Brain Imaging in the Study and Treatment of Psychiatric Disorders

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Universidade de Lisboa

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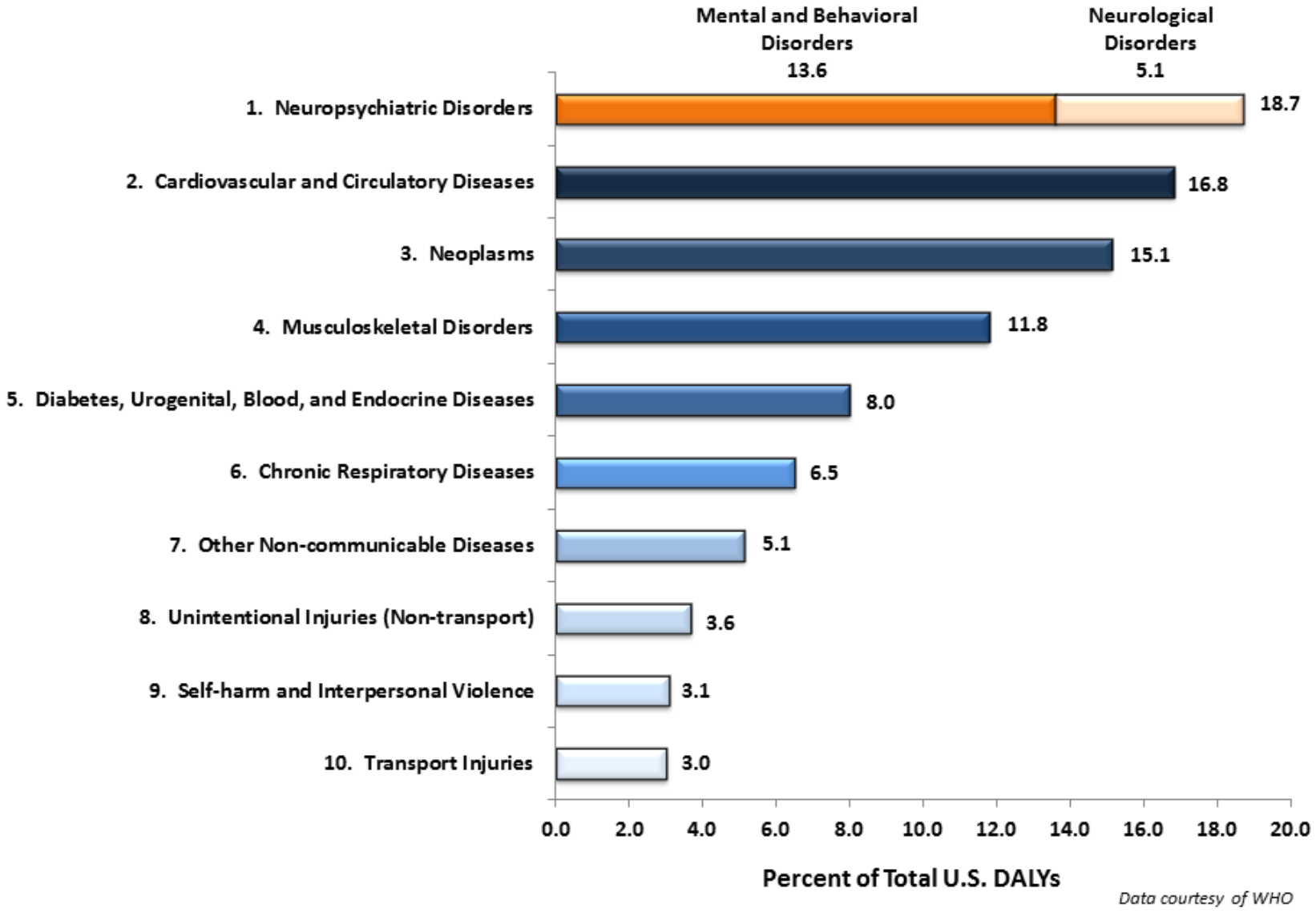
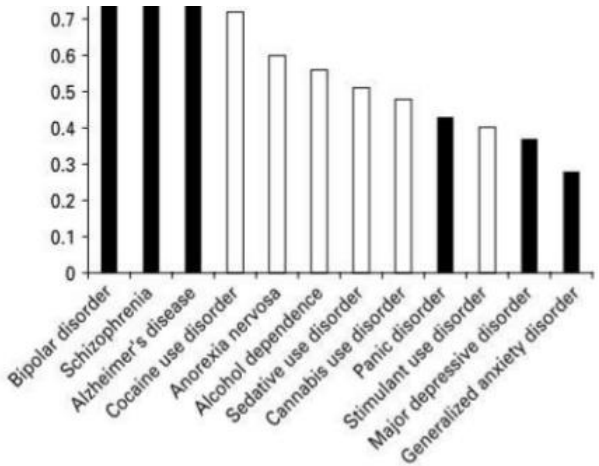
Top 10 Leading Disease/Disorder Categories Contributing to U.S. DALYs (2010)



