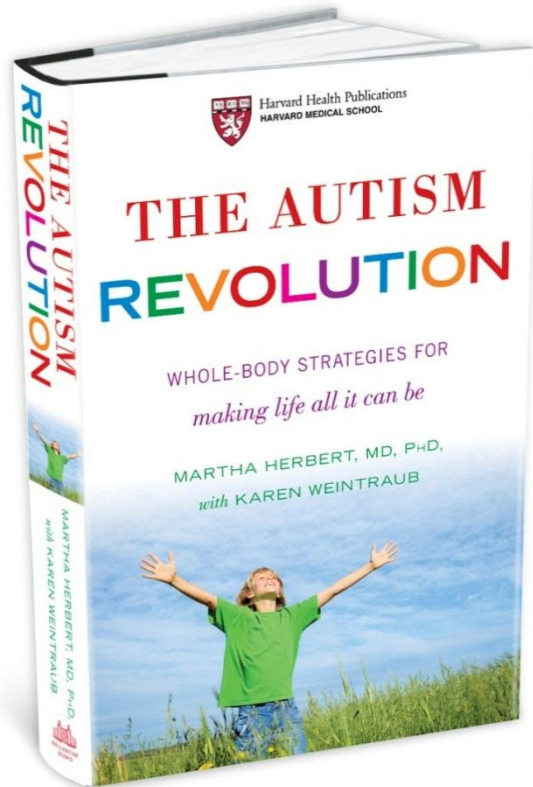


Systems biology of autism told through stories of people who got a lot better:

The Autism Revolution:

Whole Body Strategies for Making Life All It Can Be
Ballantine – Harvard Health Publications, 2012

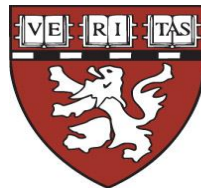


Martha Herbert, MD, PhD
www.marthahebert.com

TRANSCEND Research Program
www.transcendresearch.org

Pediatric Neurology

Martinos Center for Biomedical Imaging
Massachusetts General Hospital
Harvard Medical School



www.AutismRevolution.org

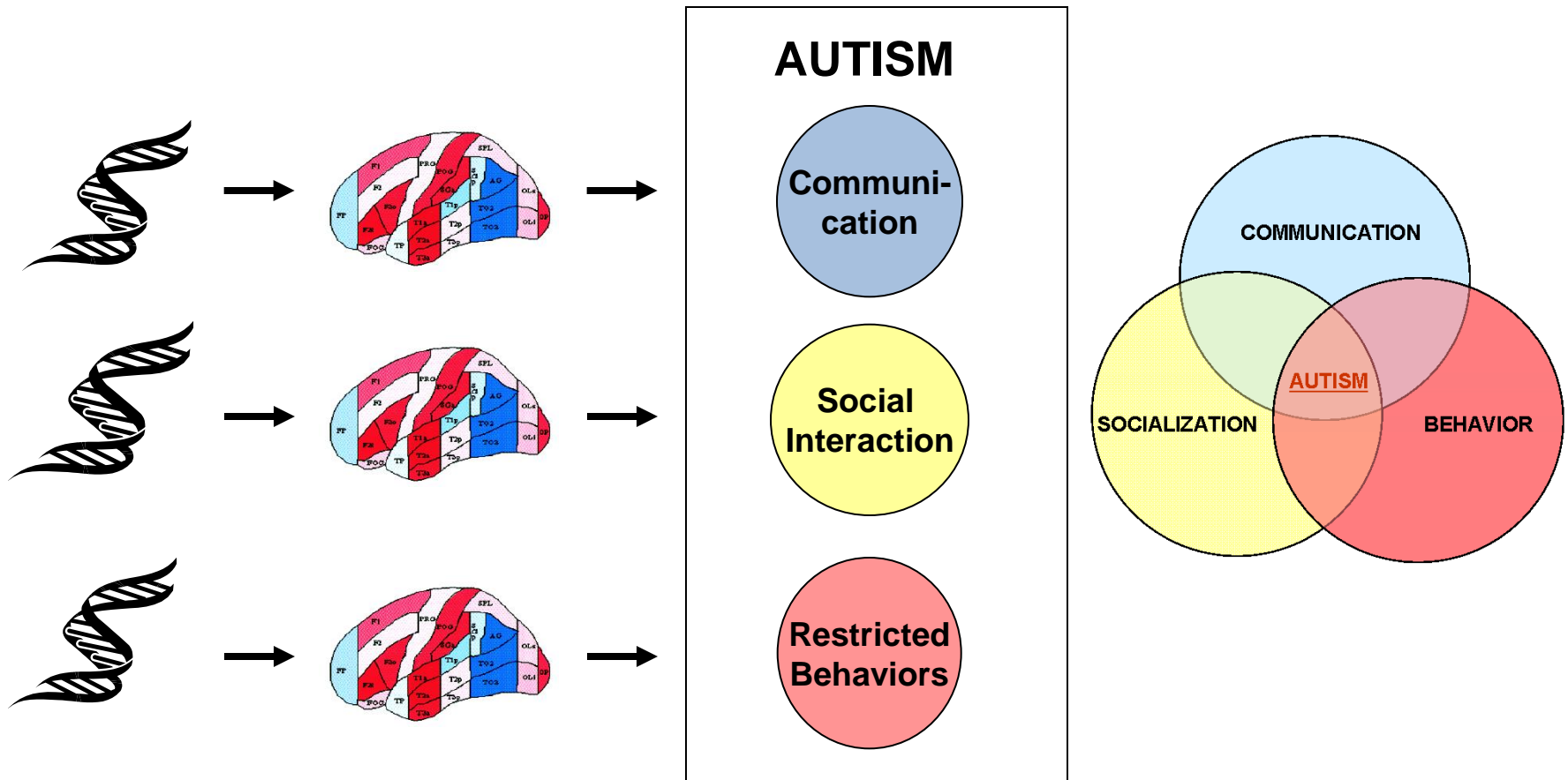
www.autismWHYandHOW.org

“LEGO” Modular Model:

Gene \rightarrow Brain \rightarrow Behavior

Determined before birth, fixed for life

Nothing you can do

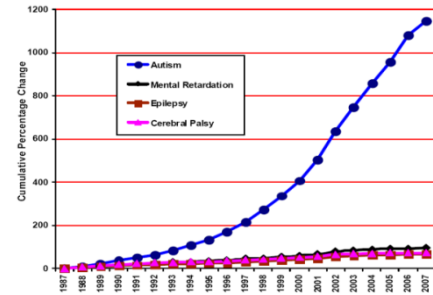


New model – an Autism Revolution:

From genetic brain impairment to environmental, medical obstruction of brain function

Not just genetic:

- *Hundreds of genes, most modest impact*
- *Numbers going up*
- *Evidence for environmental factors*



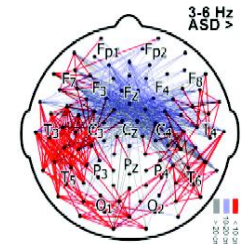
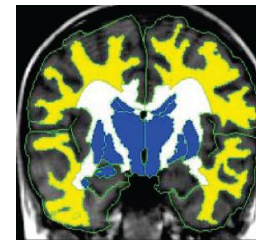
Not just brain:

- *Systemic features – Whole Body*
- *Environmentally vulnerable physiology*



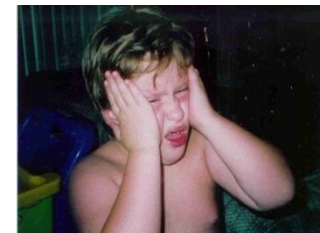
Not just brain modules:

- *Whole brain involvement*
- *Brain tissue changes*

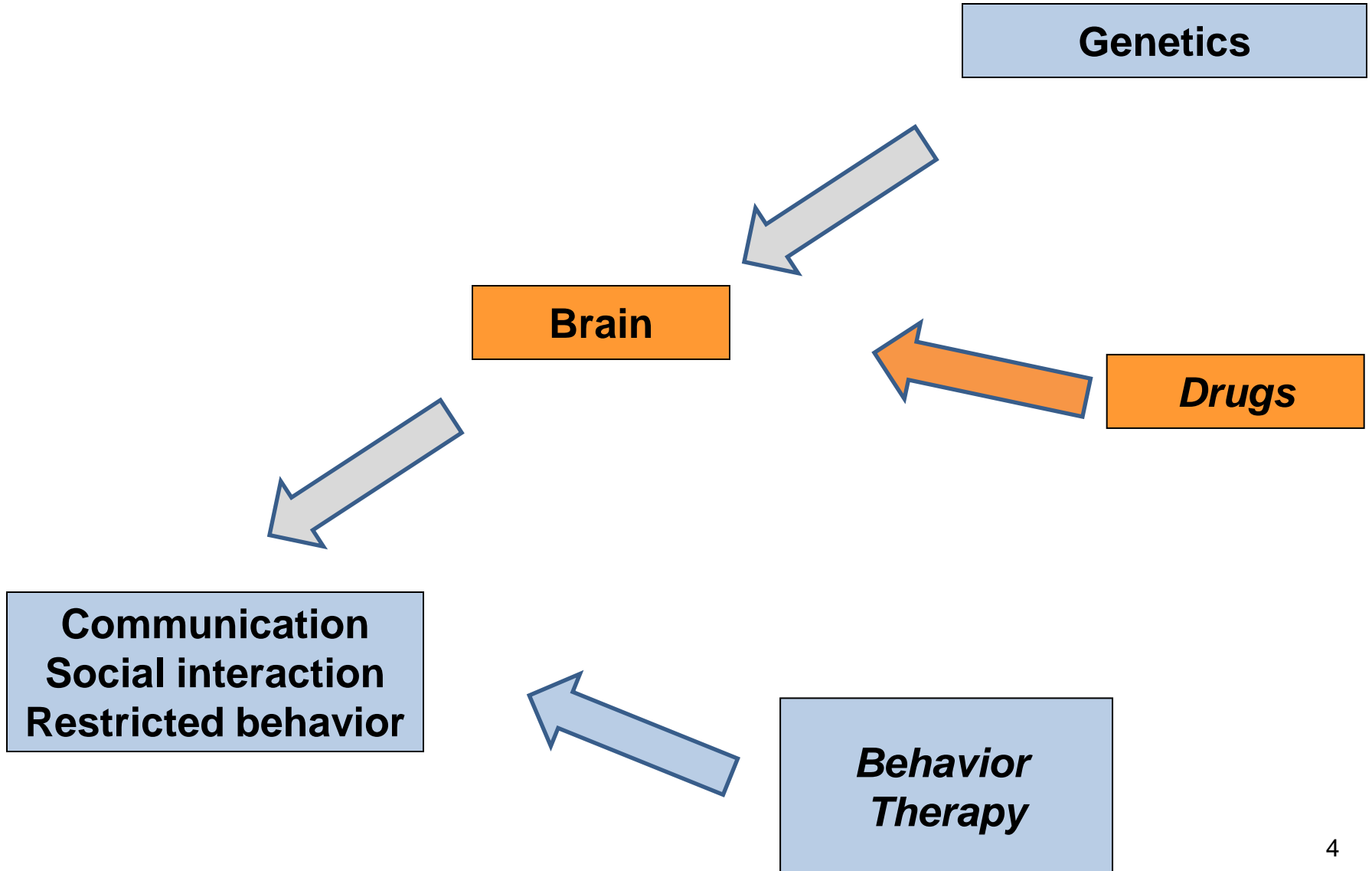


Not necessarily hardwired:

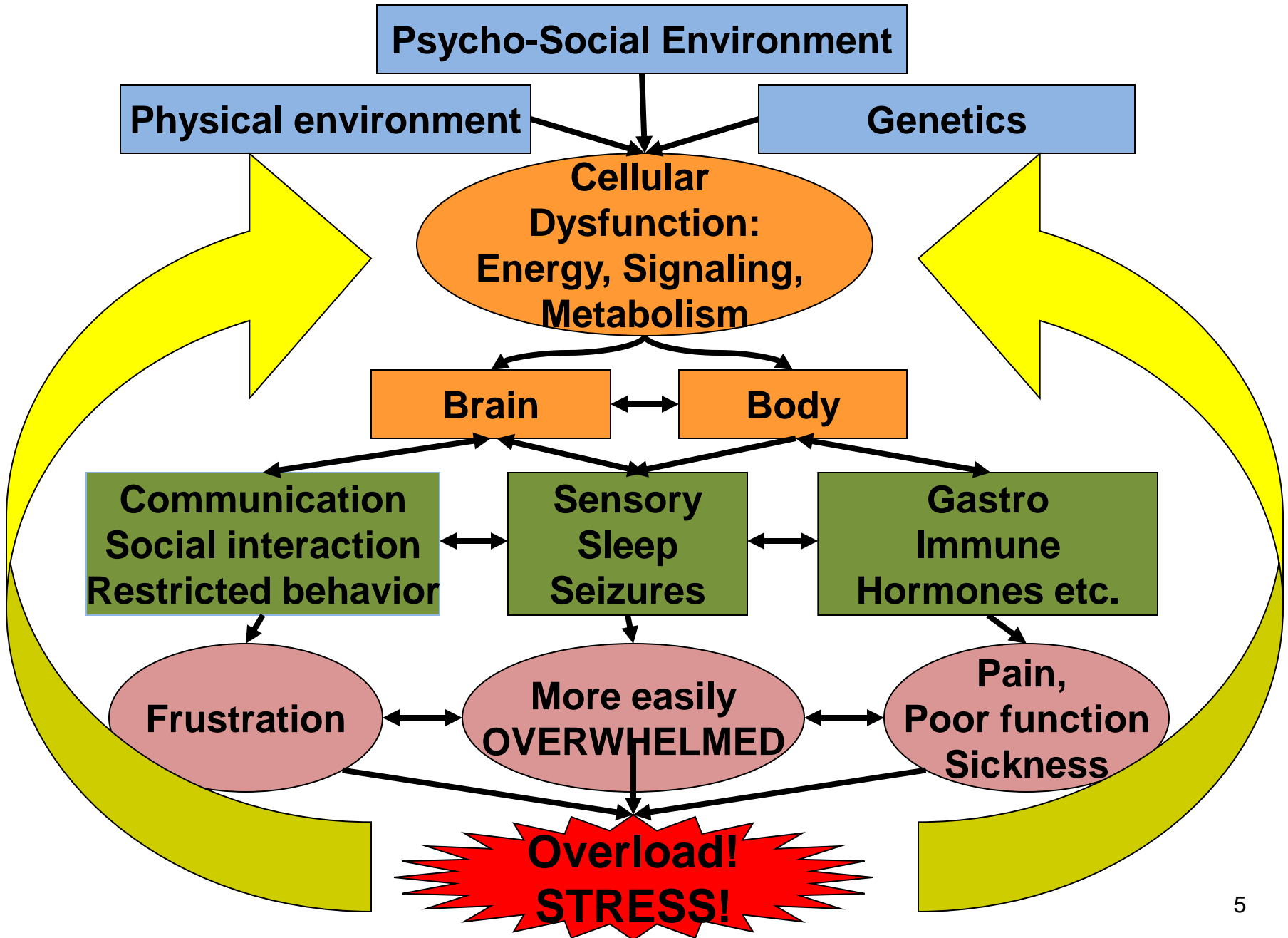
- *Plasticity and recovery*



Gene → Brain → Behavior model



Whole Body Systems Model: Vicious circles in brain and body

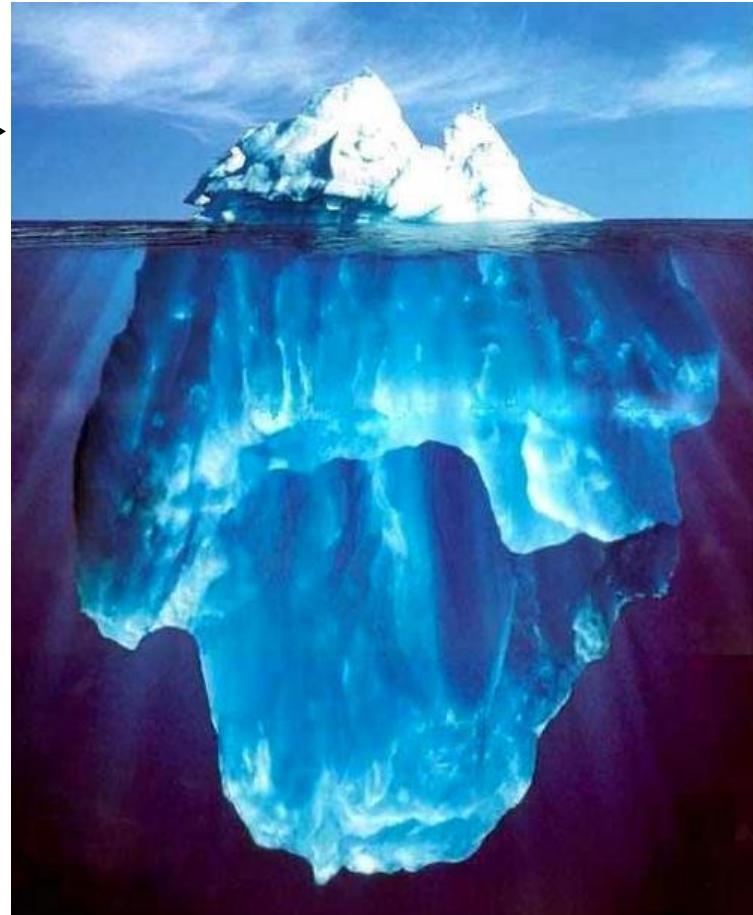


Autism's Symptoms Emerge from Problems with Underlying Functions

**VISIBLE Social
& Behavioral
SYMPTOMS**



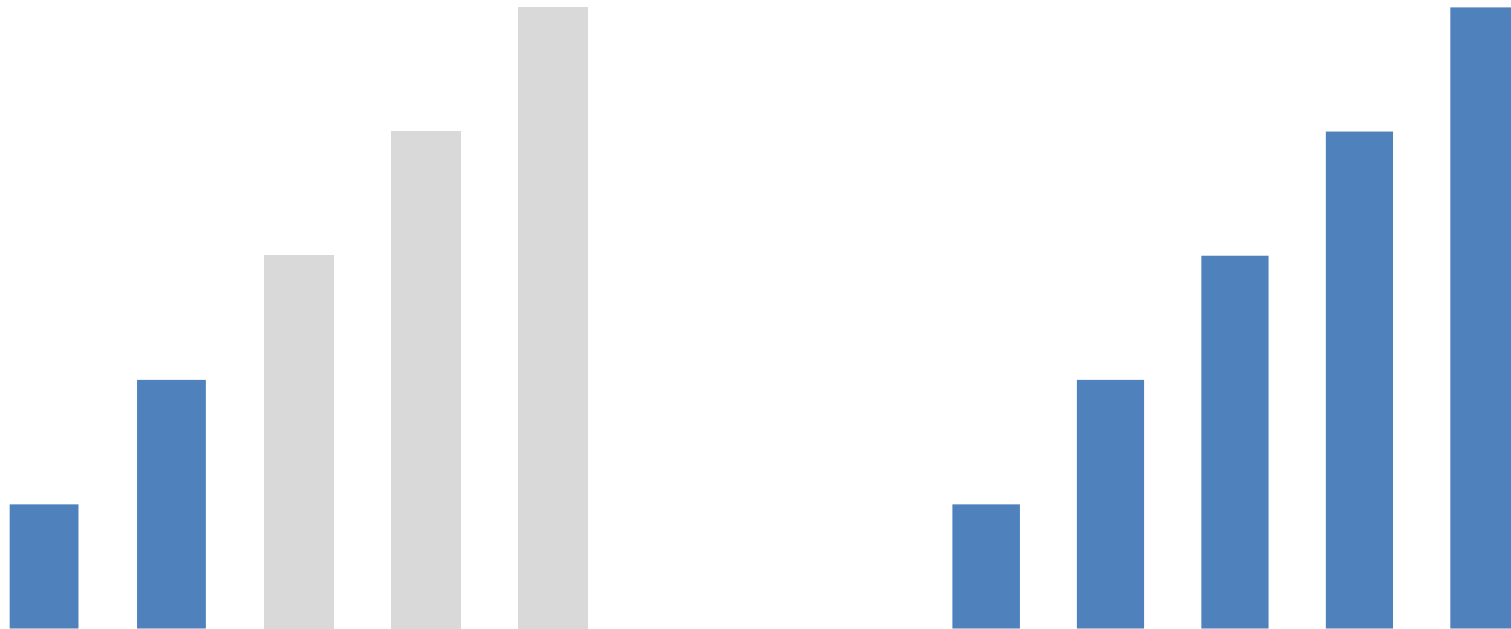
**UNDERLYING
SYSTEMIC
FUNCTIONAL
DISTURBANCES**



Reduce *Total Load* of Stressors to get Better Health, that will give Brains more “Bandwidth”

Poor Bandwidth:
Limited Reception

Lots of Bandwidth:
