# Eating Disorders and The Brain: How Does Neurobiology of Eating Disorders Inform Treatment?

Mark Warren, MD, MPH, FAED

Chief Medical Officer

The Emily Program

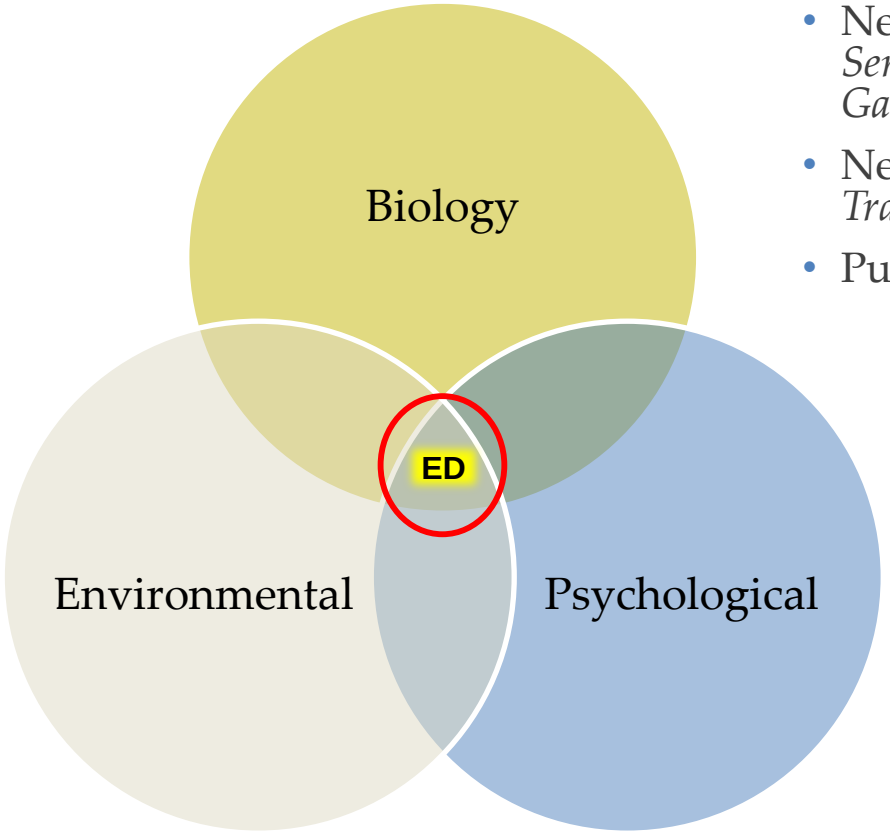
Minnesota, Ohio, Pennsylvania, and Washington

# Learning Objectives

- Become familiar with the biopsychosocial model for understanding the treatment of eating disorders.
- Understand the need for early recognition of these disorders and the need to restore physiologic stability early in the course of treatment
- Know how to anticipate the medical consequences of eating disorders.

# Eating disorders are biologically based brain illnesses influenced by environmental and psychological factors

## Bio-Psychosocial Model of Eating Disorders




BIOLOGICAL INFLUENCES

- Dieting/Food exposure
- Genetics
- Neurochemistry: *Serotonin, Dopamine, Opioid, Gaba*
- Neurobiology: *Temperament, Traits*
- Puberty/Menopause

ENVIRONMENTAL FACTORS

- Weight/appearance pressures
- Media messages
- Weight comments/teasing

PSYCHOLOGICAL FACTORS

- Stressors/coping
- Transitions
- Identity/self-image
- Trauma
- Anxiety, depression
- Substance use

# What Leads to an Eating Disorder Doesn't Always Maintain It

- **Risk factors** predispose some people
  - Genetics/Neurobiology
  - Trauma
  - Social influences (e.g., thinness ideal, weight teasing)
- **Precipitating factors** trigger risk factors
  - Dieting or significantly changing the way one eats
  - Stressful life events/transitions
- **Maintenance factors** take over
  - Biological changes that occur as a result of the eating disorder behaviors
  - Psychological factors that are connected to the eating disorder behaviors influence repetitive behaviors

