The anatomy and physiology of personality

• How can you figure out how the brain works?
• The availability of better tools for studying the brain has led to a rapid increase in knowledge about the workings of the brain
• Examination of 2 aspects of the brain
  – Anatomy
    • Examine the function of the parts of the brain to determine the timing and physical location of various brain processes
  – Biochemistry
    • Examine the effects of fundamental chemicals, neurotransmitters and hormones, on brain processes
• These 2 kinds of research are related
  – Neurotransmitters and hormones have different effects on different parts of the brain, and different parts of the brain secrete and respond to different neurotransmitters/hormones
• These differences in brain anatomy and biochemistry relate to differences in behavior and personality

The brain and personality

• The physical basis of personality is the brain and its “tentacles,” the nerves that reach into the corners of the body down to the toes
• Every part of the body constantly sends messages that report what the body is doing and feeling up to the sensory, or afferent, nerves through the spinal cord and into the brain
• The brain then sends messages back down motor, or efferent, nerves that direct the actions of all the various organs and muscles of the body
• In between are the interneurons, which connect nerves to each other; the biggest bundle of these is the large, wrinkled organ known as the brain

Structures of the brain

• Hypothalamus
  – Located near bottom center of brain, just above roof of mouth
  – Important b/c it seems to be connected to everything
    • It has nerves that extend throughout the brain
    • It also secretes several hormones that affect the entire body
• Amygdala
  – Just behind and above the hypothalamus
  – Has an important role in emotion
• Hippocampus
  – Important for memory

Structures of the brain

• Cortex
  – Wrapped around and over these inner organs
  – Divided into several regions
  – The most important of these for personality is the frontal cortex
    • The front part of the cortex (AKA the cerebral cortex)
    • The part of the brain most different in humans from animals
    • Divided into 2 lobes—right and left
    • Crucial for cognition
      – Ability to plan ahead, anticipate consequences, and emotional experience like empathy
### Research methods for studying the brain

- **3 principle sources of knowledge on the brain**
  1. People with accidental brain damage
     - Track specific problems caused by damage to different parts of the brain
  2. Deliberate damage to brain—brain surgery
     - Parts of brain are "lesioned" or damaged by being cut off from other brain structures or completely removed
     - Most of this research has been done with animals
  3. Studying the brain to observe its functions directly—see what it’s doing while it’s doing it
     - Determines *when* the brain is active, but not *what* it’s doing in what specific part of the brain

### Research methods for studying the brain--functional

- Studying the brain to observe its functions directly—see what it’s doing while it’s doing it
  - Determines *when* the brain is active, but not *what* it’s doing in what specific part of the brain
  - **EEG (electroencephalography)—oldest**
    - Electrodes placed on scalp pick up electrical signals generated by the brain activity underneath
  - **MEG (magnetoencephalography)**
    - Delicate sensors detect magnetic (vs. electrical) indications of brain activity
    - More specific localization
  - **PET (positron emission tomography)**
    - Creates map of brain activity by following the location of a harmless radioactive tracer injected into the bloodstream
    - The brain needs more blood the harder it works and following the blood flow can learn where it works hardest when doing different tasks
  - **fMRI (functional magnetic resonance imagery)—newest**
    - Magnetic pulses generated by blood flow to generate an image of the course of blood through the brain to see where the brain is most active at any given moment

### Research methods for studying the brain

- Since these imaging techniques are new, their use is complex
- Since all parts of the brain are metabolically active to some degree, must do more than simply measure what the brain does during a certain task
- Must come up with a control task so the *difference* in activation can be measured
  - i.e. do a task that evokes an emotion (picture of a family member) and then a task that is as similar as possible w/o being emotionally relevant (picture of a stranger)
  - Then the areas where brain activation is different are mapped
  - These areas may or may not be parts of the brain specifically relevant to emotion
- As technology becomes more sophisticated and sensitive it becomes more difficult to use and delicate
  - It’s impressive that psychologists have made such progress using these techniques to understand the brain
  - This recently invented technology is still in its Model-T phase and subject to further advances in knowledge

### The Ascending Reticular Activating System (ARAS)

- **Brain stem**
  - At the point where the spinal cord enters the base of the skull, it grows thicker and more complex
  - Some of the brain stem is devoted to the maintenance of automatic activities such as breathing and swallowing
  - Reticular formation
    - Another part of the brain stem that has connections that lead up into the cerebral cortex and the rest of the brain
The Ascending Reticular Activating System (ARAS)

