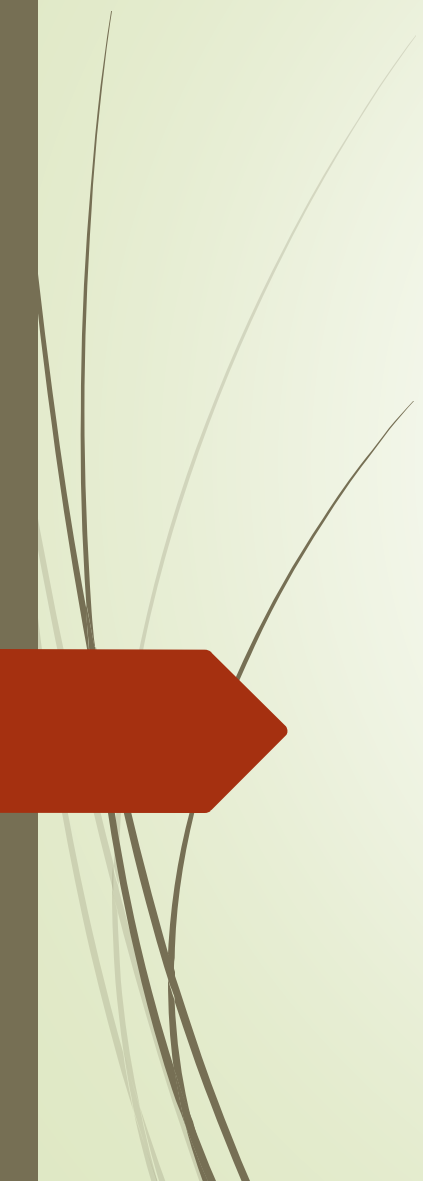




Neurophysiology of Hypnosis: Level 1 May 2026

Mary J. Wells, PhD

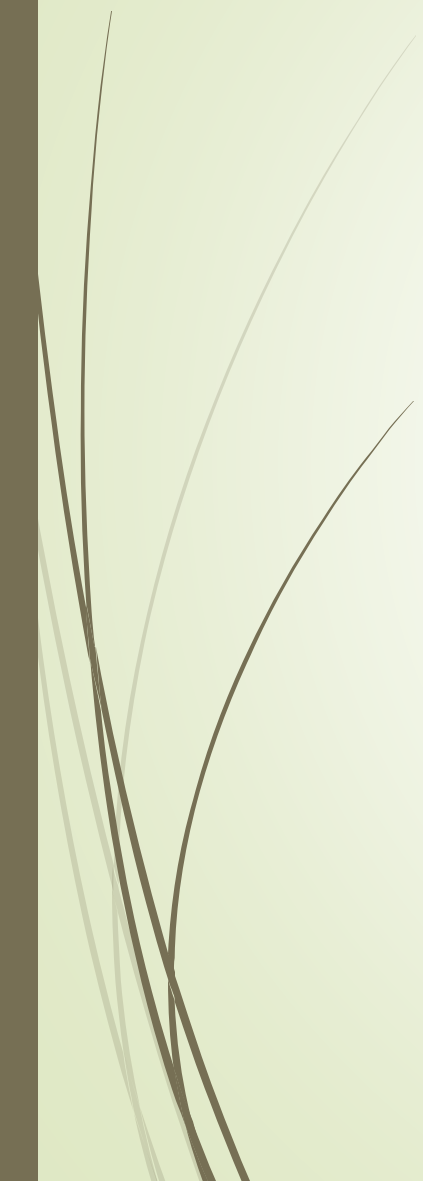
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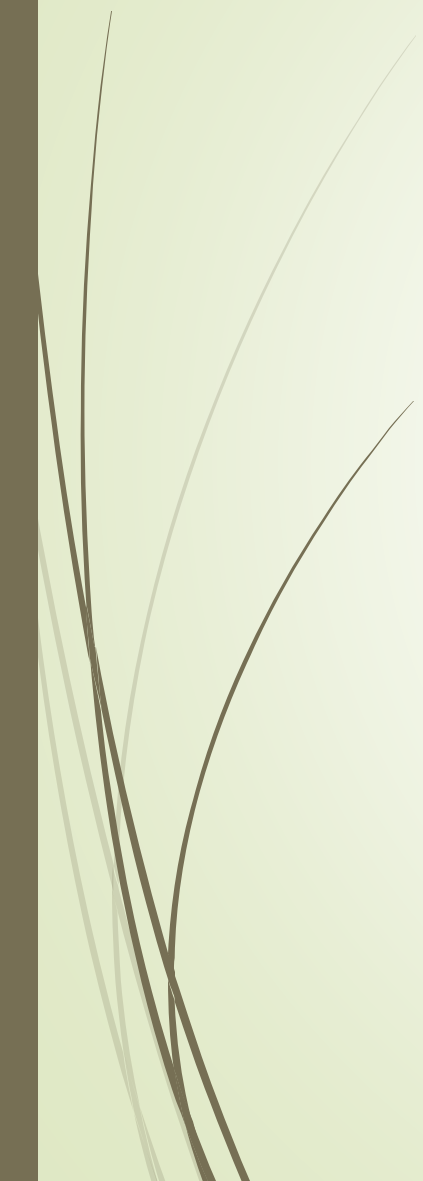
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Disclaimer



- I do not have any financial conflicts of interest to claim
- I will not discuss off label or investigational uses of medications.



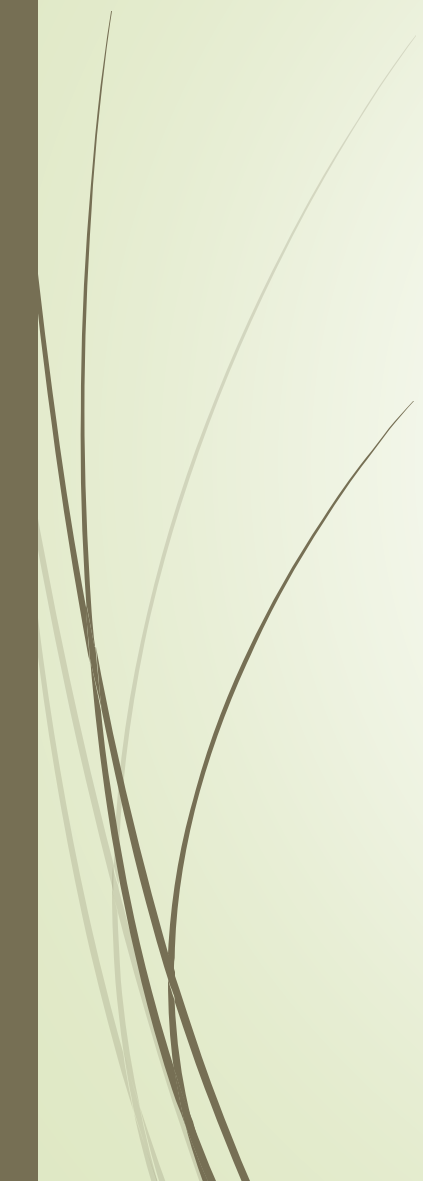
Objectives

At the conclusion of this session the participant will be able to:

- *Describe how hypnosis affects the autonomic nervous system and the stress response;*
- *Detail three implications of neurophysiological research on the practice of clinical hypnosis.*



What is Stress?

