



## **Bi/CNS/NB 150: Neuroscience**

**Lecture**

**Monday, Nov. 23, 2015**

**Ralph Adolphs**

**Emotion**

We emphasize these points from Kandel in Bi/CNS 150

Read

Lecture

<p>Ch. 47: p. 1056-1061 Ch. 48</p>	<p>Emotion</p>	<p><b>Emotion and Social Behavior</b></p> <p>Emotions are functional states implemented in the brain              Emotion states cause feelings, behavior, psychophysiology              Emotions also cause changes in cognition (attention, memory)              Specific brain structures participate in processing emotions              The amygdala is important for fear</p>	<p>Nov. 23</p>
<p>Ch. 64: p. 1425-1434</p>	<p>Autism</p>	<p><b>Autism</b></p> <p>Autism is a spectrum with an unscientific diagnosis              Autism involves atypical social cognition              Autism involves many genes that influence brain connectivity              There are animal models for autism</p>	<p>Nov. 25</p>
<p>review for final</p>	<p>Thanksgiving</p>	<p><b>eat Turkey</b></p>	<p>Nov. 27</p>

Emotion theories

ANS

fear & disgust

Emotion structures

hypothalamus

OFC

Amygdala

What is an emotion?

Not cognition

# Dual Process Theories

## System 1:

- automatic
- emotional
- rapid

## System 2:

- effortful/ controlled
- rational
- slow

# Some Emotions

- **Basic Emotions:** happiness, surprise, fear, anger, disgust, sadness
- **Social/Moral Emotions:** guilt, shame, pride, embarrassment, jealousy

# **Emotions are important!**

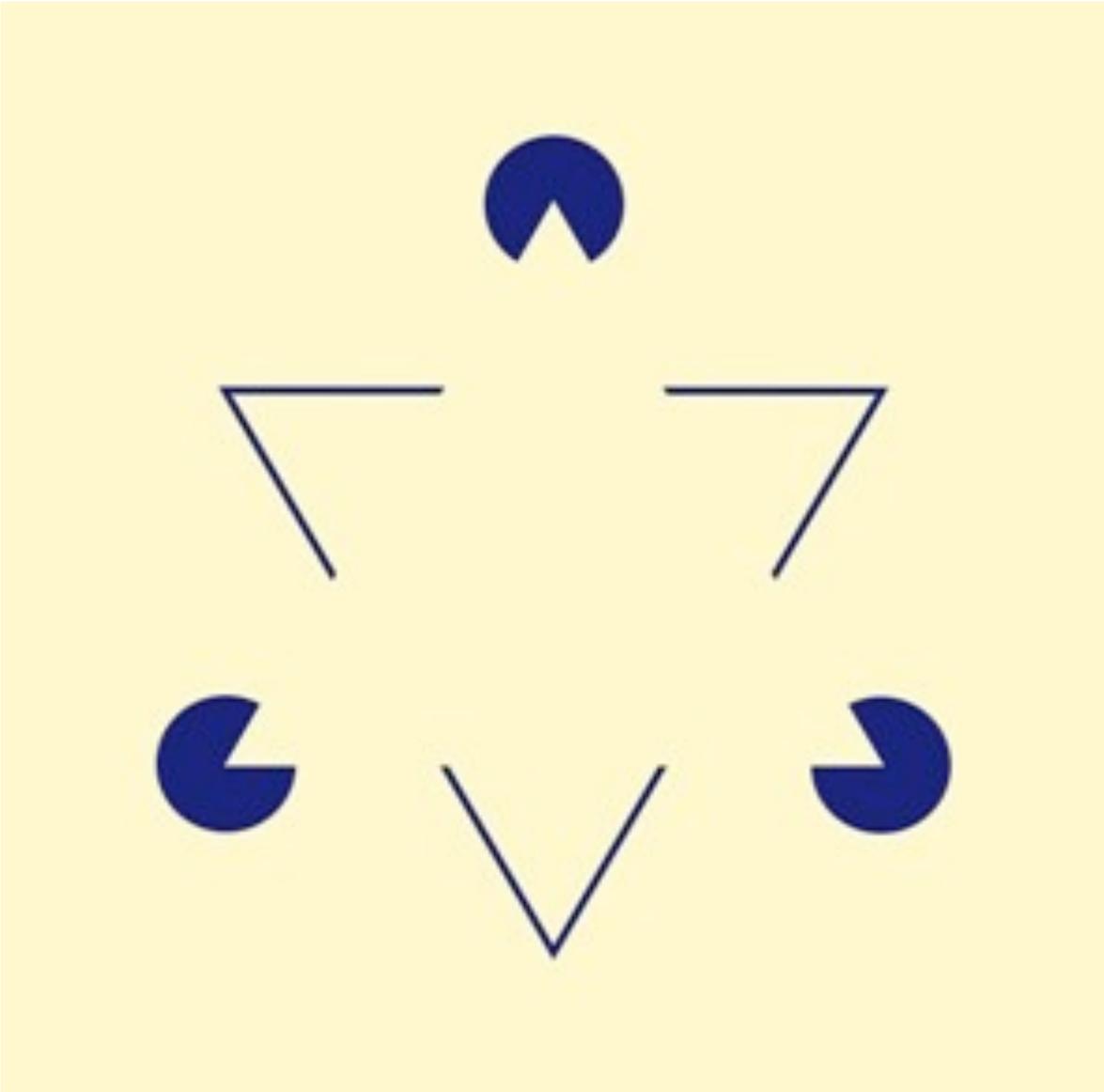
We (nearly) always feel some emotion

Emotions are what matters most about our experience



There is also a big field of study of how we INFER what emotions people are having

Social perception--> **attributions** --> social behavior



WHEN YOU'VE BEEN MARRIED A LONG TIME, YOU GET TO KNOW WHAT THE OTHER PERSON THINKS.

NO YOU DON'T.



# Process Theories of Emotion

# Motor output at different levels

## Reflexes

- spinal
- central

Stimulus-coupled

"Fixed action patterns"