Good Reception



Better Reception Allows Better Discernment of Differences and More Spontaneous Learning

Is autism is really a hard-wired defect?

Research and clinical observations suggest otherwise:

- **Published transient improvement with fever**
 - Reports of improvement under various other circumstances
- **Documented recovery / remission in some cases**
- **Reversal of symptoms in autism-relevant animal models**

HOW CAN THE BRAIN IMPROVE LIKE THIS?

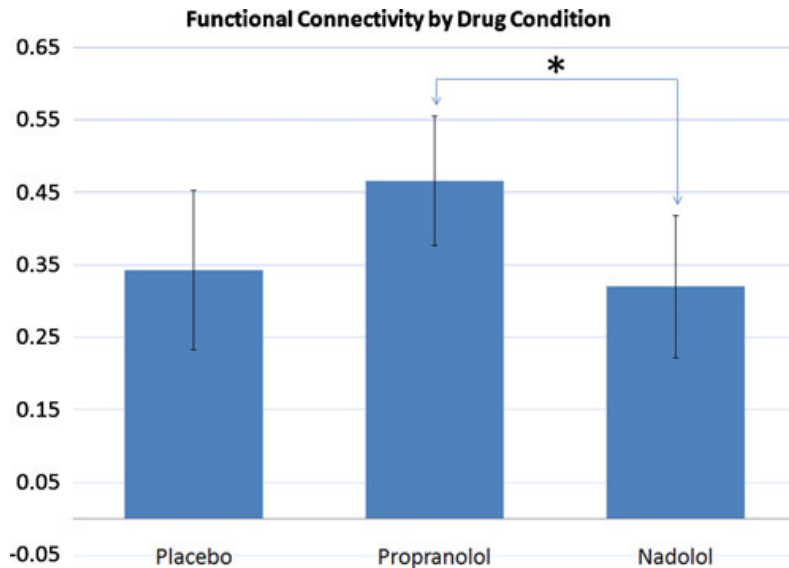
WHAT IS THIS TELLING US ABOUT AUTISM??