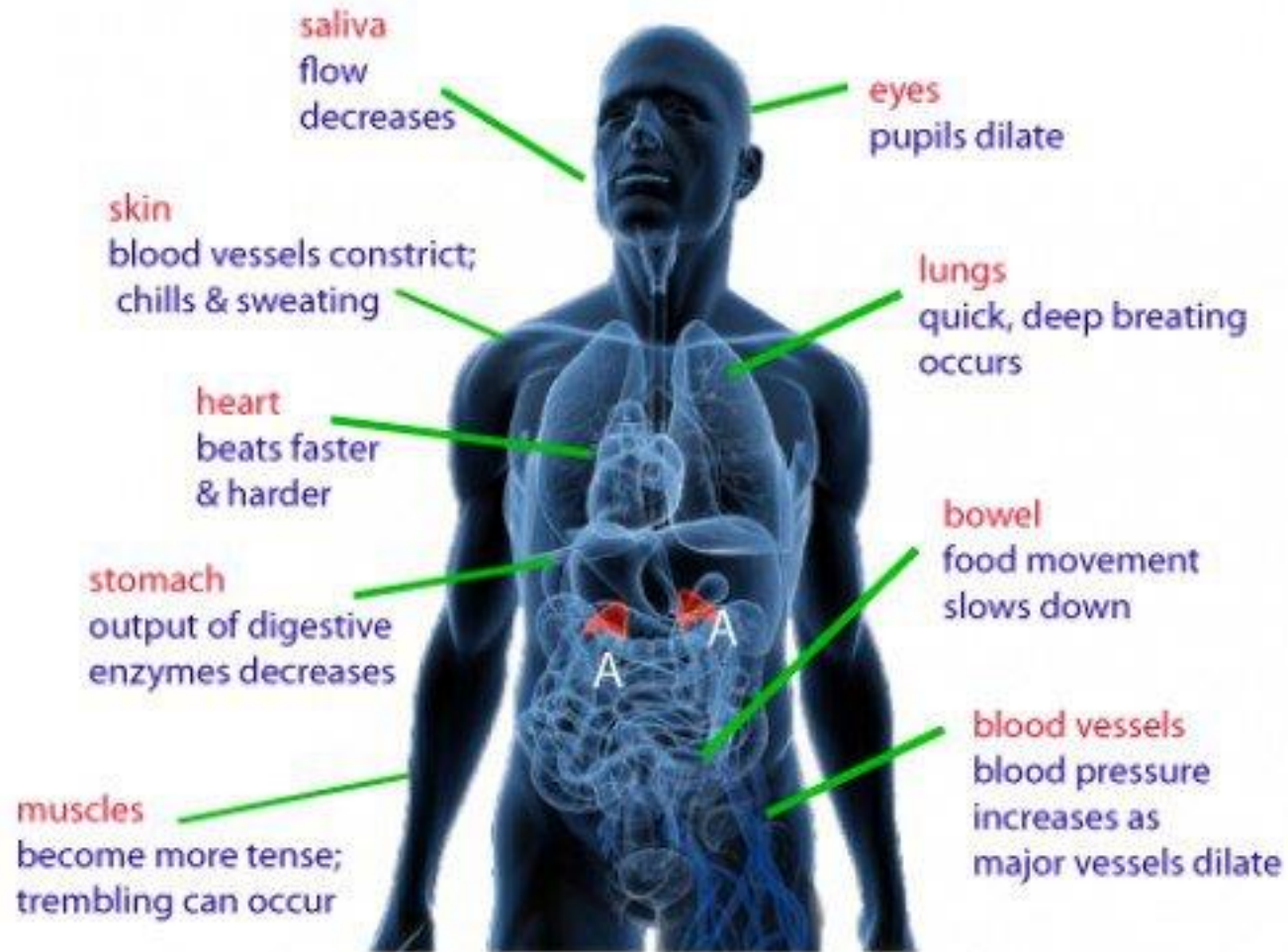
- a state of mental tension and worry caused by problems in your life, work, etc.
 - something that causes strong feelings of worry or anxiety
 - physical force or pressure
 - a physical, chemical, or emotional factor that causes bodily or mental tension and may be a factor in disease causation
- 



The “Dr. Wells” definition

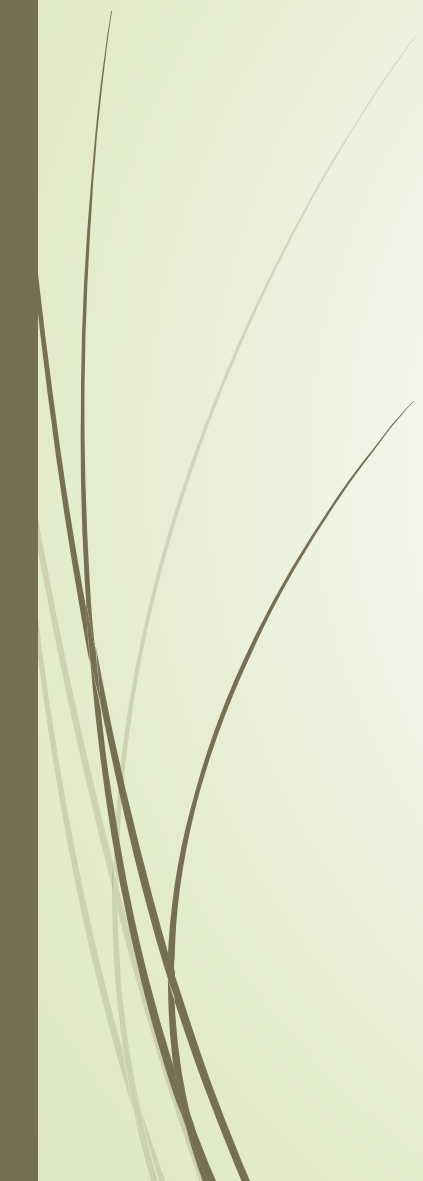
- A psychophysiologic response to perceived threat
 - Psychological-change in processing speed, loss of filters, appraisal of event as stress or harm
 - Physical-increased heart rate and blood pressure, increased muscle tension, decreased digestion and healing

Fight or Flight Response





Hans Selye

- Early 1930s
 - Developed concept of “generalized adaptation response”
 - Idea that chronic stress reaction differs from acute stress response and sets the stage for certain types of illness
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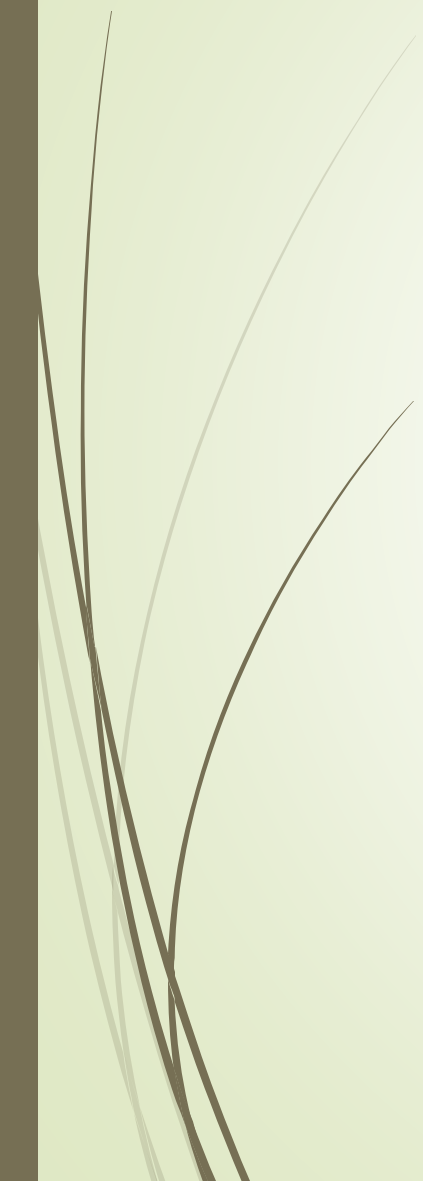


