

Lecture 36 – Hypothalamus -- Salzman

- 1) Overall purpose. The hypothalamus and limbic system serve to maintain homeostasis, i.e. to maintain the stability of the internal environment. To achieve homeostasis, the hypothalamus and limbic system exert control on the autonomic nervous system, the endocrine system, and brain systems for emotion and motivated behavior.
- 2) Clinical context. Numerous clinical conditions have symptoms that arise from hypothalamic and/or limbic system brain circuits. We will examine in some detail neural circuits related to four such conditions: fever, obesity, anxiety disorders, and addiction.
- 3) Hypothalamus
 - a. Basic integrative functions; the hypothalamus regulates
 - i. BP and electrolytes (drinking and salt appetite)
 - ii. Body temperature
 - iii. Energy metabolism and feeding behavior
 - iv. Reproduction
 - v. Stress responses
 - vi. Aspects of emotional responses and motivated behavior
 - b. Anatomy
 - i. Lines the walls of the 3rd ventricle, above the pituitary
 - ii. Many nuclei with distinct functions
 - iii. Specific neural pathways deliver visceral information and control autonomic responses
 - c. Inputs and Outputs: examples
 - i. Neural in/neural out: autonomic responses controlled by emotion
 - ii. Neural in/hormonal out: milk letdown reflex
 - iii. Hormonal in/neural out: used for drives and motivated behavior (e.g. sex)
 - iv. Hormonal in/hormonal out: controls vasopressin release for fluid regulation
 - d. Model of hypothalamic function: servo-control systems
 - i. Servo-control systems have a biological set point and compare sensory information with this set point to adjust an array of autonomic, endocrine and behavioral responses aimed at achieving homeostasis
 - ii. Temperature regulation as an example of a servo-control system
 1. distinct regions of the hypothalamus mediate increases or decreases in heat.
 2. Increases and decreases of heat can be mediated by a) ANS, b) endocrine responses, and c) behavioral responses. The hypothalamus appears to mediate all of these
 3. the hypothalamus integrates peripheral and central temperature information to guide behavioral responses
 - iii. Feeding behavior, a less good example of a servo-control system

1. Although there is evidence of biological set points for feeding behavior, the set points are variable within and across individuals depending upon numerous social and emotional factors and possibly biological factors.
2. Historical view of hypothalamic role in feeding proposed that different centers existed in the hypothalamus for feeding and satiety respectively.
3. Modern theories of feeding propose that discrete neural pathways generate integrated response to satiety and adiposity signals.
4. Leptin, secreted by adipose tissue, and insulin, secreted by the pancreas, are adiposity signals that exert long-term control on feeding behavior.
5. Satiety signals arising from the liver and GI tract in the form of both neural and chemical (CCK) signals function as short-term signals controlling feeding.
6. Adiposity signals act on neurons in the arcuate nucleus of the hypothalamus, which in turn act on neurons in the paraventricular and lateral hypothalamic nuclei. The paraventricular pathway has a net catabolic action, decreasing food intake and increasing energy expenditure. The lateral hypothalamic pathway has a net anabolic action.
7. Preliminary work in animal models suggests that leptin may also play a role in establishing a biological set point for body weight. In leptin-deficient mice, scientists have recently obtained evidence supporting a role for leptin in inducing 1) rapid changes in the strength and number of excitatory and inhibitory synapses that have inputs on arcuate nucleus neurons; and 2) neurite outgrowth of arcuate neurons, increasing projections from the arcuate to the paraventricular nucleus.

Relevant reading: ch. 49 (pp. 974-980) and ch. 51 (pp. 998-1007) in “Principles”