Cannabinoids and Health

Module 5 Lecture 3: The Etiology (causes) of Chronic Pain

The Puzzle of Pain

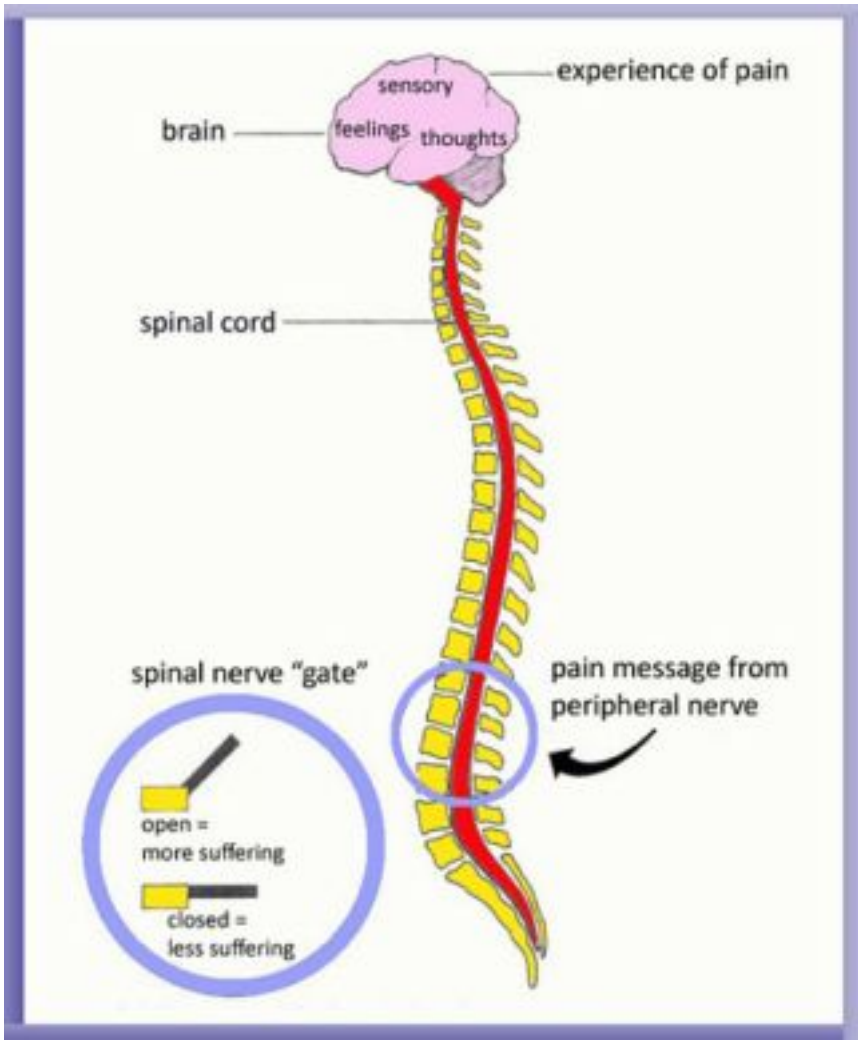
- Explaining why some people develop persistent or continuing pain after the original injury should have “healed” is very difficult
- Most people who experience acute pain do not live with persistent pain
- Why a large subset of people continue to experience persistent pain 3-6 months or more after the first episode is a very important question
- The “mystery” or “puzzle” of **chronic pain** has led to an array of theories and hypotheses about its causes and implications

The Gate Control Theory of Pain

- **Pain is a mix of psychological and physiological factors**
- A major force for expanding our understanding of pain was the Gate-Control theory of Melzack and Wall (1965, 1982)
  - Why do innocuous stimuli cause pain?
  - Why do people under hypnosis fail to react to painful stimulation?
  - The Gate-Control theory proposes both upward (from the senses) and downward (from the brain) pathways that determine the pain experience

Gate Control Theory

- A neural “gate” that can be opened or closed to modulate pain experience
- Gating mechanism located in dorsal horns of spinal cord
- Pain signals project from peripheral sense organs to spinal cord via pain fibers
- If they pass the gate, these fibers activate transmission cells which signal the brain
- However, descending messages from the brain can send messages to open or close the gate
- The gate may close through the action of medications, the operation of positive emotions, intense concentration or distraction, and focusing on important goals and life pursuits
- Tension, anxiety, fear, excessive activity, boredom, and stressors tend to open the gate (enhancing pain experience)



Gate Control Theory

- Ushered in a modern neurocognitive approach to chronic and acute pain
- The descending signals from the brain modulate the pain experience
- By modifying their thoughts, emotions and other conscious psychological processes, people have the ability to regulate their pain experience (to varying degrees)

How does pain change the brain?

