

MIT OpenCourseWare
<http://ocw.mit.edu>

9.01 Introduction to Neuroscience
Fall 2007

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.

Emotion

Sebastian Seung

Emotions

- love/hate
- lust
- disgust
- pride/shame
- generosity/envy
- innocence/guilt
- gratitude
- resentment
- trust
- approval/disdain
- fear
- anger
- anxiety

Emotional expression in animals



- Standing at full height
- Arched back
- Hair standing on end
- Ears drawn back
- Teeth exposed
- Spit, hiss, or growl

Charles Darwin, *The expression of the emotions in man and animals*, 1872

Emotional expression in humans



anger



fear



happiness



sadness



surprise

Japanese Female Facial Expression (JAFFE) Database
<http://kasrl.org/jaffe.html>

Courtesy of Michael J. Lyons.

See Lyons, Michael J., Shigeru Akamatsu, Miyuki Kamachi, and Jiro Gyoba.

"Coding Facial Expressions with Gabor Wavelets." Proceedings, Third IEEE

International Conference on Automatic Face and Gesture Recognition. *Nara Japan, IEEE Computer Society*, (April 14-16, 1998): 200-205.

Emotional expression in robots

Images removed due to copyright restrictions.

Photos of Kismet with different facial expressions.

See <http://www.ai.mit.edu/projects/humanoid-robotics-group/kismet/kismet.html>.

Two aspects of emotion

- Expression
 - behavioral
 - blushing, laughing, crying, running
 - physiological
 - heart rate, skin conductance, neural activity
- Experience
 - subjective feelings of humans
 - linguistic, conscious

The amygdala is in the medial temporal lobe

Image removed due to copyright restrictions.

See Figure 18.6a in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007.

- Emotional effects of temporal lobe lesions may be due to loss of amygdala.

The amygdala is a fear center

- bilateral lesions
 - reduce fear and aggression
- electrical stimulation
 - produce fear (as well as other emotions)
- fMRI
 - activation when viewing fearful faces

S.M.

- bilateral amygdala damage
- impaired recognition of fear in others
- impaired fear learning
- impaired social judgments

Fear learning

- fear response
 - US: foot shock
 - UR: change in heart rate
- pair tone (CS) with shock
- tone (CS) by itself evokes fear response

Neural basis of fear learning

- neurons in central nucleus of amygdala
 - no response to tones prior to training
 - increased response to aversive tone
 - unchanged response to benign tone
- training reversed by lesions of amygdala
- human fMRI: recall of emotional memories is associated with enhanced amygdala response

Connections allow a stimulus to produce a fear response

- basolateral: important input region
- central: important output region

Image removed due to copyright restrictions.

See Figure 18.9 in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007.

Types of aggression

- Predatory (for food)
 - few vocalizations
- Affective (for show)
 - vocalizations
 - threatening/defensive posture
 - activation of sympathetic ANS
 - example: cat hissing and arching its back

Brain transections and sham rage

- sham rage
 - triggered very easily
 - not followed by attack
- posterior hypothalamus is essential

Image removed due to copyright restrictions.

See Figure 18.10 in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007.

Rage from electrical stimulation

Photos removed due to copyright restrictions.

See Figure 18.11 in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007.

See this image in Google Books: http://books.google.com/books?id=75NgwLzueikC&pg=PA563&source=gbs_toc_r&cad=0_0#PPA580,M1

- medial hypothalamus
 - affective aggression
 - threat attack
- lateral hypothalamus
 - predatory aggression
 - silent biting attack