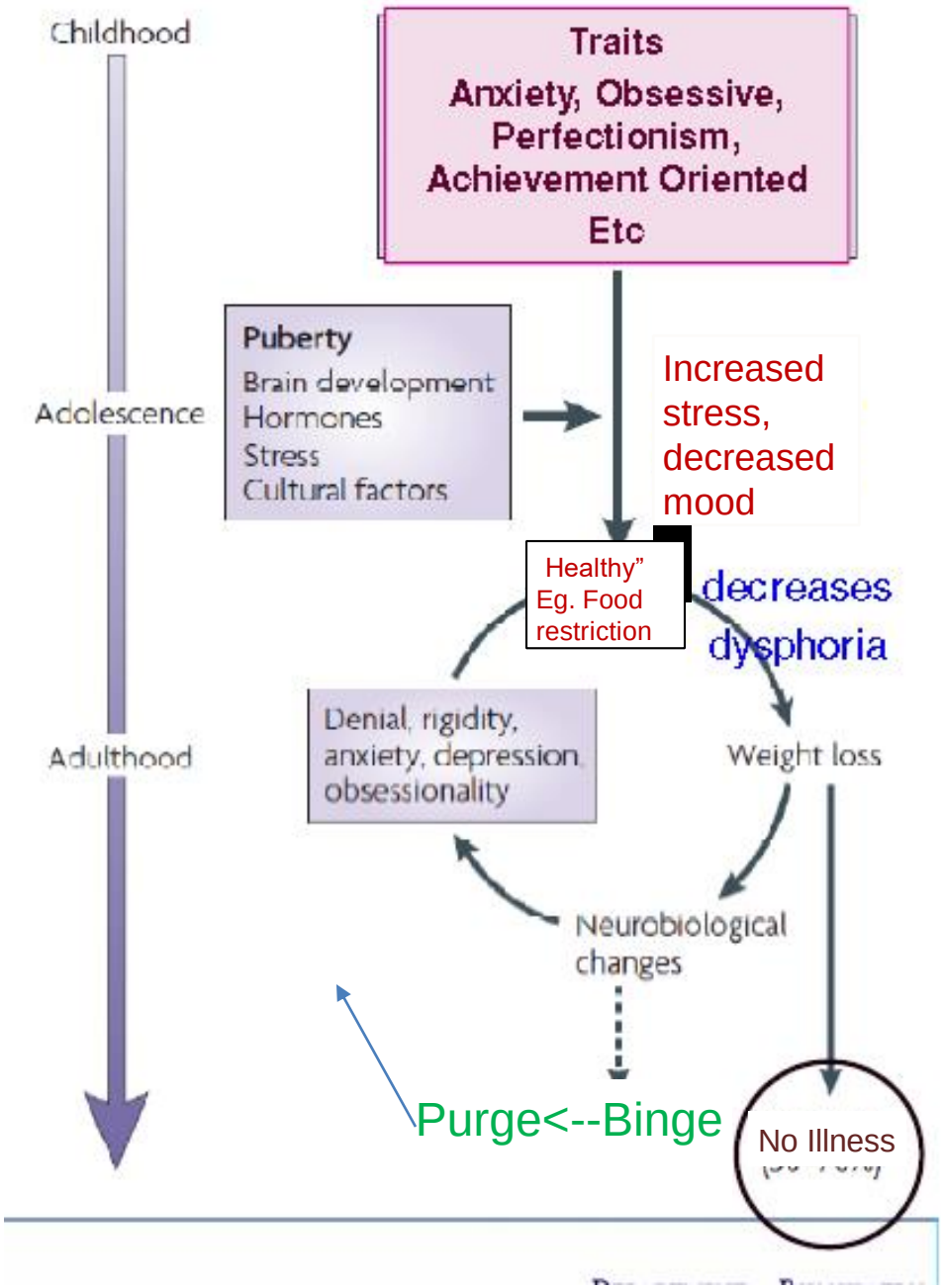
# But why do only some people get eating disorders?

- Many people diet/restrict/limit eating/overeat
- Many people have environmental and psychological risk factors
- Relatively few develop an ED
- Are there susceptibility factors that make some people vulnerable to dieting, weight loss, overeating?
- “Where” are these factors?
- How are they “triggered”?

# The Key Facts

- All Eating Disorders Restrict
- All people with an ED are Starving
- This is true regardless of ED diagnosis
- Most research on AN
- We can utilize it for other ED because people with BN, BED, OSFED and ARFID are all in starvation mode as well

# Eating Disorders and Development



# Biologic Vulnerabilites

- Family studies – 7 to 12 fold increase in prevalence of A.N. and B.N. in relatives of eating disorders compared to control families.
- High heritability in twin studies - The concordance for AN in monozygotic twins is approximately 10X greater than for dizygotic twins
- There is likely a genetic contribution to temperamental / personality vulnerabilities