- **Central Sensitization**
  - A prominent conception of adaptation to pain is contained in the idea of **central sensitization.**
  - In the 1880s, a cardiologist working with heart patients suggested a “commotion” in the central nervous system contributed to his patient’s pain symptoms.
  - It was not until the 1980s that Clifford Woolf introduced the notion that nociceptive stimulation could influence an increase in the excitability of neurons in the spinal cord.
  - This increased excitability produces *pain hypersensitivity* that Woolf labeled **central sensitization**.

Central Sensitization

- Prior to central sensitization idea, pain processing was viewed as a “passive neural relay” system involving a pain stimulus (e.g., cutting one’s finger) traveling along nociceptors to the spinal cord, to brain stem, to thalamus, to cortex (where it is interpreted as pain).

- However, this relay system does not explain **allodynia**

- Allodynia is the perception of an ordinary painless stimulus as painful

- Woolf (2011) suggested “…the pain we experience might not necessarily reflect the presence of a peripheral noxious stimulus.”

Central Sensitization

- **Central sensitization** says: “CNS can change, distort, or amplify pain, increasing its degree, duration, and spatial extent in a manner that no longer directly reflects the specific qualities of peripheral noxious stimuli, but rather the particular functional states of circuits in the CNS”

- Pain stimulation is a necessary but not a sufficient cause of pain experience

- Central sensitization of the pain experience occurs due to *increases in the efficiency of transmission at the synapses of the CNS* and *reductions in the brain’s inhibitory capacity*.