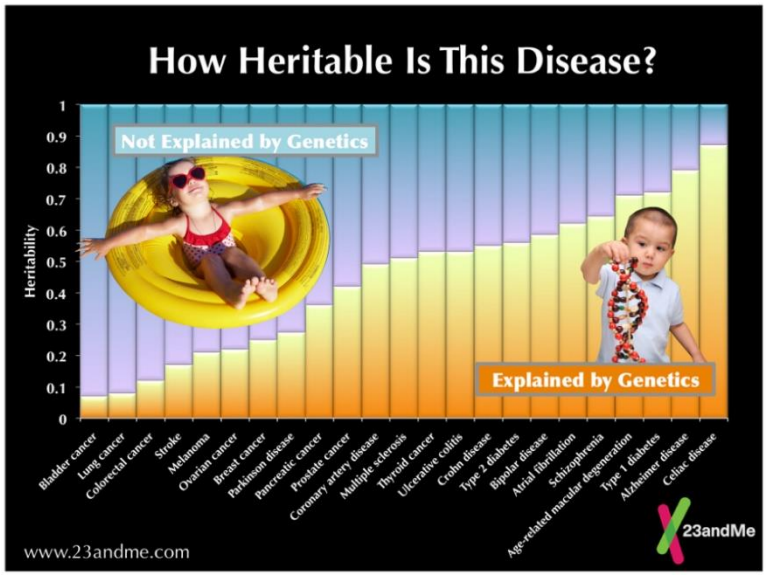
Data courtesy of WHO

Heritability of Psychiatric Disorders

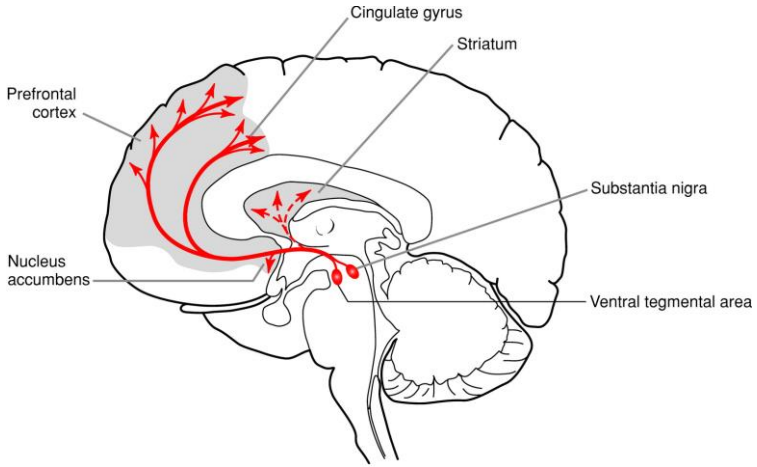


Bienvenu et al. Psychiatric 'diseases' versus behavioral disorders and degree of genetic influence. Psychological Medicine 2011;41;33–40.