Hans Selye

- Generalized Adaptation Response
- Impact of sustained stress on physiology
- Foundation of psychophysiologic disorders
 - Acute and chronic pain
 - Headache
 - Cardiovascular disease
 - Raynaud's syndrome, autoimmune disorders
 - Gastrointestinal disorders
 - Asthma and COPD



The toll of stress

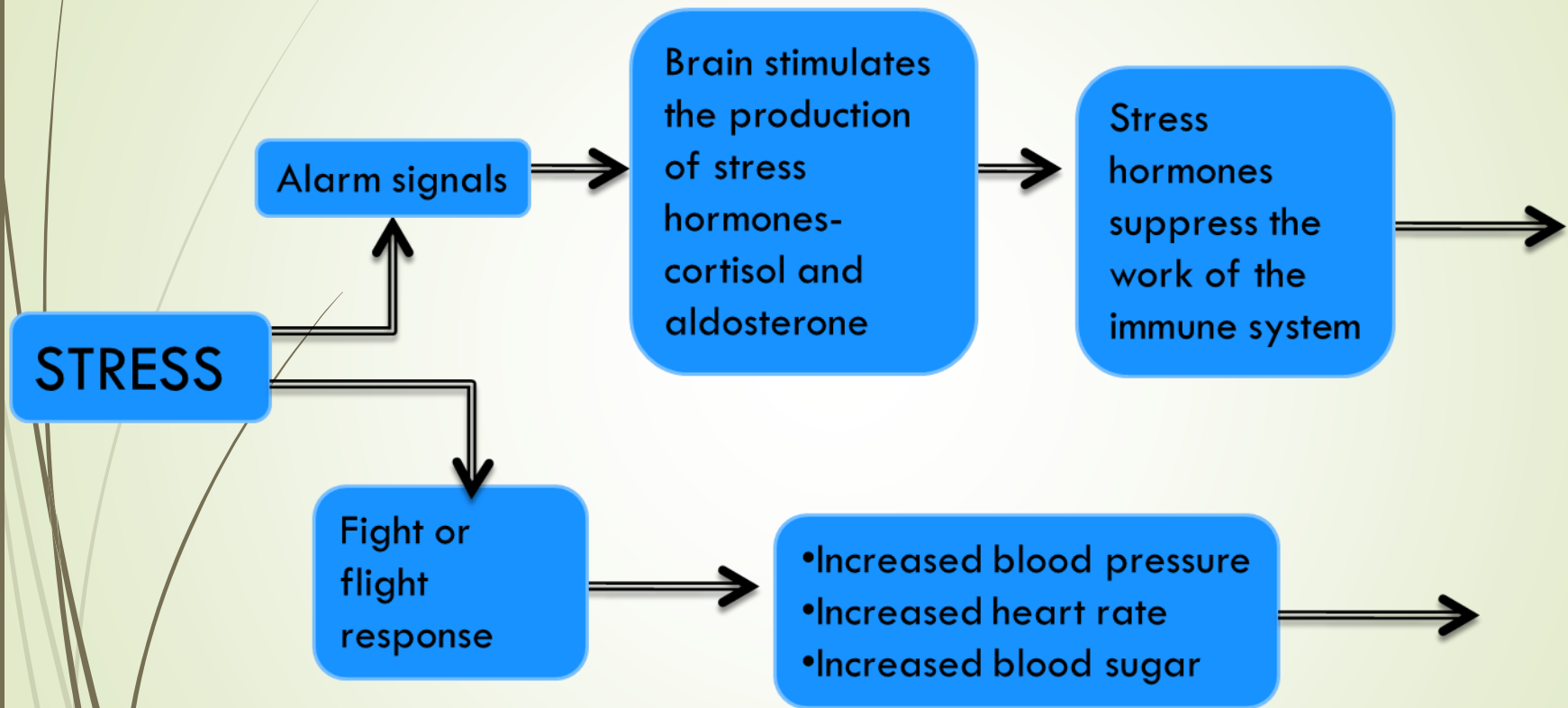
- Hard wired to click into fight or flight
 - No differentiation between mild and severe stress in the body's response
 - Current 21st Century living rife with stressors to include bills, traffic, information overload, relationship issues, to name a few
 - Are we human beings or human “doings”?
- 



Info from Mayo Clinic Website

- Stuck in High Gear or Chronic Stress
 - Useful but not designed to be on all the time
 - Hypothalamus triggers a response that stays on all the time
 - Increased cortisol and adrenalin
 - Increased heart rate, blood pressure, release of energy reserves, increased respiration rate
 - Decreased growth rate, immune function, digestion and reproduction systems

How stress leads to illness



INCREASED SUSCEPTIBILITY TO DISEASES AND INFECTIONS

HOW STRESS AFFECTS THE BODY

Zzzzz

Chronic Fatigue

Stress is recognized as the #1 proxy killer disease today. The American Medical Association has noted that stress is the basic cause of more than 60 % of all human illness and disease

Headaches, Dizziness, ADD/ADHD, Anxiety, Irritability & Anger, Panic Disorders

Grinding Teeth & Tension in Jaw

Increased Heart Rate, Strokes, Heart Disease, Hypertension, Diabetes Type I & II, Arrhythmias

Digestive Disorders, Upset Stomach, Abdominal Pain, Irritable Bowel Syndrome

Weight Gain & Obesity

Decreased Sex Drive



STRESS AFFECTS THE ENTIRE BODY & CAN CAUSE MANY OTHER PROBLEMS SUCH AS:

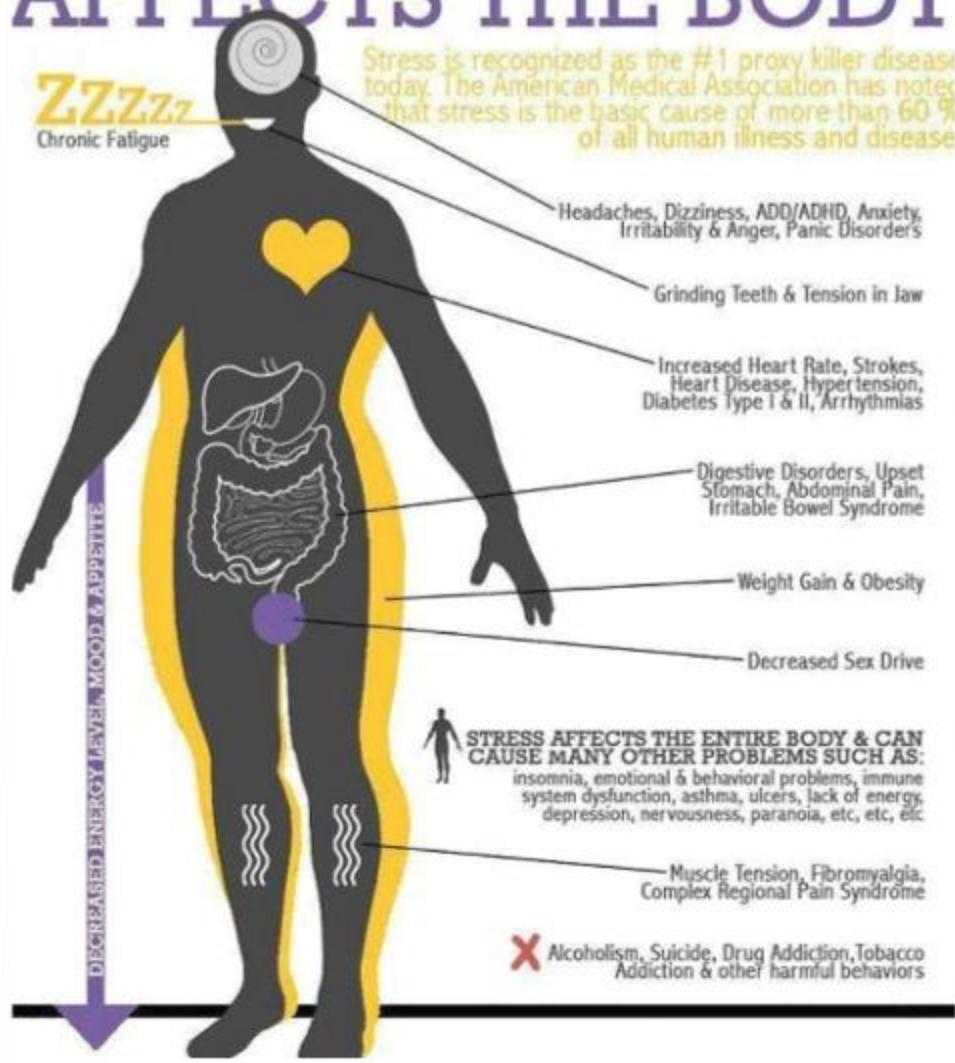
insomnia, emotional & behavioral problems, immune system dysfunction, asthma, ulcers, lack of energy, depression, nervousness, paranoia, etc, etc, etc