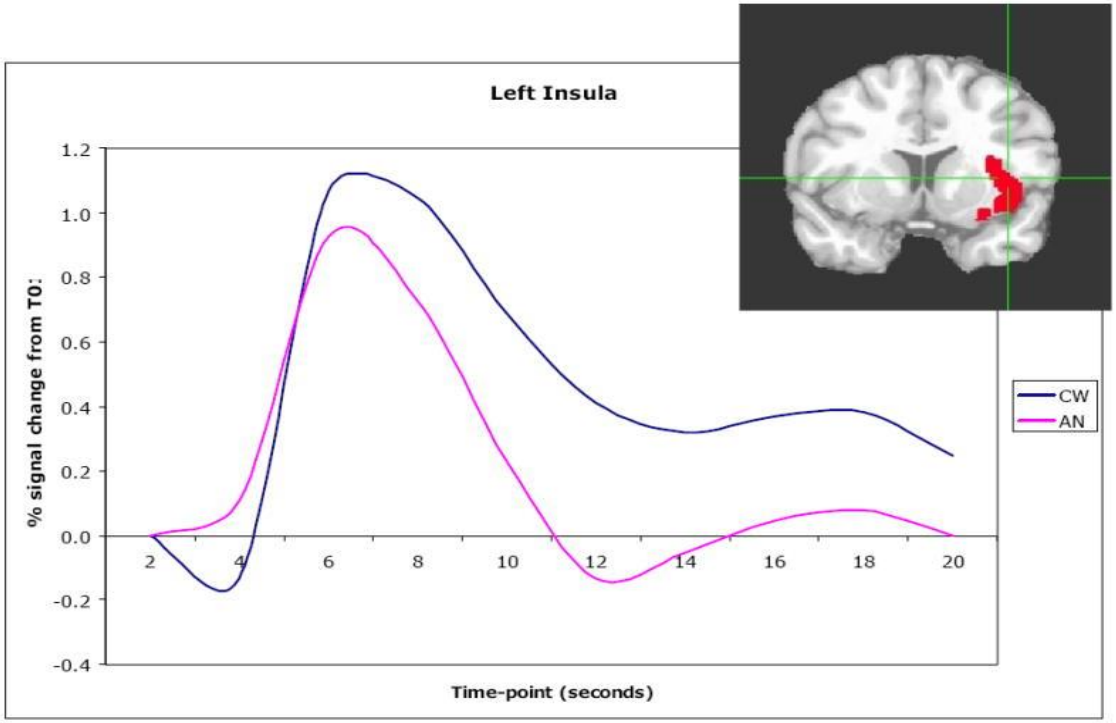
# Genetics, Heritability estimates

- Genetic contribution accounts for:
  - 58% - 76% of the variance in AN
    (Klump et al, 2001; Wade et al 2000)
  - 54% - 83% of the variance in BN
    (Bulik et al, 1998; Kendler et al 1991)
- These heritability estimates are in line with those of Major Depression, Bipolar Disorder and Schizophrenia
- Heritability estimate for breast CA is about 27% (Lichtenstein, 2000)

# Altered Neural Circuit Function in AN?

- Premorbid temperament, personality
  - Stice 2002, Anderluh 2003, Connan 2003, Lilenfeld 2006, Kaye 2009
- Altered reward, anxiety
  - Kaye 2004, Cassin 2005, Wagner 2007, Harrison 2010, Jappe 2011
- Altered 5 HT and DA function and neurotransmitter circuits
  - Kaye 1999, 2008, Lawrence 2003, Frank 2005, Bergen 2005, Friederich, 2006, Wagner 2007
- Altered Interoceptive Processing/ Altered Insula Function

# Altered Insula Response to Taste in AN - R




Coronal view of left insula ROI (x=-41, y=5, z=5). Time course of BOLD signal as a mean of all 16 recovered restricting-type anorexia nervosa and 16 control women for taste-related (sucrose and water) response in the left insula.

# Biologic Precipitating Factors

- Genetics
  - Strober 2000, Lilenfeld 1998
- Premorbid temperament, personality
  - Stice 2002, Anderluh 2003, Connan 2003, Lilenfeld 2006, Kaye 2009
- Altered reward, anxiety
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- Altered 5 HT and DA function and neurotransmitter circuits
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- Altered Interoceptive Processing/ Altered Insula Function
  - Wagner 2008, Nunn 2008

# Dopamine function and motivation/behavior

- DA cell fires in response to salient environmental stimuli (rewarding, aversive, novel)
- DA encodes motivation and appropriate choices
- Part of apparatus that makes value judgments and makes “correct” decision in response to a stimuli
- Disturbances of brain DA - altered activity, reward, motivation

# Altered Dopamine function and psychiatric correlates

Compare normal to psychiatric conditions

- AN: increased DA sensitivity, hyper responsive
- Addict: reduced DA sensitivity, takes a lot to stimulate
- Obesity: DA sensitivity inversely proportional to weight (high weight, low DA sensitivity)

# Biologic Perpetuating Factor: Starvation

- **Low Body Weight and Dieting** can result in eating disorder behavior and thinking.