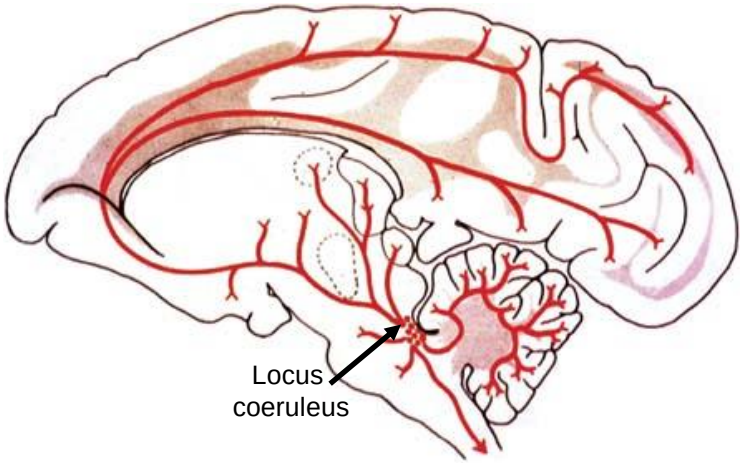
Heritability of Other Disorders



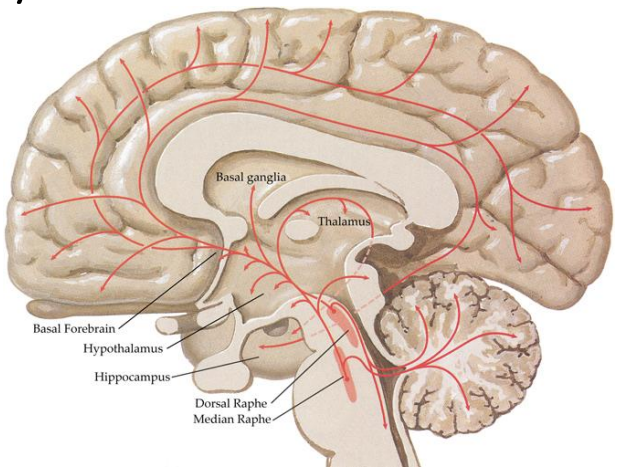
Neuromodulatory Systems



Dopaminergic Pathways



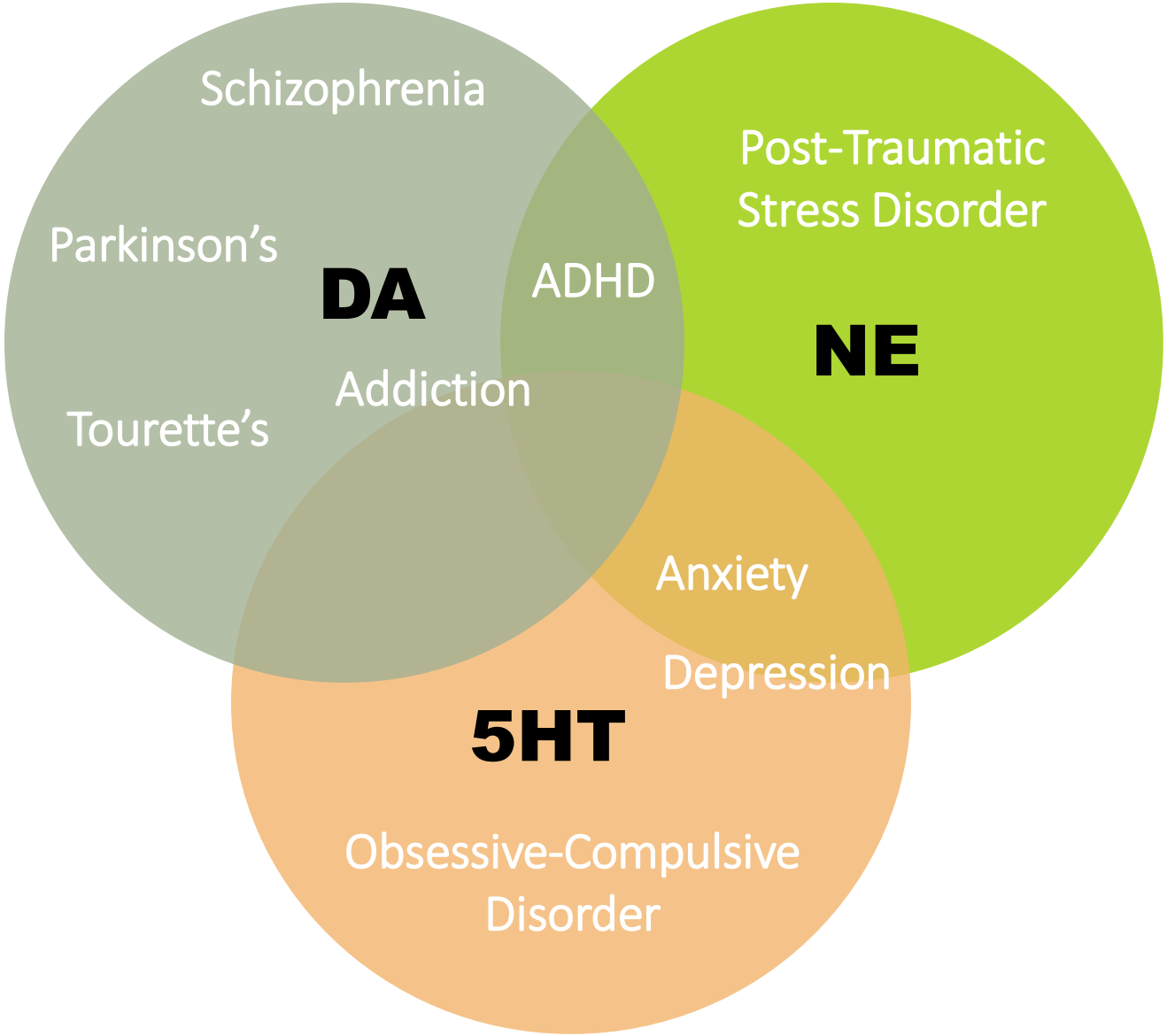
Noradrenergic Pathways



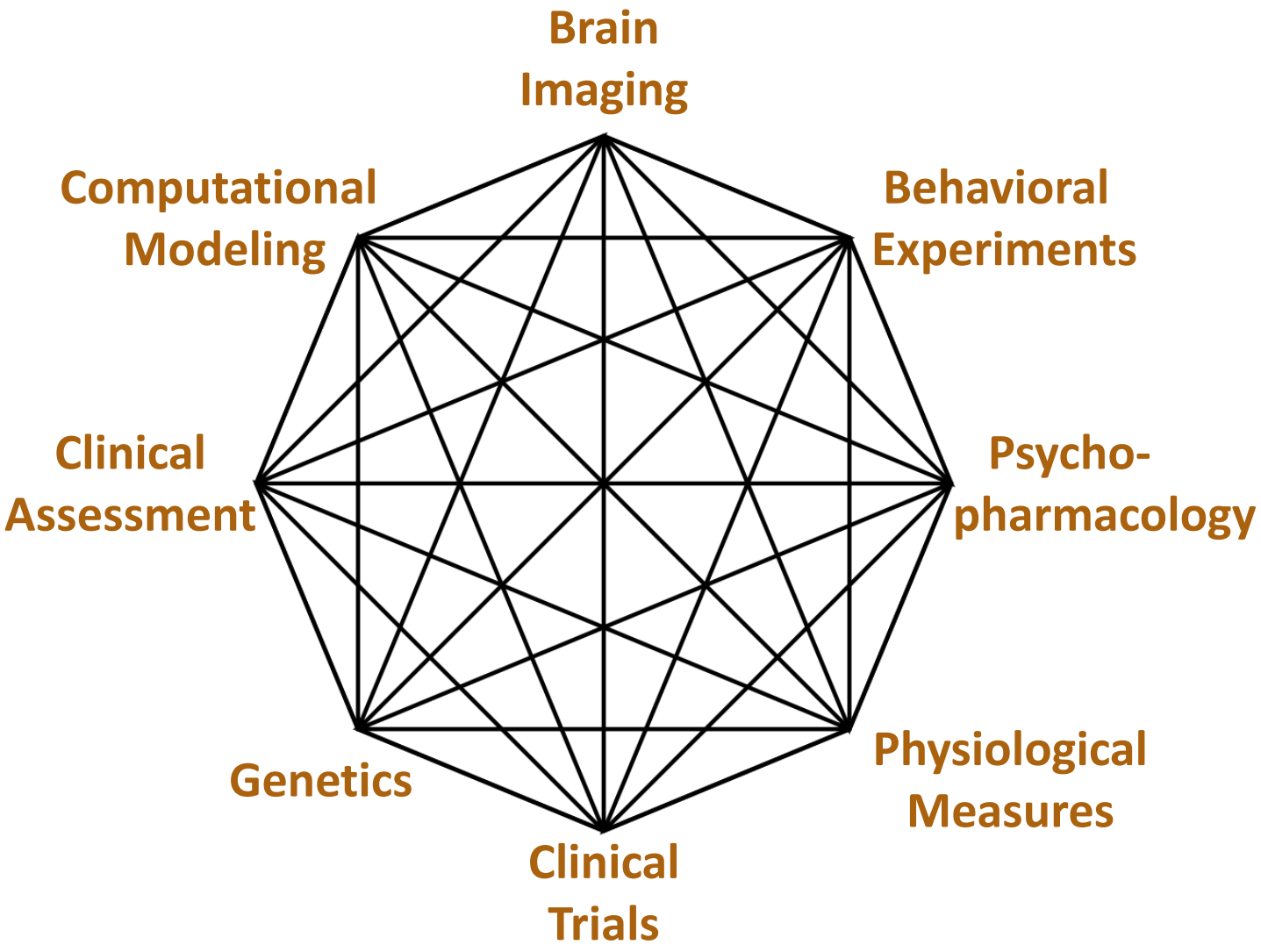
Serotonergic Pathways

Figures from Hyman et al. (2006), Aston-Jones & Cohen (2005), and Scarr et al. (2013)

