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

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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

Increased stress, decreased mood

Traits
Anxiety, Obsessive, Perfectionism, Achievement Oriented, Etc

Increased stress, decreased mood

Healthy
Eg. Food restriction

No Illness

Purge <-- Binge

Neurobiological changes

Denial, rigidity, anxiety, depression, obsessionality

Weight loss

Puberty
Brain development
Hormones
Stress
Cultural factors

Childhood

Adolescence

Adulthood
Biologic Vulnerabilities

- 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

- Altered reward, anxiety

- Altered 5 HT and DA function and neurotransmitter circuits

- 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
- Altered reward, anxiety
- Altered 5 HT and DA function and neurotransmitter circuits
- 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

Adapted from LeDoux, NYU Center for Neural Science website
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 obsession
- 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 activities
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

BRAIN FUNCTION IN ED

- Frontal-Executive Deficits
- Nucleus Accumbens-Reward
- Insula
- Hippocampus-Memory
- Amygdala-Extreme Anxiety
- Basal Ganglia-Obsessional Drive
- Parietal Lobe-Visuospatial Deficits
- Somato Sensory Cortex-Distorted Body Image
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


• Liking vs. Wanting Information: http://lsa.umich.edu/psych/research&labs/berridge/research/affectiveneuroscience.html
For More Information:

  - [http://www.jkp.com/usa/catalogsearch/result/?q=living+sensationally](http://www.jkp.com/usa/catalogsearch/result/?q=living+sensationally)
- Sensory Podcasts by Winnie Dunn, sensory integration researcher:
- Sensory Processing Lecture on Dunn’s model:
  - [https://www.youtube.com/watch?v=rrlCV-Zws_l&t=35s](https://www.youtube.com/watch?v=rrlCV-Zws_l&t=35s)