Woolf, 2011, *Pain*

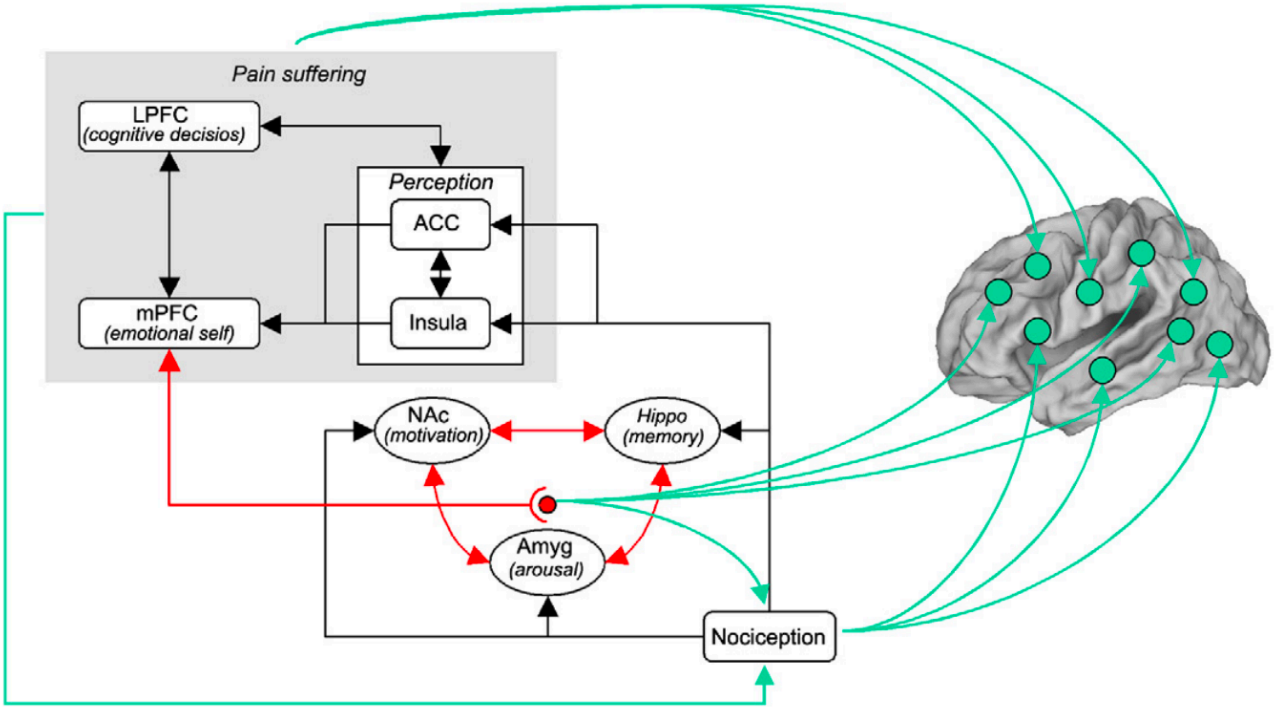
Brain Re-Organization in Chronic Pain

- Recent work conducted at the Northwestern School of Medicine by Apkarian, Baliki, and colleagues centers on their findings of **structural changes** in the brain in response to acute (nociceptive) and chronic (dysfunctional) pain

- Their working model of chronic pain contains several premises
  - Neuropathic pain (in contrast to acute and inflammatory pain) involves **specific changes to brain circuitry**
  - Brain regions in pain patients undergo decreased gray matter density, cell death and atrophy
  - There is no unitary set of brain regions that can be linked directly to the presence of pain
  - Understanding pain in the brain requires a focus on **multiple interacting circuits**

Brain Re-Organization in Chronic Pain

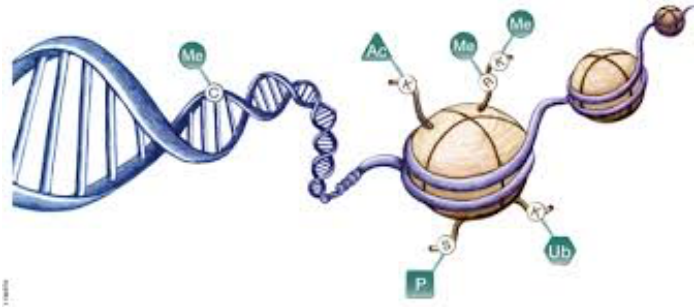
- Whereas acute pain motivates protective action, chronic pain **undermines motivational processes**
- Chronic pain conditions particularly engage medial prefrontal cortex and subcortical limbic areas (especially the dorsal and ventral basal ganglia, the amygdala, and the hippocampus).



From Apkarian et al., 2011 *Pain*

System Dysregulation and Diatheses

- The nervous system, the immune system, and the endocrine system work together when the body is exposed to stressors like pain
- Pain dysregulates these systems
- Dysregulation or breakdown in ability of system to recover normal functioning after trauma or injury
- People may also have specific vulnerabilities (diatheses) to injury
- Genetics may play a role in determining susceptibility to certain types of pain and pain sensitivity.



The Interplay of Cognitive and Contextual Factors in Pain

- The pain experience depends mostly upon the *subjective interpretation* of the person and differs depending on
  - the specific setting (at home, at work, at play) and
  - who else is present (family, friends, physician)
  - cognitive and affective variables

The Interplay of Cognitive and Contextual Factors in Pain

- Cognitive models of pain assume:
  - People have varying degrees of *internal control* over their pain experience and expression
  - People are not the "victims" of their biology or experiences
  - Cognitive models differ in how they categorize and explain the assortment of potential internal factors—expectancies, beliefs, imagery, coping skills, goals, anticipatory habits, self-awareness, attentional focus, patterns of self-talk, emotion regulation, etc.
  - These internal factors operate together to affect pain experience.
  - There are considerable *individual differences* in the operation of these mechanisms

The Interplay of Cognitive and Contextual Factors in Pain

- **Contextual models** assume
  - that internal mechanisms tend to be activated or elicited and subsequently supported by environmental conditions and cues
  - They also emphasize *cultural factors*
    - ethnicity, religion, and language differences may influence the experience and management of chronic pain
- Treating chronic pain necessitates altering both the internal factors and modifying the various situational variables that jointly contribute to the experience of chronic pain

Summary

- Many different forms of chronic pain with many different causes
- Still do not understand all of the factors or why pain persists for some and not others
- Common explanations include the gate control theory of pain, central sensitization, and brain re-organization
- Cognitive and contextual factors are important