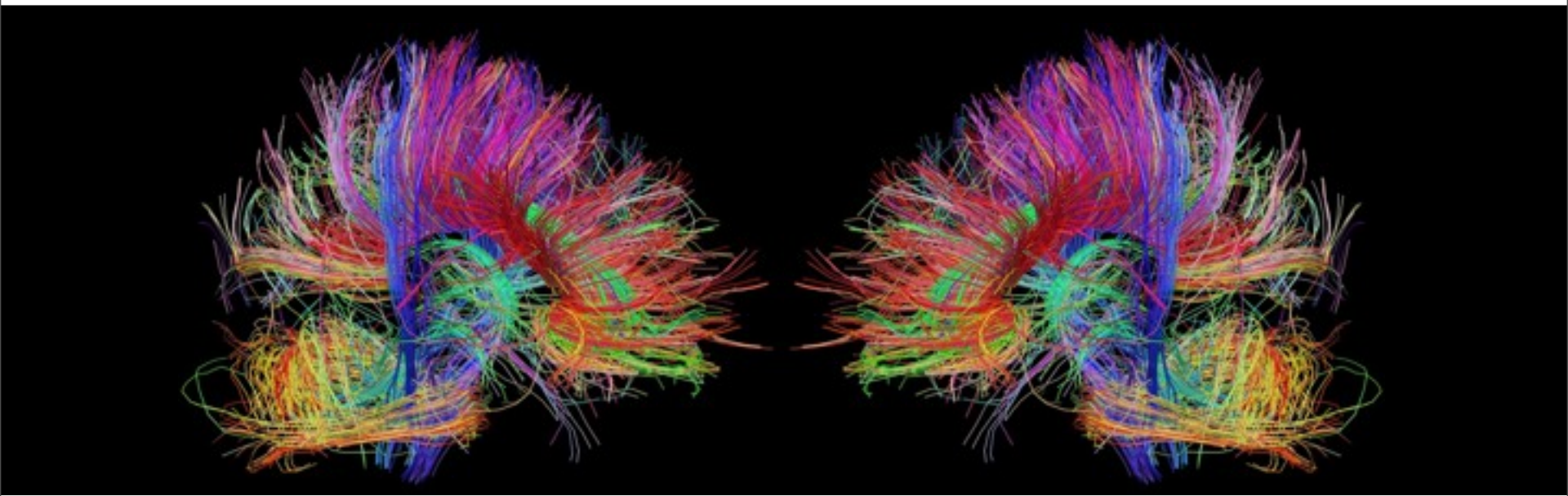
The Neuropsychology of Emotion



Joseph P. Barsuglia, Ph.D.

VA GRECC Neuropsychology Postdoctoral Research Fellow

Hemali Panchal

UCLA Neuroscience Undergrad & Research Assistant

January 17, 2014

***Special thanks to Natalie Kaiser and Dr. Mendez*

The Neuropsychology of Emotion

"We think too much and feel too little."
- Charlie Chaplin

"Unexpressed emotions will never die. They are buried alive and will come forth later in uglier ways."
- Sigmund Freud

"Is it really possible to tell someone else what one feels?"
- Leo Tolstoy

The Neuropsychology of Emotion

- Exercise

- As you transitioned into the exercise did anything shift or change inside of you?

- What was the series of events that happened inside?

- Could you describe your experience with an emotion?

The Neuropsychology of Emotion

Emotions Defined

What are emotions?

- Science Daily.com - “neural impulse that moves an organism to action, prompting automatic reactive behavior that has been adapted through evolution as a survival mechanism to meet a survival need.”

- Izzard (2010) - Surveyed 35 distinguished scientists in psychology and behavioral neuroscience and asked, “What is emotion?” Unable to synthesize responses; however best definition:

  “Neural circuits, response systems, and a feeling state/process that motivates and organizes cognition and action. Emotion provides information to the person experiencing it, and may include antecedent cognitive appraisals and ongoing interpretation of its feeling state, expressions or social-communicative signals, and may motivate approach or avoidance behavior, exercise control/ regulation of responses, and be social or relational in nature.

The Many Meanings/Aspects of Emotion: Definitions, Functions, Activation, and Regulation 2010 2: 363 *Emotion Review*

The Neuropsychology of Emotion

Emotions Defined

What are emotions?

Feelings - subjective representation of emotions, private to the individual experiencing them.

Mood - diffuse affective states that generally last for much longer durations than emotions and are also usually less intense than emotions.

Affect - is an encompassing term, used to describe the topics of emotion, feelings, and moods together, even though it is commonly used interchangeably with emotion.

Separated into facets:

- **Behavioral (Actions)**
- **Autonomic (Physiological)**
- **Hormonal (Physiological)**
- **Internal Subjective Experience (Psychological)**

Fox, Elaine (2008). *Emotion Science: An Integration of Cognitive and Neuroscientific Approaches*. Palgrave MacMillan.

The Neuropsychology of Emotion

Defining Emotions

Categorical Model

- "Basic" emotions.
- Consensus is 5-6 basic emotions: happiness, fear, sadness, anger, disgust/contempt, and surprise. Surprise questioned (e.g., Oatley and Johnson-Laird, 1987) because it is rarely present in the absence of a secondary emotion.

Appraisal Scenarios	Distinct Universal Signals	Distinct Physiology
Happiness	Happiness	---
Fear	Fear	Fear
Disgust	Disgust/Contempt	Disgust
Anger	Anger	Anger
Sadness	Sadness	Sadness
---	Surprise	---

From text *Cognition and Emotion, From Order to Disorder*, Power & Dalgleish, 2008

The Neuropsychology of Emotion

Can you identify the six emotions?

The Neuropsychology of Emotion

Can you identify the six emotions?

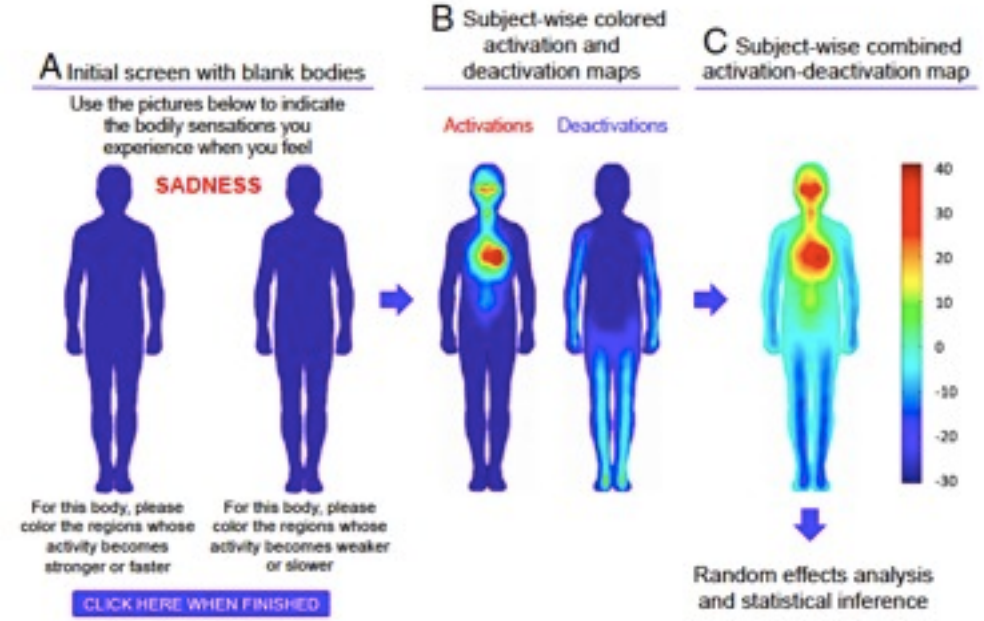
The Neuropsychology of Emotion

Defining Emotions

Categorical Model - Universality of Basic Emotions

- Eckman and Friesen in 1971 landmark study, Constants across cultures in the face and emotion. Told stories to natives with themes of 6 primary emotions.

- In a recent paper (2013), 701 participants from Finland, Western Europe, Taiwan, and East Asia viewed emotional words and movies and colored the regions on a silhouette they felt increased or decreased while viewing each stimulus.



The Neuropsychology of Emotion

Defining Emotions

Categorical Model - Universality of Basic Emotions

●Had 72% accuracy. One-out linear discriminant analysis (LDA) classified each of the basic emotions and the neutral state against all of the other emotions with a mean accuracy of 72% (chance level 50%),

Nummenmaaa, Glereana, Harib, & Hietanend (2013) *Bodily maps of emotions*, PNAS

The Neuropsychology of Emotion

Defining Emotions

Categorical Model

- Secondary or "Complex" emotions. Emotions that develop with cognitive maturity and vary across individuals and cultures. More socially-determined and culturally-bound.

Behavioral States	Motivational States	Moods &Background Emotions	Emotion Systems+	Basic Emotions	Social Emotions*
Approach	Reward	Depression	Seeking	Happiness	Pride
Withdrawal	Punishment	Anxiety	Panic	Fear	Embarrassment
	Thirst	Mania	Anger	Rage	Quilt
	Hunger	Cheerfulness	Fear	Disgust	Shame
	Pain	Contentment		Sadness	Maternal love
	Craving	Worry		(Surprise)	Sexual love
				(Contempt)	Infatuation
					Admiration
					Jealousy

Emotions are situated in a continuum of response classifications. The more primitive classes, towards the left, pertain to emotional reactions, whereas the more complex classes, towards the right, pertain to social communication. Typically, researchers working on animals have adopted a scheme relying on reward and punishment, whereas research in humans has often used so-called 'basic' emotions, and psychiatric or social psychological studies have utilized even more complex constructs such as the **'social' emotions***, whose neural underpinnings are at present very poorly understood. Reproduced with permission from Adolphs's 2002 article that appeared in *Behavioral & Cognitive Neuroscience Review.*

From: Ralph Adolphs (2002), Neural Systems for Recognizing Emotions

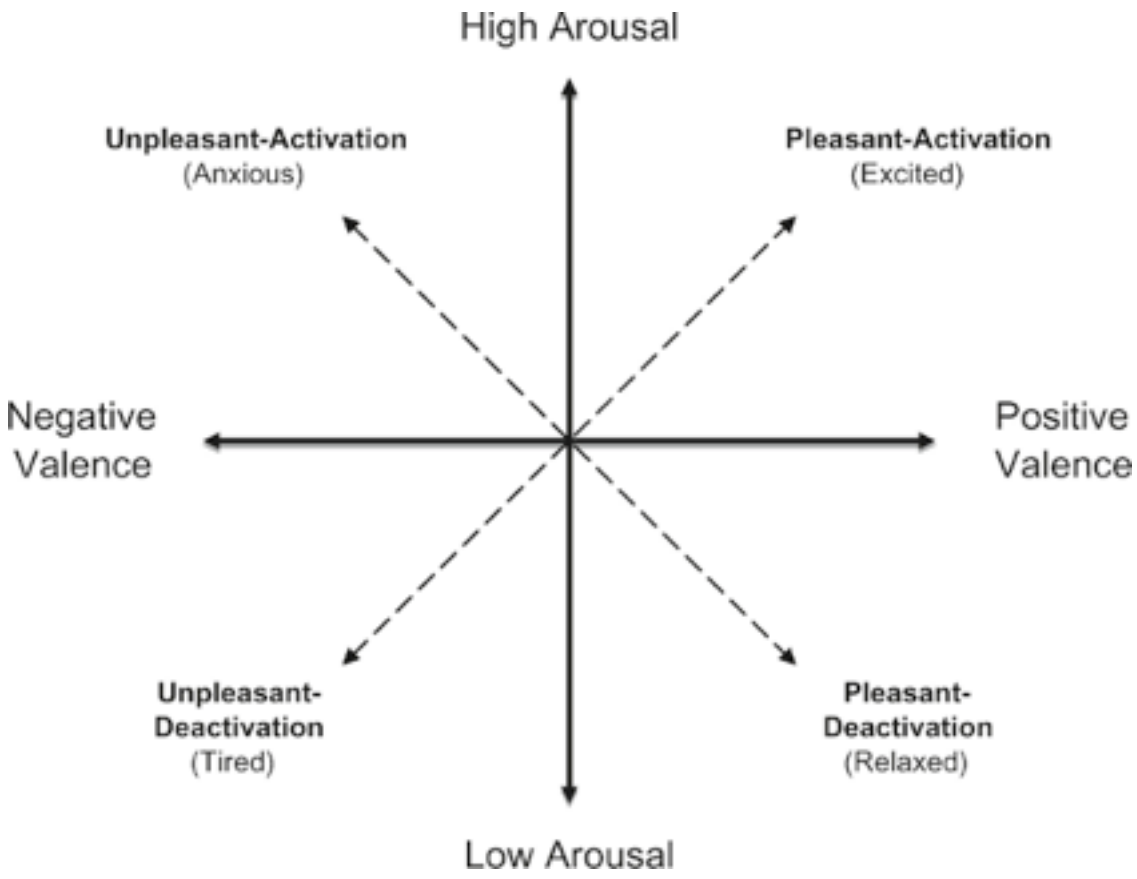
+ Panksepp J: *Affective Neuroscience*. New York: Oxford UniversityPress; 1998.