- Treatment goal is to normalize weight before we can expect to normalize behavior and thinking.

# Semi-Starvation Experiment Minnesota 1944

Study by Ancel Keys et all.

## 40 healthy volunteers.

(Conscientious Objectors of WW II)

- **3 month** observation
- **6 month** semi starvation
- **3-9 month** refeeding and observation

# 3 month observation period

- 40 men chosen from >400 volunteers
  - Young
  - Highest level of physical and psychological health
  - Personality, eating patterns, behavior observed

# During 6 month semi-starvation period (Average 1600 kcal/day)

Emotional and Personality Changes seen:

- depression
- severe mood swings
- experienced irritability
- anger and anxiety
- started biting nails, smoking
- decrease in personal hygiene
- withdrawn, isolation
- lost sense of humor and sex drive
- Some could not finish college classes and dropped out of other activities

# During 6 month
# Dramatic increase with Food Preoccupation

- Preoccupation with food
  - Increased conversations about food, read about it, dreamed about it, even collected recipes, cookbooks.
  - Rapid eating or prolonged 2 hour meals
  - food rituals, hoarding, smuggling food.
  - Dramatic increase in tea and coffee consumption and chewing gum (40 packs/day)
  - Increased use of salt and pepper
  - Pleasure out of watching others eat

# 3 month refeeding period

- 2 months – 2 years to normalized eating.
  - Binge eating, purging followed by guilt and restricting. Abnormal eating persisted average of 5 months.
  - Initially emotional distress increased after refeeding was initiated.
  - On average, subjects gained original plus 10% over the next 6 months after which most returned to normal weight.