• Eysenck developed this theory that the human brain has excitatory and inhibitory mechanisms, and important aspects of a person’s personality are determined by the balance between these mechanisms
  – Excitatory mechanisms
    • Cause one to be awake, aroused, and alert
  – Inhibitory mechanisms
    • Reverse affect
  – The balance between the 2 mechanisms produces the level of psychological arousal at any given moment

• Eysenck hypothesized that this balance is regulated by the ARAS which regulates the amount of info and stimulation that goes into the brain—opened up or closed down
  • Each person’s ARAS functions differently and lets in info and stimulation all the time and others reduce the sensory stimulation
  • Eysenck believed this difference to be the basis of the difference between introverts and extroverts
    – A person whose ARAS leads to being chronically overaroused is an introvert and one that is underaroused is an extrovert
    – You seek activities that maintain the level of sensory input that makes you feel good—higher requirements for Es than Is
    – “lemon juice test”
      • Small amount of lemon juice dropped on tongues of Is and Es (as assessed by EPQ)
      • Introverts scored the test as having less taste than extroverts
      • Results show that Is react more strongly to sensory stimulation
  – Eysenck’s theory is ½ right
    – Is aren’t chronically more aroused than Es
    – One part of the brain can be stimulated while another is not
    – It does seem to be that Is react more strongly and often negatively to sensory stimulation compared to extroverts
      • When the environment is quiet, Es and Is are about equally aroused, but when loud, Is react more quickly and strongly which leads them to W/D
    – This same level of stimulation may be what the introvert needs

The amygdala

• Small organ located near base of brain, behind the hypothalamus
• Function is to link perceptions and thoughts about the world with their emotional meaning
  – Amygdala
    • Basic motivations and emotions
    • Also, cerebral cortex
      • Thinking and planning
• The amygdala has important effects on – emotions like anger and fear and + emotions like social attraction and sexual responsiveness
• May be the physical basis of human personality traits like chronic anxiety, fearfulness, sociability, and sexuality
• Whitman case illustrates that the “lower” parts of the brain near and including the amygdala may be capable of producing motivations for actions that might not be accompanied by understanding

The frontal lobes and neocortex

• The neocortex is the outer layer of the brain that is most uniquely human
• The frontal lobes (L & R) are important for “higher” cognitive functions like speech, planning, and interpreting the world
• EEG studies suggest that the L frontal lobes are more active when a person experiences pleasant emotions and unpleasant are associated with activity in the R
• The degree to which the 2 sides of the brain respond differently (brain asymmetry) may be an important individual difference associated with emotional sensitivity
• The importance of the frontal lobes also comes from the observed effects of brain injuries
  – Major injuries to this area can result in a person who has little left of what made them seem human
Phineas Gage

- 1848 railroad construction supervisor too close to a dynamite explosion had an iron rod go through his lateral cheek into his frontal lobes and through the top
- Initial reports suggested that he was fine afterwards
  - Could speak and move normally and memory was intact, but maybe a bit less emotional than usual
- These early reports led to surgeons thinking it was OK to remove large portions of the brain to "cure" excessive emotionality
- Gage’s Dr’s final reports indicated that he retained some reasonable mental functioning, but his personality had changed for the worse
  - Emotional life flattened out

“Capgras syndrome”

- Injury to R frontal lobe (important in emotional response) leads these patients to recognize close family members, but not feel any emotional response to this recognition
- This led these patients to conclude the family members can’t be who they appear to be and must’ve been replaced by nearly identical doubles
- Damage to tissue in the R frontal lobes impaired their emotional reaction to events and thoughts
- Somatic marker hypothesis
  - This emotional reaction is what allows humans to tell the difference between what’s important and what’s not
  - Without this emotion, lose the ability to make decisions
    - Everything seems equally important (or unimportant)
  - These cases demonstrate how cognition and emotion are intertwined
    - You can’t have one without the other
    - Understanding is important for full emotional experience, and emotional experience is important for real understanding

The lessons of psychosurgery

- Prefrontal leucotomy damages areas of white matter behind the frontal lobes
  - It was believed that patients with pathological levels of agitation and emotional arousal had overactive frontal lobes, and this operation of the same area of Gage’s iron bar might make them less emotional, more rational, and calmer
- Lobotomy removes whole sections of the frontal lobes
  - Some of these patients were worse off after the procedure
    - I.e. One Flew Over the Cuckoo’s Nest
    - I.e. Rosemary Kennedy institutionalized as a shell of former self
- The frontal lobes are centers of cognitive control to anticipate the future and plan for it
- A particular function of the frontal lobes might be to anticipate future negative outcomes and respond emotionally to their possibility—worrying
- This emotional aspect of forethought is important b/c unless you have the appropriate reaction to future possibilities (pleasant anticipation or worrying), you won’t be able to plan appropriately or make good decisions about what to do now
- Rarely done today