Emotional reactions

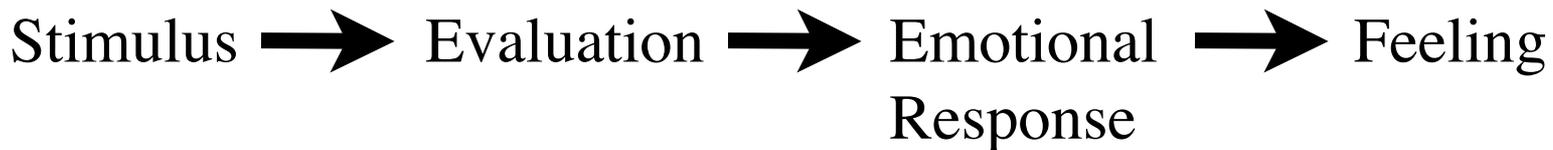
Actions

Long-term plans

Stimulus decoupled

## Some characteristics of an emotion

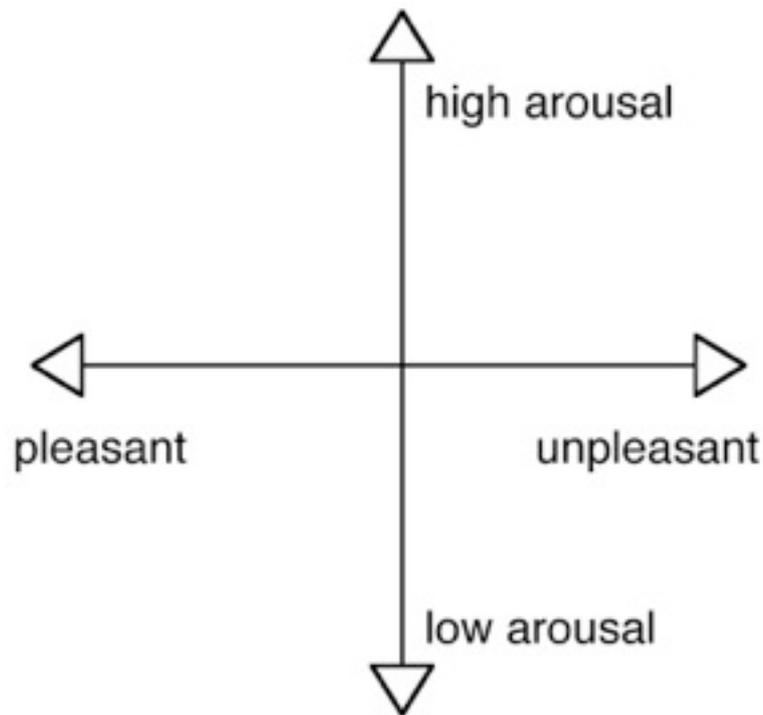
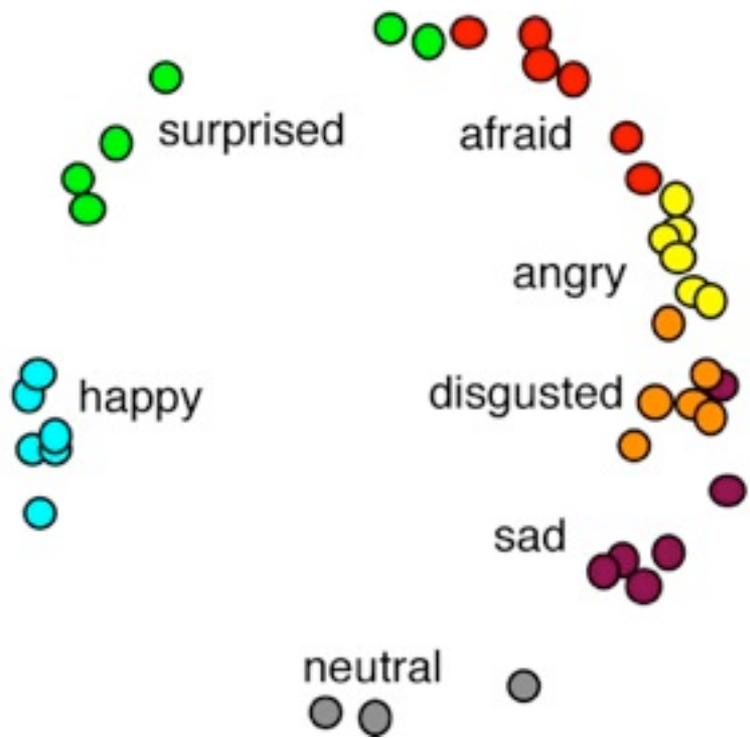
1. Phasic (vs. moods)
2. Has onset, duration, decay
3. In humans, often regulated
4. Can be broken down into some components