The Neuropsychology of Emotion

Defining Emotions

Dimensional or Circumplex Models (Tellegen & Watson):

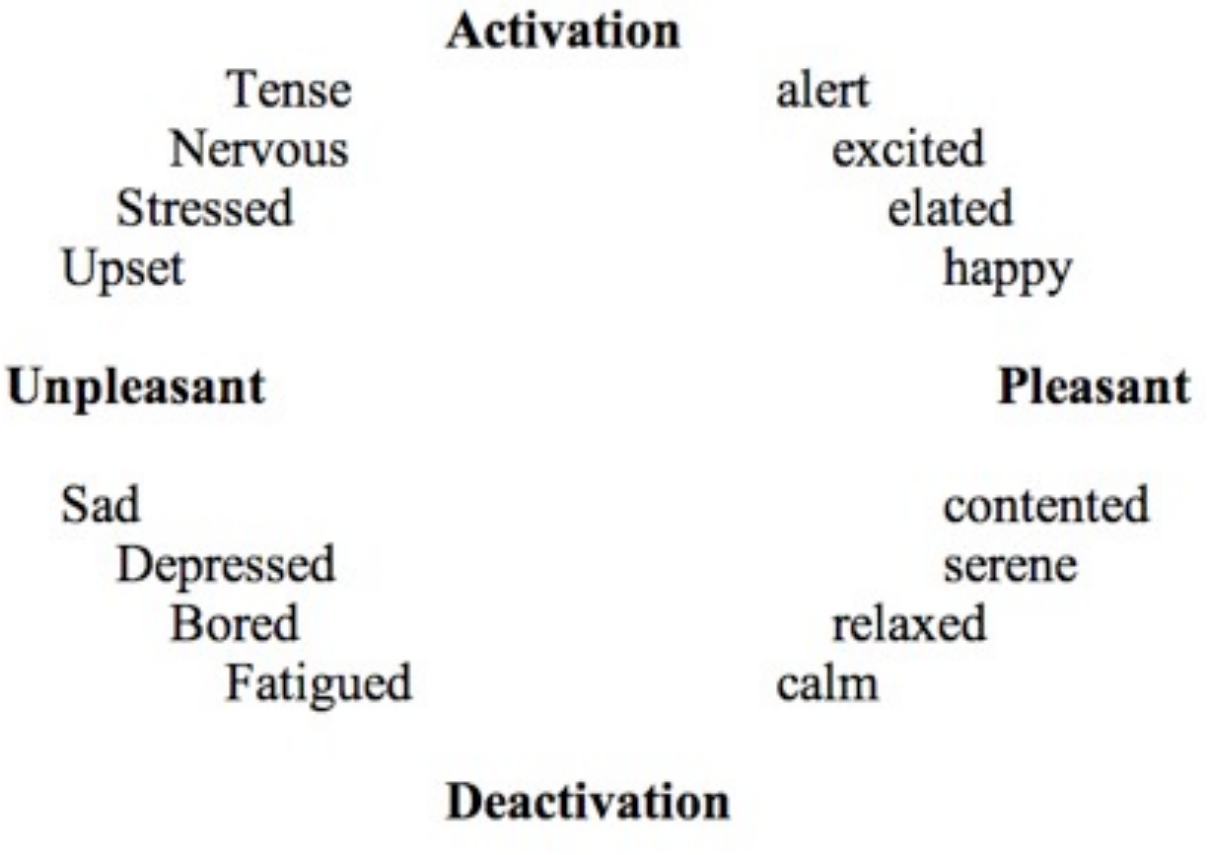
- Orthogonal, positive/ negative bipolar dimensions (e.g., PANAS scale)



The Neuropsychology of Emotion

Defining Emotions

Dimensional or Circumplex Models (Tellegen & Watson):



Evolutionary Function of Basic Emotions

TABLE 10.1

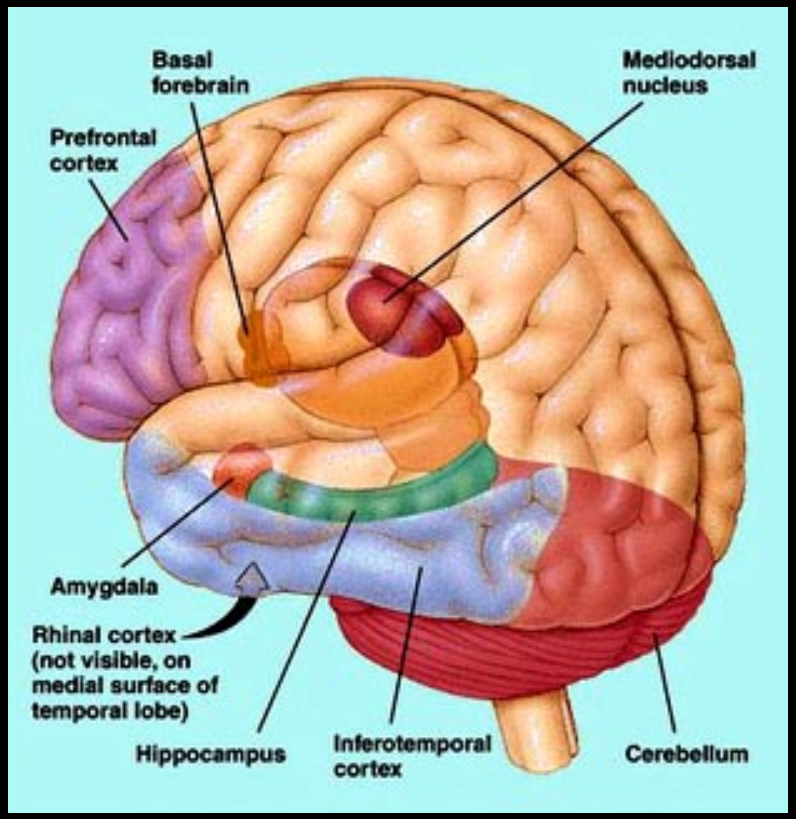
Characteristics of Some Families of Emotion

Emotion type	Goal connected with the emotion	Meaning regarding the self	Meaning regarding others	Action tendency
Disgust	Avoiding contamination or illness	This stimulus may contaminate me or make me ill	—	Active rejection of the thing causing disgust
Fear	Maintaining one's own physical and psychological integrity	This stimulus is threatening to me	—	Flight or withdrawal
Anger	Attaining the end state that the individual currently is invested in	There is an obstacle to my obtaining my goal	—	Forward movement especially to eliminate obstacles to one's goal
Sadness	Attaining the end state that the individual currently is invested in	My goal is unattainable	—	Disengagement and withdrawal
Shame	Maintaining others' respect and affection; preserving self-esteem	I am bad (my self-esteem is damaged)	Others notice how bad I am	Withdrawal; avoiding others, hiding oneself
Guilt	Meeting one's own internalized values	I have done something contrary to my values	Someone has been injured by my actions	Movement to make reparation, to inform others, or to punish self

Adapted from Saarni et al. (1998), p. 239

Affective States & Traits

- Affect correlates with two rudimentary motivational systems
  - Approach – positive (happiness, pleasure)
  - Avoid – negative (fear, disgust)
- Motivation/affect & prefrontal cortex
  - Left PFC – happiness & pleasure
  - Right PFC – anxiety & depression



Emotions and the Brain

Emotions and Culture

- Culture determines what people feel angry, sad, lonely, happy, ashamed or disgusted about.

- Some cultures have words for specific emotions unknown to other cultures.
  - Ex. Schadenfreude

- Some cultures don't have words for emotions that seem universal to others.
  - Tahitian and sadness

- Differences in secondary emotions appear to be reflected in differences in languages.

The Neuropsychology of Emotion

Historic Theories of Emotional Processing

James-Lange Theory (late 19th century)

- Emotion is a direct result of physiological arousal.
- We feel sad because we are crying. We feel fear because our hearts are racing. "I am trembling, therefore I am afraid"
- "The nervous system of every living thing is but a bundle of predispositions to react in particular ways upon the contact of particular features of the environment" (James, 1884)

Cannon-Bard Theory (early 20th century)

- Physiological arousal does not have to precede emotional expression or experience. Arousal and emotion are separate independent events that occur simultaneously.

Schachter-Singer - Two-factor (mid 20th century)

- Emotion is based on two factors: arousal & cognitive labeling
- Did "Suproxin" (epinephrine) experiment.

The Neuropsychology of Emotion

Modern Theories of Emotional Processing

Appraisal Theories (e.g., Arnold, 1960; Frijda 1986; Lazarus, 1966)

- The cognitive aspect involved in elicitation of emotion is unconscious or otherwise automatic, and occurs immediately after the stimulus, prior to the bodily response.

Network Theories (Berkowitz, 1990; Bower, 1981; Lang, 1985)

- Activation of memory is the principal cause of emotions. A limited number of stimuli elicit unconditioned emotional responses; however the range of stimuli that evoke emotions is elaborated through conditioning. Emotions are represented in schemas, in which each has a localist representation (node).

Barrett's Theory (2006)

- Two factor theory: (1) A stimuli elicits core affect. (2) Core affect is cognitively categorized. Internal categorization of core affect is a form of perception that is influenced by prior conceptual knowledge. Whether a core affect is categorized as anger, fear, or sadness depends on acquired emotion scripts.

The Neuropsychology of Emotion

Modern Theories of Emotional Processing

Zajonc-Lazarus Debate

Does emotion **precede** or **follow** cognition?

Robert Zajonc

Emotion precedes cognition.

People react to stimuli often before knowing what it is.

Richard Lazarus

cognitive appraisal theory

emotion cannot occur without prior cognitive appraisal

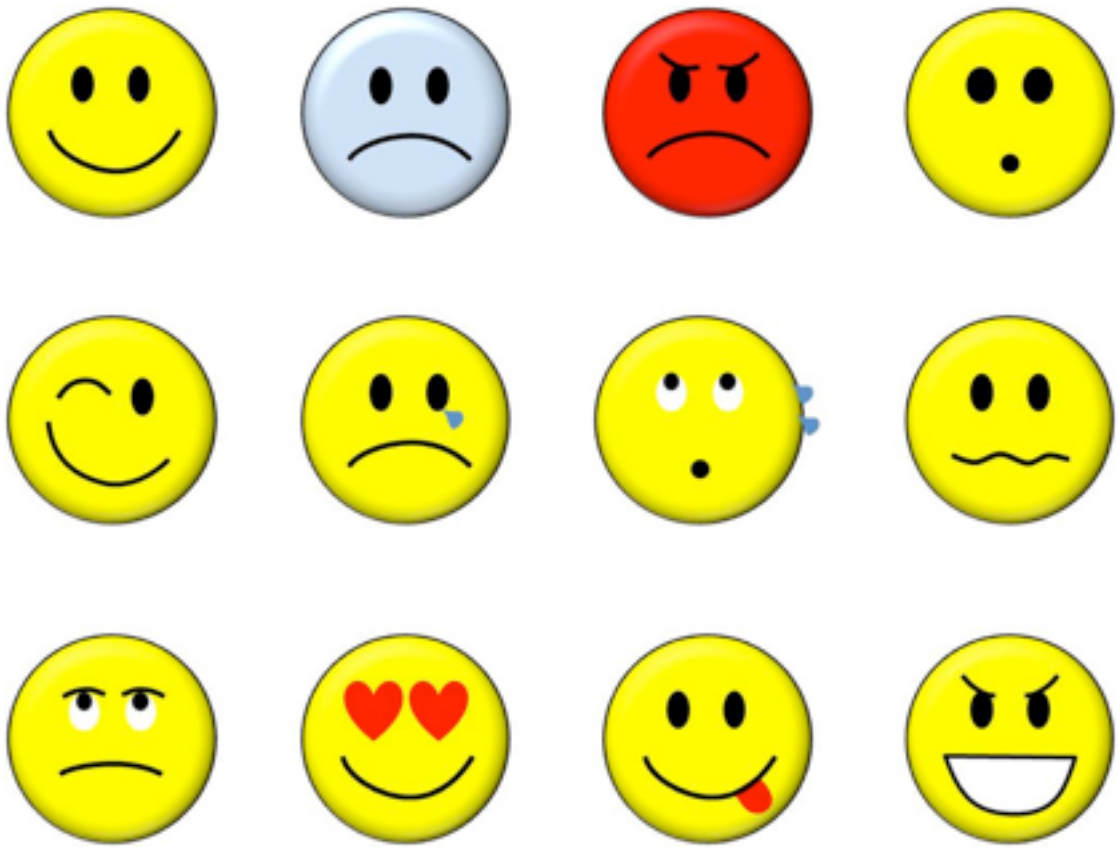
Joseph LeDoux

fear involves interaction between immediate processing amygdalar processing and slower more elaborate neocortical represenations.

The Neuropsychology of Emotion

Cognition and Emotion

If only it were as simple as this diagram...