Biochemistry and personality

- Hippocrates
  - Personality as dependent upon the balance between 4 humors or fluids in the body
    - Blood, black bile, yellow bile (choler), and phlegm
      - Sanguine (cheerful), ruddy, and robust
        » More blood relative to other humors
      - Choleric, angry, and bitter
        » Excess of black bile
      - Phlegmatic, old, apathetic, and bitter
        » Excess of phlegm
    - Depressed and melancholy
      » Excess of black bile
    - Choleric, angry, and bitter
      » Excess of yellow bile
    - Phlegmatic, old, apathetic, and bitter
      » Excess of phlegm
The chemistry of the mind

- The physical basis of behavior is the nervous system
  - made up of billions of cells, called nerve cells or neurons, that are connected with each other through complex pathways
- The brain is a thick bundle of neurons, other neurons form the brain stem and spinal cord, which connect the brain to muscles and sensory receptors all over the body
- The essence of neuronal activity is communication
  - The activity of one neuron may affect the activity of many other neurons, transmitting sensations from the far reaches of the body into the brain, connecting these sensations into the brain, connecting these sensations with feelings, memories, and plans in the brain; and sending behavioral instructions back out to the muscles, causing the body to move

Neurotransmitters

- Communication between neurons is based on neurotransmitters
- A bioelectrical impulse causes a release of neurotransmitters at the end of the neuron
- These neurotransmitters travel across the synapse to the next neuron in line, where they cause a chemical reaction that results in that 2nd neuron firing an impulse that causes the neurotransmitters at its other end to be released, and so on down the neural network

Hormones

- Hormones work slightly differently
- They are released from central locations, such as the hypothalamus and the adrenal glands (on top of the kidneys), and spread throughout the body in the bloodstream
- Once they reach the nerve cells that are sensitive to them, they will either stimulate or inhibit their activity
- The difference between neurotransmitters and hormones can be confusing b/c they both affect the transmission of nerve impulses, and some chemicals qualify as belonging to both categories
  - I.e. norepinephrine functions as a neurotransmitter w/in the brain but is also a hormone that’s centrally released from the adrenal gland in response to stress

Neurotransmitters and hormones

- Different neurotransmitters and hormones are associated with different neural subsystems and so have different effects on behavior
  - I.e. norepinephrine, dopamine, and serotonin work almost exclusively in the central nervous system (CNS)—the brain and the spinal cord
- Epinephrine is found mostly in the peripheral nervous system (PNS)—the neuronal networks that extend all over the body
- Some neurotransmitters cause adjacent neurons to fire, while others inhibit the neuronal impulse
  - I.e. the body’s own natural pain-killing system is based on endorphins that works by inhibiting rather than facilitating the neuronal transmission of pain
  - I.e. the antidepressant Prozac increases the amount of serotonin in the body by inhibiting the activity of the chemical that causes
Neurotransmitters

- The functioning of the various parts of the nervous system is affected in important ways by the amounts of various neurotransmitters available at the moment.
- This availability can vary as a function of what the individual is doing and can fluctuate widely over short periods of time.
- People also differ from each other in their average levels of various transmitters, and these differences seem to be associated with various personality traits.

Neurotransmitters: Epinephrine and norepinephrine

- Epinephrine (AKA adrenaline) and norepinephrine are two particularly important neurotransmitters.
- Epinephrine and the neurons that respond to it are found throughout the body, while norepinephrine and its neurons work primarily within the brain itself.
- The levels of both hormones can rise dramatically and suddenly in response to stress—"fight-or-flight response".
- Heart rate increases, digestion stops, and muscles tense—the "adrenaline rush"—and the brain becomes fully alert and concentrated on the task at hand.
- Almost all of the F-O-F studies have been conducted on males—animals and humans.
- The response to threat may be different in men and women.
- For a woman caring for children, fighting or running away might put her children and herself at risk.
- Instead, it might make sense for her to calm everyone down and band together to fend off the threat—"bend-and-befriend".
- Oxytocin is a hormone that has specific effects in females of promoting nurturing and sociable behavior along with relaxation and reduction of fearfulness.

Neurotransmitters: Dopamine

- Dopamine allows the brain to control body movements and involved in reward response systems, and approach attractive objects and people (also an important part of the chemical process that produces norepinephrine).
- Theorized to be part of the basis of sociability and general activity level.
- An inherited inability of the brain to properly use dopamine can produce reward deficiency syndrome, characterized by outcomes such as alcoholism, drug abuse, etc.