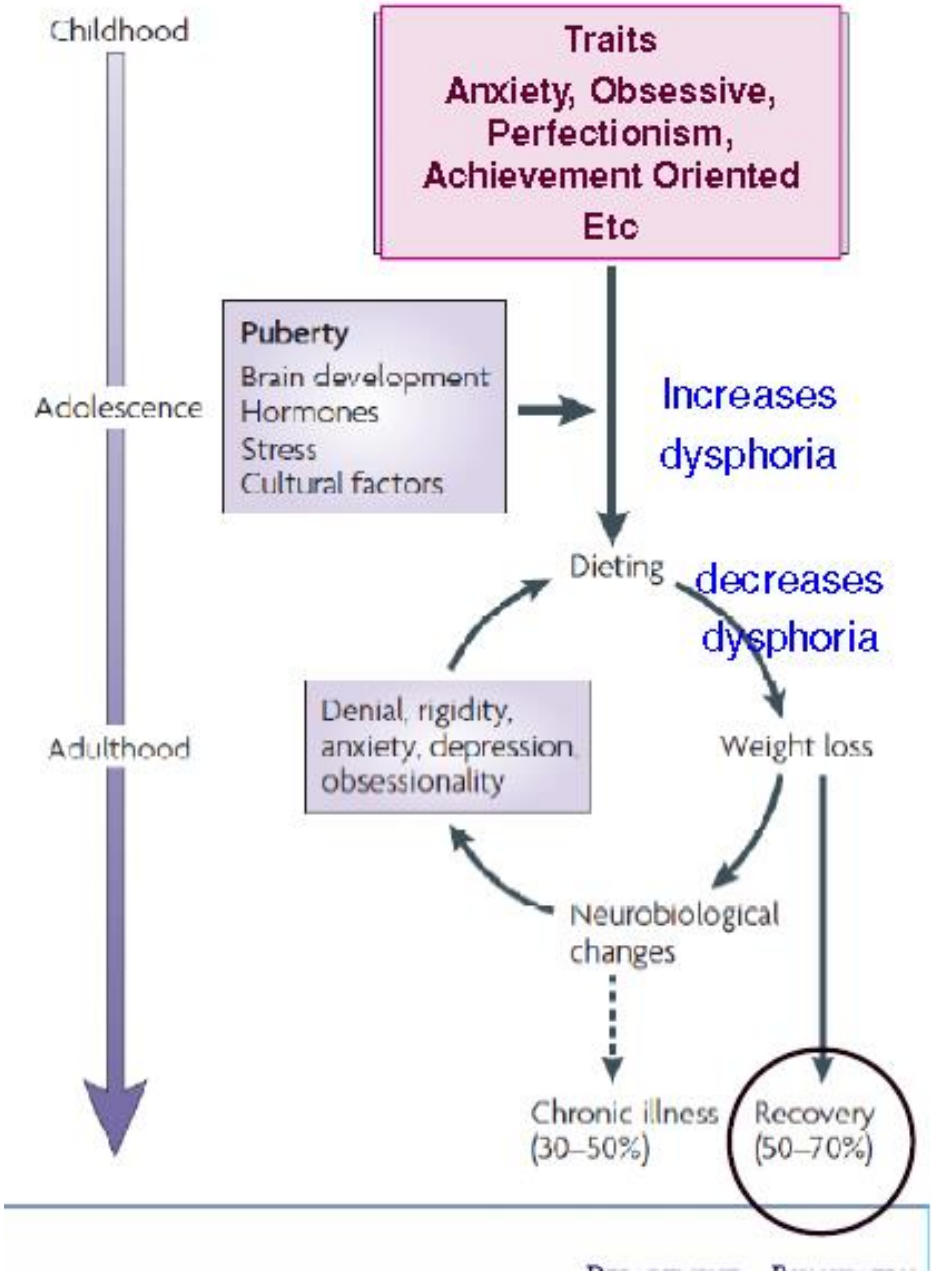
# Psychologic vulnerabilities

- Individuals with AN tend to be:
  - Perfectionistic
  - High behavioral constraint
  - Difficulty expressing negative emotions
  - Dysphoric mood, low self esteem, poor self image
- Individuals with BN tend to be:
  - Perfectionistic
  - More impulsive
  - Sensation seeking

# Societal Influences. - Over The Years

**1965** **2005**

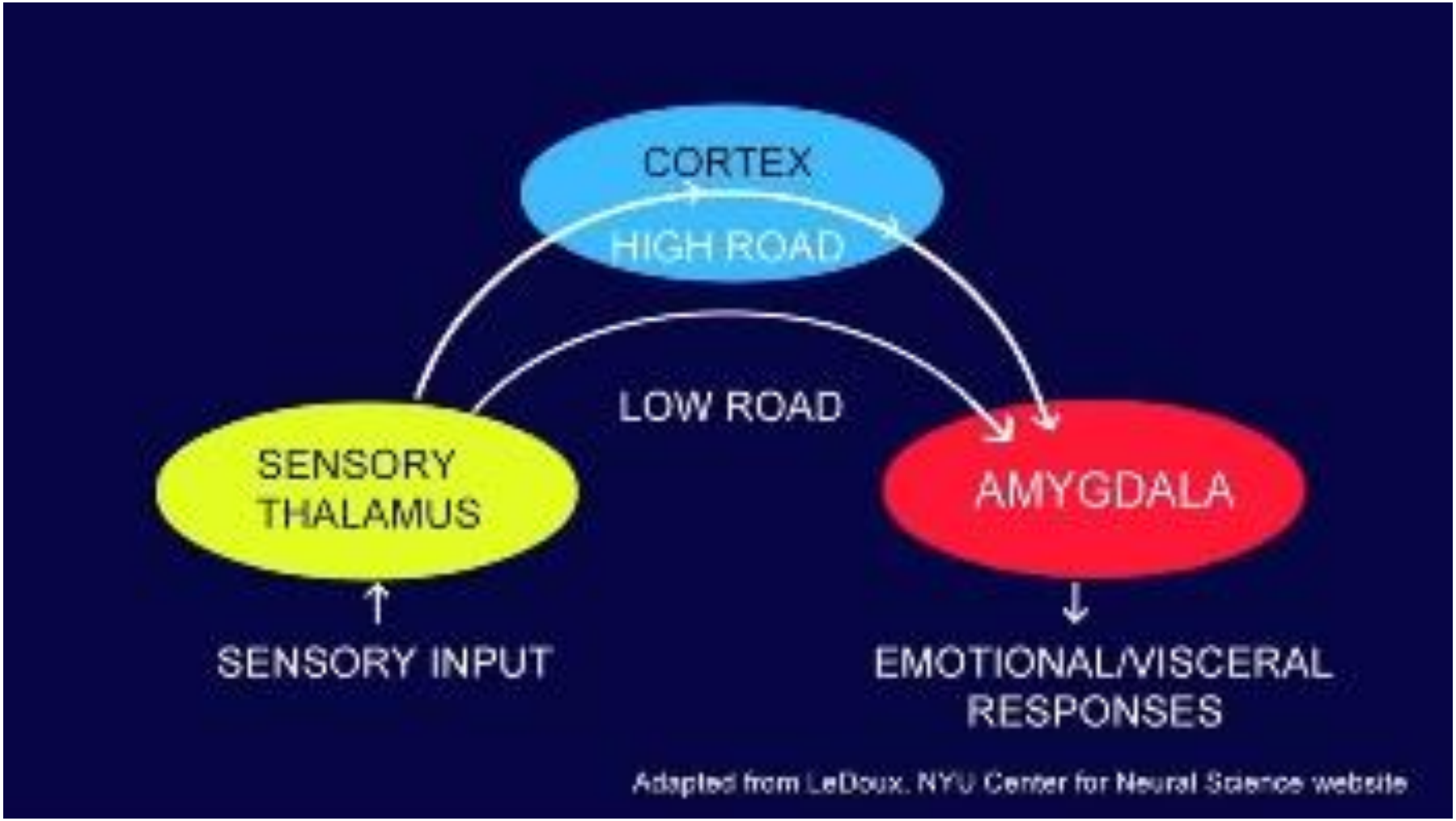
Makes sense, doesn't it?