A neural circuit for aggression

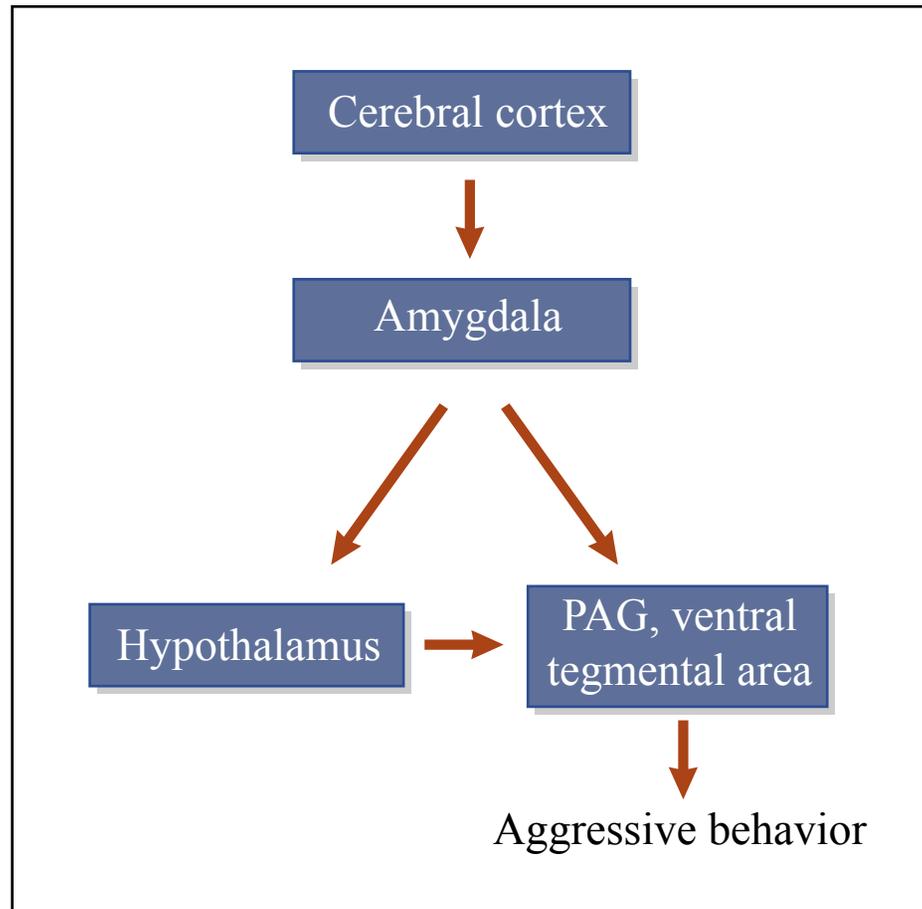


Figure by MIT OpenCourseWare. After Figure 18.12 in Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience: Exploring the Brain*. 3rd ed. Baltimore, MD: Lippincott Williams & Wilkins, 2007.

Attachment

Selective and enduring social
interaction

Infant to mother

- Konrad Lorenz: imprinting
- Harry Harlow
 - cloth and wire mother surrogates

Photo removed due to copyright restrictions.
Small monkey with cloth and wire mother surrogates.

Mother to infant

- hormone oxytocin
- involved in
 - labor
 - breastfeeding

The vole as a model system for pair-bonding

- Prairie vole
- Pair-bonding
 - pair lives in one nest
 - male and female cooperate in parenting
- Meadow vole
- Promiscuous
- Asocial
 - isolated nest
 - males do not parent
 - females parent little

Oxytocin and vasopressin

- Peptides of nine amino acids
 - differ in two amino acids
- Released in mothers by labor and breastfeeding
- In voles, copulation releases oxytocin (females) and vasopressin (males)

Partner preference formation

- Prairie females prefer previous partner male.

Image removed due to copyright restrictions.
Diagram and graph.

- This preference is eliminated or reversed by oxytocin antagonists.

Species differences may arise from receptor distributions

- Prairie voles have more oxytocin receptors in the nucleus accumbens and related areas.
- Meadow vole males have been genetically engineered to prefer partners by overexpressing vasopressin receptors in the ventral pallidum

Ultimatum game

- Proposer
 - proposes a division of the money
- Responder
 - accepts or rejects
- Rejection result in both getting nothing.

Behaving irrationally can be a
rational strategy!

Unfair – fair offer

- bilateral anterior insula
- prefrontal cortex Sanfey et al. Science (2003).
- anterior cingulate cortex

Pair of brain fMRI images removed due to copyright restrictions.
See Fig. 2 in Sanfey, A. G., et al. "The Neural Basis of Economic Decision-Making in the Ultimatum Game." *Science* 300, no. 5626 (2003): 1755.

Lovers - friends

- middle insula
- anterior cingulate
- hippocampus
- caudate/putamen
- cerebellum

Image removed due to copyright restrictions.
Fig. 3 in Bartels and Zeki, 2000.

Bartels and Zeki, The neural basis of romantic love, *Neuroreport* 11:3829 (2000)

Further reading

- Joe LeDoux, The emotional brain
- Edmund Rolls, The brain and emotion
- Robert Frank, Passions within reason
- Marvin Minsky, The emotion machine