The Neuropsychology of Emotion

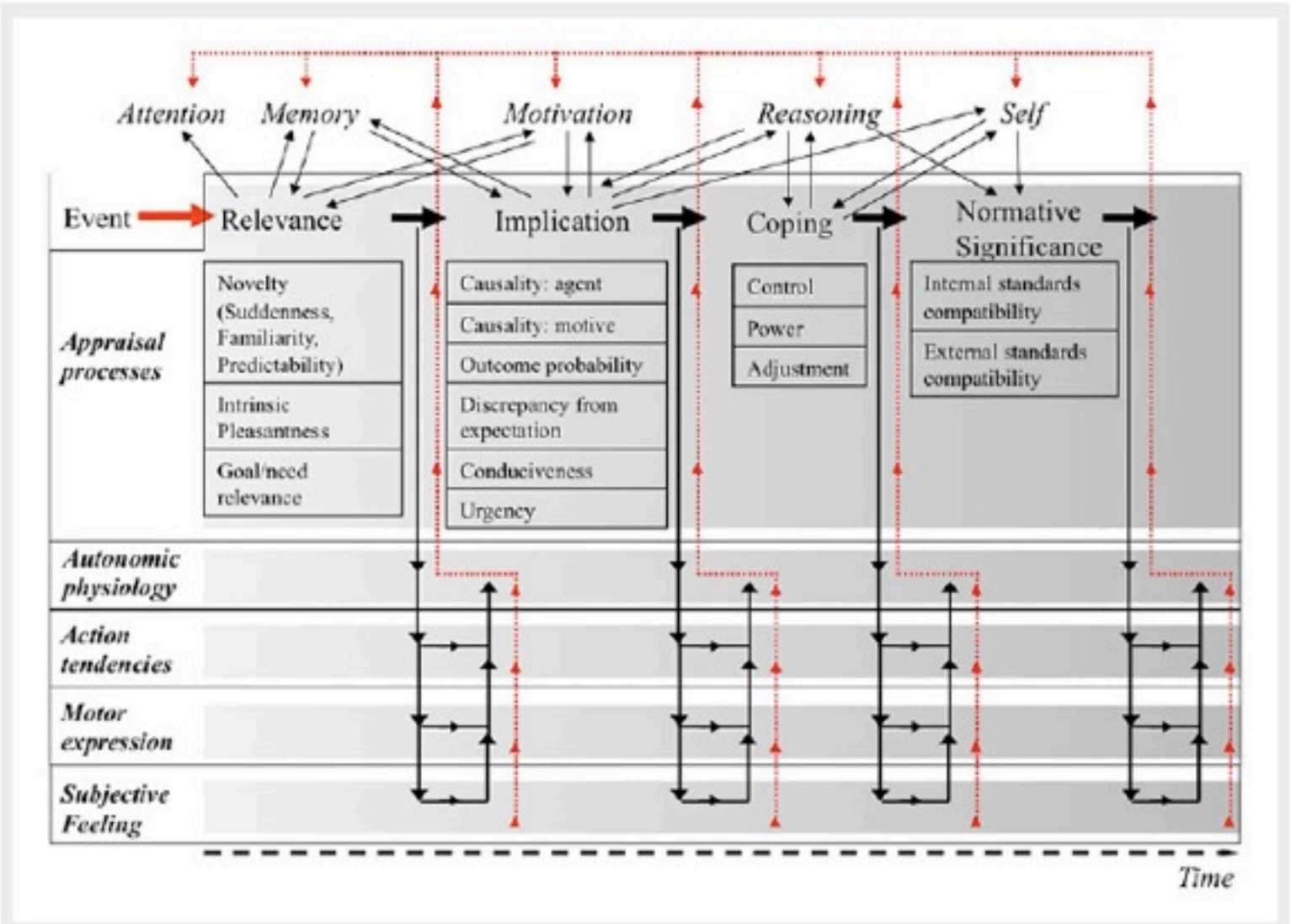


Figure 1

The Neuropsychology of Emotion

Cognition and Emotion

Two components are necessary for recognition of basic emotions:

Perceptual Processing (taking in all the salient pieces of information from the stimulus)

Recognition of the Emotional Meaning of the Stimulus, that is, linking the stimulus with previously learned information which includes :

- the emotional response from one's knowledge base,
- the "word" or lexical label,
- and knowledge about the motor "representation" needed to produce the emotion (i.e. the motor response of a smile produces feelings/recognition of the emotion happiness).

From: Adolphs (2002), Neural Systems for Recognizing Emotions

The Neuropsychology of Emotion

Cognition and Emotion

Two factor model:

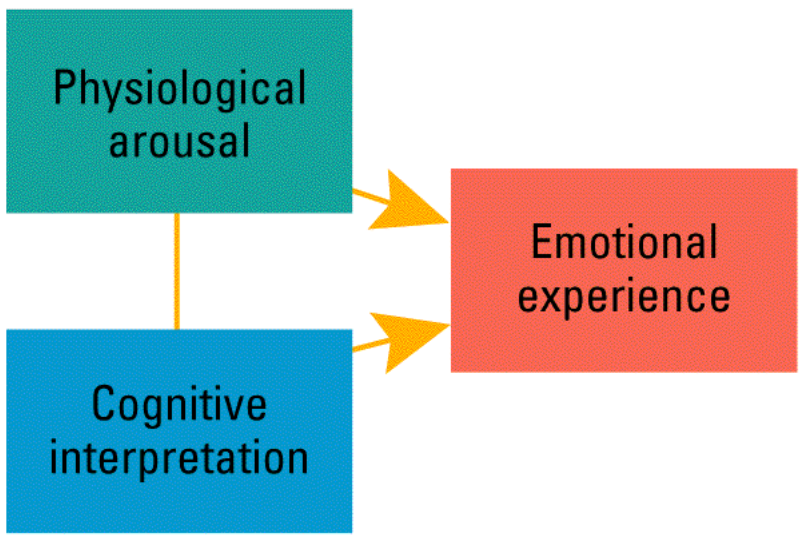
Physiological arousal

- Sweaty palms
- Increased heart rate
- rapid breathing

Cognitive Label

- Attribute source of arousal to a cause

To have an emotion, both factors are required



The Neuropsychology of Emotion

Defining Emotions

Problems with Studying Emotions

Although early neuroimaging studies wereinterpreted as evidence for emotion faculties (e.g., amygdala and fear, insula and disgust, subgenual anterior cingulate cortex (sgACC) and sadness, the orbitofrontal cortex (OFC) and anger, **recent meta-analyses** fail to demonstrate a consistent and specific relationship between activation in any one region of brain tissue and any one emotional faculty (e.g., the amygdala shows increased activity across experiences and perceptions of anger, disgust, fear, happiness and sadness.

To date, no consistent and specific one-to-one correspondence have been observed between physical measurements and anger, sadness, fear, disgust, etc. Together, these findings point to a qualitatively different model of the mind.

Kristen A. Lindquist[1,*] and Lisa Feldman Barrett[2, & 2012

The Neuropsychology of Emotion

Defining Emotions

Seven Deadly Sins of Neuroscience Research

Sin 1: Affect and cognition are subserved by separate and independent neural circuits.
Sin 2: Affect is subcortical.
Sin 3: Emotions are in the head.
Sin 4: Emotions can be studied from a purely psychological perspective.
Sin 5: Emotions are similar in structure across both age and species.
Sin 6: Specific emotions are instantiated in discrete locations in the brain.
Sin 7: Emotions are conscious feeling states.Seven sins in the study of emotion: Correctives from affective neuroscience

Richard J. Davidson: Brain & Cognition, Brain and Cognition 52 (2003) 129–132

The Neuropsychology of Emotion

Emotion and Neural Regions

Attributing Function to the Structural Arrangement of the Limbic System (easier said than done).

Numerous studies led to paradoxical findings making definitions of the limbic system confusing. The following brain areas are most commonly regarded as components of the Limbic System because they appear to play a role in one or more aspects of emotion (e.g. visceral brain, emotional memory, neuroendocrine control):

- Cingulate Gyrus
- Hippocampus
- Parahippocampus Gyrus
- Amygdala
- Septal Nuclei
- Thalamus
- Hypothalamus

The Neuropsychology of Emotion

Neural Structures & Circuits

I. Limbic System
- Amygdala
- Papez Circuit

II. Hypothalamus

III. Basal Ganglia

IV. Anterior Cingulate Cortex (ACC)

V. Orbitofrontal

The Neuropsychology of Emotion

The Limbic System is really a “Non Limbic System” because specific function cannot be assigned to specific neural pathways (Robert L. Isaacson, 1992 & 2007), in addition to the disparity in identifying system structures.

The Neuropsychology of Emotion

Meta-analysis of fMRI studies:
(1) The medial prefrontal cortex had a general role in emotional processing
(2) fear specifically engaged the amygdala;
(3) sadness was associated with activity in the subcallosal cingulate
(4) emotional induction by visual stimuli activated the occipital cortex and the amygdala
(5) induction by emotional recall/imagery recruited the anterior cingulate and insula
(6) emotional tasks with cognitive demand also involved the anterior cingulate and insula

REVIEW
Functional Neuroanatomy of Emotion: A Meta-Analysis of Emotion Activation Studies in PET and fMRI[1]

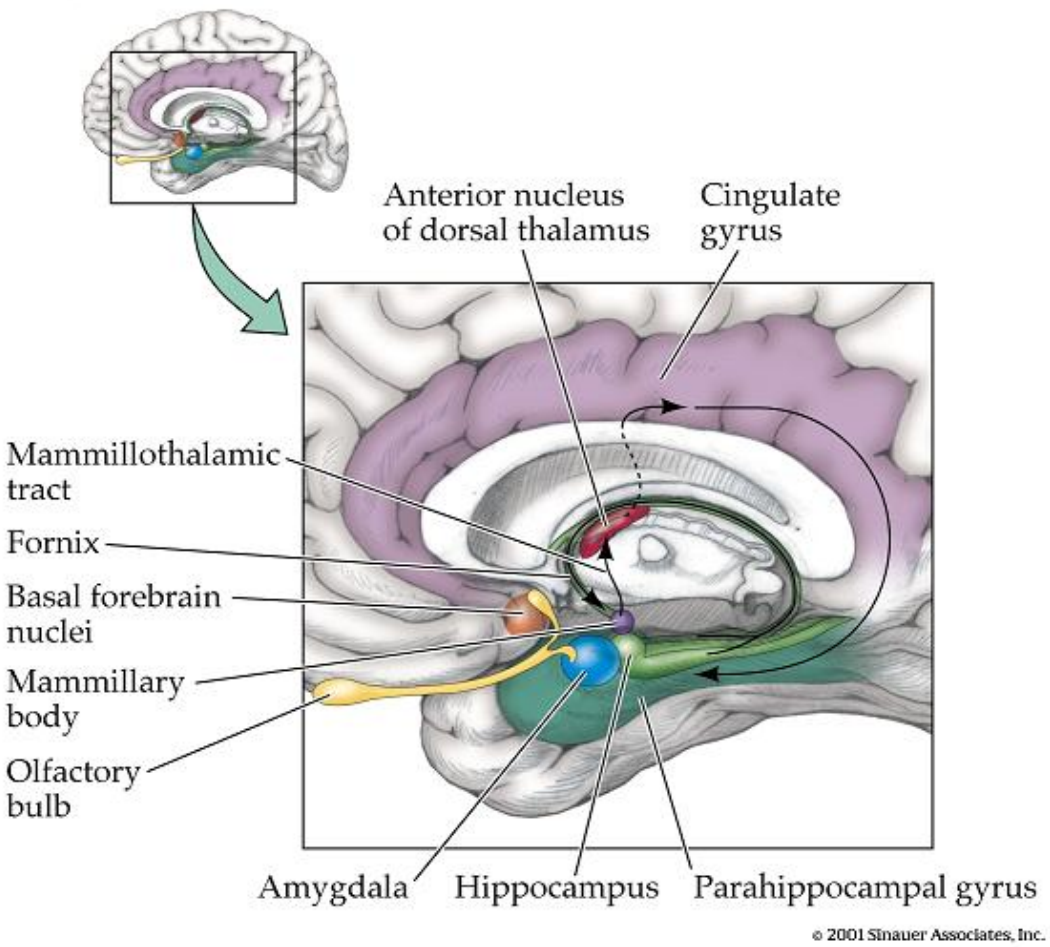
K. Luan Phan,*[,2] Tor Wager,† Stephan F. Taylor,* and Israel Liberzo
NeuroImage 16, 331–348 (2002)

The Neuropsychology of Emotion
Neural Regions

Limbic System

What is it?