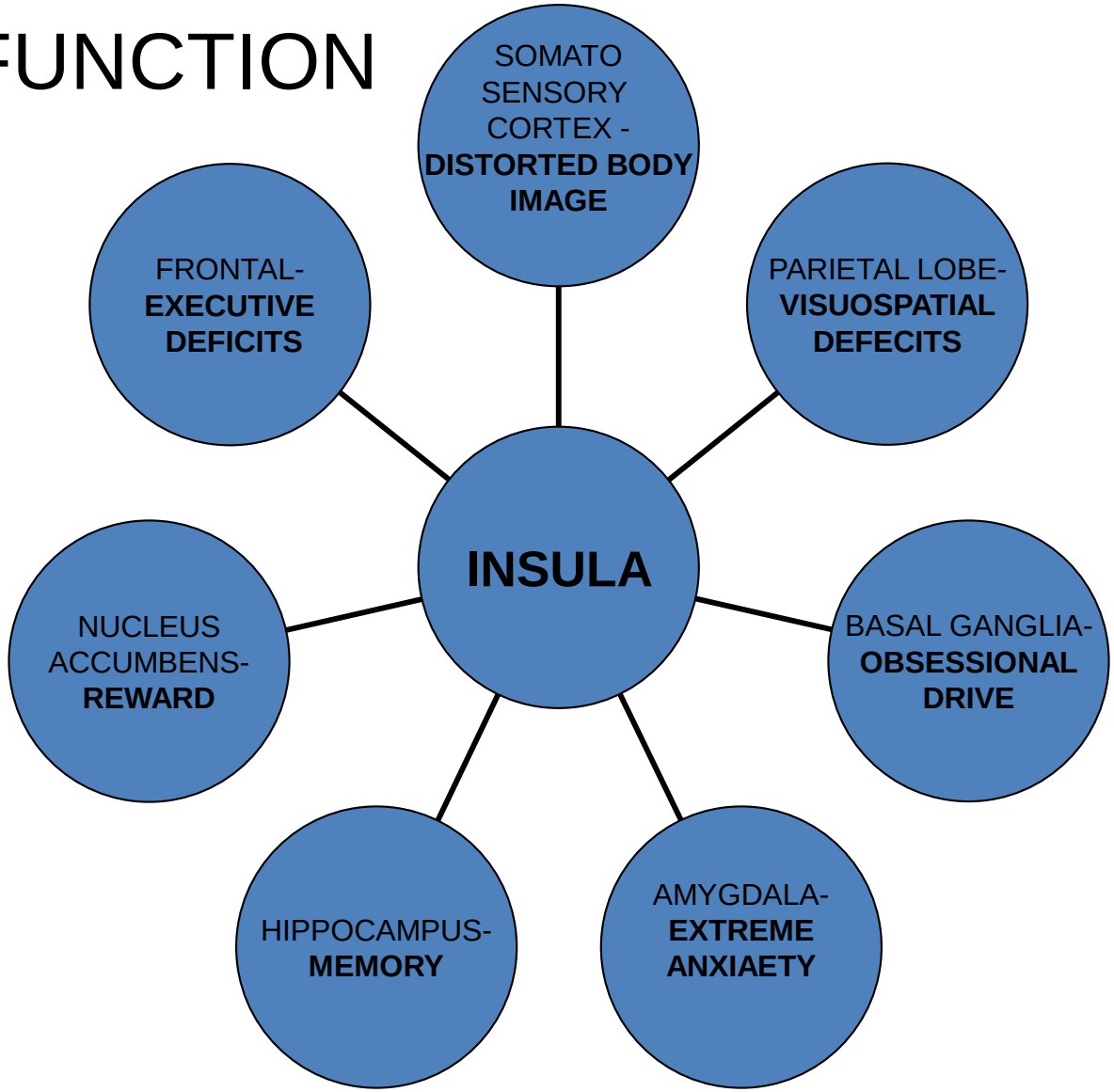
# Neurobiology

- History of ED treatment
- Why do we treat the way we do?
- How the brain develops
- Autonomic Nervous System

