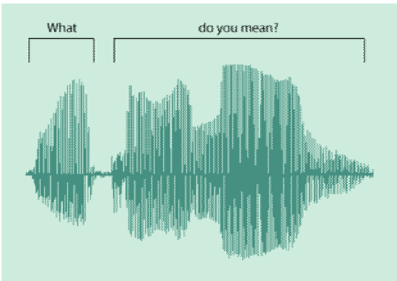
Language, lateralization (Ch 26)

Language Acquisition – what happened?

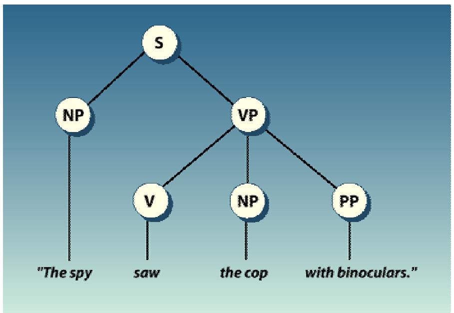
1. **Language is universal across all human societies. That is, all societies use language in similar ways.**
2. **Despite the apparent diversity of human languages, any language can be learned by anybody.**
3. **Accordingly, languages must have some common underlying structures.**

Universal Grammar (UG; Chomsky, 1965): A set of abstract general (and innate) principles that are universal to all natural languages. Each language is nothing but a specific implementation of these principles (e.g., temperature by F, C or K)

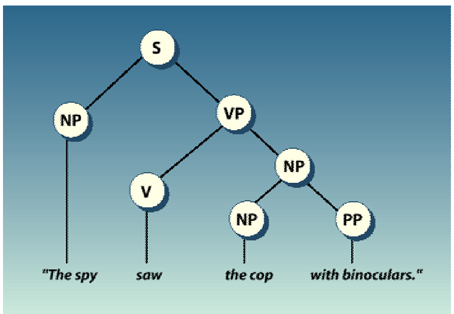
Speech perception is very difficult



Understanding language is even more difficult



Language is hierarchical and can be extremely ambiguous



Animal Communication

What is communication?
One possible definition (E.O. Wilson)

> *"Communication occurs when the action of or cue given by one organism is perceived by and thus alters the … behaviour in another organism in a fashion adaptive to either one of both"*

Do animals communicate?
Yes, lots! (and plants too)
So what's special about us? Reference? Complexity? Acquisition?

Vervet Language?

Vervet monkey gives different alarm call for three predators:
- Eagles
- Snakes
- Leopards

Are these referential?
Closed system – mostly innate.

Bee Language?

Honey Bees communicate about:
- -What direction to look for nectar
- -How far away it is
- -How good it is

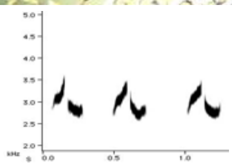
Easily as complex as information in a sentence of human language

Songbird Language?

Song in some species is learned

Regional “dialects”

Not really saying much



Human Language…

Digital infinity/recursion

Allows us unbounded expression – we can talk about anything

This is the farmer sowing the corn, that kept the cock that crowed in the morn, that waked the priest all shaven and shorn, that married the man all tattered and torn, that kissed the maiden all forlorn, that milked the cow with the crumpled horn, that tossed the dog, that worried the cat, that killed the rat, that ate the malt, that lay in the house that Jack built.

So is it a gradual or a Big Bang development?

Could language evolve gradually, or as one improbable mutation?

We need fossils of early protolanguage

Living fossils
- Early child language
- Pidgin languages
- Trained chimps

PROTOLANGUAGE:
- No closed-class words
- No grammatical endings/morphology
- No embedding, relative clauses etc.
- No established word-order

Chimps’ and Other Apes’ Language?

Language used from 6 months (critical period?)

Able to understand some syntax

Kenzi

1. *Go get the carrot that’s in the oven*
2. *Put jelly in milk*
3. *Put milk in jelly*

A chimp called Washoe…
(Washoe – group, US)

Experiments with chimps and other apes show they are capable of much more than we thought, in terms of language.

Chimps do not have the physical apparatus for human speech, but Washoe, a female chimp, was taught 160 signs in Ameslan.

Generalizing signs

Washoe moved beyond the signs and generalized them – and combined them.

She learned “open” for one door, and then used it to ask for other doors to be opened

She asked for refrigerators to be opened and pointed to open drawers and briefcases.

Washoe and Lucy (another chimp) learned the sign for feces and generalized it to mean dirty.

Lucy used the term as an expletive when she got mad at her trainer for not giving her something.

Lucy invented “cry hurt food” – three signs in Ameslan – to talk about radishes and “candy fruit” to talk about watermelons. Chimps and other great apes achieve the linguistic capacity of a 2–3 year old human.