Neurotransmitters: Dopamine

- A severe lack of dopamine is the basis of Parkinson’s disease.
  - Awakenings
  - L-dopa increases brain’s production of dopamine, and for some patients who had been nearly catatonic for years, the results were dramatic.
  - They could move around much better than before, but also were able once again to experience positive emotions, motivation, sociability, and interest in and awareness of their environment.
  - Over time, most of these patients’ conditions worsened again.
- Dopaminergic systems might have something to do with bipolar disorder.
- Dopamine may be relevant to the personality traits of extraversion, impulsivity, and perhaps others.
- Neuropsychologist Jeffrey Gray hypothesized that dopamine and the brain structures in the hypothalamus that the neurotransmitter activates are the basis of the tendency to seek out reward—behavioral activation or “Go” system (BAS).
  - Someone with a strong and active Go system will tend to be active and impulsive.
  - This system interacts with other areas of the brain like the frontal lobes that assess and respond to risk and constitute a behavioral inhibition or “Stop” system (BIS).
  - Someone with a strong and active Stop system will tend to be inhibited and anxious.
- Because these are separate systems any combo of these 2 traits is possible.
  - One could be highly anxious and impulsive and be considered neurotic or could be highly anxious, but not impulsive and be considered introverted.
### Neurotransmitters: Dopamine

- A severe lack of dopamine is the basis of Parkinson’s disease (*Awakenings*)
  - L-dopa increases brain’s production of dopamine
  - Catatonic patients can move around and able once again to experience positive emotions, motivation, sociability, and interest in and awareness of their environments
  - Over time most of these pts’ conditions worsened again
- Dopamine may be relevant to the personality traits of extraversion, impulsivity, and perhaps some others
- Gray hypothesized that dopamine and the brain structures in the hypothalamus that this neurotransmitter activates are the basis of the tendency to seek out reward—behavioral activation or “Go” system (BAS)
  - A strong and active Go system will tend to be active and impulsive
  - This system interacts with other areas of the brain like the frontal lobes that assess and respond to risk and constitute a behavioral inhibition or “Stop” system (BIS)
  - A strong and active Stop system will tend to be inhibited and anxious

### Neurotransmitters: Serotonin (and Prozac)

- Seems to play a role in the inhibition of behavioral impulses
- People with insufficient serotonin have serotonin depletion
  - Symptoms include irrational anger, hypersensitivity to rejection, chronic pessimism, obsessive worry, and fear of risk taking
  - Violent criminals, arsonists, and people who die by violent suicide
- SSRI Prozac raises the serotonin levels
- Listening to Prozac
  - The ability of drugs to change aspects of personality may mean that personality is primarily a matter of chemicals
  1. This could give rise to “cosmetic psychopharmacology” like unnecessary plastic surgery
  2. Although chemicals clearly influence personality, the idea that personality is based so specifically on chemicals that it can be precisely adjusted is likely an exaggeration
  3. Sometimes the drugs have no effect and sometimes they make things worse

**Hormones**

- Biological chemical that has effects on the body in a location different from where the chemical was produced
- Some neurotransmitters such as norepinephrine can also be considered hormones because they affect nerve cells far from their origin
  - Produced in a central location and broadcast throughout the body, stimulating the activity of neurons in many locations in the brain and body at the same time
- Different hormones affect different nerve cells and so influence different neural systems
- Hormones that are important for behavior are released by the hypothalamus (part of the limbic system of the brain), the gonads (testes and ovaries), and the adrenal cortex (part of adrenal gland that sits on top of kidneys)
Hormones and Testosterone

- Males of many species are more aggressive than females, but not all—wolves, rabbits, lab rats
- Men with high levels of T are not necessarily aggressive
- Males with more T are higher in “stable extraversion”—sociability, self-acceptance, and dominance
- Higher levels of T in women are associated with higher levels of self-reported sociability and impulsivity, lack of inhibition, and lack of conformity
- In women, female prisoners who committed “unprovoked” violent crimes had higher levels of T than women violent after provocation or nonviolent
- It’s an oversimplification to conclude that T causes aggression or sexuality in any simple or direct way
- T plays a role in the control and inhibition of aggressiveness and sexuality
- T is not just a cause of behavior, it is an effect

Hormones: Cortisol

- Released into the bloodstream by the adrenal cortex as a response to physical or psychological stress, C is part of the body’s preparation for action and is also an important part of several normal metabolic processes
  - Can speed the heart rate, raise blood pressure, stimulate muscle strength, and metabolize fat
- The rise in C seems to be an effect of stress and depression rather than a cause; injecting C into people doesn’t produce these feelings
- People with low levels of C may be impulsive sensation seekers who are disinclined to follow the rules of society