# Low Road, High Road



# BRAIN FUNCTION IN AN




UNLIKELY THAT EACH OF THESE IS NOT FUNCTIONING CORRECTLY

# Acting out a hypothesis: ?? Underactive Insula

Theory proposed by Ken Nunn, Ian Frampton, Isky Gordon and Bryan Lask

# Frontal Cortex
# Executive Functioning

- Processes information
- Considers the possibilities
- Makes Decisions
- Considers Outcomes
- “The Boss” of the brain and body

# Frontal Cortex – when unwell

- Can’t think flexibly
- Obsessive thoughts
- Indecisiveness
- Can’t screen out intrusive thoughts
- “Analysis Paralysis”

- Treatment: Family Based Therapy, CBT

# Somatosensory Cortex
# Body-image representation, self-aware

- Body image awareness
- Concerned with appearance
- Processes body sensations
- Senses the position of the body
- Works with parietal cortex

# Somatosensory Cortex – when unwell

- Body-image distortion
- Body-image dissatisfaction
- Note: OVERFOCUS on sensory image, especially in heightened emotional states, leads to perceptual distortions even in normally functioning brains (sound, taste, smell, sight, tactile)

Treatment ideas: Mirror Therapy (place visual sensory input into proportional context)

# Parietal Cortex
# Environmental Representation

- Visual spatial skills
- Knows the size and shape of every thing
- Expert “map reader”
- Numbers and math
- Contributes to body shape awareness/ acceptance

# Parietal Cortex – when unwell

- Impairment of visual memory
- Impairment of size/ shape assessments
- Cannot evaluate body size
- Overemphasis and distortions related to numbers

Treatment : Cognitive Remediation therapies, practice visual spatial skills Photographs from healthier and happier times

# Hippocampus - Memory

- Memory, especially personal memory
- Puts memory into context
- Recognizes new environments / experiences

# Hippocampus – when unwell

- Memory impairment
- Unable to remember things clearly
- Unable to place things in context

Treatment: Autobiographical assignments, Time line, Journaling

# Amygdala-
# Detects threat, Sounds alert

- The security system of the brain
- Passionate
- Active
- Detects threat and “sounds an alarm”
- Pushes towards decisions that relieve stress/ anxiety

# Amygdala – when unwell

- Oversensitive to threat
- Continuous high alert

Treatment: Medications, relaxation training

# Basal Ganglia
# Quality control, Drive

- Energy
- Drive – Repetitive movement
- Movement – Initiates Movement
- Quality control

# Basal Ganglia – when unwell

- Decreased Motivation
- Perfectionism becomes obsessional
- RESTLESS
- Irritable

Treatment: Motivational Enhancement Therapy, CAREFUL use of monitored exercise/ mindful movement

# Nucleus Accumbens
# Seeks reward and pleasure

- Reward Center
- Plays a role in motivation and addiction
- Pushes towards decisions that feel good

# Nucleus Accumbens – when unwell

- Decreased enjoyment in life
- Less satisfied with achievements – have to work harder to get the same reward effects
- Decreased motivation

Treatment: ASSIGN pleasurable activites

# Insula

- Performs networking in the brain
- Interoceptive awareness – senses the physiologic condition of the whole body
- = link between thinking and mood
- = link between brain and body

# Insula – When Unwell

- Lose sight of the “big picture” – become detail focused
- Brain – body physiologic awareness decreased
- Disgust is amplified