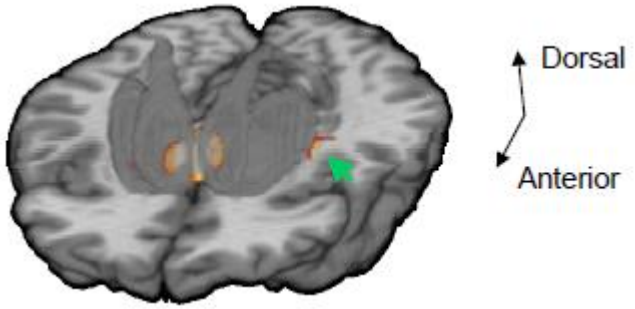
Neuromodulatory Systems and Neuropsychiatric Disorders



Methods


Brain Imaging
Behavioral Experiments
Psycho-pharmacology
Physiological Measures
Clinical Trials
Genetics
Clinical Assessment
Computational Modeling

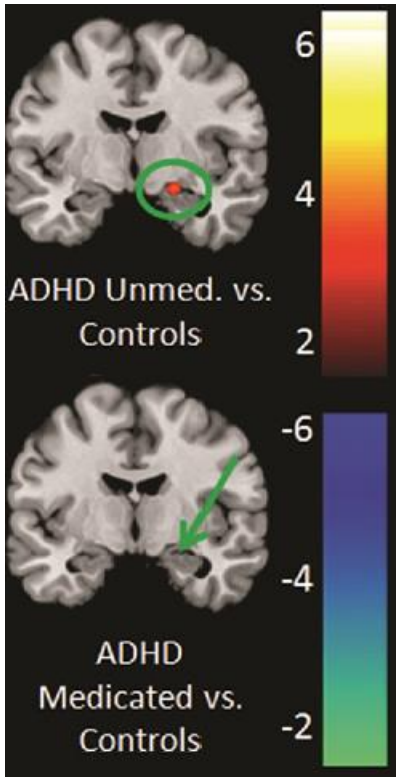
Brain Imaging

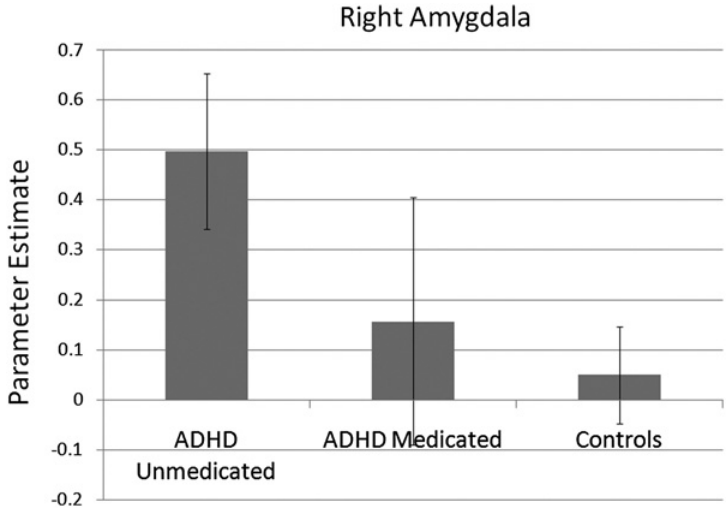


Horga*, Maia*, et al. (2015),
Human Brain Mapping

Some Example Results

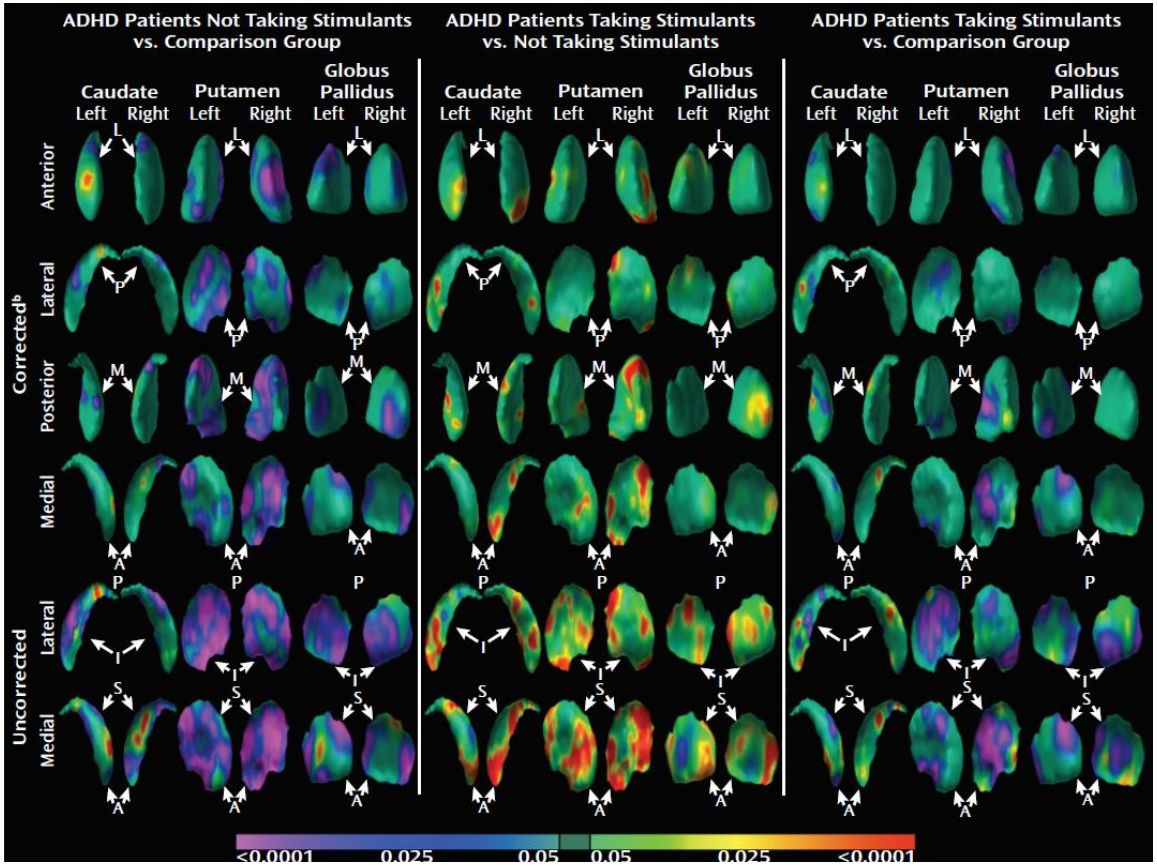
Emotional Hyper-Reactivity in Attention-Deficit/Hyperactivity Disorder and its Amelioration by Stimulants