LIMBIC SYSTEM
- amygdala
- hippocampus
- fornix
- septum
- hypothalamus
- cingulate gyrus
- mammillary bodies



The Neuropsychology of Emotion

Neural Regions

Limbic System

Higher Cortical Processes ("Secondary Emotions")

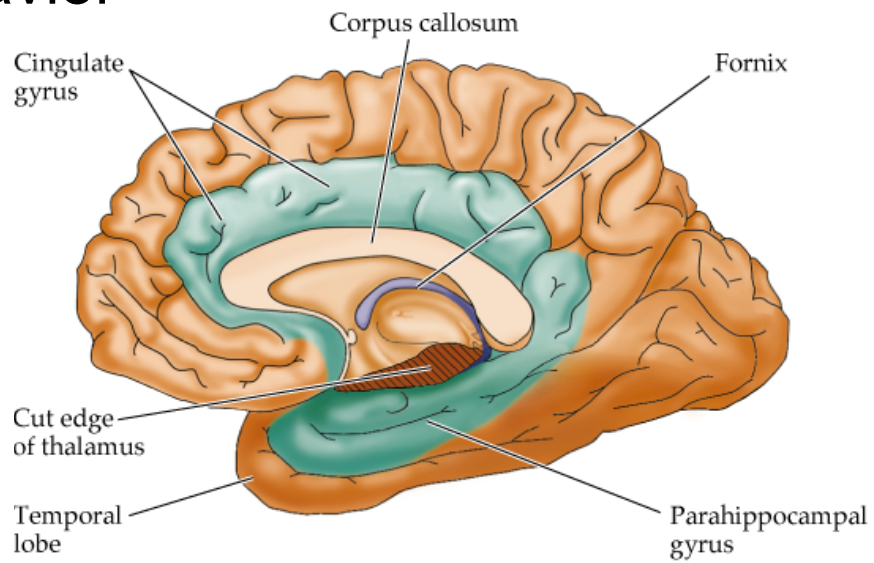
Why do humans feel embarrassed with flatulence and dogs don't?

Link between higher cortical activity and the "lower" systems that control emotional behavior

Limbic Lobe

Deep lying structures

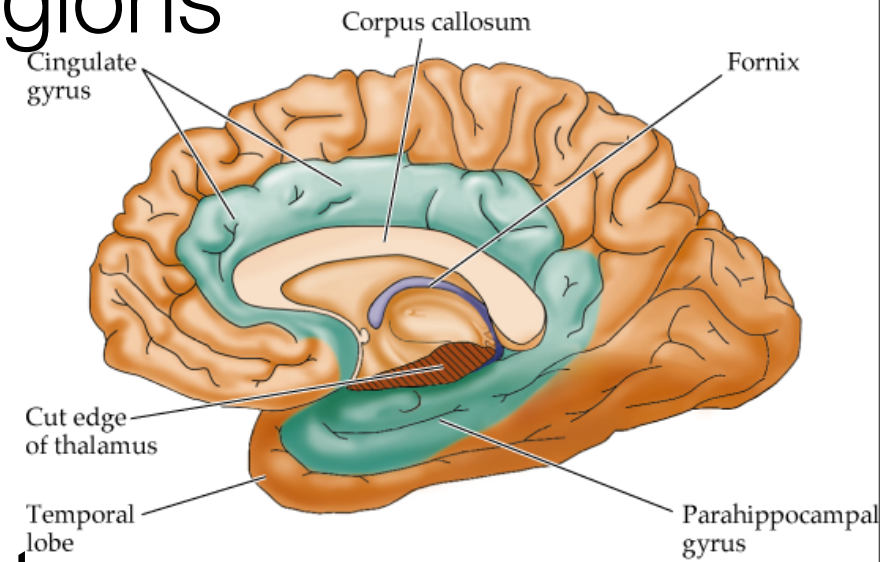
- amygdala
- hippocampus
- mamillary bodies



The Neuropsychology of Emotion

Neural Regions

Limbic System



What is it?

- Cingulate gyrus
- Parahippocampal gyrus

Where is it?

- Encircles the upper brain stem around corpus callosum

What does it do?

- Integrates information from cortical association areas

How do we know this?

- Kluver - Bucy Syndrome

The Neuropsychology of Emotion

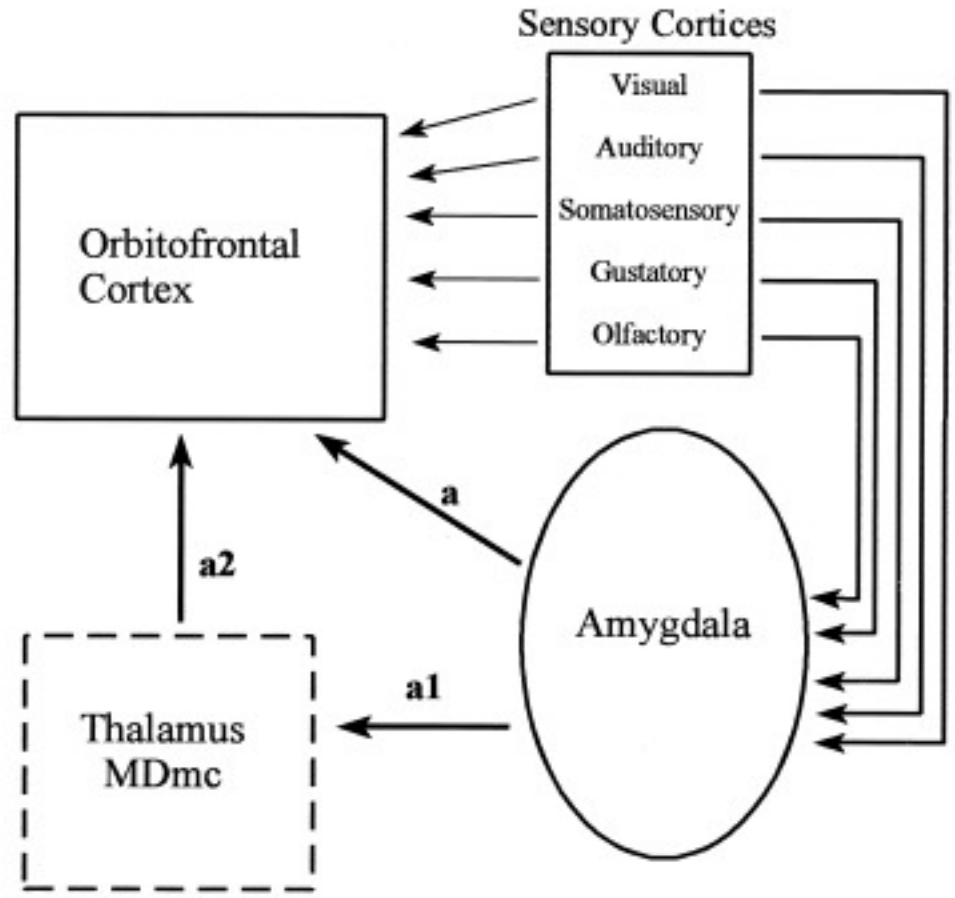


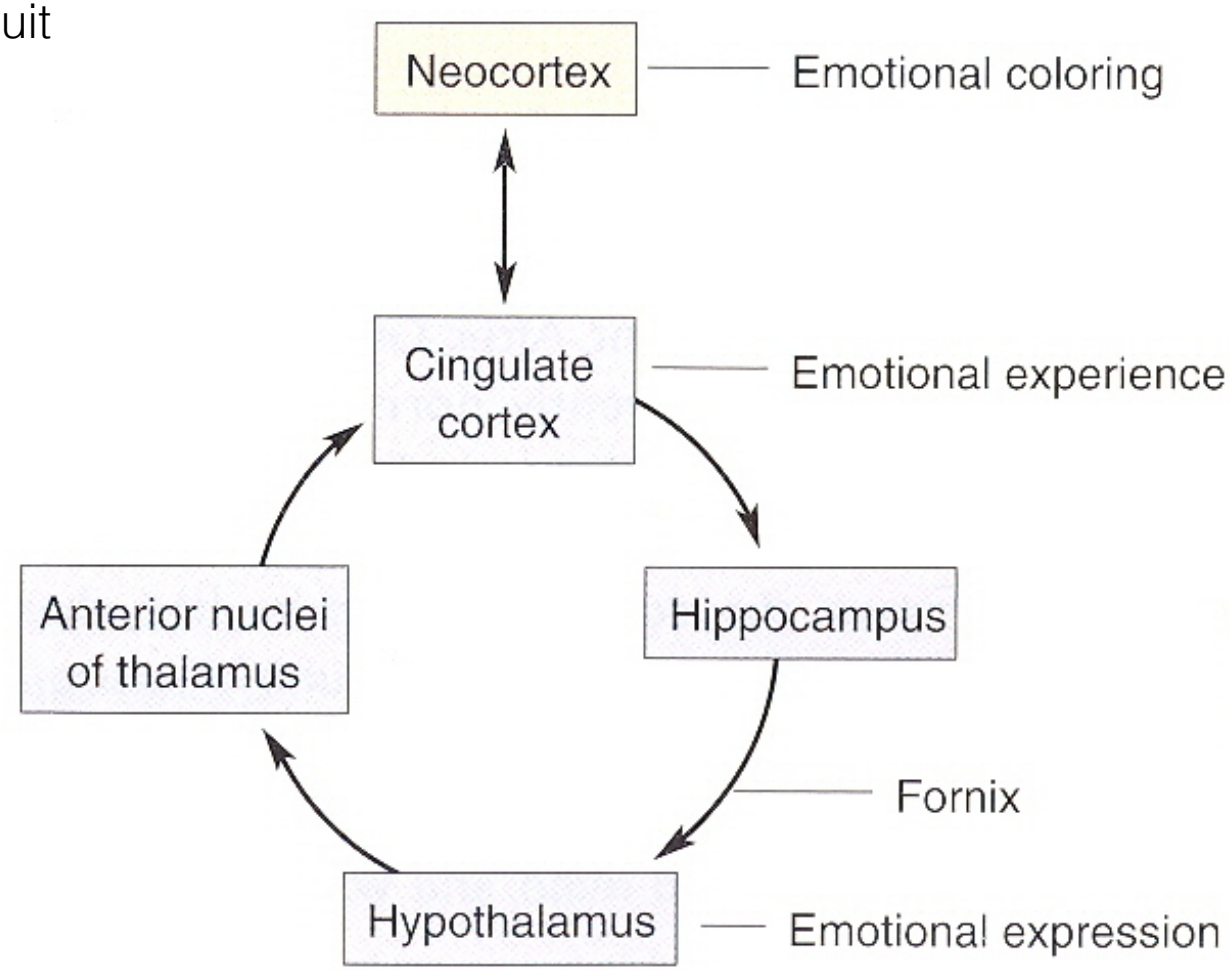
FIG. 3. Direct and possible indirect projections associated with sensory processes and emotion to orbitofrontal cortices in rhesus monkeys. Orbitofrontal cortices receive direct projections from visual, auditory, somatosensory, gustatory and olfactory cortices and possible indirect sensory input through the amygdala (a). Projections from the amygdala reach the orbitofrontal cortex directly (a) and possibly indirectly through the thalamic MDmc (a2), which receives projections from the amygdala (a1). MDmc, magnocellular mediodorsal nucleus.

Proceedings of the Human Cerebral Cortex:
From Gene to Structure and Function
Connections underlying the synthesis of cognition,
memory, and emotion in primate prefrontal cortices

Barbas (2000)

The Neuropsychology of Emotion

- Papez Circuit



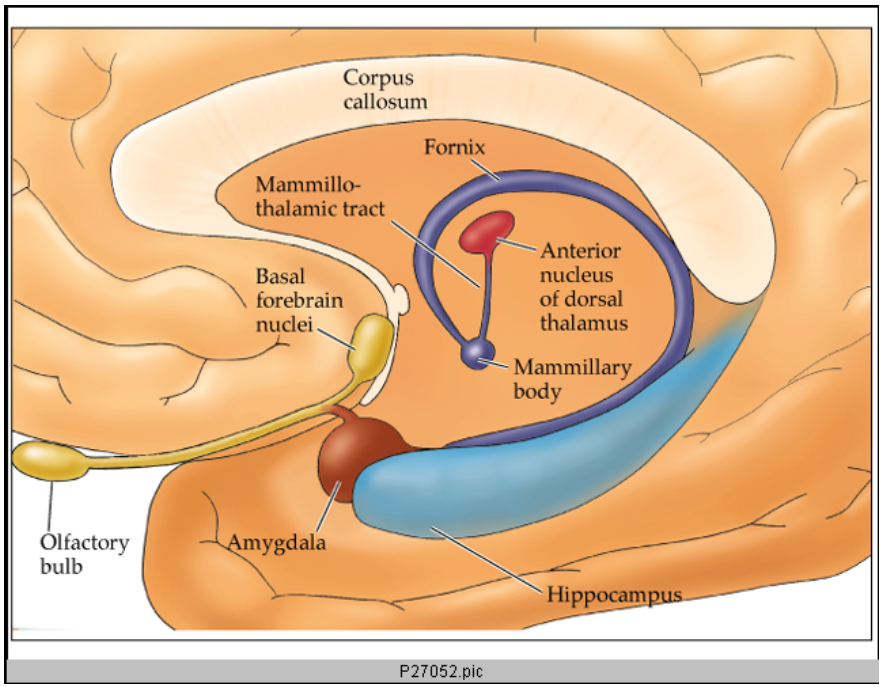
From: Bear et al., 2007

The Neuropsychology of Emotion
Neural Regions

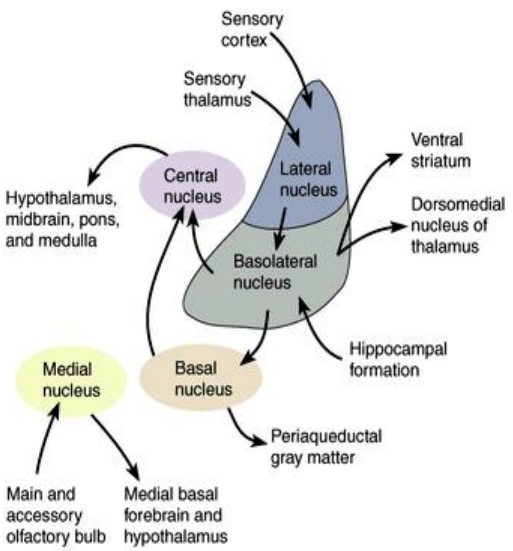
Amygdala

What is it? Nuclear mass

Where is it? Buried in the white matter of the temporal lobe, in front of the hippocampus