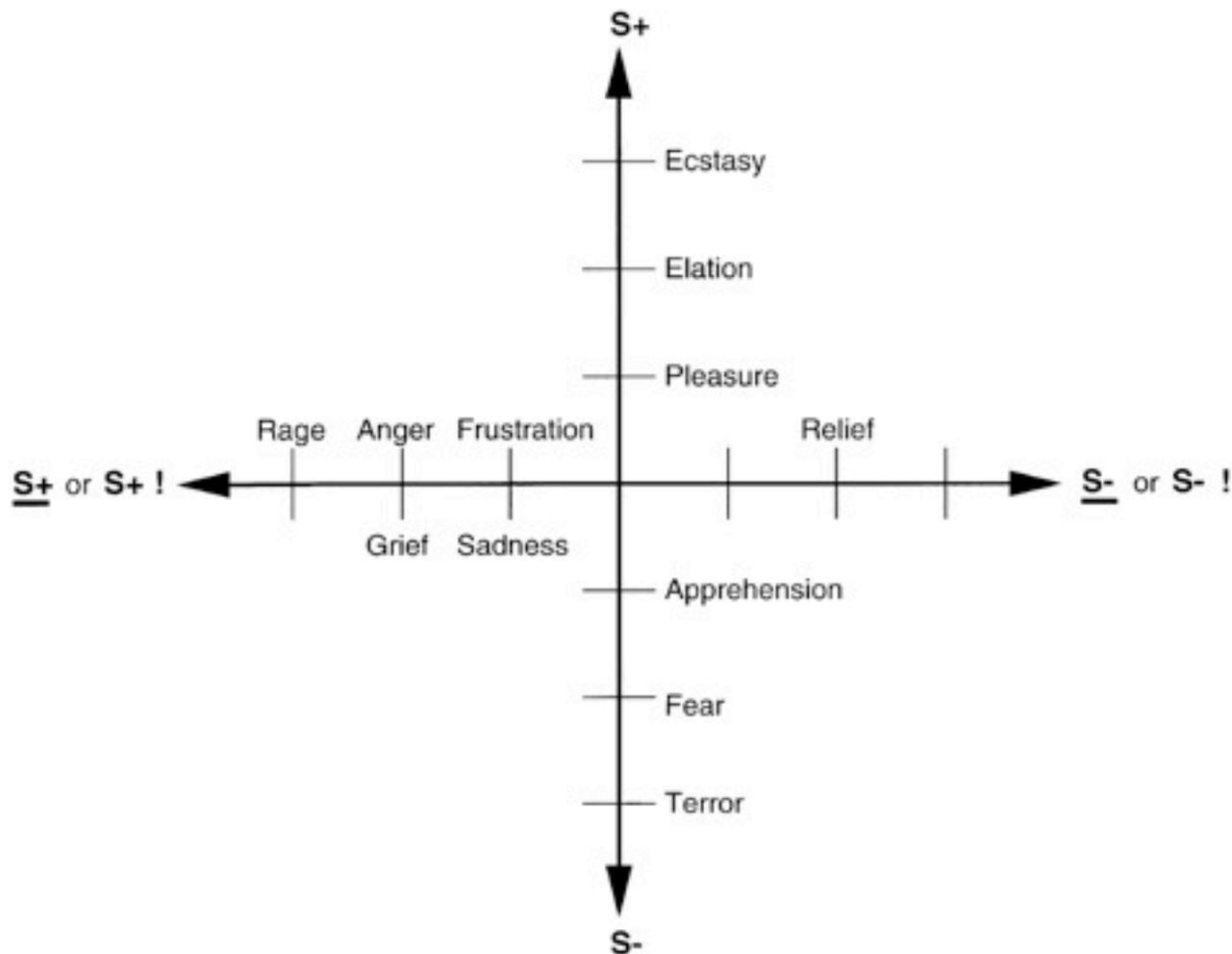


Context

Expectation

Individual Differences





**Figure 1**

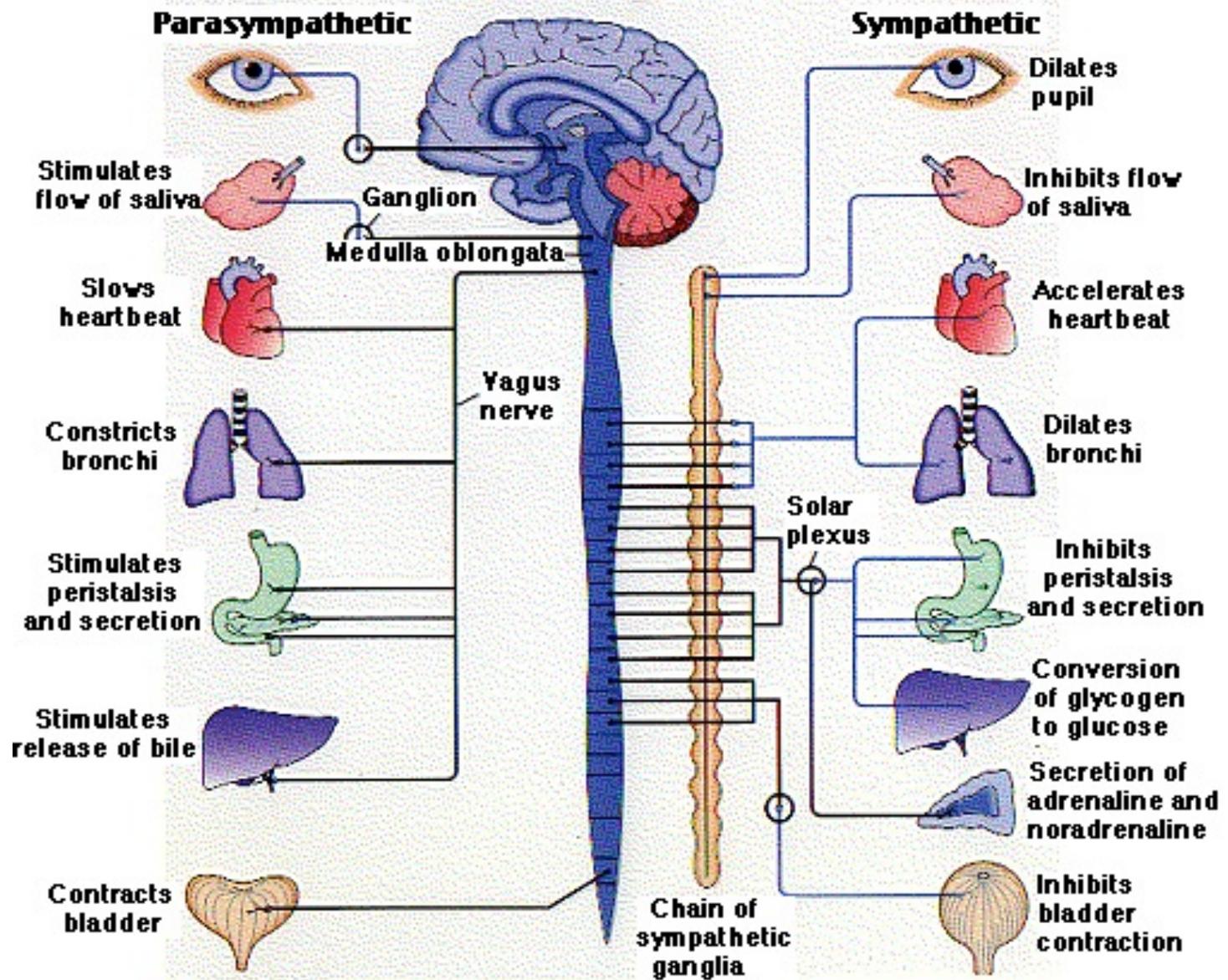
Some of the emotions associated with different reinforcement contingencies are indicated. Intensity increases away from the centre of the diagram, on a continuous scale. The classification scheme created by the different reinforcement contingencies consists of (a) the presentation of a positive reinforcer ( $S+$ ), (b) the presentation of a negative reinforcer ( $S-$ ), (c) the omission of a positive reinforcer ( $\underline{S+}$ ) or the termination of a positive reinforcer ( $S+!$ ), and (d) the omission of a negative reinforcer ( $\underline{S-}$ ) or the termination of a negative reinforcer ( $S-!$ ).

William James (1882): "What is an emotion?"

--perception of our emotional response

--pattern of bodily response discriminates emotions

“If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its characteristic bodily symptoms, we find we have nothing left behind, no “mind-stuff” out of which emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains.”



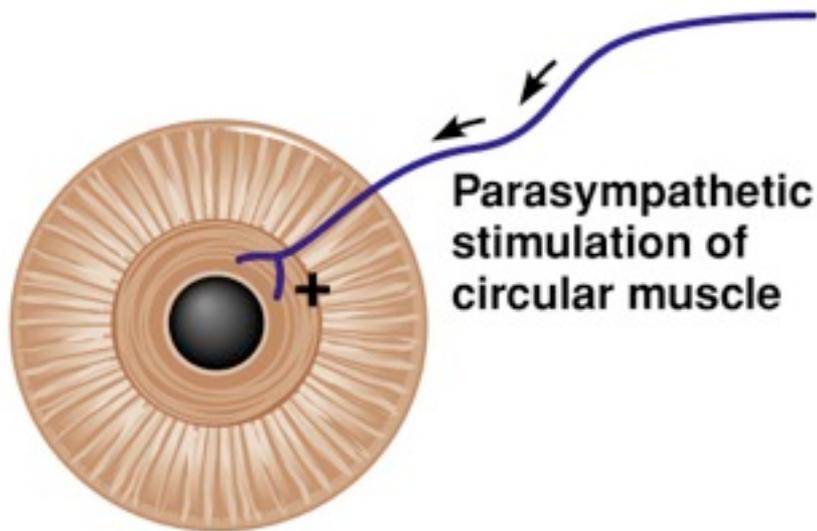
# Psychophysiology

Galvanic Skin Conductance (GSR, SCR)

Electrocardiogram (EKG)

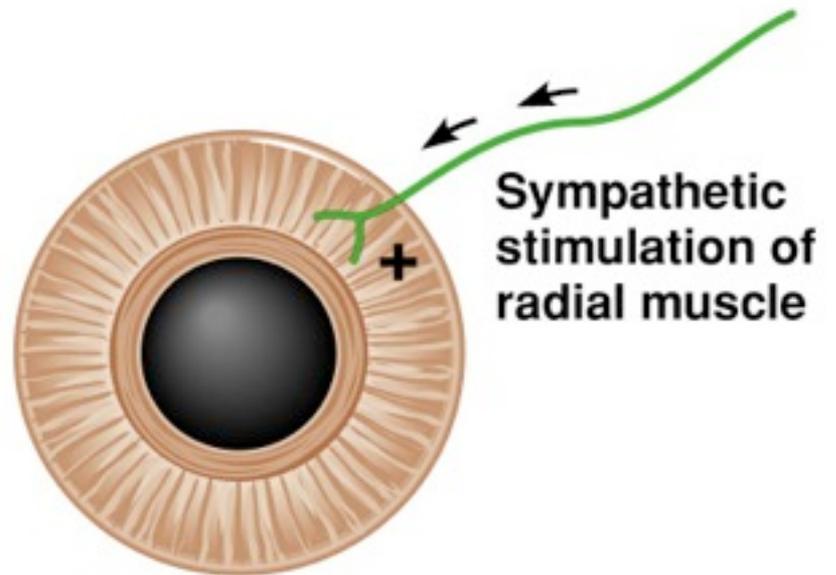
Facial Electromyogram (facial EMG)

Pupillometry, Respiration, Skin temperature,  
blood pressure



**(b) Pupillary constriction**

Copyright © 2008 Pearson Education, Inc., publishing as Benjamin Cummings



**(c) Pupillary dilation**

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Charles Darwin (1872)

"The Expression of the Emotions in Man  
and Animals"

--3 principles:

serviceable associated habits

antithesis

direct action of nervous system

--idea of "basic" emotions



FIG. 7.—Half-breed Shepherd Dog in the same state as in Fig. 5. By Mr. A. May.