Hypothesis: ASD is

→ Not fixed but changeable

→ Not a STATIC but a DYNAMIC encephalopathy

Rapid IMPROVEMENT in brain connectivity suggests autism may be “state,” not “trait”



- Functional connectivity changed rapidly with drug that impacts brain stress level (propranolol)
- Most research assumes it is a fixed trait
- *Could other interventions reducing total load also decrease stress and improve brain function?*

Effect of Propranolol on Functional Connectivity in Autism Spectrum Disorder—
A Pilot Study

Narayanan et al. (Beverdors lab)
Brain Imaging and Behavior, 2010

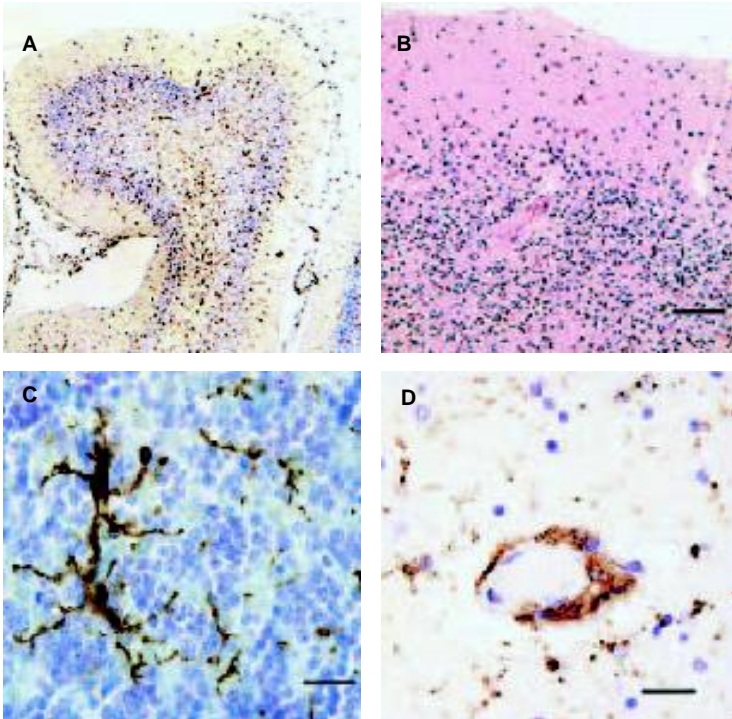
More than “genetically altered wiring diagram”: Brain tissue shows signs of immune activation or “neuroinflammation.”

Neuroglial activation and neuroinflammation in the brain of patients with autism

Vargas et al, 2005, Annals of Neurology

Oxidative stress in brain tissues from autistic patients

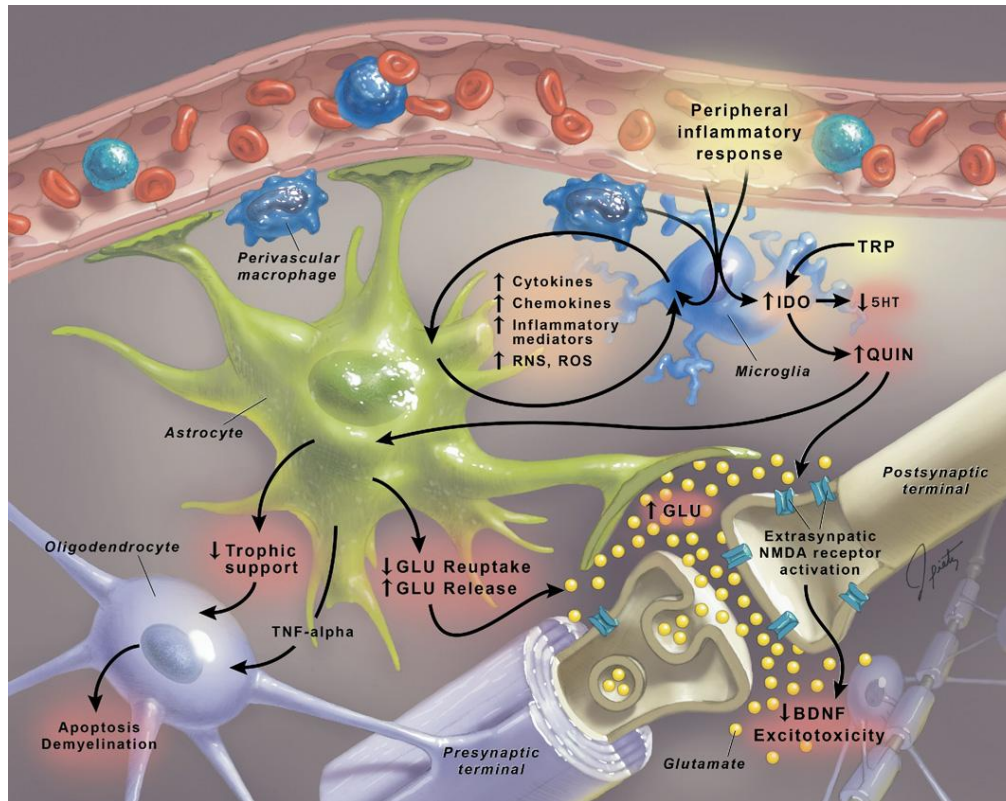
Vargas et al, 2005, Annals of Neurology



ACTIVATED GLIAL CELLS

- **Activated ASTROGLIAL cells (astrocytes)**
- **Activated MICROGLIAL CELLS**

Brain cells in inflammation



- Excitatory chemicals created by activated glial cells
- Normal housekeeping and communication functions of glial cells get neglected or overwhelmed
- Glial cells are the brain's "garbage collectors" so trash and debris pile up
- Chronic inflammation can cause damage
- Chronic inflammation is irritating and promotes excitotoxicity
- Early immune problems can alter development

Inflammation and Its Discontents: The Role of Cytokines in the Pathophysiology of Major Depression.