► Diagram of the Major Divisions and Connections of the Amygdala



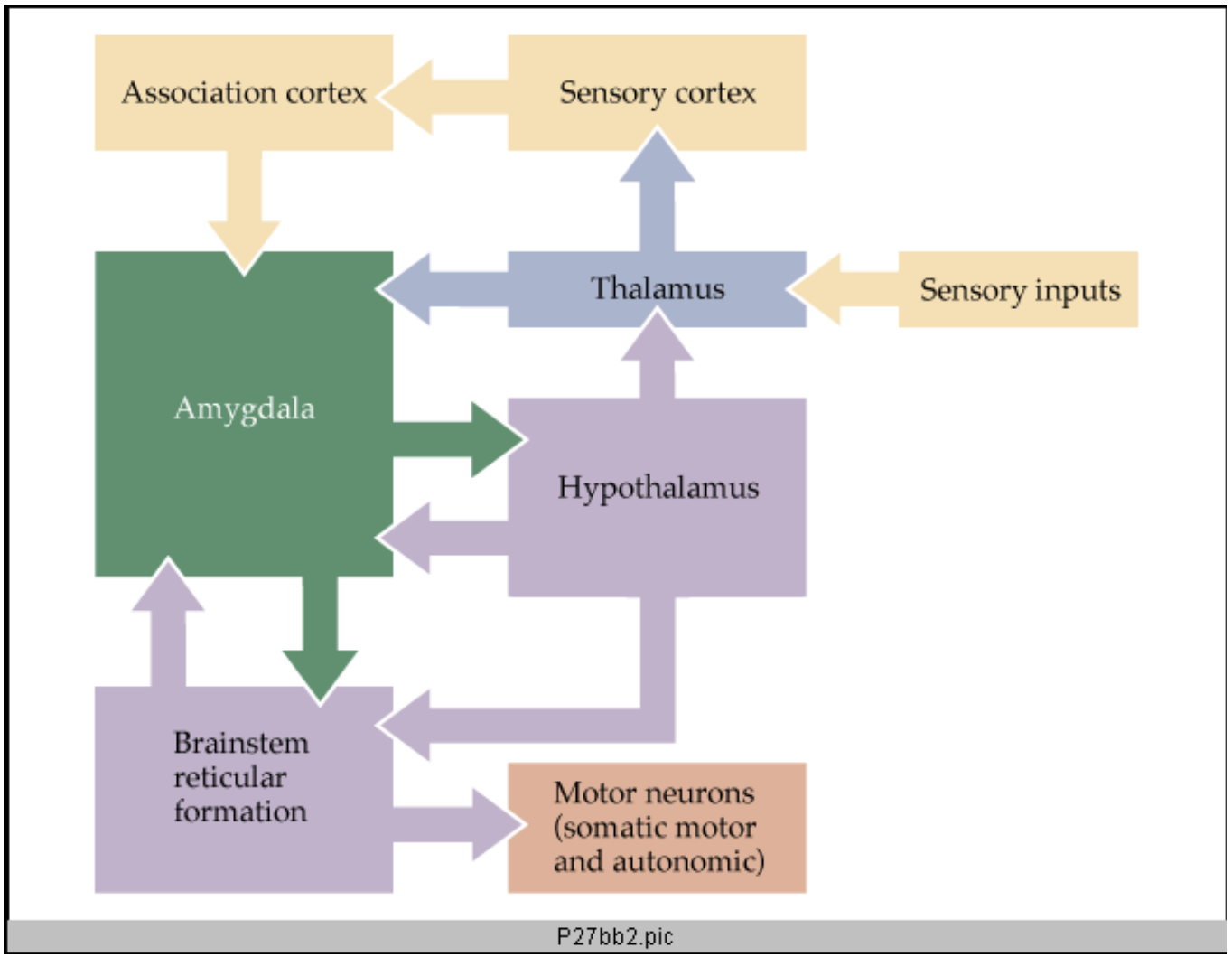
The Neuropsychology of Emotion

Emotion and Neural Regions

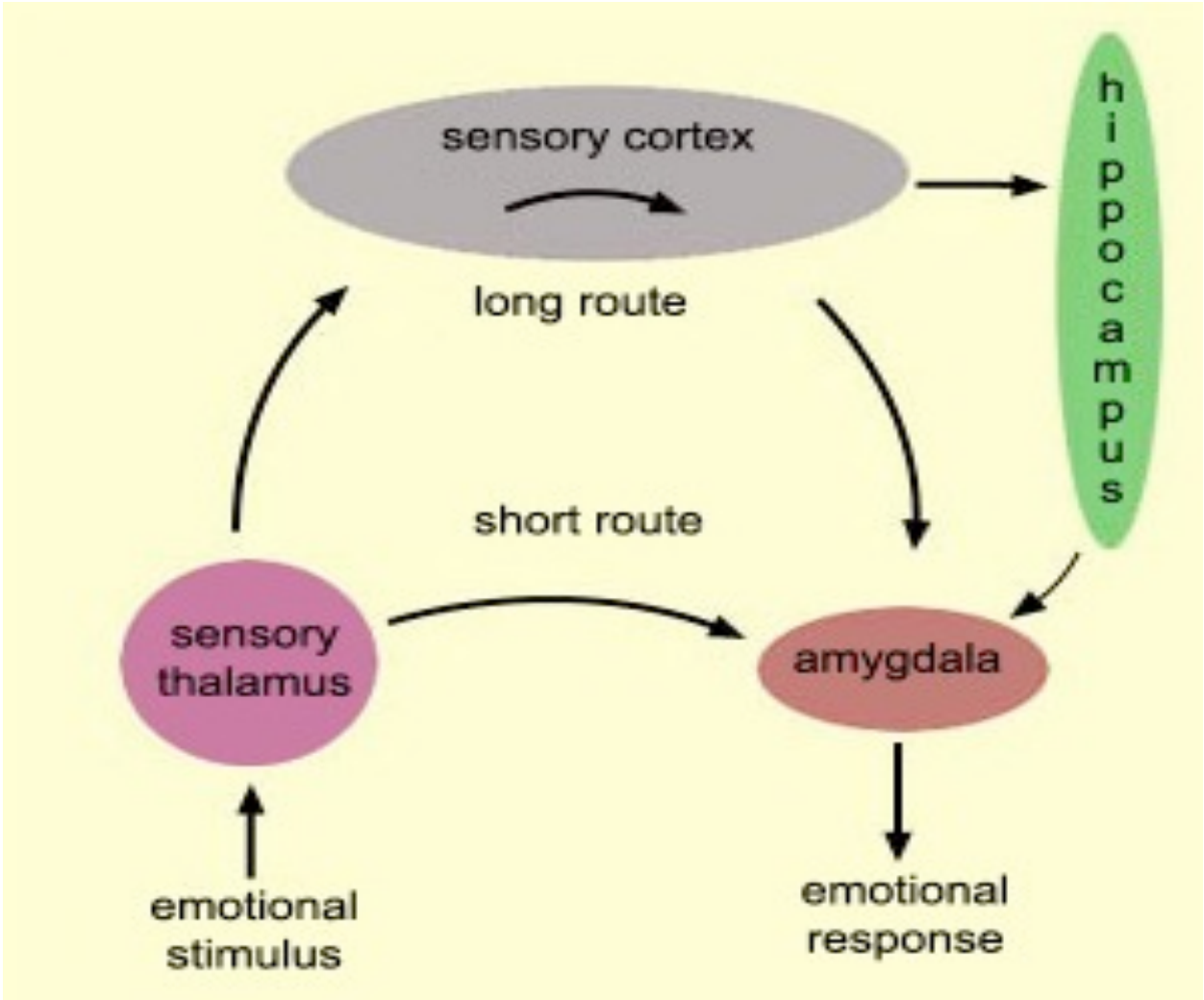
The lateral amygdala (LA) projects to the central nucleus of the Amygdala (Ce) directly and via the basal amygdala nuclei. The Ce is the origin of amygdala outputs to fear generating structures in the hypothalamus and brainstem. (LeDoux et al 1988).

LA is seen as the site of fear memory, while Ce is seen as the site of fear expression (LeDoux, 2000).

The Neuropsychology of Emotion
Neural Regions



Short and Long Routes via the Amygdala



Fear Conditioning (LeDoux, 1995)

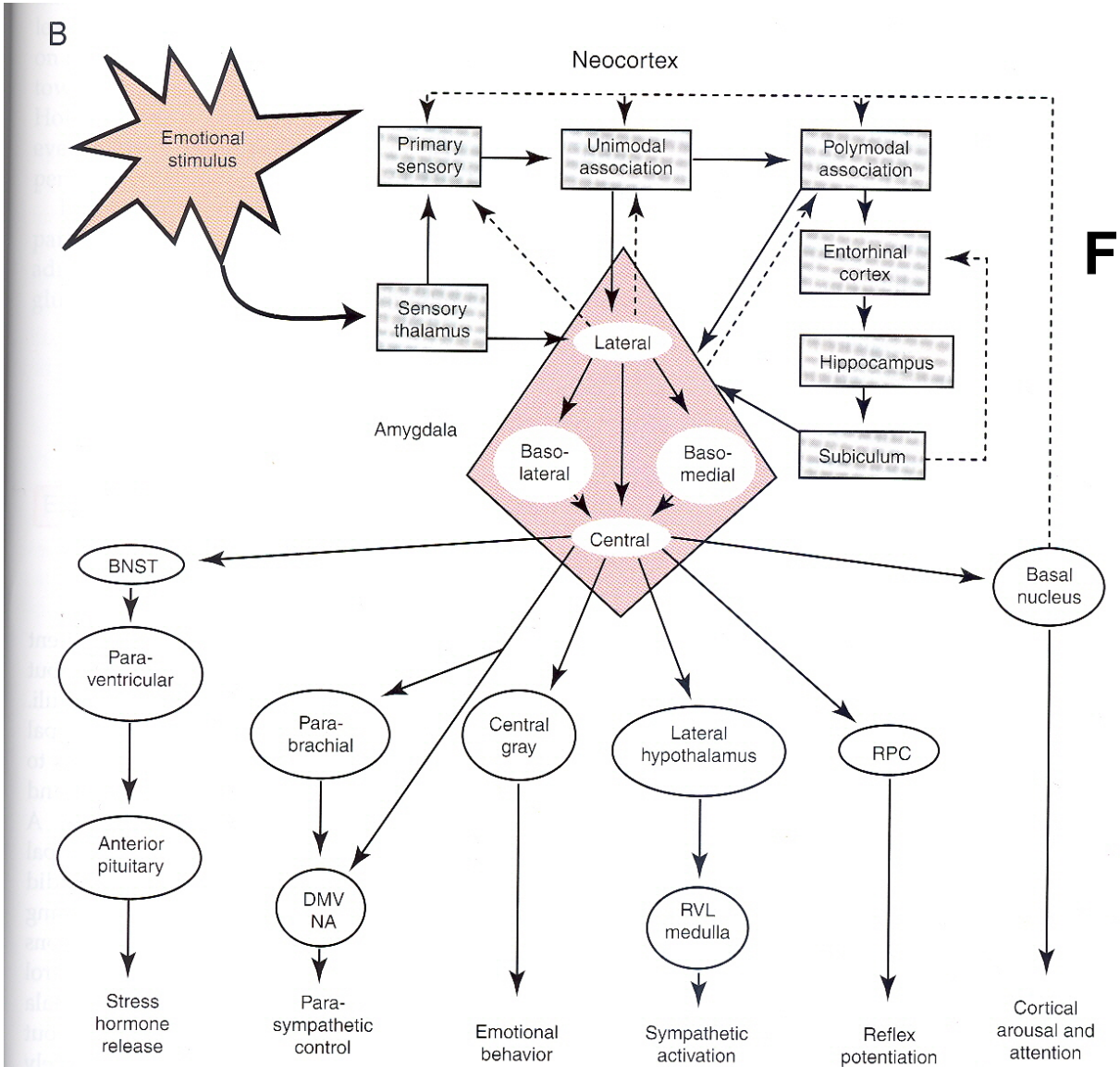
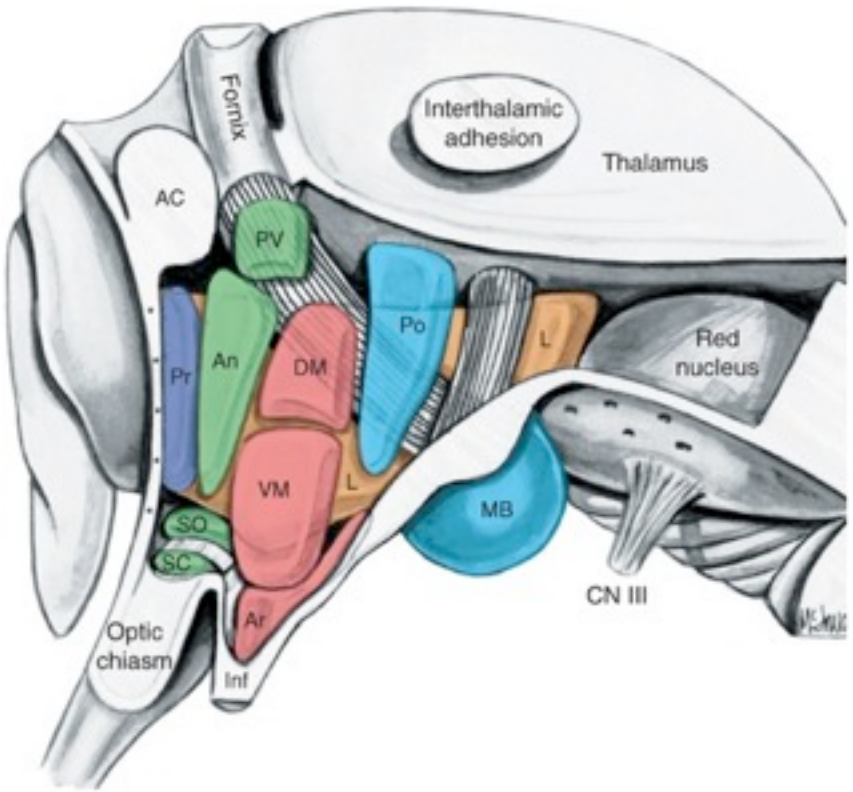