Treatment: FOLLOW A PRESCRIBED PLAN, Family Based Therapy for kids, DBT/ CBT

# FUNCTIONS OF THE INSULA

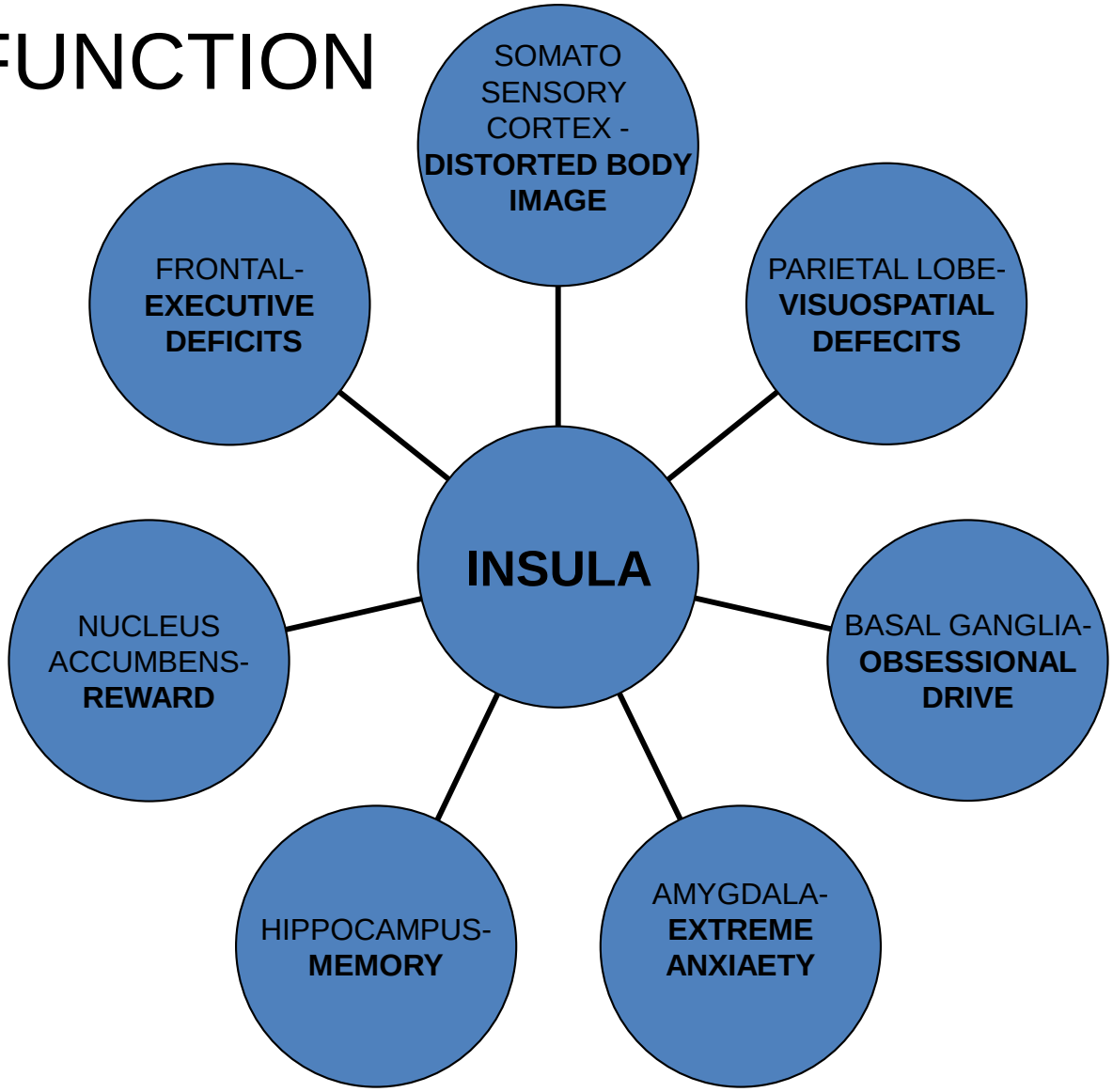
- Interoceptive awareness
- Regulates the ANS (anxiety)
- Regulates appetite and eating
- Monitors the gut (sense of fullness / emptiness)
- Monitors body image
- Reception, perception and integration of taste
- **Perception and integration of disgust**
- Perception of pain
- Integrates thoughts and feelings
- Awareness of illness
- Social awareness
- Global processing

# FUNCTIONAL EFFECTS OF AN ON BRAIN

- Significantly reduced activity in antero-medial temporal region (insula)
- Correlates with neuropsychological findings
- Does not correlate with BMI, mood, length of illness nor cerebral dominance

Gordon et al 1997, Chowdhury et al 2003, Key et al 2004, Lask et al 2005, Agrawal and Lask 2009, Brewerton et al 2009, Frampton et al 2010

# BRAIN FUNCTION IN ED



# Neuroplasticity

- What we count on to move toward ultimate health and recovery
- The brain's natural ability to rewire itself with learning
- When one part of the brain is not functioning well, other parts can take over the function
- The functionality of the brain can be restored to health

# Brain Resources

- **Brain differences help explain eating disorders:** https://www.scientificamerican.com/article/brain-differences-help-explain-eating-disorders/
- **Brain networks influence eating disorders:** https://psychcentral.com/news/2012/04/04/how-brain-networks-influence-eating-disorders/36897.html
- **Liking vs. Wanting Information:** http://lsa.umich.edu/psych/research&labs/berridge/research/affectiveneuroscience.html

# For More Information:

- Living Sensationally, Understanding Your Senses. Author: Winnie Dunn. Published in 2009 by Jessica Kingsley Publishers.
  - http://www.jkp.com/usa/catalogsearch/result/?q=living+sensationally
- Sensory Podcasts by Winnie Dunn, sensory integration researcher:
  - http://www.kumc.edu/school-of-health-professions/occupational-therapy-education/media-archive.html
- Sensory Processing Lecture on Dunn's model:
  - https://www.youtube.com/watch?v=rrICV-Zws_I&t=35s