how human beings think and remember, and how specific defects in our circuitry may contribute to autism, schizophrenia and Parkinson's disease. With Blue Brain, research inquiries that used to require several years of laboratory work can now be done in a matter of days, or even minutes.



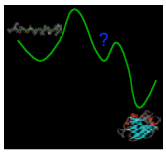
Blue Brain Project



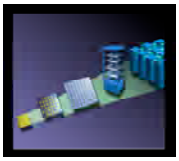
Modeling the circuitry in the neocortex
Simulating the high speed electro-chemical interactions of the brain interior.
Shedding light on internal processes: thoughts, perception and memory
Understanding psychiatric disorders: autism, schizophrenia, and depression

Blue Gene project

- Advance our understanding of biologically important processes, in particular the mechanisms behind protein folding
  - protein structure and function
  - protein-ligand and protein-protein interactions
  - nanotechnology



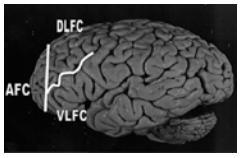
- Advance our knowledge of supercomputer architectures, and of the software needed to exploit them effectively
  - rethink processor design
  - rethink parallel programming
  - deliver orders of magnitude higher performance/cost, density

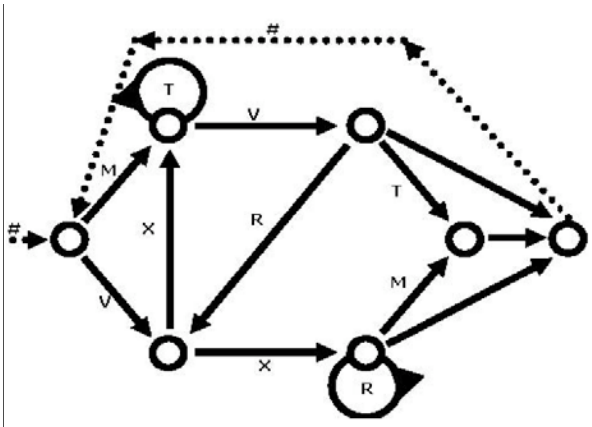


SwedeBlueGene

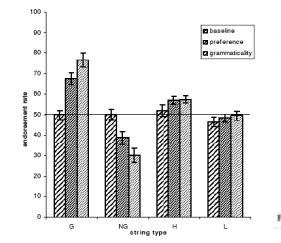
Issues for modeling

- Working memory
- Sequential learning
- Cognitive control of emotion





Empiri



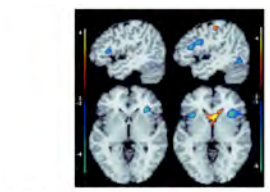


Figure 5. Implicit AGL. FMRI results from Forkstam et al., [2006].