FIGURE 51.12 Fear conditioning. (A) Prior to training, the tone produces a transient orienting response. During training the tone is followed by a brief foot shock. Following training, the rat is reintroduced into the chamber and freezes when the tone is presented. (B) Anatomical pathways that mediate fear conditioning. A hierarchy of sensory inputs converges on the lateral amygdala nucleus, which projects to other amygdala nuclei and then to the central nucleus, which send outputs to several effector systems for emotional responses. BNST, bed nucleus of the stria terminalis; DMV, dorsal nucleus of the vagus; NA, nucleus ambiguus; RPC, nucleus reticularis pontis oralis; RVL, rostral ventral nucleus of the medulla. From LeDovx (1995).

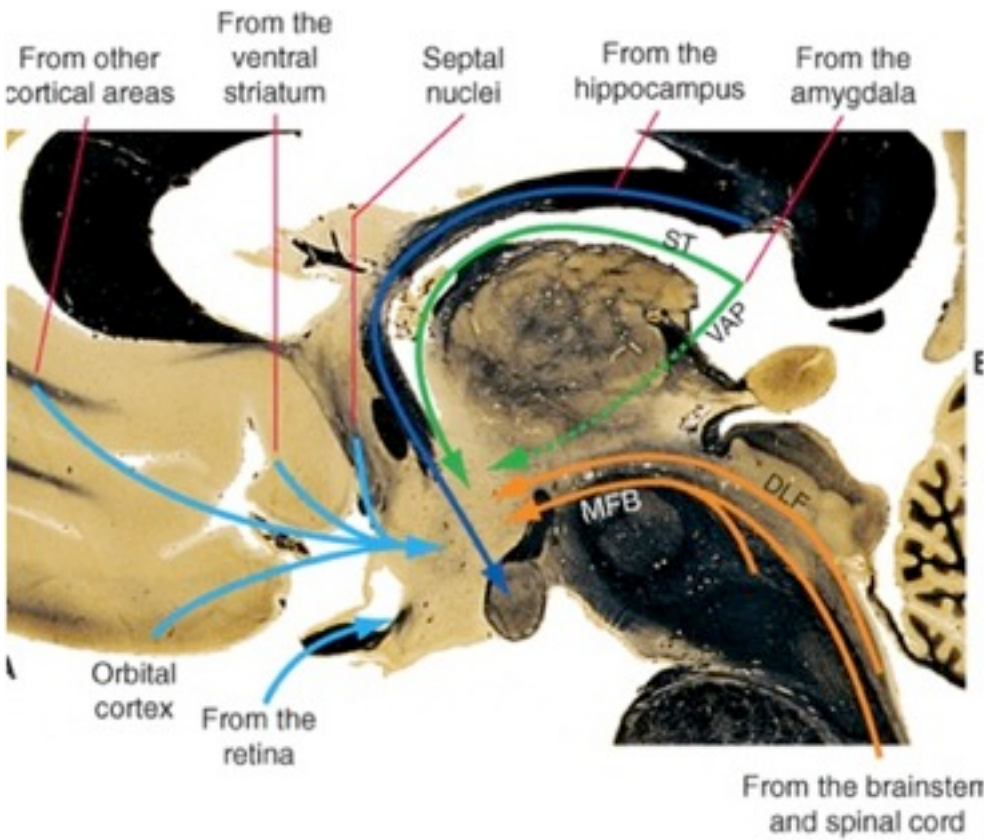
From: Squire et al., 2003

Hypothalamus and Emotion

- The hypothalamus is primarily dedicated to the maintenance of physiological homeostasis
- However, it also plays a role in emotional processing:
  - Specifically, the mammillary bodies (often categorized as part of the hypothalamus) are involved in emotion and lesions of the mammillary bodies produce decreased emotivity (Santacana 1972).
  - Additionally, organized somatic activity associated with emotion can be generated by the hypothalamus without cortical input (Panksep 1998).



Hypothalamus Circuitry



- The hypothalamus receives inputs from the hippocampus (part of the limbic lobe) and amygdala (involved in fear processing) via the ventral amygdalofugal pathway and the stria terminalis
- The connections between known emotional centers of the brain (e.g. the amygdala) to the hypothalamus suggests its involvement in emotional

The Hypothalamus-Pituitary-Adrenal Axis

- Consisting of the periventricular nucleus of the hypothalamus, anterior lobe of the pituitary gland, and the adrenal cortex this system is primarily involved in the regulation of stress
- The hypothalamus secretes corticotropin-releasing hormone
- Increased exposure to stressful events (such as death of a loved one, loss of a job) can alter the HPA set point, causing HPA activity to increase
- Hypercortisolism is thought to be a marker for major depressive disorder (Carroll et al., 2007; Parker 2003).

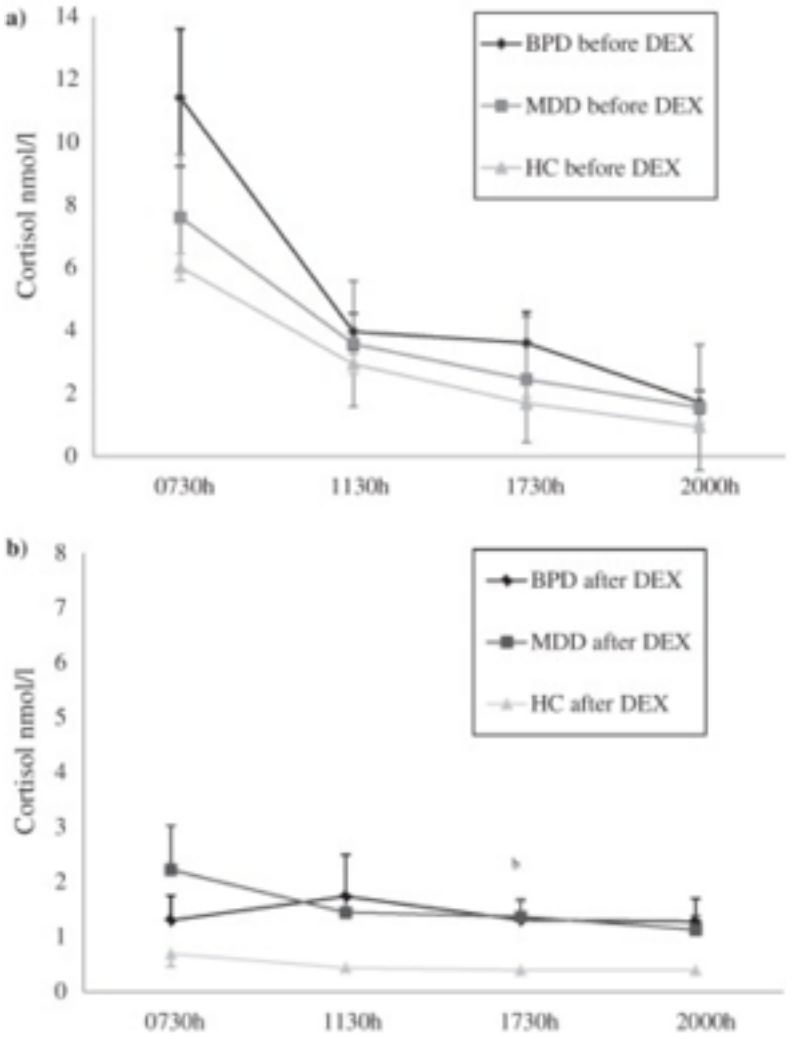


Figure by Fernando et al., showing hypercortisolism in MDD and BPD versus healthy controls

Overview of regions involved in fear response

- Amygdala involved in emotional arousal and conditioned fear; ACC and insula also active during increased fear states
- Ventromedial prefrontal cortex (vmPFC) involved with extinction of the fear response, modulated during reappraisal inverse to amygdala
- Both hippocampus and insula are associated with extinction of fear
- Ventrolateral PFC involved in labeling, conscious appraisal of affect, inversely correlates with amygdala
- Dorsal, superior and dorsomedial PFC correlates positively with amygdala activity- accentuates
- Dorsal ACC associated with anticipatory anxiety

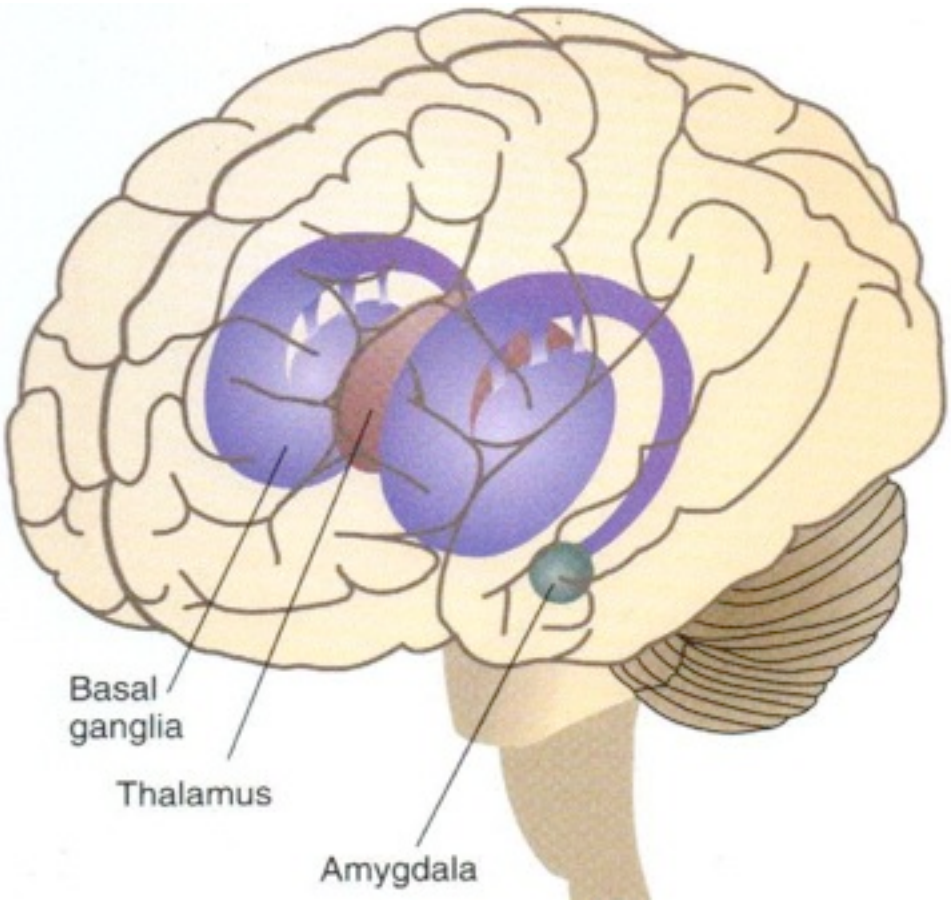
The Neuropsychology of Emotion

Emotional Regulation

The study of emotion regulation is intimately associate with the concept of inhibition, namely, higher cortical functions are responsible for inhibiting subcortical areas. Thus, the term: “down regulation