Muscle Tension, Fibromyalgia, Complex Regional Pain Syndrome



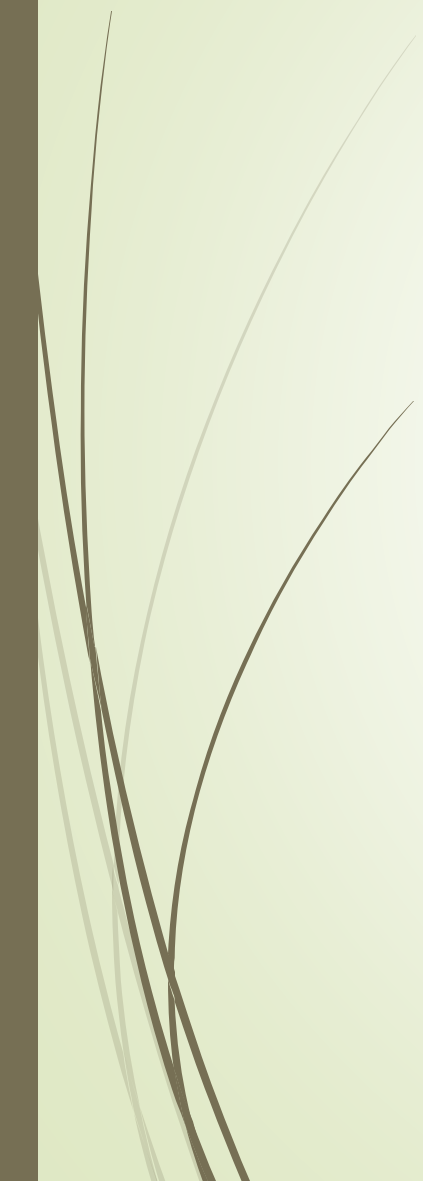
Alcoholism, Suicide, Drug Addiction, Tobacco Addiction & other harmful behaviors

DECREASED ENERGY LEVEL, MOOD & APPETITE





Balance Issue

- The stress response is designed to be followed by the relaxation response which returns the body functions back to normal state.
 - With chronic stress, that balancing system gets disrupted, setting the stage for marked system imbalance which can set the stage for a number of health problems
- 





New Research on Stress and Illness

- Clear links in literature between stress and arthritis
- Clear links in literature to links between stress and disease flares in autoimmune disorders

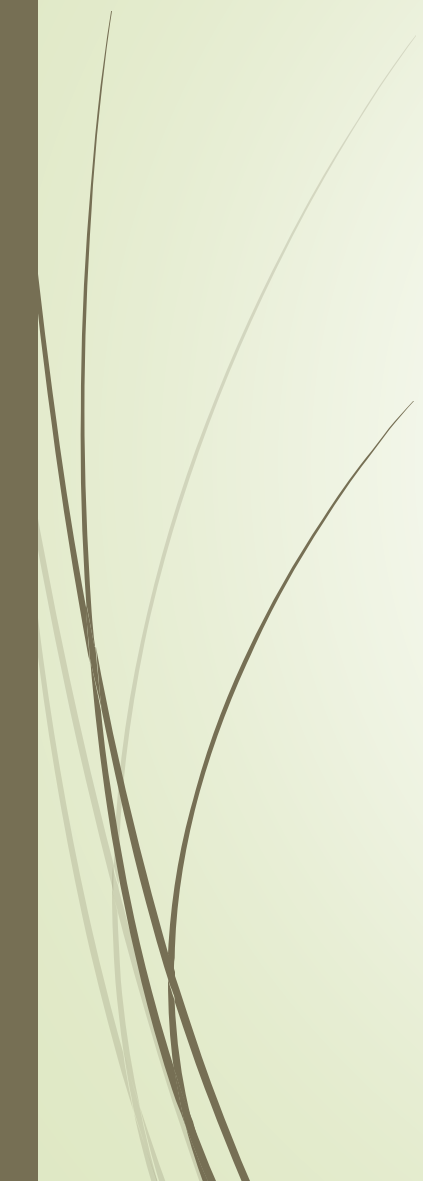


Cortisol and Inflammation Links

- Theory that long term stress exposes body to high levels of cortisol which may cause immune system molecules that promote inflammation to become overactive and attack healthy cells
- Cohen and the Carnegie Mellon work on colds: Cohen's contention that if the glucocorticoid receptors on the cells of the immune system fail to respond as they should to the presence of cortisol –“glucocorticoid resistance”, as it's known – the body's arrangements for keeping inflammation in check break down.
- Stress, says Cohen, changes the sensitivity of these receptors; they become resistant to the activating effects of cortisol.



Stress and Inflammation

- The real importance of the work, says Cohen, lies in its relevance to the many other conditions in which inflammation is a factor. “It’s a model that can be applied to many diseases. Cardiovascular disease, asthma, autoimmune disease, diabetes...The regulation of inflammation plays a big role in the progression of all of them.”
- 

Neurophysiology of Stress

Emotion/Stress involves the entire nervous system.

But...

Two parts of the nervous system that are especially significant:

Autonomic Nervous System

Limbic System



Steven Porges and the Polyvagal Theory

- New explanation of the autonomic nervous system
 - Used to be thought that there were only parasympathetic and sympathetic sides to the autonomic system
 - New research suggests that there is a hierarchical organization of function based in evolutionary biology, occurring in humans and other mammals
 - This theory focuses on the importance of “safety” and the adaptive consequences of detecting risk on our physiological state on our physiological state, social behavior, psychological experience and overall health

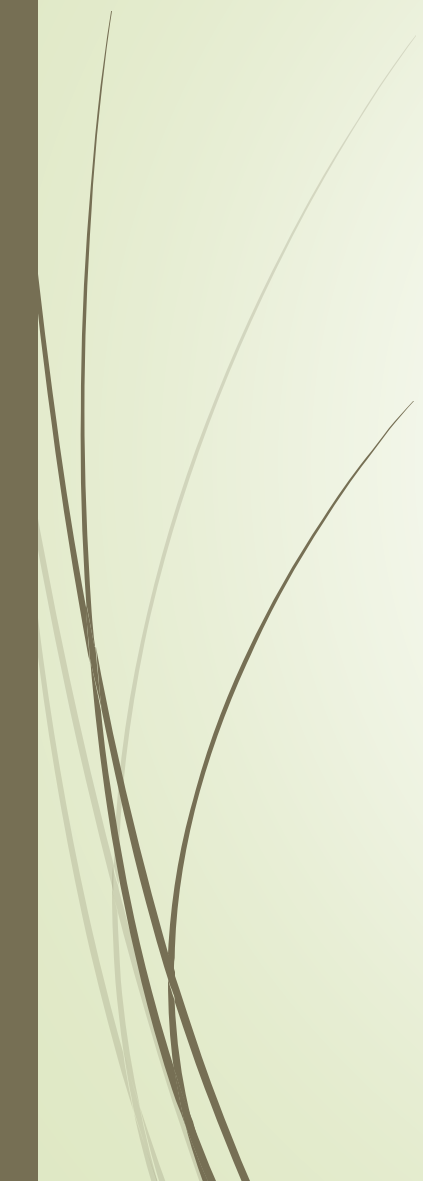


Neuroception

- Visceral reactions evaluate risk in the environment and determine if a situation is safe or potentially threatening
- Cognition plays a very secondary role
- The neural process that evaluates risk in the environment without conscious awareness is called **neuroception** (Porges 2003)



