Ingestive Behaviors

11/1/16

Reading: Chapter 12 (209-302, 310-317)

Brain Mechanisms: Evidence

- Hunger and satiety signals arise from the periphery and reach the brain
- Eating and drinking are evolutionarily ancient (involve the brain stem)
- Control mechanisms do not require the cortex
- Decerebrated animals (lesion)
    - Cannot seek food
    - Can eat, can respond to hunger and thirst
    - Can differentiate different kinds of food
    - Can vomit/reject bad food: area postrema is intact

Lateral Hypothalamus

- Controls hunger
- Lesion -> decrease eating/drinking and body weight
- Stimulation -> increase eating/drinking
- Block glutamate transmission -> decrease food intake
- LH needs inputs -> hunger and thirst are active processes
- 2 types of neurons producing:
    - Melanin Concentrating Hormone (MCH)
        - Food deprivation increases MCH
        - Satiety decreases MCH
    - Orexin (aka hypocretin)
- Stimulation of MCH/orexin neurons
    - Increase appetite
    - Decreases metabolic rate
    - Increase motivation and movement
- MCH/orexin neurons project to areas involved in planning, motivation and movement

What triggers the LH MCH and Orexin neurons?

NeuroPeptide Y (NPY)

- NPY injections in the hypothalamus will trigger eating frenzies
- Rats will tolerate pain in order to eat -> NPY increases motivation to eat
- NPY from the Arcuate nucleus (in hypothalamus, near 3rd ventricle)

- NPY secretion is triggered by brain stem nuclei and controlled by stomach secretions (Ghrelin)
- Endocannabinoids act like NPY
    - Marijuana used to increase appetite in chemotherapy patients
- Stomach (Ghrelin)/Brain Stem (liver) -> Arcuate (NPY) -> Lateral Hypothalamus (MCH, orexin) -> increased eating, decreased metabolism

How do we stop eating?

Two parallel inhibitory pathways

- Leptin (from fat cells) inhibits NPY neurons in the Arcuate Nucleus
- Cocaine and Amphetamine Regulated Transcript (CART) neurons in the Arcuate Necleus
    - CART neurons inhibit the MCH/Orexin neurons via the MC-4R receptor

Leptin

- Hereditary leptin deficiency (OB-like) in humans
    - Genetic deficit in production of leptin
- Leptin no longer used in weight loss diets; body becomes desensitized to leptin

Obesity

- Increasing problem: obesity -> diabetes
    - Obesity correlated with diabetes
    - Type 1 diabetes: deficiency in insulin production (required by injections)
    - Type 2 diabetes: deficiency in insulin receptors (treated with pills)
- Average energy consumption
    - 20% muscles
    - 20% brain
    - 60% heat + digestion
- Body weight = energy stored – energy spent
- Definition of obesity: more than 20% of normal weight
- Body Mass Index (BMI): body fat based on height and weight
    - 25-30: overweight
    - 30-40: obese
    - 40 and above: morbidly obese
- Why are people overweight?
    - On average: 2,500 kCal in and only 300 kCal out
    - Foods eaten are high in fat, sugar and calories
    - Not enough activity (1/3 of what is required)

    - Overwriting of physiological signals of satiety: encouraged to eat more, large portions
    - Availability of bad foods
- Biological causes of obesity
    - Metabolic disorder (more calories in than out)
        - Due to fast metabolism
            - High metabolic rates -> increase availability of calories -> spent if needed, stored if not
            - Low metabolic rates -> no opportunity for fat storage
        - In general not due to a deficiency in leptin production
    - Genetic factors: different metabolic rates
        - Twin studies (high/low calorie diets)
        - Epidemiological studies
    - Mice: due to leptin deficiency
    - Humans: no evidence for leptin deficits, but:
        - Deficit in leptin transport through BBB
        - Deficit in sensitivity of leptin receptors (MC4 receptors, age related)
    - In humans, high fat diets inherently decrease satiety signals
    - Night Eating Syndrome (NES): more Ghrelin and less leptin at night
- Treatment
    - Exercise (especially at a young age)
    - Wire In Jaw (close the mouth) and liquid diet
    - Gastroplasty: reshaping the stomach
    - Intestinal bypass: directly to the large intestine
    - Gastric bypass: 35% success in long-term decrease in weight, diminish secretion of Ghrelin (skip the stomach)
    - Gastric bubble
    - 5-HT promoters (relapse, cardiovascular side effects)
    - Uncoupling protein (UCP): convert nutrients to heat
- Conclusion
    - Eat slowly
    - Eat regularly
    - Exercise
    - Don’t eat at night

- Anorexia Nervosa
    - Definition
        - Refusal to maintain weight over the lowest considered normal for age/height

        - Intense fear of gaining weight or becoming fat (even when underweight)
        - In women: three consecutive missed menstrual periods without pregnancy
    - 80% of cases are young women (aged 15-24)
        - 15% death rate
    - Can be due to too much exercise (too much exercise decrease hunger signals)
        - Restricting food results in increased physical activity (and weight loss)Respond physiologically correctly to food -> not a loss of interest in food
        - >6 months starvation has psychological consequences (OCD?)
        - Genetic factors (twin studies)
        - Brain imbalance of NE, 5-HT and NPY
            - No effective drug treatment
            - Treatment: psychotherapy