F55



H16



F50



C 11B



HE 4



J38

# Rethinking the Emotional Brain

Joseph LeDoux<sup>1,2,\*</sup>

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<sup>2</sup>Emotional Brain Institute, New York University and Nathan Kline Institute, Orangeburg, NY 10962 USA

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DOI [10.1016/j.neuron.2012.02.004](https://doi.org/10.1016/j.neuron.2012.02.004)

LeDoux, Neuron 73:653-676 (2012)

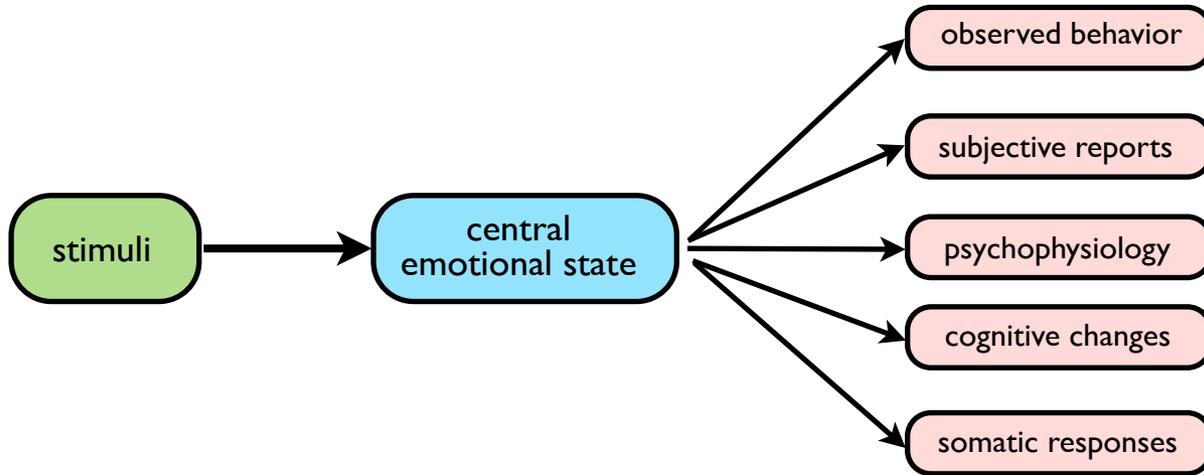
- Do not use “emotion” scientifically

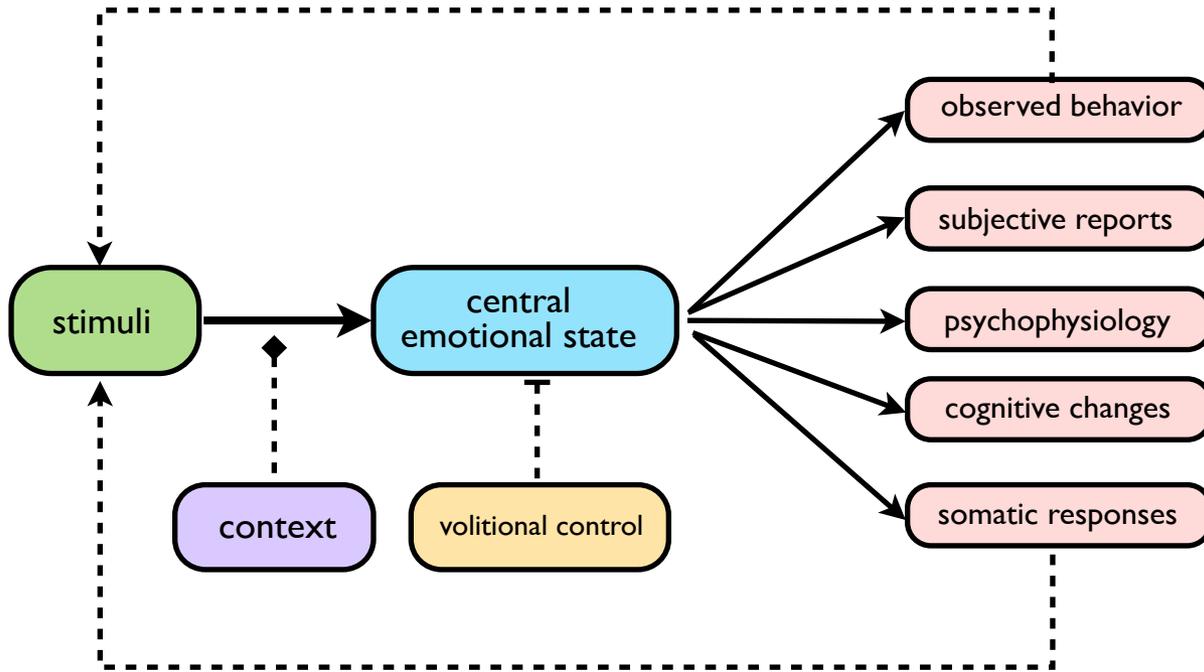
Why?

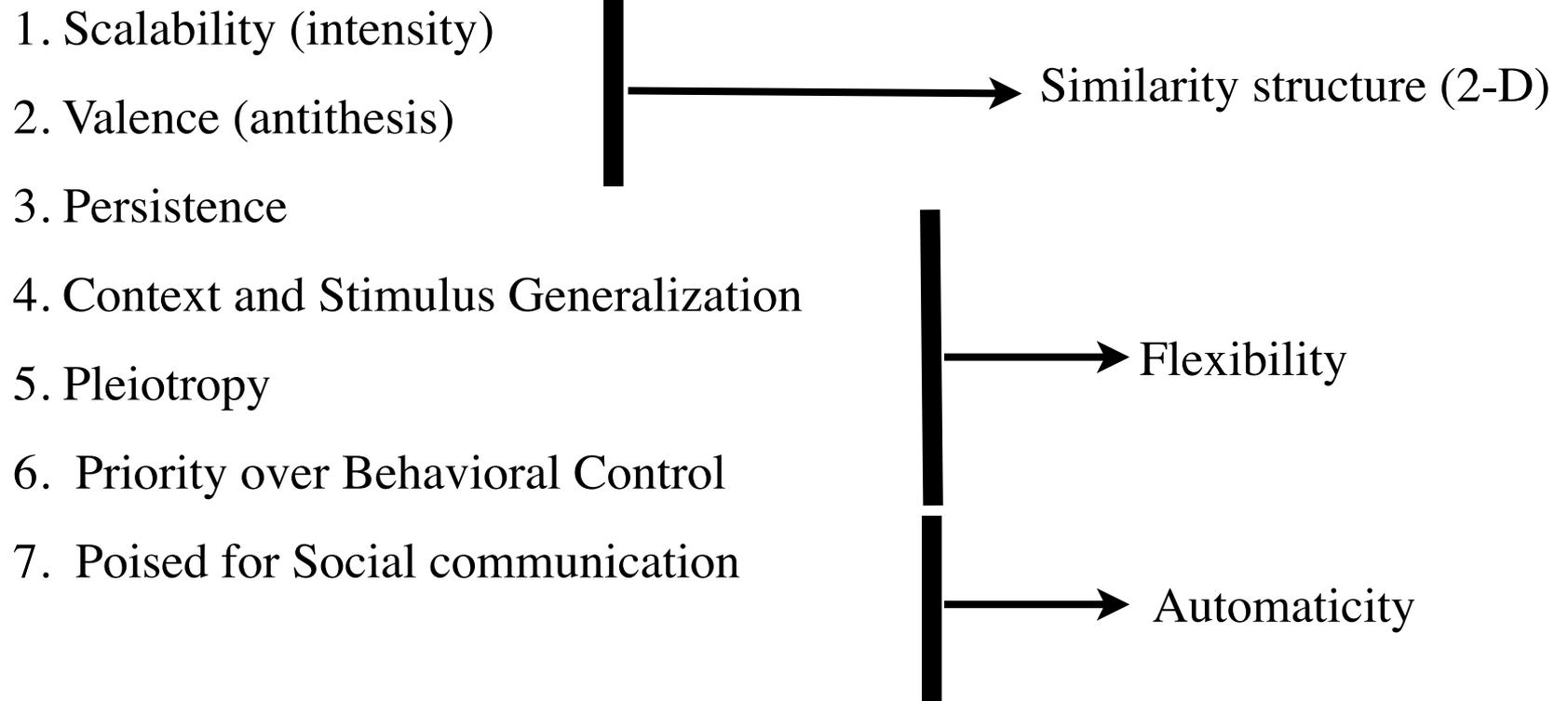
1. Because most people confuse “emotion” with “feelings”
2. And we cannot tell if animals have feelings