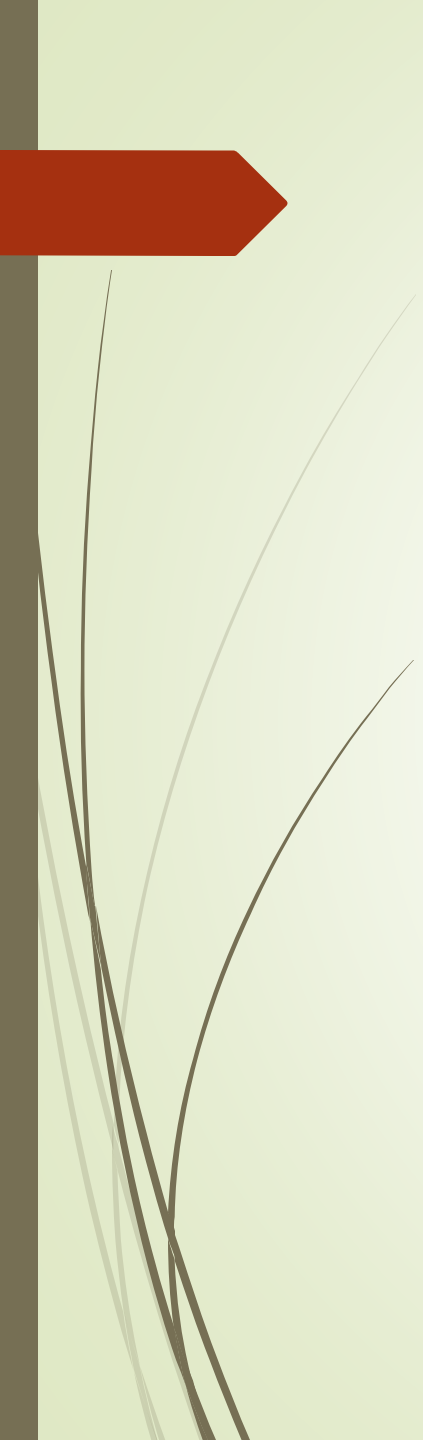
The Polyvagal Model-Two vagal mechanisms identified

- 1-Unmyelinated vagal pathways that provide primary vagal regulation of the organs below the diaphragm
 - 2-Myelinated vagal pathways that provide primary vagal regulation of the organs above the diaphragm
 - 3-Sympathetic nervous system
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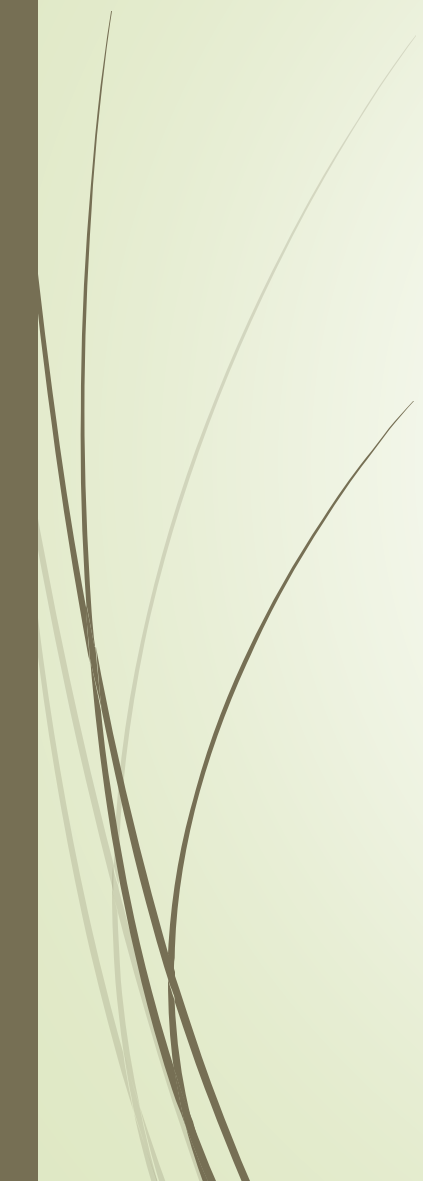
Different neural circuits are involved in different adaptive behaviors

- Unmyelinated: Ancient defense system, seen in reptiles and other ancient vertebrates is still embedded in mammals, including humans. This is an extreme response and consistent with what is seen in trauma reactions
 - Immobilization, feigning death, brachycardia and apnea
 - Potentially life threatening for mammals due to oxygen demand
 - Can be very difficult to recover and normalize after this type of response

- 
- Myelinated: Later evolutionary development that links engagement behaviors with physiological state.
 - *Enables cuing and detecting the affective states of individuals within species.*
 - *Signals whether it is safe to approach, make physical contact and create social relationships.*
 - *If cues reflect aggression or defensiveness, engagement can be immediately terminated without conflict or potential injury.*



Myelinated vagal system

- The social engagement system is defined as the nerves and structures that regulate facial expression, ingestion, listening and vocalizing and are integrated with the neural pathway of the autonomic nervous system that calms the heart and down-regulates defenses.
 - This is the “parasympathetic” system that we are all familiar with and is a defining feature of mammals, including humans.
 - It is bidirectional and links body state with facial expression and vocalizations that allow for social communication that involves requests for co-regulation and mechanisms to calm and repair the co-regulation following disruption.
- 



Adverse Childhood Experiences

- The relationship between adverse experiences and child well-being: (from a fact sheet published by Child Trends, July 2014, Moore, Sacks, Bandy and Murphy)
- Studies of adults who experienced multiple adverse experiences in their youth have found increased risk for poor health outcomes such as obesity, alcoholism, and depression.²
- Less is known about the relationship between adverse experiences and well-being in childhood or adolescence. The large sample of the NSCH allows us to examine the association between high numbers of negative experiences and measures of child well-being. The data reflect a consistent association, similar to that found for adults, indicating that a greater number of adverse childhood experiences are related to poorer well-being.
- In particular, our analysis finds that the percentage of adolescents with indicators of poor well-being is much higher among those who have had **three or more** adverse childhood experiences, compared with those who have experienced one or none, according to parental report. Nearly half of adolescents who have experienced three or more adverse childhood experiences have low levels of engagement in school, and do not finish tasks they start. Also, just over 40 percent demonstrate negative behaviors outwardly, such as arguing too much and bullying or being cruel to others, compared with 25 percent and 18 percent, respectively, of adolescents who have had no adverse childhood experiences. Our findings suggest a need for research and intervention efforts to prevent adverse childhood experiences and to mitigate their consequences.
- They also suggest that the ACEs measure represents a potential screening tool to identify children and youth at risk for negative outcomes.