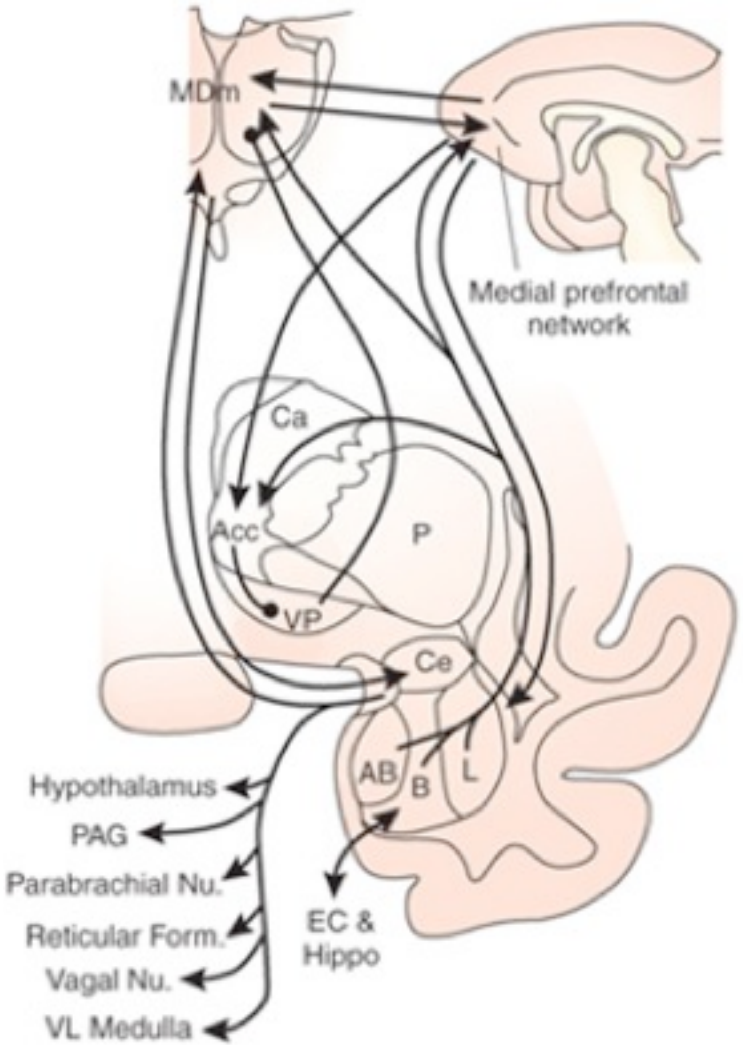
The Brain as a Regulator of Emotional Homeostasis

- Most mental disorders are a disorder of Regulation



Limbic Arousal and Regulation

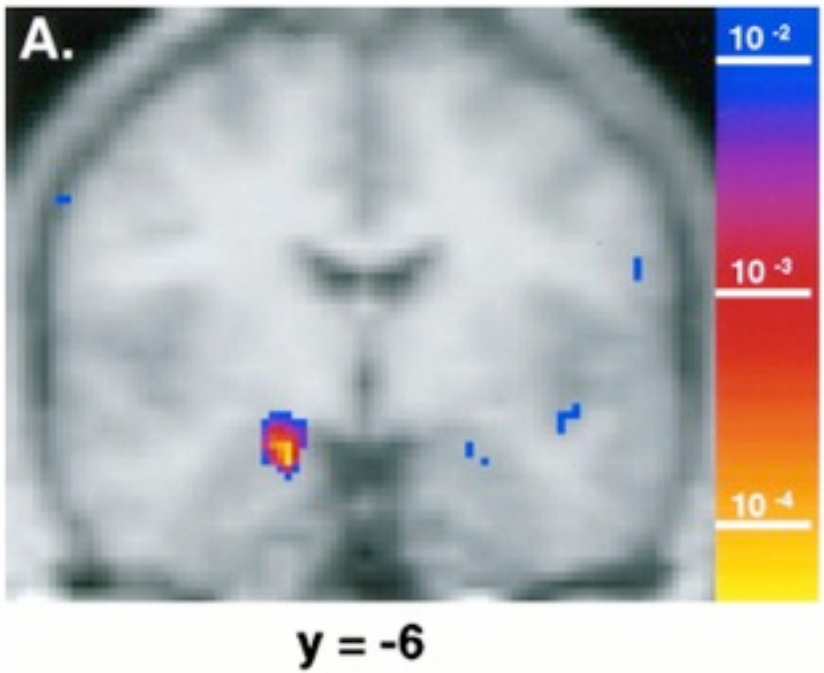
- Medial and ventral lateral PFC: inhibit emotional response
- Major medial PFC connections to the amygdala
  - MPFC connections to amygdala, HC and BG in non-human primates

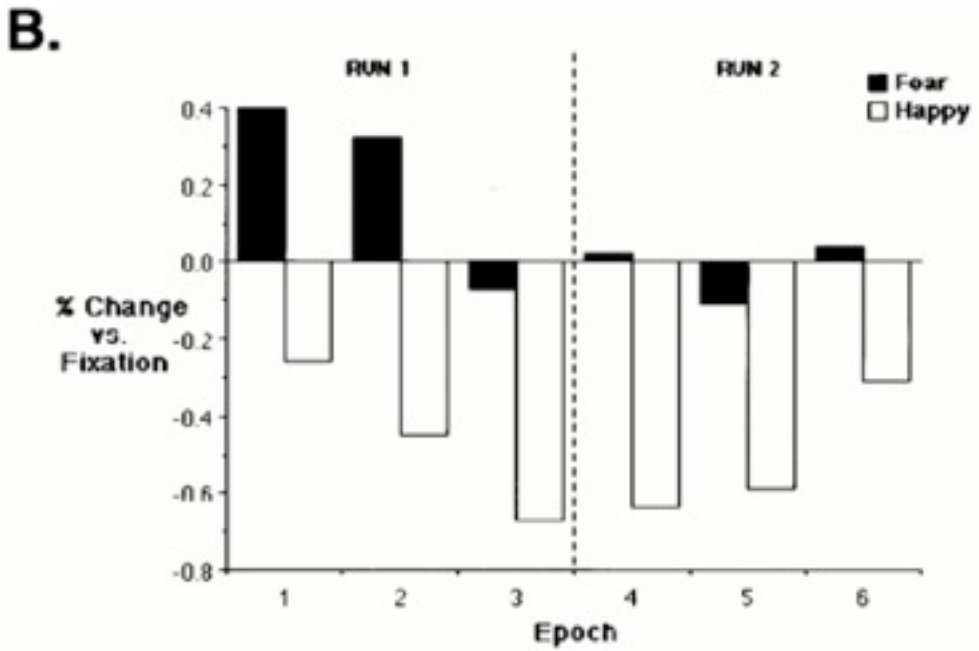


Price and Drevets, Neuropsychopharmacology, 2009

Development and Emotion Regulation

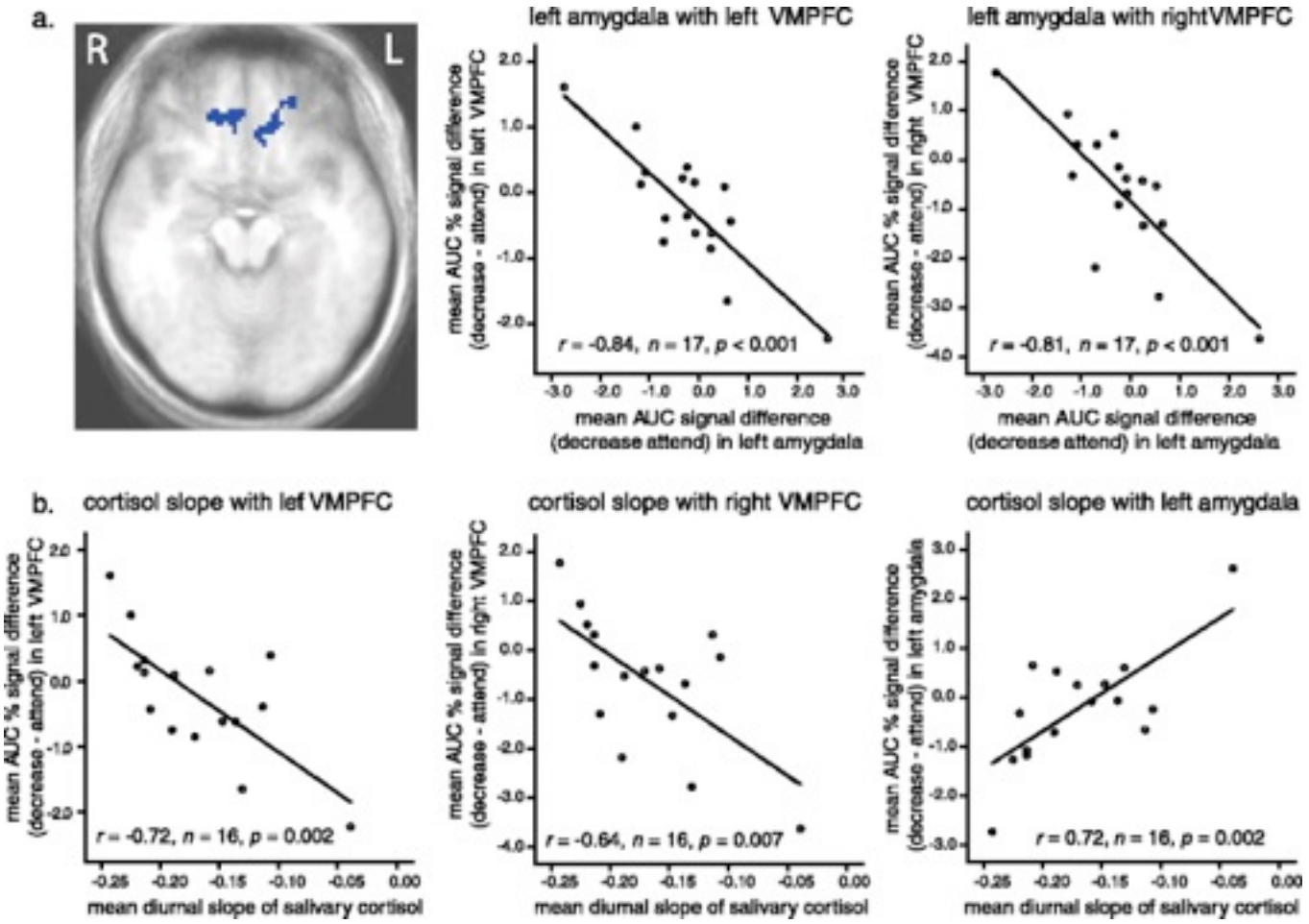
Subconscious Processing and the Amygdala (Whalen et al, 1998)