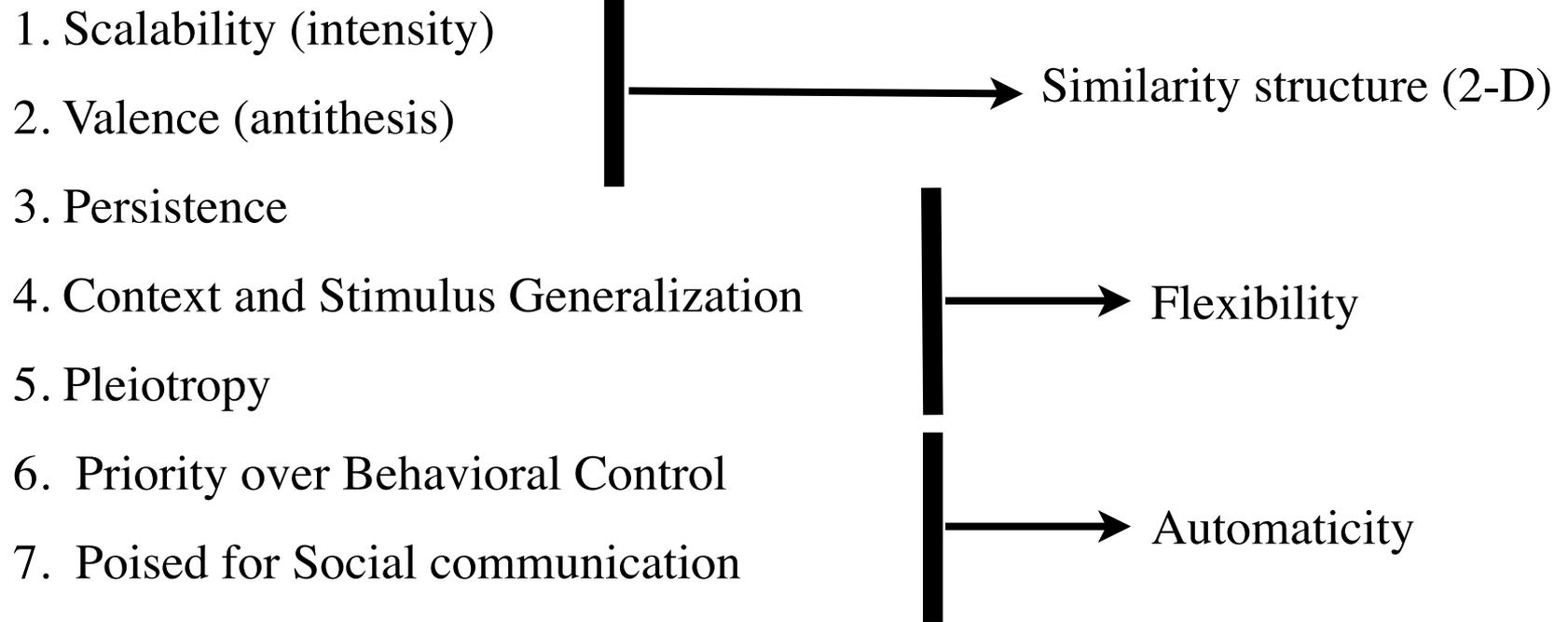
Anderson & Adolphs, “A framework for studying emotion across species.” Cell (2014)

1. Emotions are Internal/Central Functional States
2. Emotions are caused by particular stimuli/contexts
3. Emotions CAUSE behavior
4. Emotions CAUSE feelings
5. Emotions have characteristic features









### **Uniquely Human Aspects?**

8. Control
9. Subjective Report
10. Stimulus Decoupling





Roger T. Matson

# Modules for recognizing emotions from faces

- Fear: amygdala
- Disgust: basal ganglia (HD), insula

**a** Disgust



**b** Fear



**a** Disgust

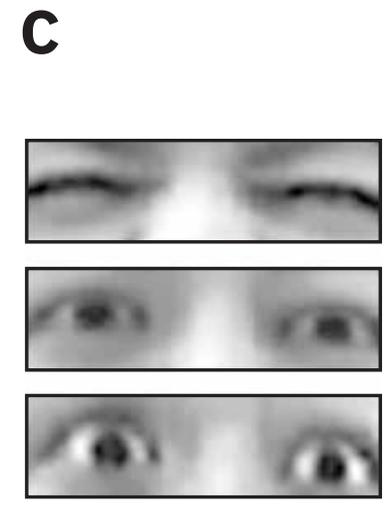
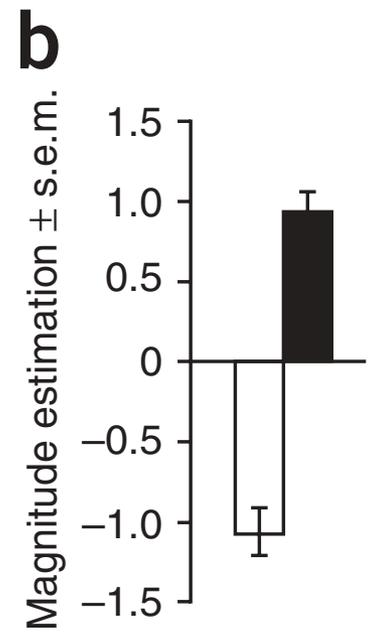
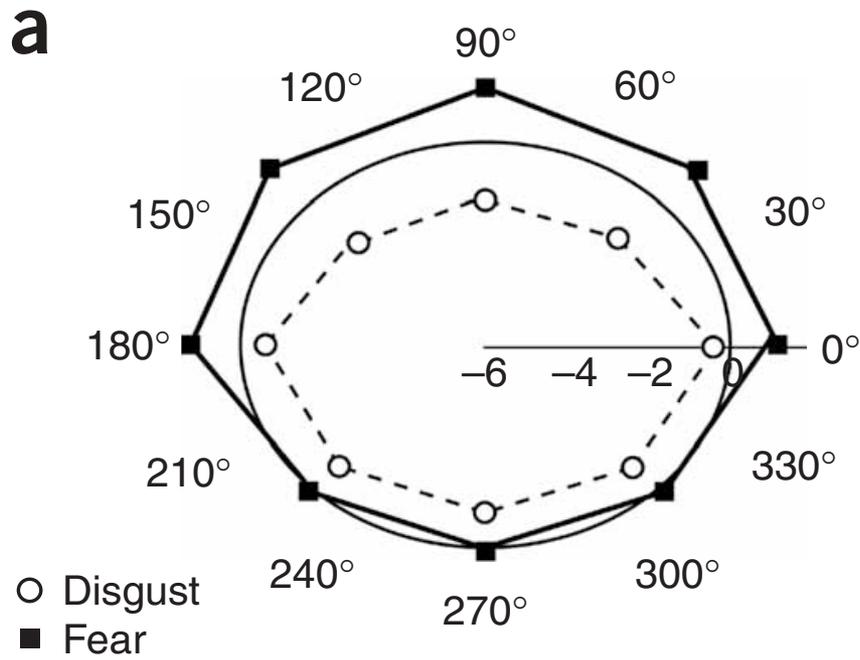