<https://www.ncjfcj.org/sites/default/files/Finding%20Your%20ACE%20Score.pdf>



NPR article 3/2/2015

Take the ACE quiz

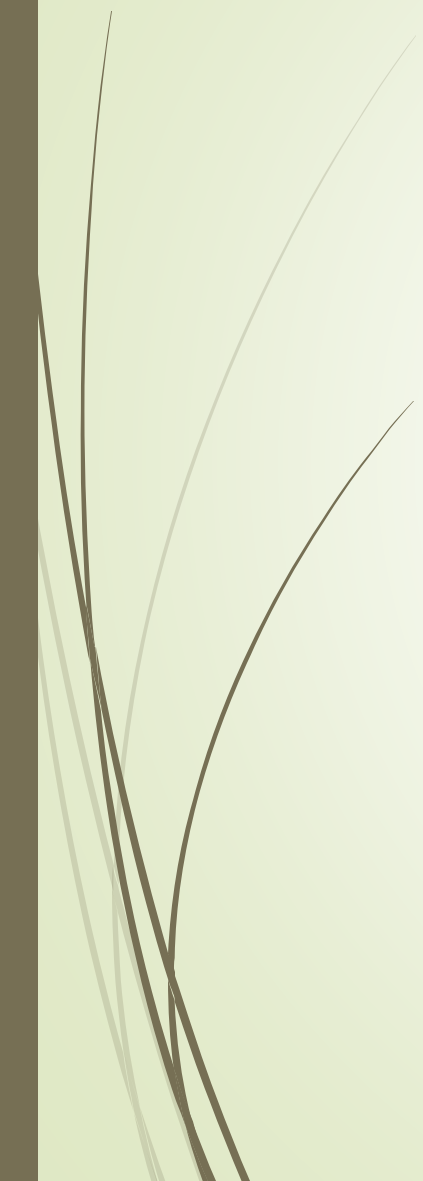
- An ACE score is a tally of different types of abuse, neglect, and other hallmarks of a rough childhood. According to the Adverse Childhood Experiences study, the rougher your childhood, the higher your score is likely to be and the higher your risk for later health problems.
- "There are people with high ACE scores who do remarkably well," says Jack Shonkoff, a pediatrician and director of the Center on the Developing Child at Harvard University.
- Resilience, he says, builds throughout life, and close relationships are key. Recent [research](#) also suggests that for adults, "trauma informed" therapy — which can center on art, yoga or mindfulness training — can help.



The Brain and the Nervous System (in brief)



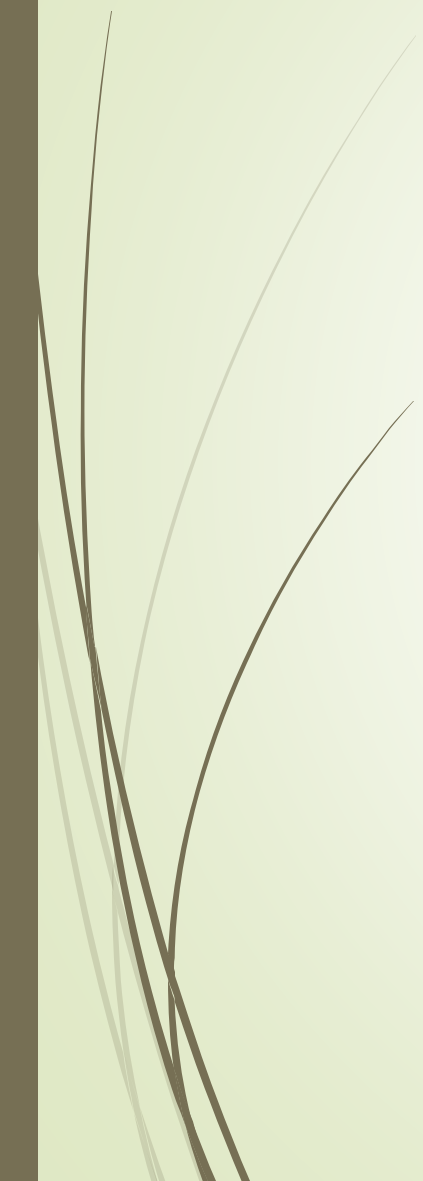
Nervous System



- Brain and spinal cord, peripheral nerves
- Autonomic nervous system
 - Takes care of most of the “automatics”
 - Blood pressure, digestion, arousal, healing
 - The back stage of the entire nervous system
 - Important in managing stress and arousal levels
 - Made up of two parts: sympathetic and parasympathetic



Basic Brain Anatomy

- Brain Stem-reptilian brain
 - Limbic System-mammalian brain
 - Cerebral Cortex-uniquely human part of brain
 - Demonstration
- 



Cerebral Cortex

- Prefrontal Cortex
 - Acts as “executive” for decision making process
 - Able to process current environment and past memories
- Somatosensory Cortex
 - Integrates sensory information about the body
 - Encodes where and severity and quality of stimulus

Limbic System

- Group of structures (Hypothalamus, Anterior Cingulate Cortex (ACC), Hippocampus, Amygdala, Insula) in the brain that is involved in emotion, motivation and memory
- Mediates emotional experience, emotional behavior, and **conversion of emotion into physiology.**

Limbic System

➤ Thalamus

- Gathers information from the internal and external environment
- Decides where to send incoming sensory data
 - From eyes, ears, mouth, skin
- Activation of thalamus , activates the amygdala

➤ Hypothalamus

- Major output pathway of the limbic system
- Electrical impulses from cerebral cortex are transduced into hormonal messengers by its connections to the ANS and Endocrine systems
- Regulates physiologically based drives such as thirst, hunger and sexual arousal

Limbic System

➤ Hippocampus

- Shaped like a seahorse
- High concentration of receptor sites for cortisol
- Important role in processing declarative memory
- Important for storing and encoding memories

➤ Amygdala

- Almond shaped
- Primary role in the experience and interpretation of emotional events and responses
- Links cerebral information to the ANS and assigns emotional significance to it.
- Does **not know** the difference between real or imagined event, it creates the **SAME** physiological response.

Anterior Cingulate Cortex

- complex cognitive functions, such as empathy, impulse control, emotion, and decision-making.



Basic Autonomic Functions

Parasympathetic	Sympathetic (flight or fight)
↓ heart rate	↑ heart rate
↓ blood pressure	↑ blood pressure
Stabilizes internal & external blood flow	Constricts peripheral blood vessels ↓ internal blood flow
↑ peristalsis of gastrointestinal system	↓ peristalsis of gastrointestinal system
	↑ epinephrine, norepinephrine, cortisol levels



The brain and hypnosis

- Explosion of research in last 20 years with newer and better tools to measure brain function
 - EEG
 - EEG and evoked potentials
 - Positron Emission Tomography (PET)
 - fMRI



Kosslyn Study (2000)

- Eight highly hypnotizable subjects were asked to see a color pattern in color, a similar gray-scale pattern in color, the color pattern as gray scale, and the gray-scale pattern as gray scale during positron emission tomography scanning by means of $[^{15}\text{O}]\text{CO}_2$.
- When subjects were hypnotized, color areas of the left and right hemispheres were activated when they were asked to perceive color, whether they were actually shown the color or the gray-scale stimulus.
- observed changes in subjective experience achieved during hypnosis were reflected by changes in brain function similar to those that occur in perception
- support the claim that hypnosis is a psychological state with distinct neural correlates and is not just the result of adopting a role.



Derbyshire et. al. Hypnosis and Fibromyalgia Pain (2009)

- suggestions following a hypnotic induction and the same suggestions without a hypnotic induction were used during functional magnetic resonance imaging to increase and decrease the subjective experience of fibromyalgia pain.
- Suggestion in both conditions resulted in significant changes in reported pain experience, although patients claimed significantly more control over their pain and reported greater pain reduction when hypnotized.