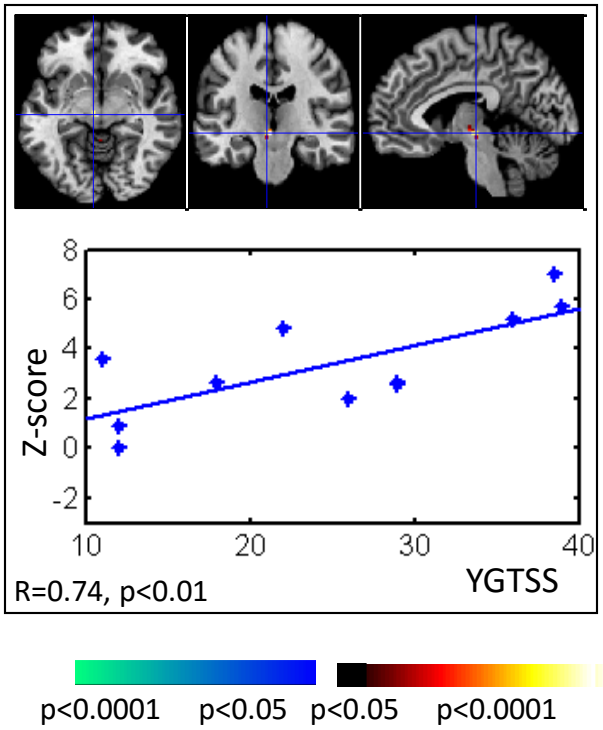
Posner, Nagel, Maia, et al. (2011), *Journal of the American Academy of Child and Adolescent Psychiatry*

Morphological Abnormalities in Attention-Deficit/Hyperactivity Disorder and their Amelioration by Stimulants



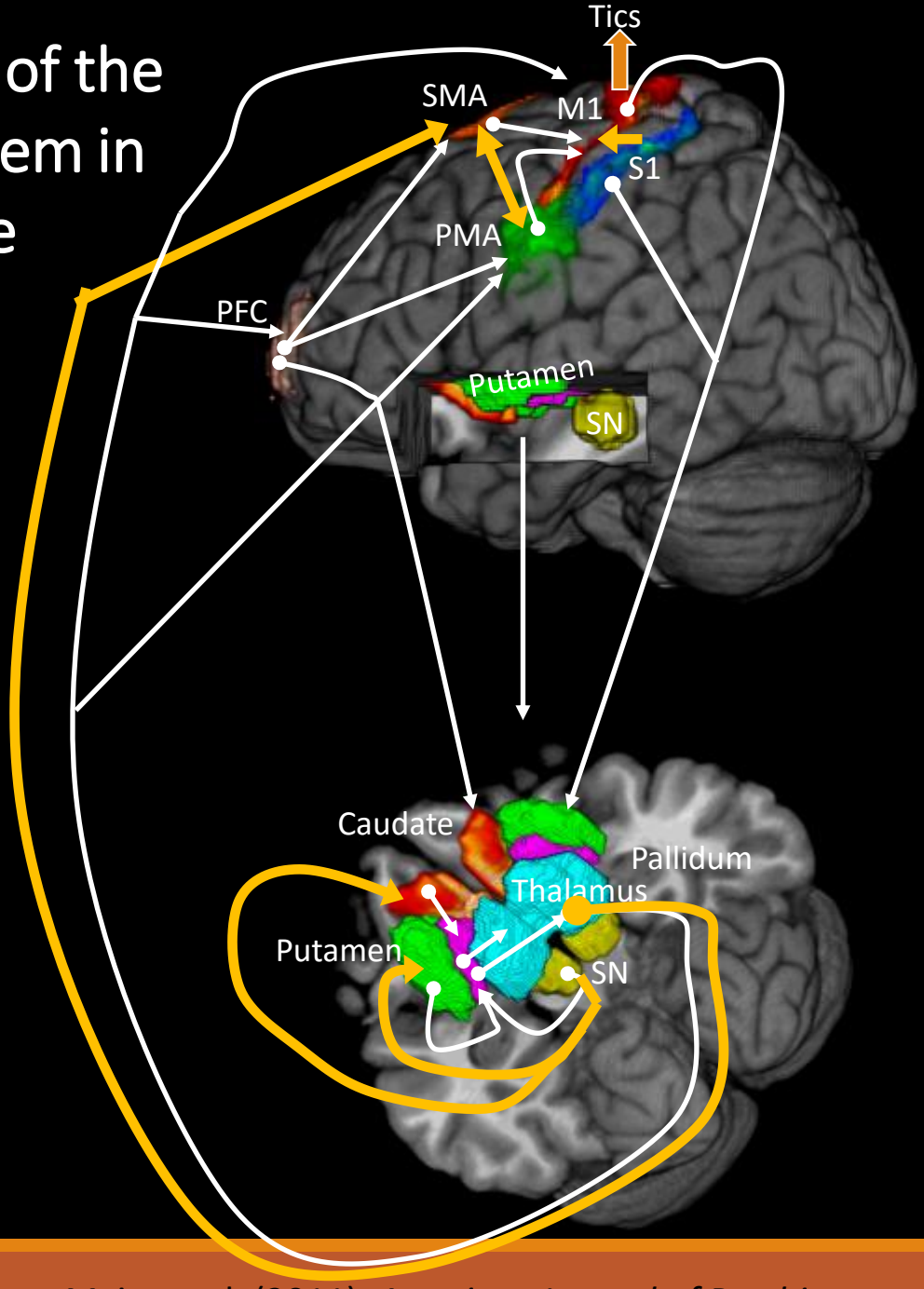
Sobel, Bansal, Maia, et al. (2010), *American Journal of Psychiatry*