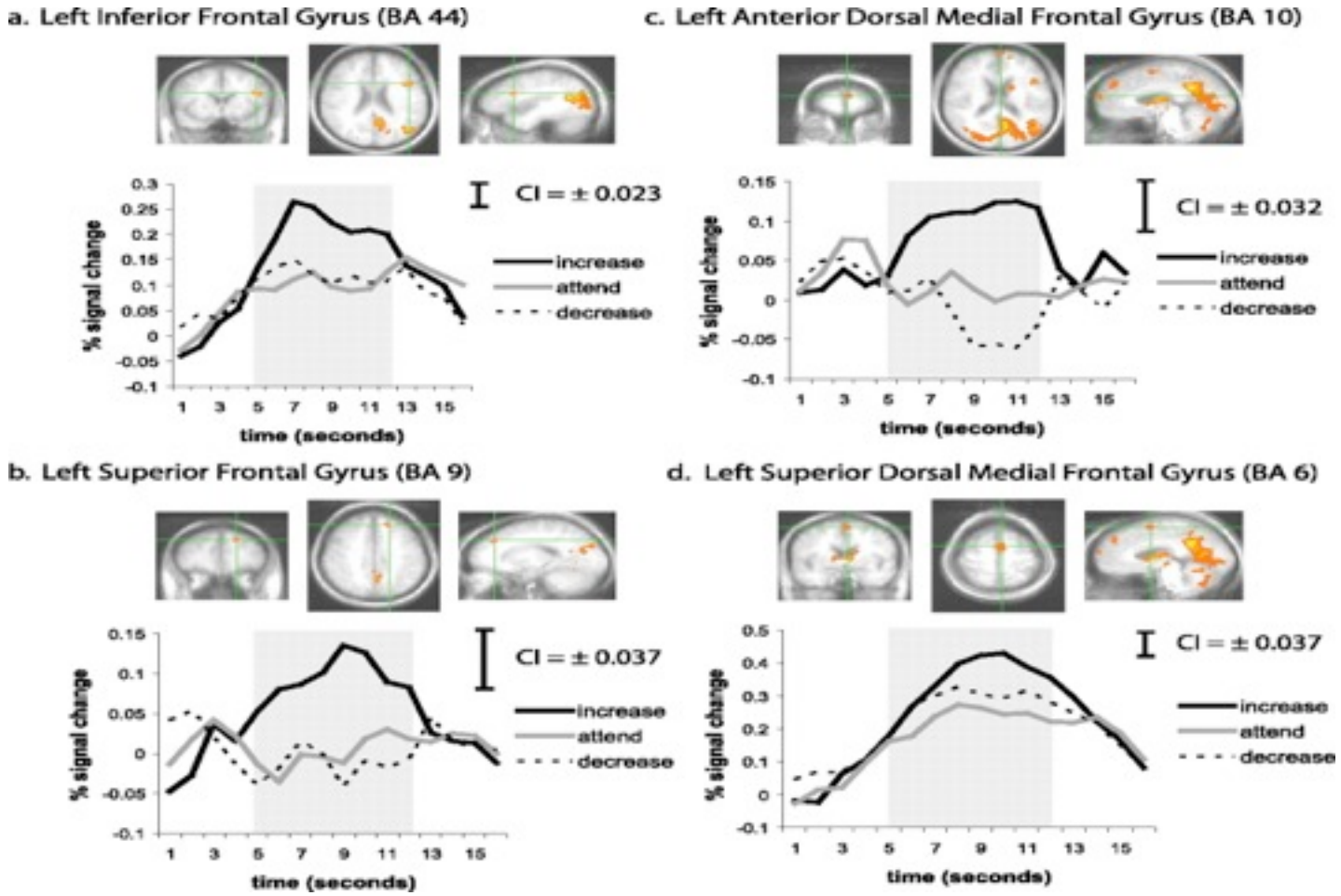
A. Rt amygdala responds to masked fearful faces when compared with masked happy faces B. changes in blood oxygenated level-dependent fMRI as function of repeated stimulus presentations (THUS, level of amygdala activation affected differentially by emotional valence of external stimuli)

Two regions in left (L) and right (R) VMPFC demonstrate an inverse across-subjects correlation with the left amygdala



Circuit involving VMPFC and amygdala underlies effective emotional regulation ability; this circuit mediates HPA disturbances associated with chronic stress and psychopathology

Emotional Regulation through conscious re-appraisal: Brain areas responsive to the regulation instructions



Reframing of negative visual stimuli produces effects in lateral/dorsal PFC and amygdala ; inverse functioning between VMPFC and amygdala during negative affect reduction

The Neuropsychology of Emotion

Processing Social Emotions

- Facial Expression -

A Feed-Forward & Feedback Sweep of Information Processing

Within ~100 msec the primary visual cortex and secondary visual cortical areas (e.g., superior temporal region) extract information from the facial expression and determine if it is communicating emotions.

Amygdala and Orbitofrontal cortices take this original coarse perception and refine it via a feedback process:

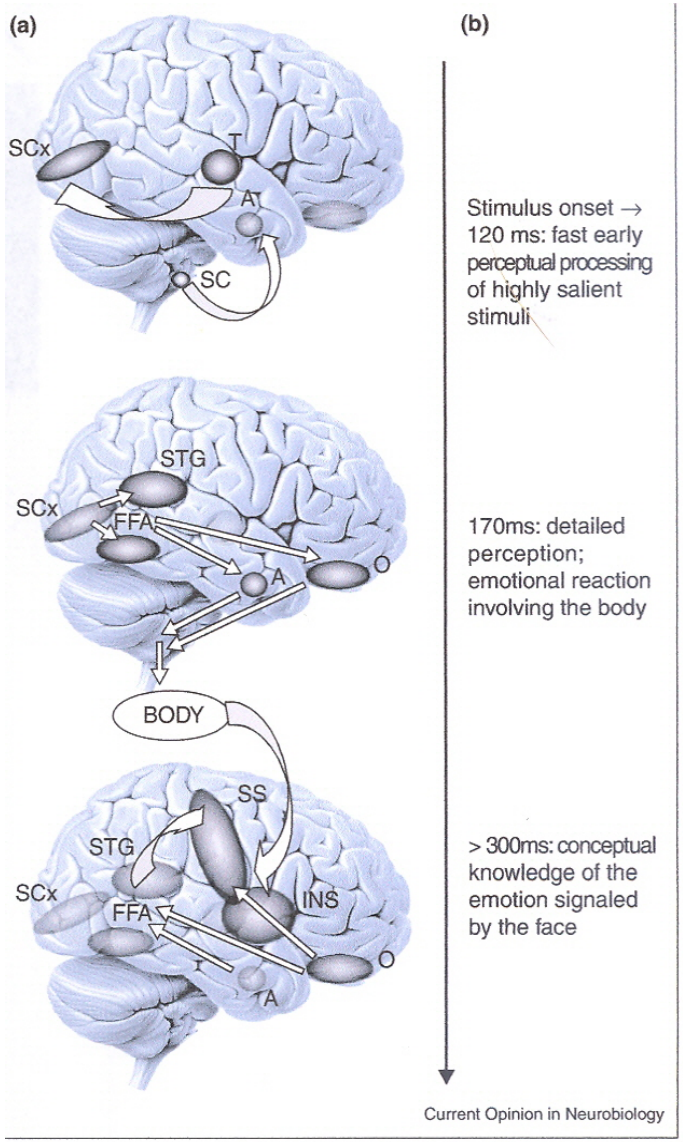
- it allocates attention to certain features
- it triggers associated knowledge via projection to other neocortical areas and to the hippocampus (retrieves conceptual knowledge about the emotional).
- it generates an emotional response in the person via connections to motor structures, hypothalamus and brainstem nuclei (where emotional response is generated). This mechanism, via a feed-forward mechanism, can induce…
- the emotional state in the person perceiving the stimulus via a simulated experience through activation of the right somatosensory cortices. (But this can also occur without direct stimulation from motor regions).

Adolphs, 2002

The Neuropsychology of Emotion

Processing Social Emotions

Sweep of Information Processing for Emotional Facial Expression



Processing of emotional facial expressions as a function of time. **(a)** Structures involved in emotion recognition at various time points. A, amygdala; FFA, fusiform face area; INS, insula; O, orbitofrontal cortex; SC, superior colliculus; SCx, striate cortex; SS, somatosensory cortex; STG, superior temporal gyrus; T, thalamus. **(b)** Time course of emotion recognition, from the onset of the stimulus at the top, through perception to final recognition of the emotion at the bottom. Attempts to localize the perception/recognition of the stimulus in space or in time suffer from the fact that the same brain structures participate in different components of processing at different points in time. Many of the mechanisms outlined here may be shared when recognizing emotion from other classes of stimuli, such as prosody. Reproduced with permission from [1••].

Adolphs, 2002

Emotions and the Brain

Laterality in Emotional Processing

Right hemisphere

- tends to be more right sided
- Motivation/affect & prefrontal cortex
  - Brain Damage
    - Left side – depression & withdrawal
    - Right side – mania & inappropriate approach behavior
  - Electrical Brain Activity
    - Left > right – positive affect
    - Right > left – negative emotion
    - Occurs with both states and traits

- Right Ventromedial Prefrontal cortex is capable of discriminating between fear and happiness with 120 msec of stimulus exposure.
- Lesions of the right ventral primary and secondary somatosensory cortices impair recognition of emotions from visual stimuli.

The Neuropsychology of Emotion

Anger/Aggression Processing

Offensive Behaviors

- Predatory (related to feeding)
- Social (establishing, maintaining social hierarchy or territory, related to reproduction)

Defensive Behaviors

- Defensive attacks
- Freezing and Flight
- Maternal Defensive Behaviors
- Risk Assessment

Emotions and the Brain

Emotion and Neural Regions

Recent studies point to the medial prefrontal cortex (mPFC) as a possible inhibitor of fear in extinction (Quirk, 2006).

Early studies implicated the primate ventromedial prefrontal cortex (vmPFC) in extinction of appetitive conditioning.

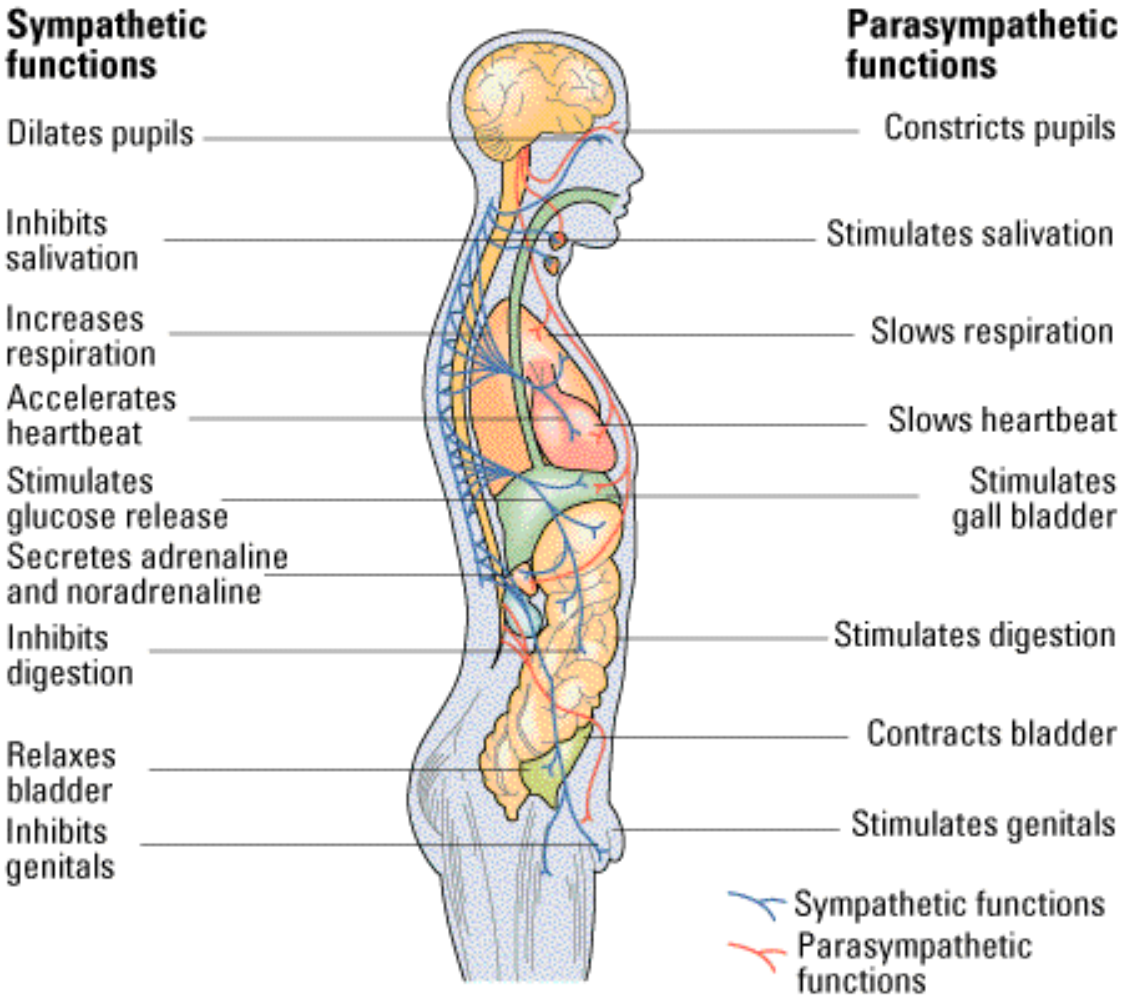
It is connected to the infralimbic (IL) and prelimibic (PL) sub-regions. IL is therefore well situated to inhibit the expression of fear either via the amygdala or by acting directly on lower centers.

Inactivation of the hippocampus prior to extinction training leads to impaired recall of extinction (fear) (Corcoran et al, 2005).

Direct projections from the hippocampus to the amygdala are sufficient for contextual extinction.

Emotions and the Brain

Emotions and the Body



The Neuropsychology of Emotion

Serotonin

- Serotonin levels show negative correlations with aggression
  - Destruction of 5-HT axons in forebrain facilitates aggressive attack.
  - 5-HIAA levels are lower in more aggressive animals (linked to risky behavior).
  - Diminished 5-HIAA levels in CSF of people with history of violence and impulsive aggression.
- SSRIs and violent acts
  - mostly anecdotal reports and media hype

The Neuropsychology of Emotion

Processing Social Emotions

- Social Phobia is related to an acute capacity to process facial information.

- Facial expressions of disgust are processed in the insular cortex, an area closely linked to descending control of the viscera.

- Damage to basal ganglia interfere with the facial perceptions of disgust (note: occurs in OCD, Parkinson's Disease, and Huntington's Disease).