Lowered brow  
Narrowed eyes  
Narrowed nostrils  
Closed mouth

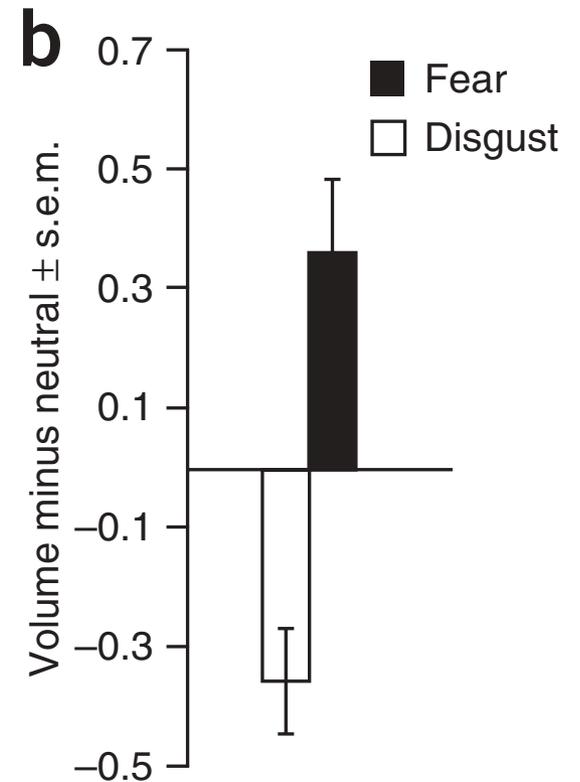
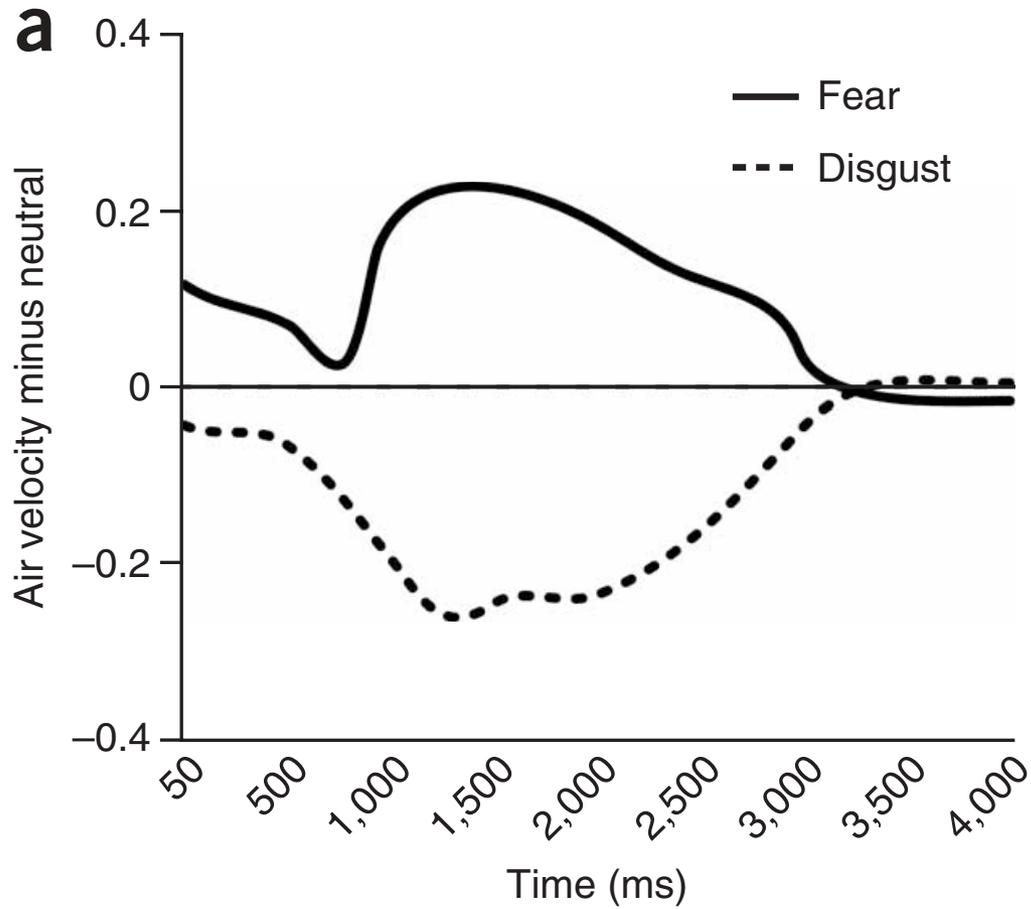
**b** Fear