Comparative linguistics and language origins
(Sci Am, April 2004)

Brent Berlin and Paul Kay studied 110 languages and found seven stages in the development of color terms.

All languages have at least two terms, white and black, or color and lack of color.

When languages acquire a third term, it is always red.

When languages acquire a fourth term, it is either green or yellow.

Berlin and Kay’s study…
(originated 1969)

At five terms, green or yellow enters, depending on which one entered at stage IV.

At 6 terms, blue enters, and at 7 terms, brown enters.

At the final stage of 8 or more terms, purple, pink, orange, grey or combinations of these terms enter the lexicon. Moreover, color lexicons become more complex as societies become more complex.

Pidgins and creoles

Recent studies of Pidgins and Creoles also shed light on the evolution of language.

Pidgin languages are always second languages.

They develop when speakers of different languages try to communicate, often for purposes of trade.

The lexicon usually comes from one language, and the grammar from the other.

Children's language acquisition

12 - 13 months name objects
18 – 20 months one-word sentences
18 – 24 months two-word sentences

WHY?

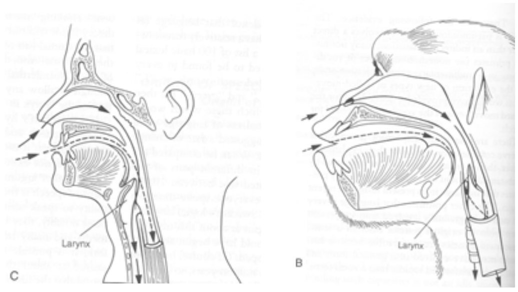
Anatomy - Bipedalism

We stood up:
- Frees up the hands (could gesture be the first form of language?)
- Breath control

Change in shape of pelvis:
- Conflict between big brains and birth canal
- Neoteny – we are embryonic after birth

Anatomy - The vocal tract

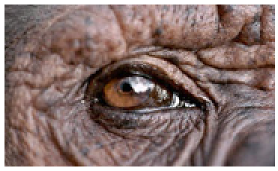
Vowels [a], [i], [u] only possible in *homo sapiens (not in Neanderthals?)*
Dangerous skill – we can choke!



Joint attention and mind reading

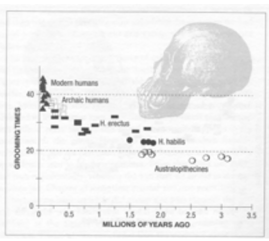
Q: When children hear a new word, what do they do?
A: They look to see what the speaker is looking at.

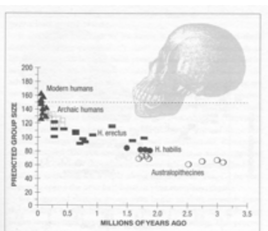
Difference in contrast between sclera and pupil
Disadvantage: chimps can hide what they are looking at but we can't...



Social Organization

Group size related to size of brain
Human group size: 150





Grooming holds together groups
How can we groom? Use gossip!

Speech and handedness – a link to be understood?

The speech area of the brain is adjacent to the area devoted to the control of the human hand.

The makers of stone tools were mostly right handed.

Chimps can make stone tools – they don't do that in the wild – but when they do in experiments in captivity, they do not show any preference for right- or left handedness (Stanley Ambrose, Science 2001).

Handedness is probably associated with lateralization of the brain, as is language.

Maybe there is advantages in lateralization in bimanual tasks requiring precision and power (both in some chimps in Tanzania and among humans females more right-handed females than males, Am J Phys Anthropol, 123:62-8, 2004)

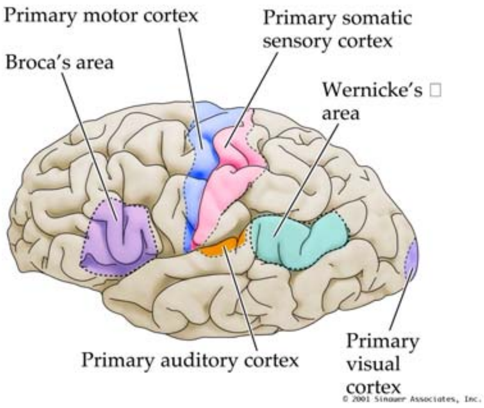
Corpus callosum fibres have similar conductance speeds across species suggesting that in bigger brains lateralization may be favoured (Braz J Med Biol Res, 36:409-20,2003)

Lateralization of language function

Left brain: 98% of right-handed people have almost all of the language functions represented in the left-hemisphere of the neocortex

Right-hemisphere processes language functions regarding metaphorical or artistic meaning of language (e.g., humor)

In left-handed people, language function is more often represented predominantly in the right-hemisphere of the neocortex