Hyperactivity in the Dopaminergic System in Tourette Syndrome



Wang, Maia, et al. (2011), *American Journal of Psychiatry*

Hyperconnectivity of the Dopaminergic System in Tourette Syndrome



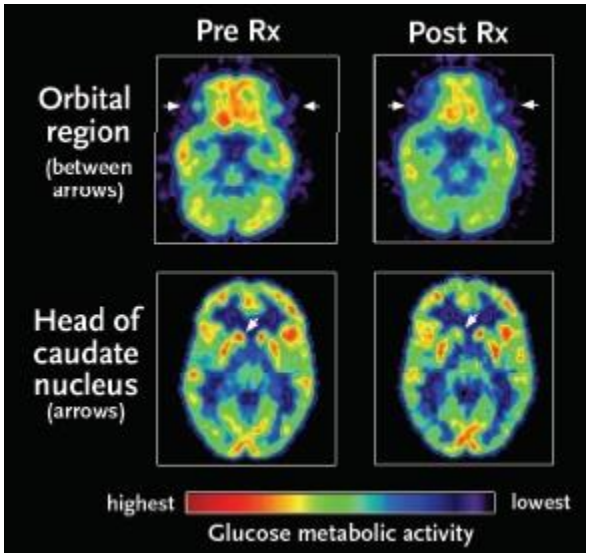
Wang, Maia, et al. (2011), *American Journal of Psychiatry*

Limitations of Brain Imaging

Serotonin in OCD

Pharmacological treatment of OCD:

- Selective serotonin reuptake inhibitors
- Clomipramine (also serotonin reuptake inhibitor)



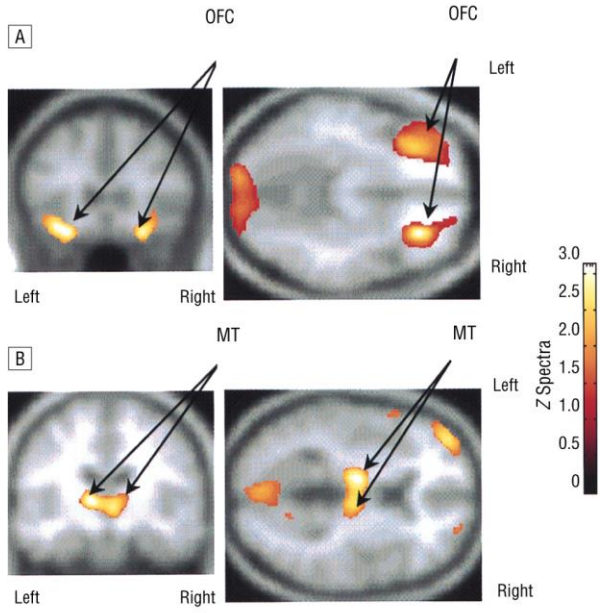
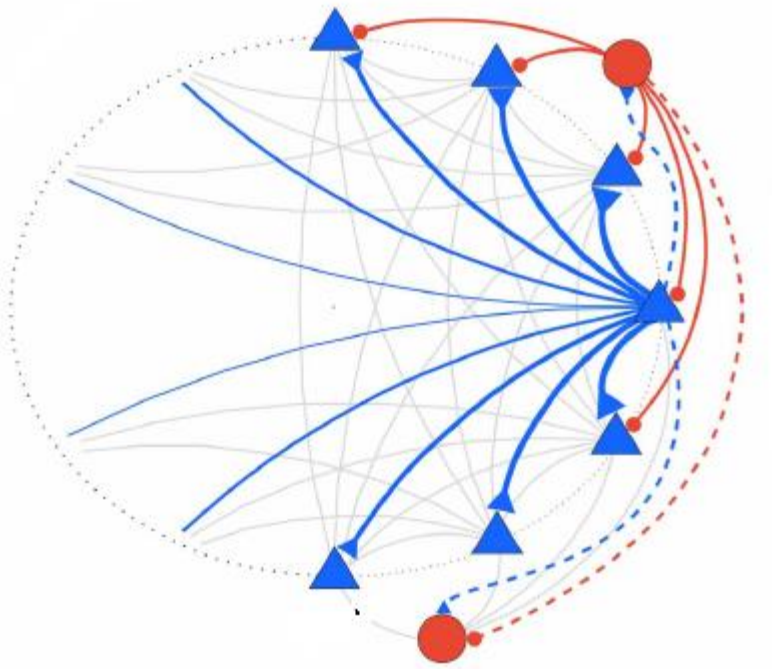
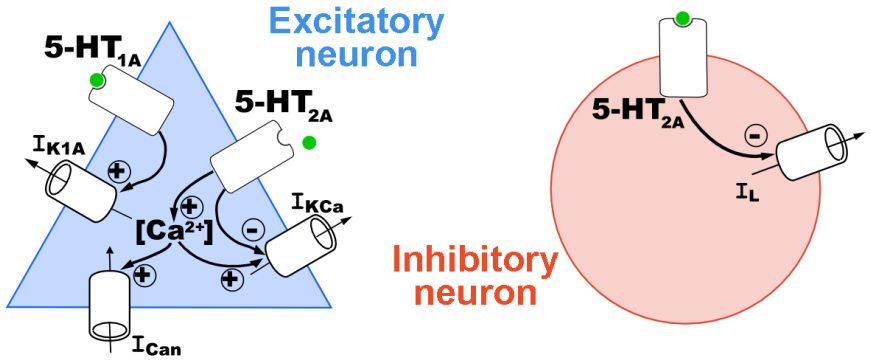