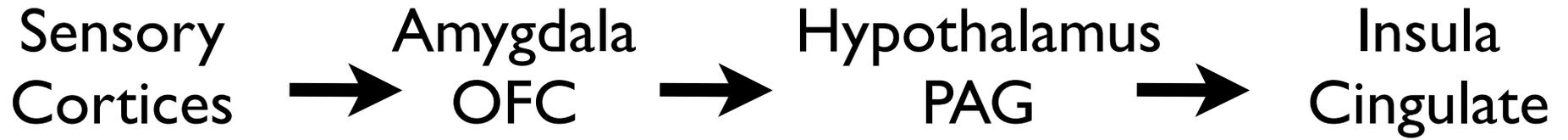


Raised brow  
Widened eyes  
Flared nostrils  
Open mouth



Susskind et al., Nat Neurosci 2008





Emotion  
Perception

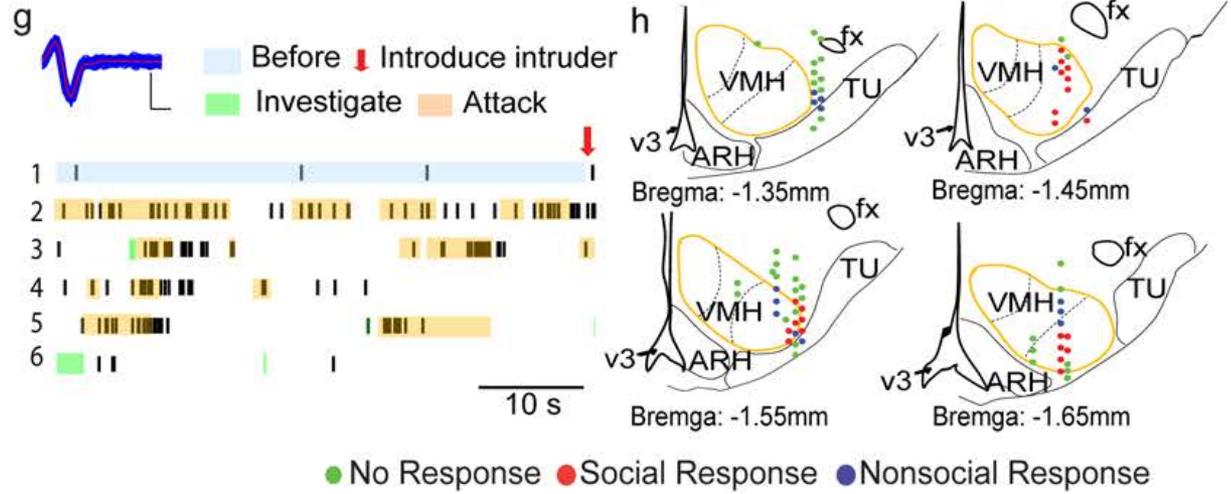
Association  
Induction

Emotional  
Response

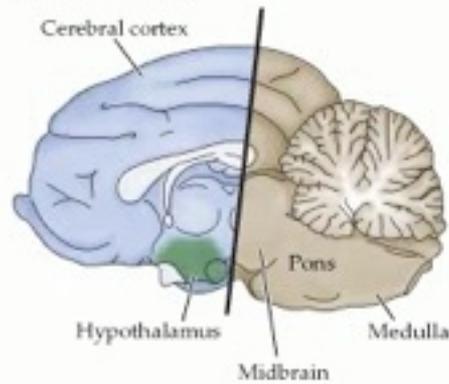
Feeling  
Awareness



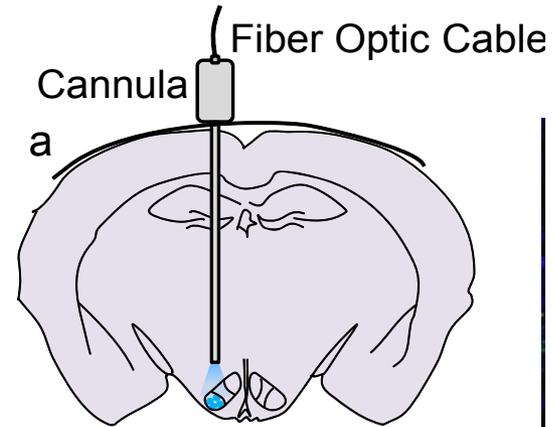
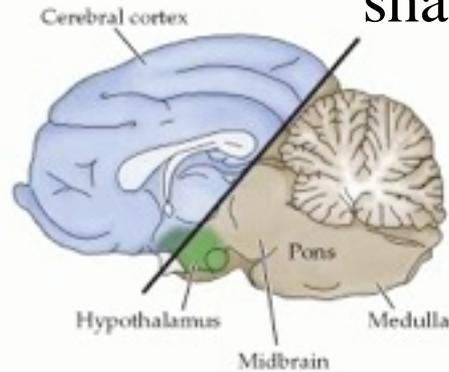
Walter Hess



Lin et al., Nature (2011)



“sham rage”





# Putative functions of some brain structures

Amygdala:

--fear, arousal, saliency

Insula:

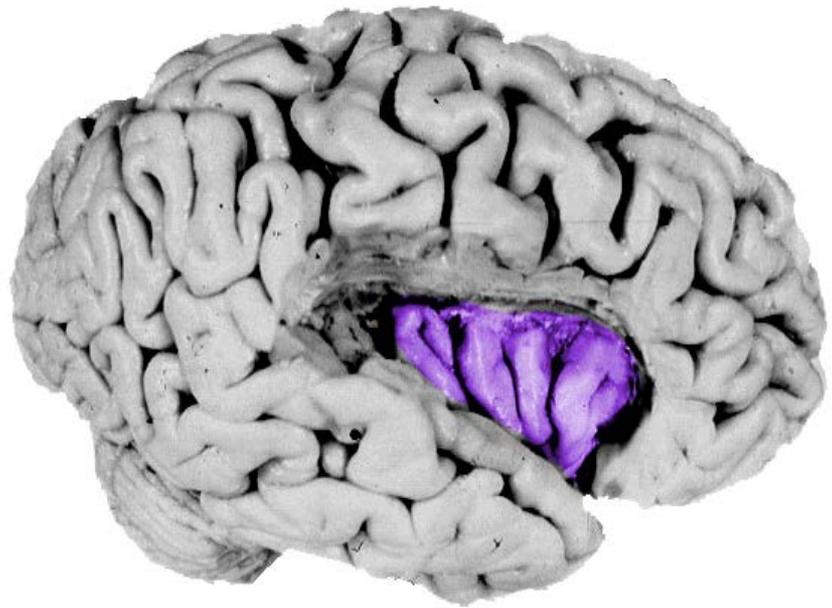
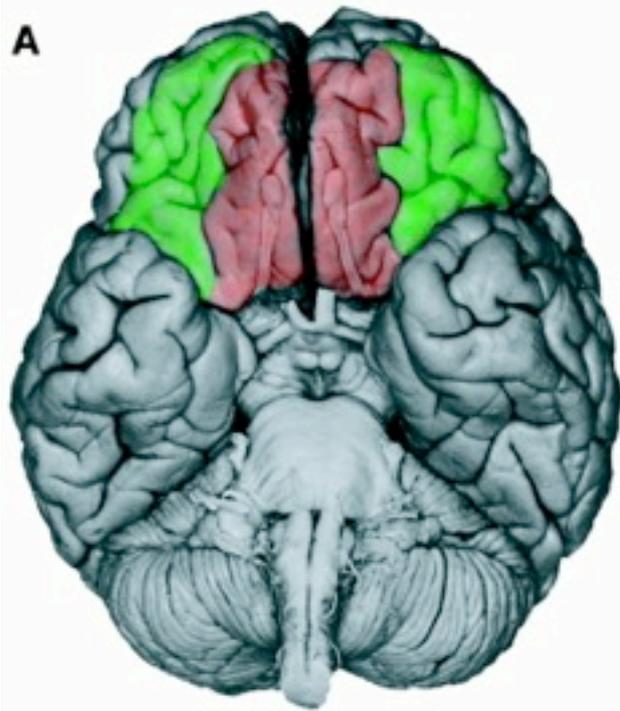
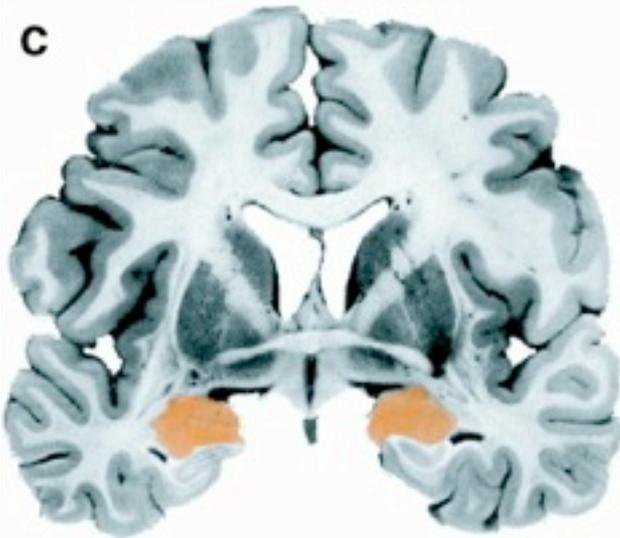
--disgust, empathy, pain

OFC:

--valence, decisions, social emotions, moral judgment

Cingulate cortex:

--pain, motivation ("akinetik mutism")

**A****C****D**

# Orbitofrontal Cortex

- emotional and social behavior
- represents reward value of stimuli
- involved in complex decision-making



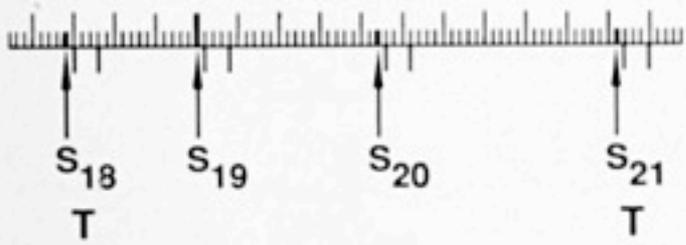
Figure 6.5  
S. Webster Wynne's 1868 photograph of Phineas Gage's skull and the woodcut

The equilibrium or balance, so to speak, between his (Gage's) intellectual faculties and animal propensities seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity ... impatient of restraint or advice when it conflicts with his desires.