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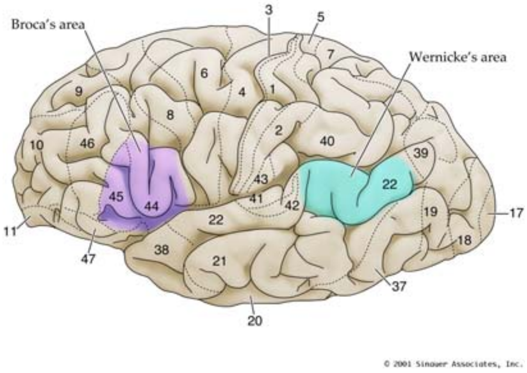
The Major Brain Areas Involved in the Comprehension and Production of Language



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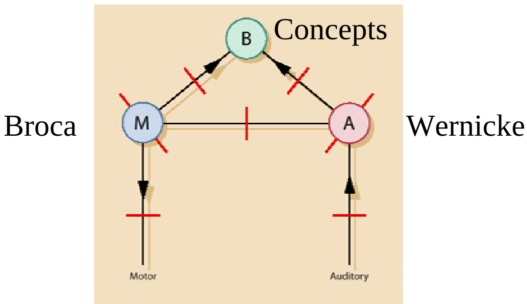
Relationship of Language Areas to the Cytoarchitectonic Map of Cerebral Cortex

Schematic model (oversimplified)



Broca's Area
Production of spoken language
(Motor programs for controlling speech sounds)

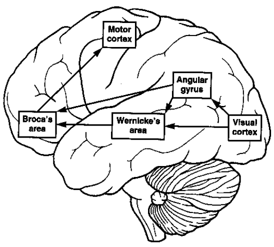
Wernicke's Area
Comprehension of language
(Interpretation of spoken and written words)

Arcuate fasciculus
Connection between Broca's and Wernicke's areas

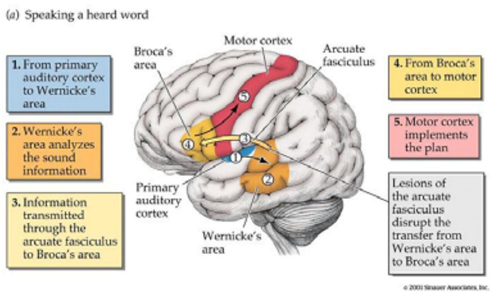
Visual Cortex
Processing of written language

Angula Gyrus
Connection among Broca's, Wernicke's and visual cortex

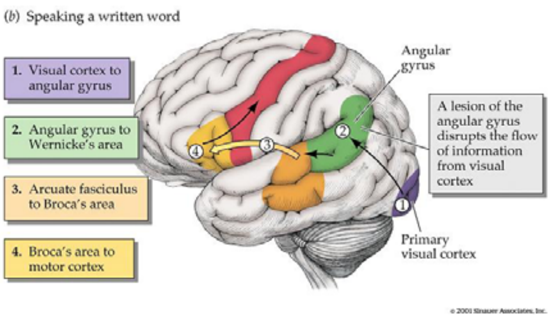
Mortor Cortex
Making of speech sounds (i.e. controlling of vocal muscles)



MODEL



MODEL



Varieties of Aphasia

Broca's aphasia:

- Damage to Broca's area
- Prevent a person from producing speech.
- Nonfluent, telegraphic speech
- Words are not properly formed

(e.g.)

"I'm a sig ... no... man ... uh, well, ... again."

"Well..mess..uh..sgga..diz..es.."

- Person can understand language

Wernicke's aphasia:

- Damage to Wernicke's area
- Loss of the ability to understand language
- Fluent but unintelligent speech
- Can form words properly but the words that are put together make no sense

(e.g.)

"I go to a dog of cookies in TV"

Conduction aphasia:

- Damage to Arcuate fasciculus
- Fluent speech / good comprehension, but unable to repeat what is head or read

Acquired alexia:

- Damaged connection between visual cortex and Wernicke's area
- Inability to read, but can see words

Agraphia:

- Inability to write words
- damages to where??

Dyslexia:

- loss & deficits of reading skills, spelling and recognizing word sounds

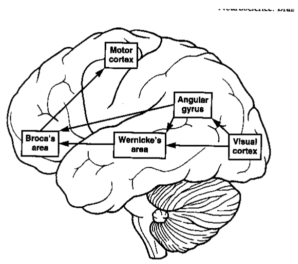


TABLE 27.1
Characteristics of Broca's and Wernicke's Aphasias

Broca's aphasia[a]	*Wernicke's aphasia*[b]
Halting speech	Fluent speech
Repetitive (perseveration)	Little repetition
Disordered syntax	Syntax adequate
Disordered grammar	Grammar adequate
Disordered structure of individual words	Contrived or inappropriate words

[a]Also called motor, expressive, or production aphasia
[b]Also called sensory or receptive aphasia