Miller et al., BIOL PSYCHIATRY 2009;65:732-741

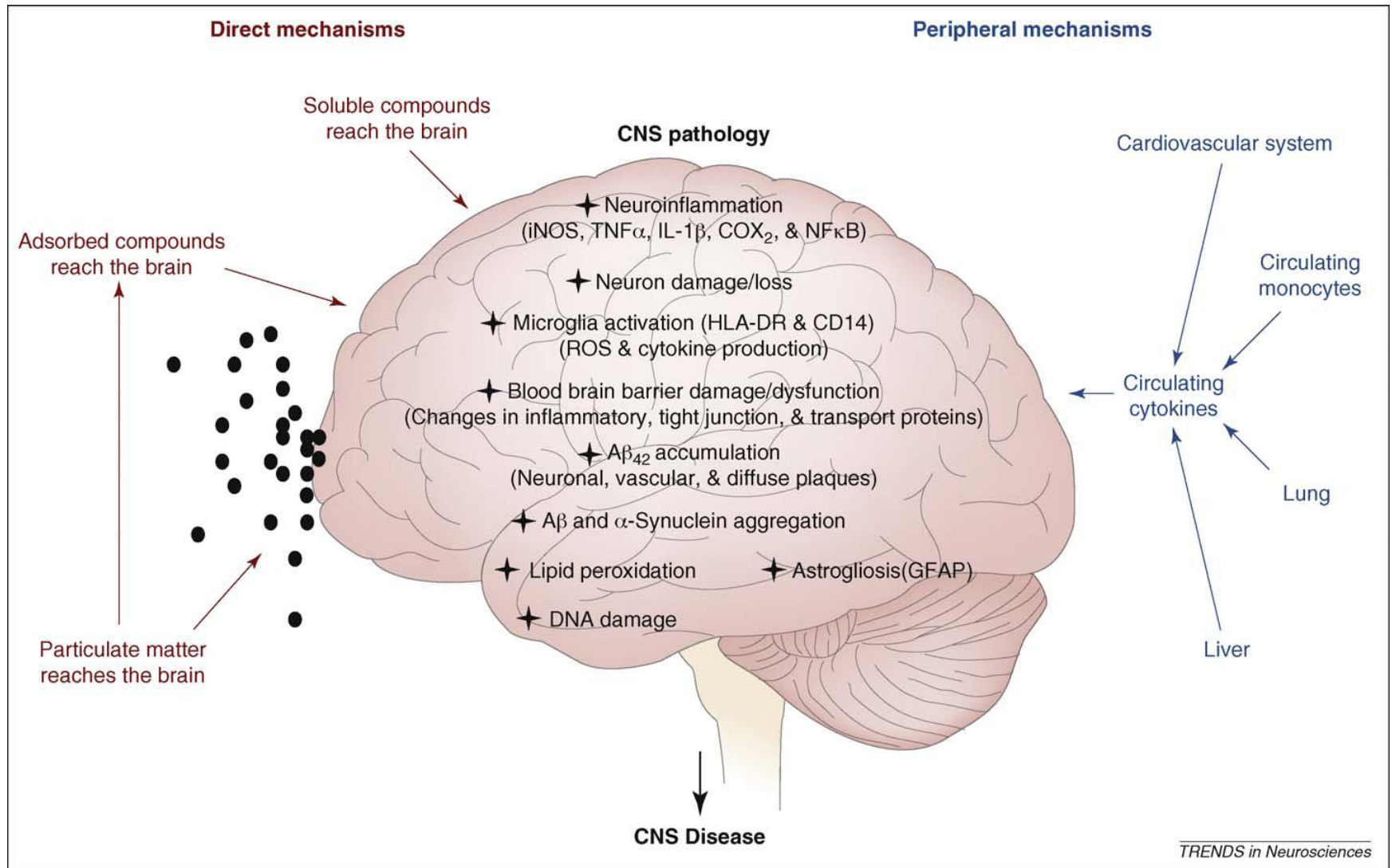
Full text available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2680424/?tool=pubmed>

Air Pollution and Brain Inflammation

Block and Calderon-Gardicuenas, *Trends in Neuroscience*, 2009

Air pollution already linked to autism

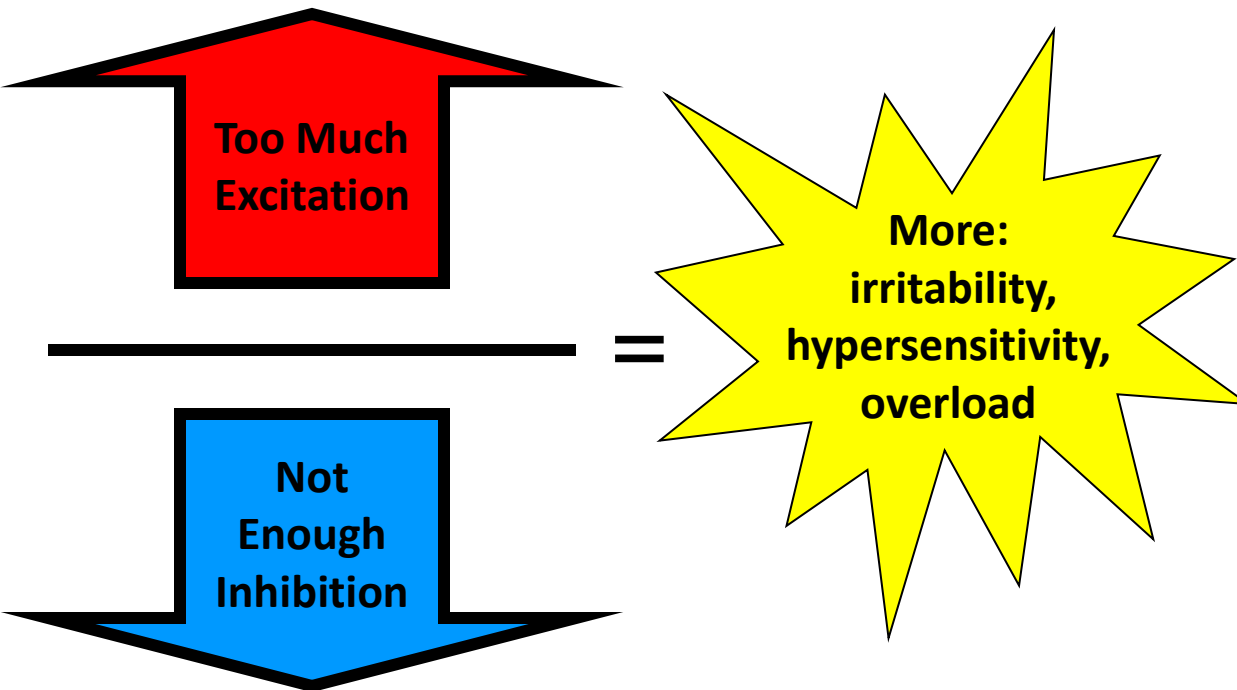
(e.g. Palmer 2006; Windham 2006; Volk 2011)