Derbyshire Continued

- ▶ Activation of the midbrain, cerebellum, thalamus, and midcingulate, primary and secondary sensory, inferior parietal, insula and prefrontal cortices correlated with reported changes in pain with hypnotic and non-hypnotic suggestion.
- ▶ These activations were of **greater magnitude**, however, in the cerebellum, anterior midcingulate cortex, anterior and posterior insula and the inferior parietal cortex when suggestions followed a hypnotic induction.
- ▶ Indicate direct involvement of a network of areas widely associated with the pain 'neuromatrix' in fibromyalgia pain experience.
- ▶ Evidence for the greater efficacy of suggestion following a hypnotic induction.



Amir Raz and the Stroop effect

- What is the Stroop effect
 - Test of asking subject to report the color of letters that appear in words. The words are color words written in conflicting colors which results in a conflict between color and meaning. Word **meaning** is more important than ink color, creating interference when instructed to attend to only ink color. This interference takes place without awareness and even when you are trying not to do it. Creates error and slowed processing.



Raz research (2006)

- Divided low and high hypnotizables
- Given post hypnotic suggestion that they would see stimulus words as meaningless
- Net effect was to **dramatically** reduce Stroop interference in research subjects
- This means that post hypnotic suggestions have an effect on automatic behaviors and may be more important than realized in working with habit disorders



Paying attention in hypnosis

- Attention is correlated with activations in the ACC and frontal cortex
 - Three attentional subsystems
 - Executive
 - Orienting
 - Alerting
- In hypnosis, there is a suggestion of inhibition of frontal lobe activity and a redistribution of functional brain activity based on suggestions given
- Supports Hilgard's concept of neodissociation



Paying attention in hypnosis

- Importance here is that attention is not a singular mechanism
- Composed of multiple, interactive conscious and unconscious processes
- Different areas of the brain regulate different types of attention
- The neural markers of hypnosis may well be dependent on the content/context of the hypnotic process rather than a single neurological marker-Kihlstrom 2003



The Brain and Hypnosis

- Distinct areas of the brain have altered activity and connectivity when an individual is in a hypnotic trance.
 1. decrease in activity in the area of the dorsal anterior cingulate, part of the brain's salience network;
 2. increase in connectivity between the dorsolateral prefrontal cortex and the insula, the brain-body connection;
 3. reduced connectivity between the dorsolateral prefrontal cortex and the default mode network, a disconnect or disassociation of actions from awareness of the actions.

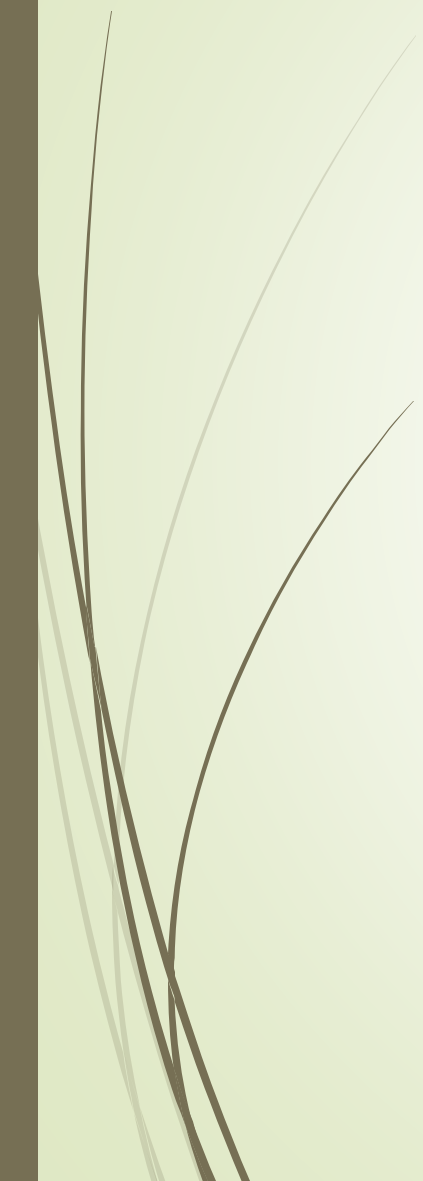


Neurophysiology in Brief

- ▶ J Cognitive Neuroscience 1999 Rainville et al
- ▶ Hypnosis was accompanied by significant increases in both occipital regional cerebral blood flow (rCBF) and delta EEG activity, which were highly correlated with each other ($r = 0.70$, $p < 0.0001$). Peak increases in rCBF were also observed in the caudal part of the right anterior cingulate sulcus and bilaterally in the inferior frontal gyri. Hypnosis-related decreases in rCBF were found in the right inferior parietal lobule, the left precuneus, and the posterior cingulate gyrus. Hypnosis-with-suggestions produced additional widespread increases in rCBF in the frontal cortices predominantly on the left side. Moreover, the medial and lateral posterior parietal cortices showed suggestion-related increases overlapping partly with regions of hypnosis-related decreases.



Neurophysiology continued

- Results support a state theory of hypnosis in which occipital increases in rCBF and delta activity reflect the alteration of consciousness associated with decreased arousal and possible facilitation of visual imagery. Frontal increases in rCBF associated with suggestions for altered perception might reflect the verbal mediation of the suggestions, working memory, and top-down processes involved in the reinterpretation of the perceptual experience.
- 



Halsbrand and Wolf Review 2021 AJCH

- Multiple studies have shown increase in plasticity in neuronal activity after trance induction (increase in occipital regional cerebral blood flow, decrease in cortical arousal, reduction in cross-modality suppression, increases in mental absorption and increased cerebral blood flow in brain's attentional systems)
- Relative deactivation or decreased functional connectivity of the default mode network in hypnosis and increased readiness to respond to suggestions
- Hypnosis is associated with greater theta oscillations (gamma is hypothesized to be involved but much harder to measure)



Jensen et al 2017 Research Summary

- Research supports the role of divisions in the anterior cingulate and prefrontal cortices in hypnotic responding
 - Neuroimaging studies have consistently demonstrated that subjective changes in response to suggestion are associated with corresponding changes in the brain regions related to the specific psychological function in question such as pain reduction
- Hypnosis treatments have demonstrated efficacy for a number of conditions to include pain, irritable bowel syndrome and PTSD



Brain and Hypnosis

From Gary Elkins Handbook of Medical and Psychological Hypnosis 2017

- Advances in neuroimaging have created expectation that neuroscience can elucidate the human mind
- 20+ years of research have yet to deliver a reliable biological model of hypnosis
- Central obstacle is the inherent complexity of hypnotic phenomena which emerge from the interaction of multiple factors



Three Factors Play a Central Role

- Individual differences in hypnotizability
 - Differences in hypnotic response connected to differences on the frontal lobe, executive control and top-down regulation and monitoring processes
- The induction procedure itself
 - Brain imaging shows the complex neural networks of alerting and executive function, connects to mental absorption and decrease in default mode network, decoupling the executive control from monitoring
- Type and content of hypnotic and post-hypnotic suggestions
 - Selectively engage specific brain networks that correspond to the content of the suggestions



In Summary

- No consensus on how to reliably measure hypnosis
- Not a stable trait and can vary from session to session or throughout a single day
- Influenced by contextual factors, individual difference and properties of stimuli (e.g. hypnotic scripts)
- In large part based on the special rapport between participant and facilitator
- The power of a suggestion is based on the client's idiosyncratic response, what the response means to the client and how it can be utilized.

Brain Waves

Beta



Alert, processing information, and learning.

Alpha



Relaxed, meditation, and daydreaming.