Figure from Saxena et al. (2002)

For review of neural findings in OCD: Maia et al. (2008), Development & Psychopathology

Computational Model

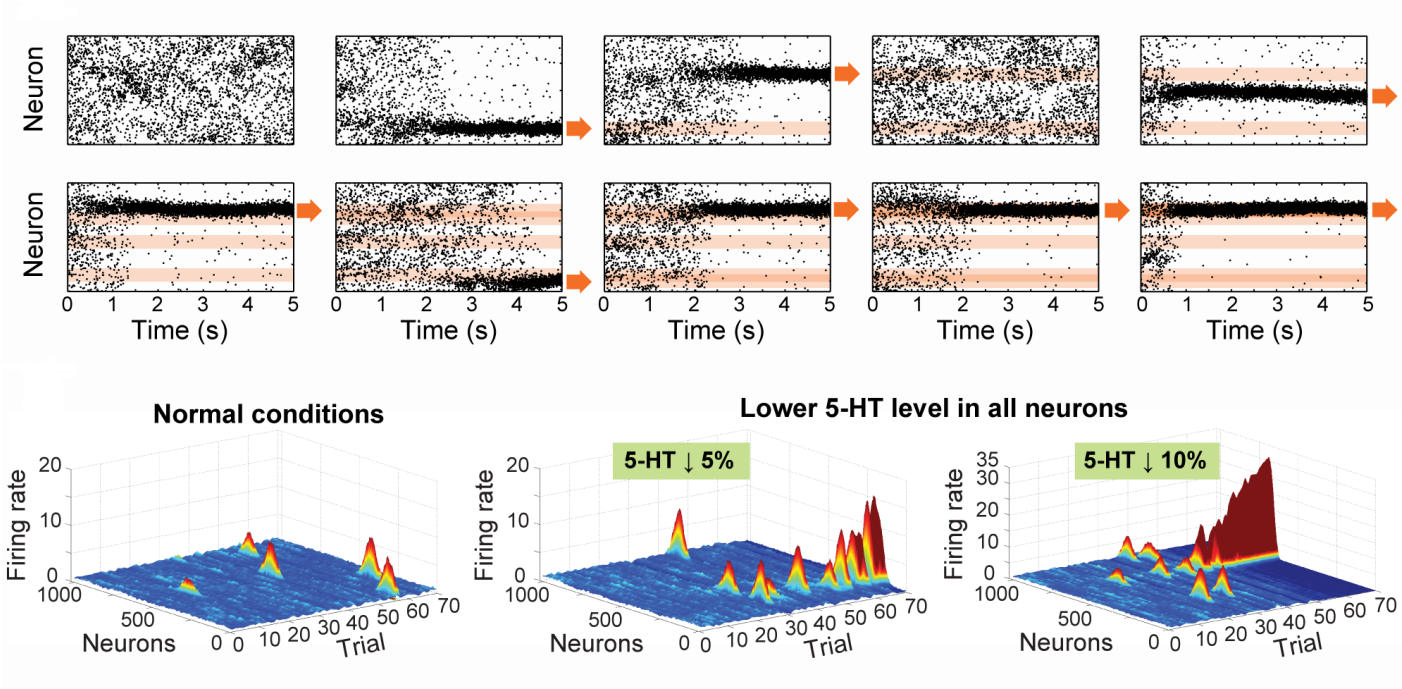




Biophysically detailed model

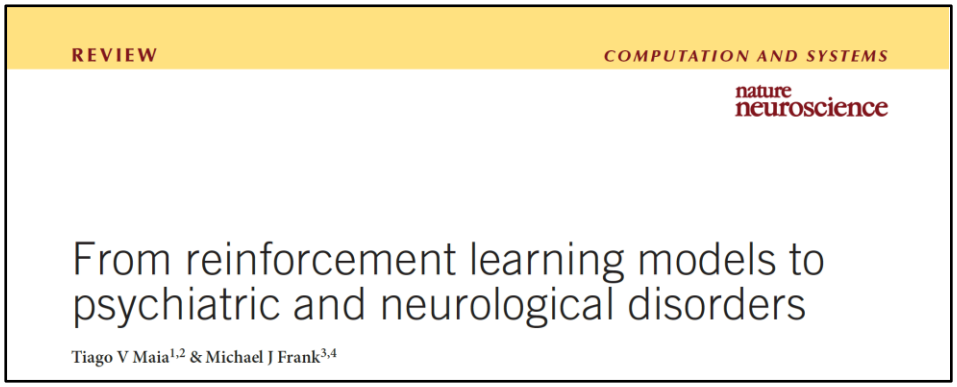
Manipulate (tonic) levels of serotonin

Low Serotonin Increases the Tendency to Develop Obsessions



Maia and Cano-Colino (2015), *Clinical Psychological Science*

Computational Psychiatry



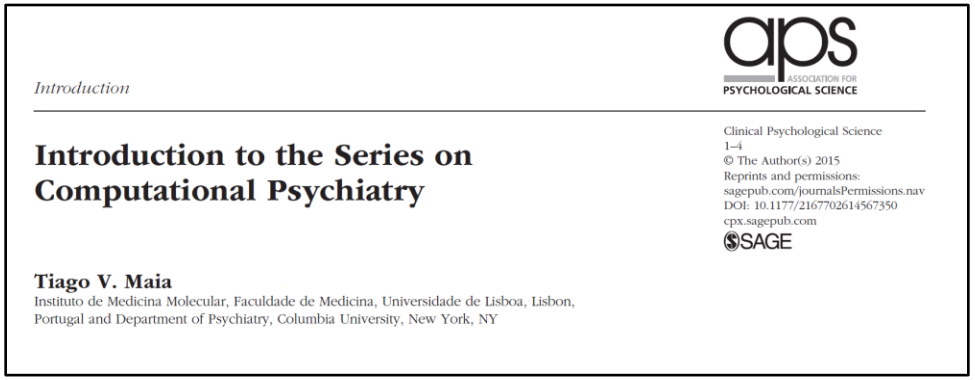
REVIEW

COMPUTATION AND SYSTEMS

nature neuroscience

From reinforcement learning models to psychiatric and neurological disorders

Tiago V Maia[1,2] & Michael J Frank[3,4]



Introduction

aps ASSOCIATION FOR PSYCHOLOGICAL SCIENCE

Introduction to the Series on Computational Psychiatry

Clinical Psychological Science
1–4
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DOI: 10.1177/2167702614567350
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Computational psychiatry as a bridge from neuroscience to clinical applications
Quentin Huys*, Tiago V. Maia*, and Michael Frank
*Authors contributed equally
Nature Neuroscience (in press)

Maia & Frank (2011), *Nature Neuroscience;* Maia (2015), *Clinical Psychological Science;* Huys*, Maia*, and Frank (in press), *Nature Neuroscience*

Detecting subgroups and making individual predictions