Environmental Stressors are contributing to an **ONGOING, CHRONIC** DEGRADATION OF BRAIN AND BODY **FUNCTION**

Model of autism: Increased ratio of excitation / inhibition in key neural systems

Rubenstein & Merzenich, *Genes, Brain and Behavior* (2003) 2: 255-267



Reduced informational complexity and organization

Reduced signal to noise ratio

Increased chaos and confusion

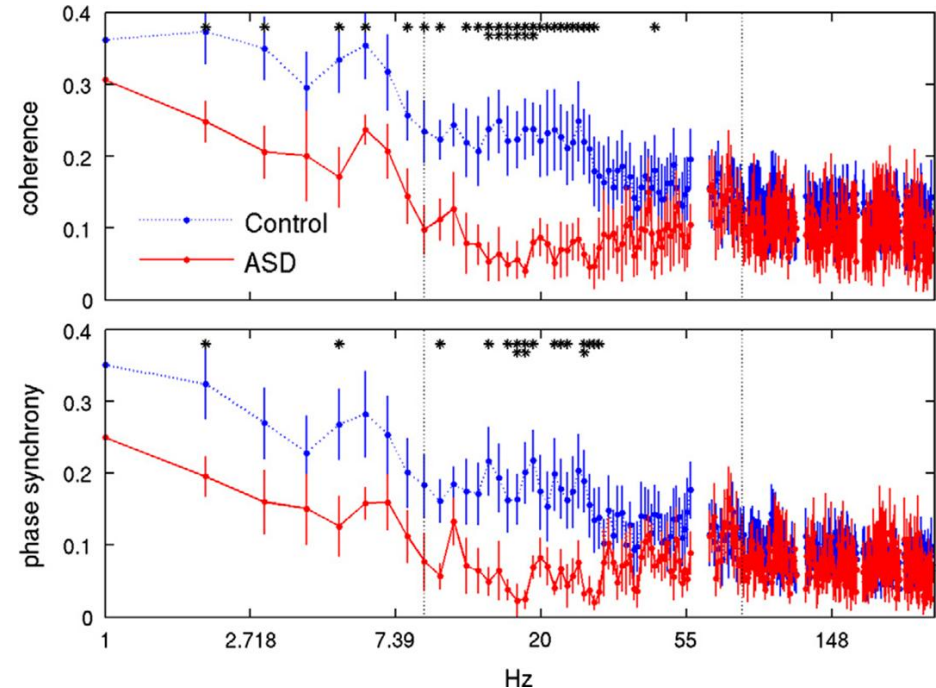
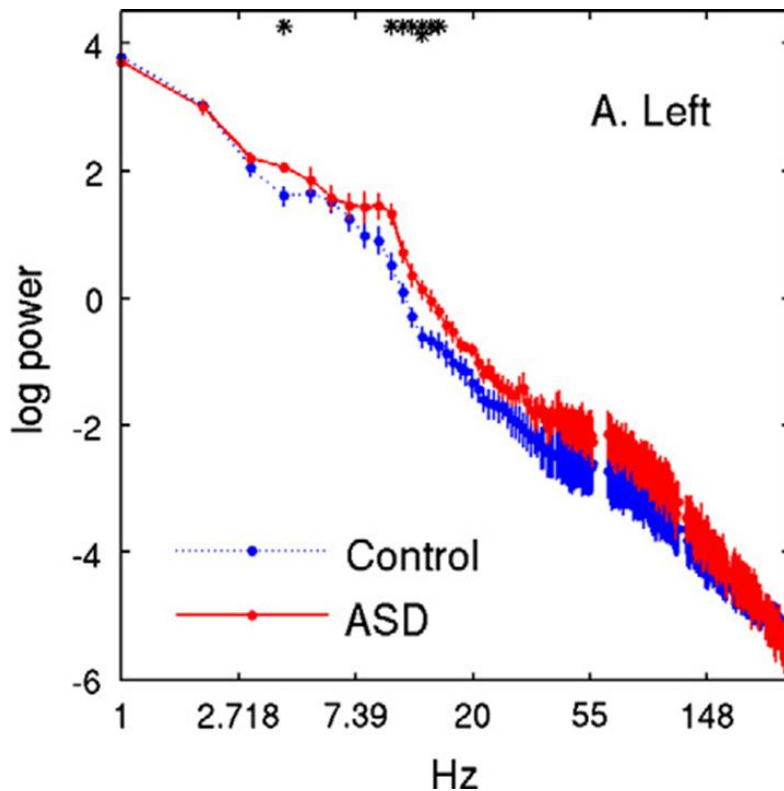
This excitation/inhibition ratio can be increased by inflammation, oxidative stress and toxicants, as well as genetic dysfunction



“Inefficiency” in brain signaling in autism

J.R. Isler, K.M. Martien, P.G. Grieve, R.I. Stark, M.R. Herbert
Clinical Neurophysiology 121 (2010) 2035–2043