Theta



Deep Meditation, Hypnosis, and light sleep

Delta

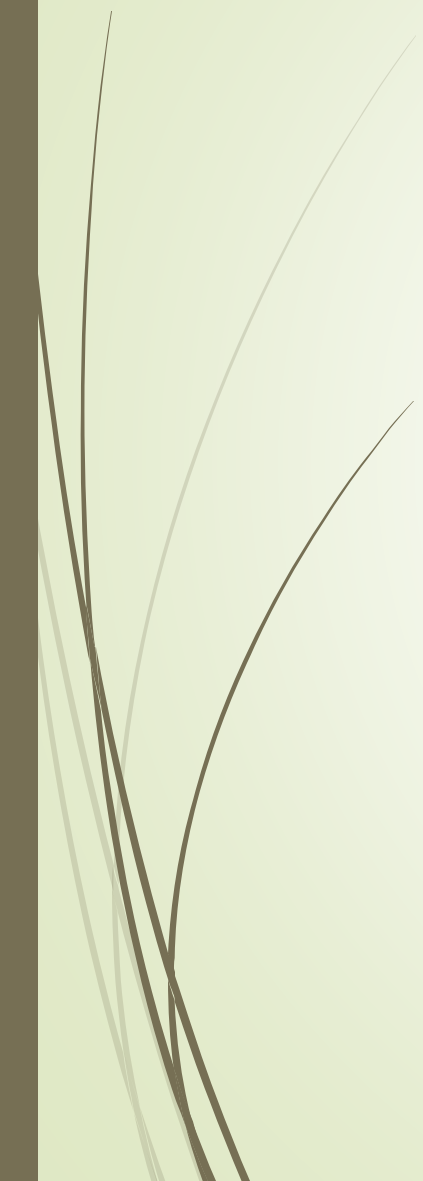


Deep hypnosis, sleep, loss of bodily awareness.

Brilliant / Side

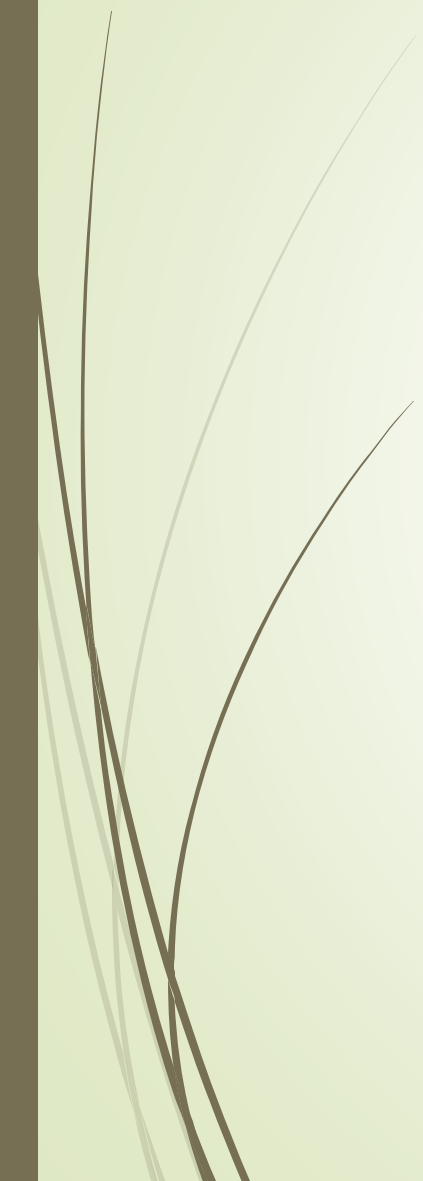


EEG-Alpha and Theta waves

- 
- Early studies suggested hypnosis is an alpha wave state but this has not held up as well over time
 - Now research focusing on coherence or synchronicity of various areas of cortex. High coherence means stronger connection of shared functions
 - High hypnotizables seem to have lower coherence, supporting notion of inhibition of frontal regions in hypnotic process



EEG and Theta

- ▶ Theta waves associated with higher levels of hypnotizability and also focused attention. As individuals enter into hypnosis theta increases.
 - ▶ Seems to be trait for relaxation but not for hypnosis
 - ▶ Neurophysiology of deep hypnosis and deep meditation are similar but not identical.
 - ▶ Suggestions seem to be the differentiating factor in what parts of the brain are activated and when.
- 



Mirror Neurons and Neuroplasticity

- Humans are hard wired for connection
- Wired monkeys: specific neurons would fire with various activities but interestingly, monkeys PASSIVELY WATCHING would have the same neurons firing, mirroring the activity.
- Humans have this same capacity which translates into attunement or harmony with others. This allows us to feel close to others and resonate with their inner world.



Mirror Neurons and Neuroplasticity

- We do create new brain cells later in life (neurogenesis) and they can change with experience, at least to some extent (neuroplasticity) Seigel 2007, 2010.
- Hypnosis has been shown to promote both neurogenesis and neuroplasticity as a direct function of the attunement made possible by mirror neurons- Rossi 2007; Simpkins and Simpkins 2010.
- All forms of psychotherapy have an emphasis on the development of a close alliance between therapist and patient/client as the key to positive change

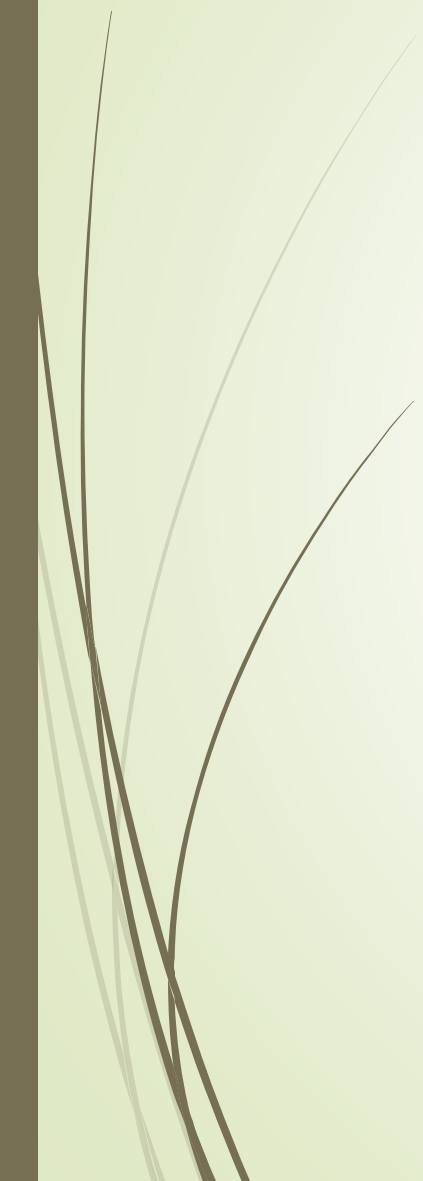


What does this mean??

- First of all, can we and should we define hypnosis or even cognition in solely biological terms? Evidence is overwhelming that all disorders have psychological and psychosocial underpinnings. We are MORE than brainwaves, cerebral blood flow or hemispheric activation.
- However, new research supports that all medical and psychological disorders can have biological underpinnings that need to be addressed.



What does this mean??

- The therapeutic alliance is KEY in the development of meaningful change and research now supports that
 - Hypnosis does change brain function
 - Different types of suggestions light up different areas of the brain.
 - Hypnosis takes place in a physical context as well as a social or interpersonal one and involves personal characteristics such as motivation and expectations.
- 



Hypnosis vs. Meditation

simplified summary

meditation = non-stimulation, non-reaction,
non-attachment, typically not goal-directed

hypnosis = stimulation, responses to external
communication, goal-directed attachment to
suggestions, and imprinting of new ideas and
behaviors





Explaining differences to patients

Mindfulness

- Goal: Detached observation of here and now experience
- Generalized Reality Orientation (GRO) heightened
- Paradigm: Self-regulation
- Method: detached observation
- Prefrontal cortex and ACC: connected

Hypnosis

- Goal: Trance to achieve behavior change and health promotion
- GRO: Faded
- Paradigm: Utilization of trance phenomena
- Method: Therapeutic Suggestion
- Prefrontal cortex and ACC: decoupled