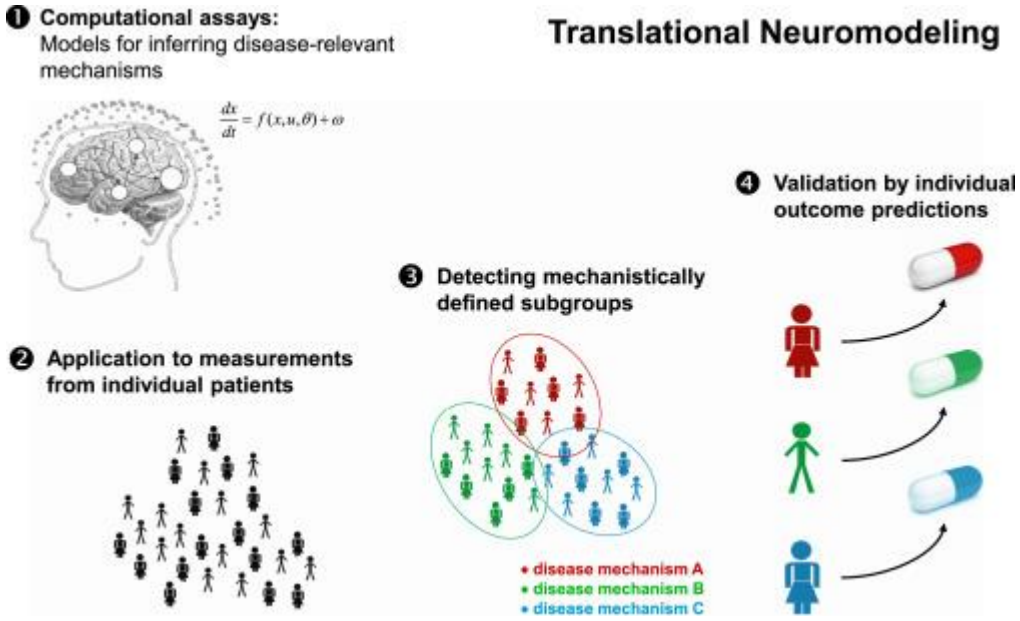

Figure from: Stephan et al. (2015), Neuron

Take-Home Message

Understanding psychiatric disorders:

- Tremendous social impact
- Needs a highly interdisciplinary approach
- Excellent area for synergies between schools
  - Faculdade de Medicina/Instituto de Medicina Molecular
  - Instituto Superior Técnico
  - Faculdade de Psicologia
  - Faculdade de Ciências
  - Faculdade de Farmácia

But requires 4 things:

1. Equipment
2. Equipment
3. Equipment
4. Equipment

Collaborators

IMM/FMUL/ULisboa

Postdoctoral Fellows

- Lena Ernst
- Maria Cano-Colino (now at Champalimaud)

Ph.D. Students

- Ana Portêlo
- Andreia Leitão
- Ângelo Dias
- Catarina Farinha
- Vasco Conceição
- Gabriela Ribeiro (with Albino Maia)

Masters Students

- Inês Ana
- João Abreu
- Rita Belo
- Tiago Henriques

Columbia University

- Guillermo Horga, Assistant Professor
- Rachel Marsh, Associate Professor
- Jonathan Posner, Assistant Professor
- Zhishun Wang, Research Scientist
- Loren Sobel

Brown University

- Michael Frank, Professor

Univ. Southern California

- Bradley Peterson, Professor & Director of Institute for the Developing Mind

ETH Zurich

- Klaas Stephan, Professor & Director of Translational Neuromodeling Unit
- Quentin Huys, Senior Research Fellow
- Frederike Petzschner, Postdoctoral Fellow