ASD has more power than controls... but less coherence



Too much noise, not enough signal
BETTER BANDWIDTH SHOULD IMPROVE THIS

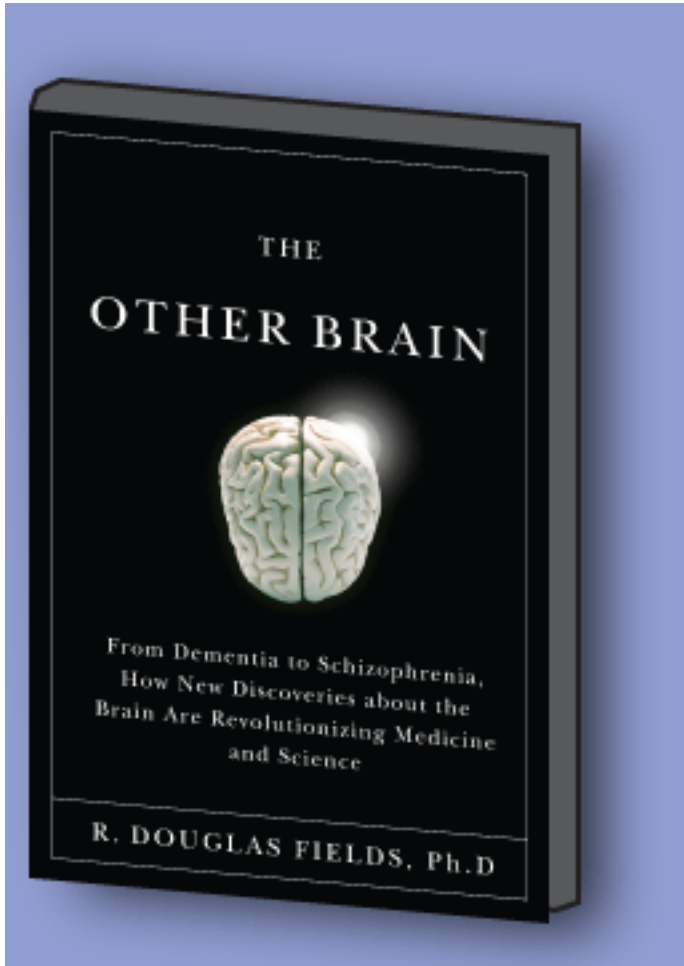
“Wild-type microglia arrest pathology in a mouse model of Rett syndrome”

Derecki et al, Nature, 2012

- Rett features had been attributed to neuronal dysfunction
- Astroglial cells now known to contribute
- **Now microglia shown to contribute as well:
bone marrow transplant of wild type microglia**
 - Increased lifespan, normalized breathing, increased body weight, improved locomotor activity
 - *Improvement even without direct change to neurons*
 - **Improvements lost when microglial phagocytic (garbage-collecting) activity inhibited**

THE OTHER BRAIN

by Douglas Fields, PhD, NIH scientist



ABOUT GLIAL CELLS

www.TheOtherBrainBook.com

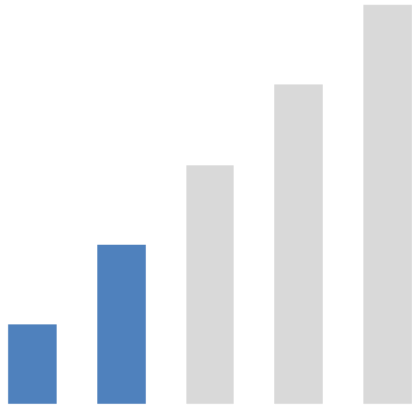
A top glial scientist explains to the public how glial cells are revolutionizing medicine and science

A Different Model of Autism:

*Autism as an **emergent property** of a system with altered parameters*

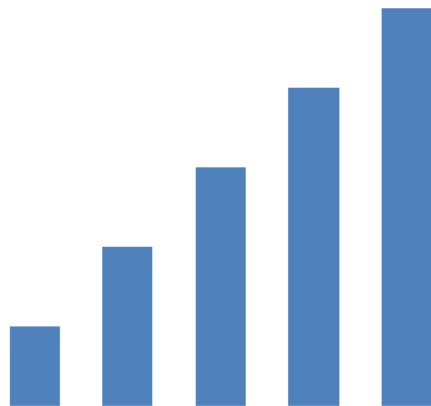
- Autism is not just a “developmental disorder” that’s hardwired into the brain before you’re born
- Autism is **created moment by moment** by **how the cells in the brain function**
- The cells of the brain function differently depending on their health
- The health of brain cells depends on the health of the whole body – and on the health of the earth

RECIPE for improvement: The basis for an AGGRESSIVE PUBLIC HEALTH PROGRAM



POOR BANDWIDTH, LOTS OF CHAOS

- Poor food: few nutrients, many allergens
- Lots of toxins and infectious issues
- Lots of stress, pressure, too much too fast



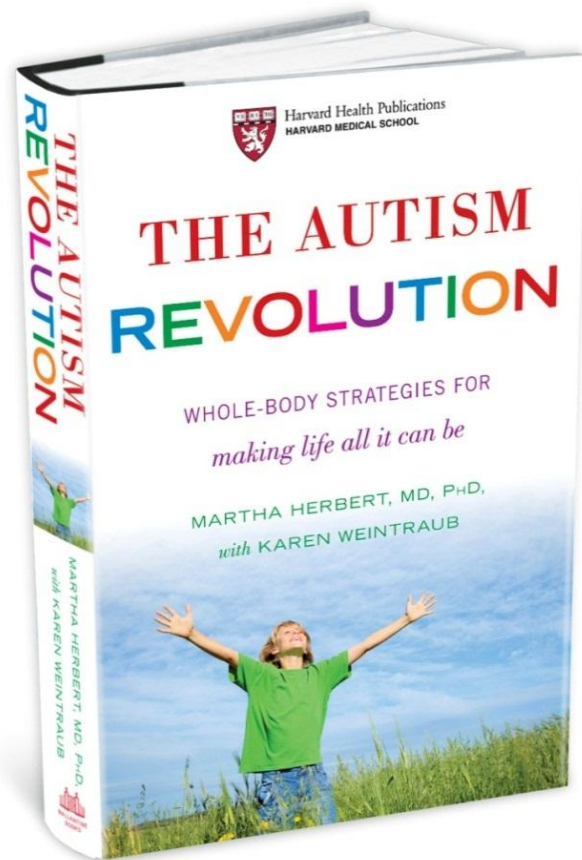
GOOD BANDWIDTH, RICH ORGANIZATION

- Excellent food: high nutrient density, minimal allergens
- Minimal toxic and infectious burden
- Love, learning, respect, sensitive sensory input, savor each moment

The Autism Revolution:

Whole Body Strategies for Making Life All It Can Be

Ballantine – Harvard Health Publications, 2012



**We all need an
AUTISM
REVOLUTION.**



www.AutismRevolution.org

www.transcendresearch.org

www.autismWHYandHOW.org

www.marthaherbert.com