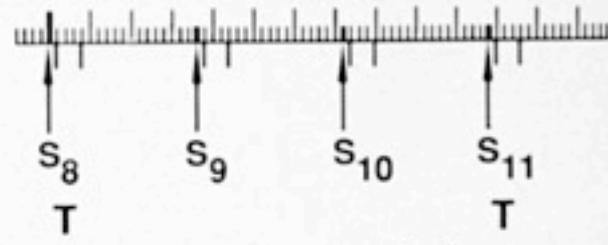
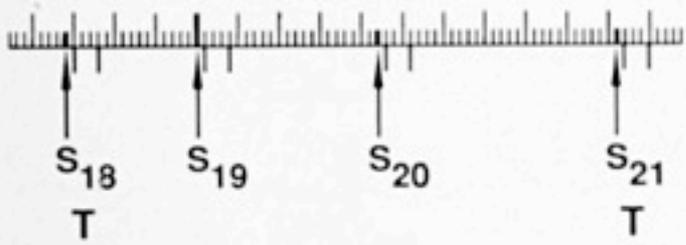
John Harlow, 1868







Brain-damaged  
Control



**Brain-damaged  
Control**

**Ventromedial  
Patient**

# Amygdala

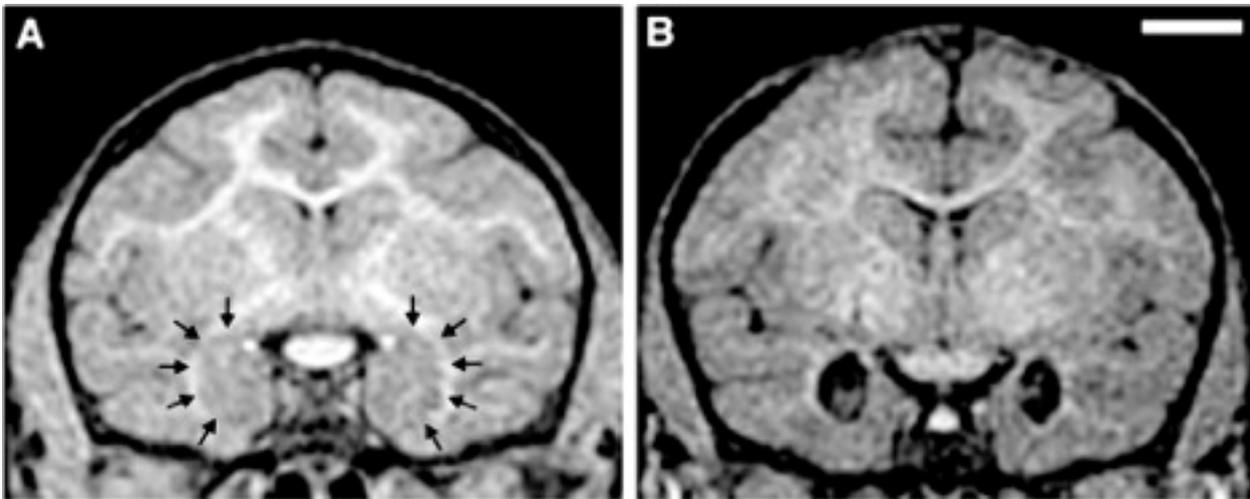
1. The Amygdala's role in implicit emotional memory (like fear conditioning) is doubly dissociable with the role of the hippocampus in declarative memory.
2. The amygdala is important for learning the value of stimuli, and for regulating social behavior, especially for fear or withdrawal-related behaviors.
3. The amygdala modulates much other cognition.
4. The amygdala shows individual differences and contributes to psychiatric illnesses such as mood disorders.



Heinrich Kluver



“Kluver-Bucy Syndrome”



- tameness
- oral tendencies
- hypersexual
- hypermetamorphosis
- psychic blindness
- altered taste preferences

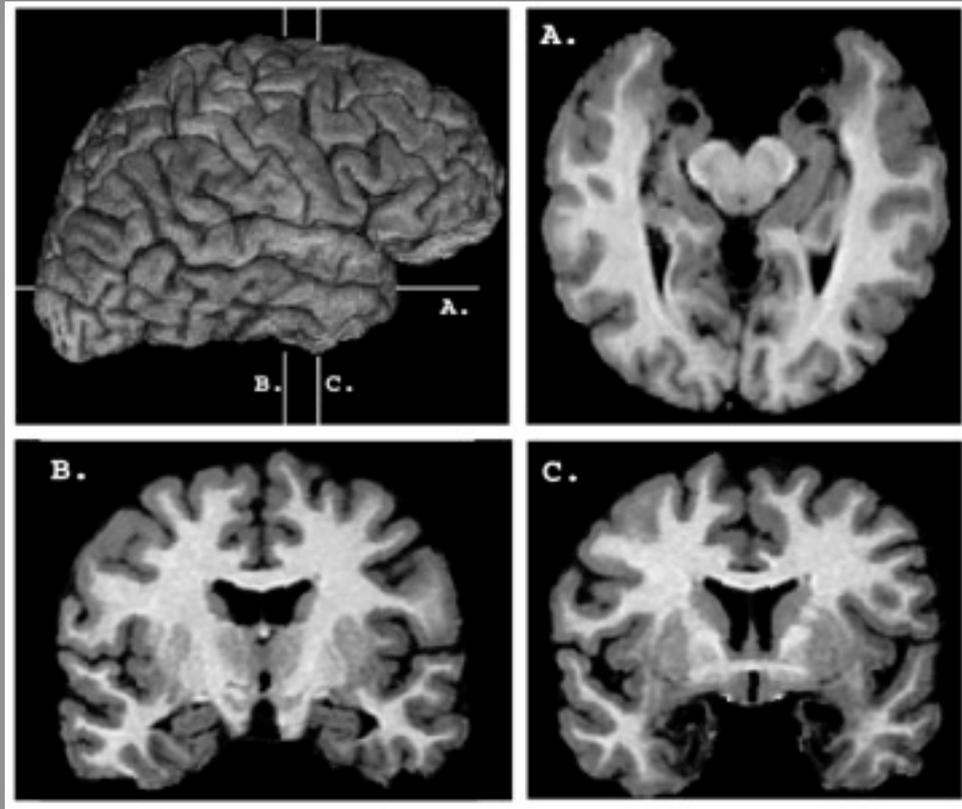
# Amygdala Lesions in Rats

# Part 1:

Hungry rat forages for food

## Part 3:

Amygdala-lesioned rat meets  
"Robogator"



**The brain of patient S.M.**

# Measuring the Experience of Fear

1. Standardized Questionnaires
2. Express fear to instruction
3. Fear to films
4. Fear in real life: autobiographical
5. Fear in real life: pet store

## Experience sampling with PDA

--3 months

--624 samples

--0 reports of afraid/scared/frightened

## Emotional films

--no endorsement of fear

## Autobiography

--no fear since age 10



# Summary

Emotions are a ubiquitous and salient aspect of our conscious experience

Fear has been mechanistically dissected in great neurobiological detail, and is an excellent model system

The amygdala is necessary not only for fear behaviors in rodents, but also for fear experience in humans

Fear is not in the amygdala, but generated by all the multiple processes orchestrated by the amygdala