NEURAL ABNORMALITIES IN DYSLEXIA

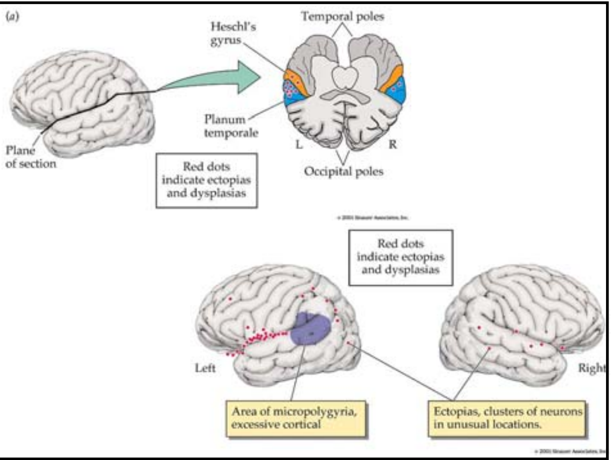
Anomalies in cortical cell arrangement

Ectopias: unusual groupings of cells in outer layers

Micropolygyria: excessive cortical folding

Disoriented cells

These abnormalities probably occur during neural migration during fetal development



BRAIN IMAGING DYSLEXIA

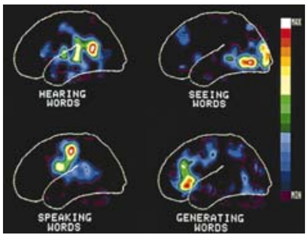
fMRI studies show different patterns of brain activation in dyslexics and nondyslexics.

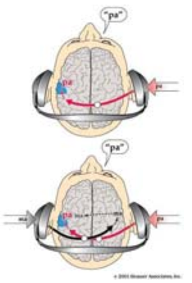
Dyslexic subjects:

- showed less activation in posterior regions (e.g. Wernicke's area) and overactivity in anterior regions compared to nondyslexics.
- showed less activation of visual cortex in response to written words.

ASSESSMENTS OF CEREBRAL LATERALIZATION

Sodium Amytal Test
Dichotic Listening Test
Tachistoscopic Tests with Split-Brain patients
Functional Brain Imaging





Some left hemisphere functions	Some right hemisphere functions
Analysis of right visual field	Analysis of left visual field
Stereognosis	Stereognosis
Lexical and syntactic language	Emotional coloring of language
Writing	Spatial abilities
Speech	Rudimentary speech

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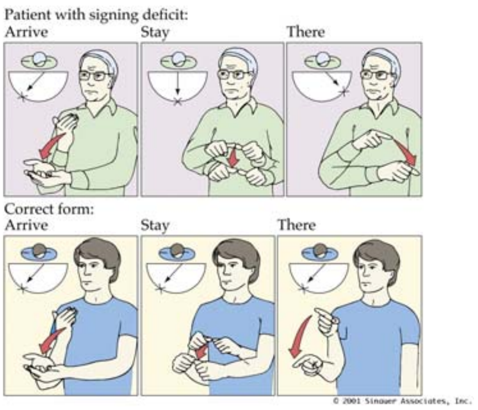
Confirmation of Linguistic Specialization of the Left Hemisphere in Humans



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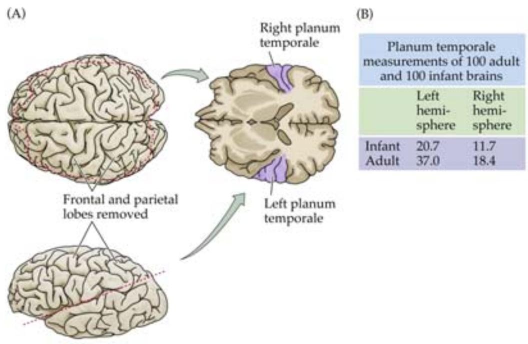
Signing Deficits in Deaf Individuals who Suffered Lesions of Language Areas in the Left Hemisphere



Planum temporale measurements of 100 adult and 100 infant brains	Left hemisphere	Right hemisphere
Infant	20.7	11.7
Adult	37.0	18.4

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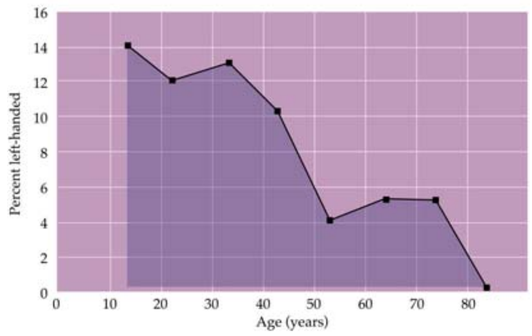
Asymmetry of the Right and Left Human Temporal Lobes



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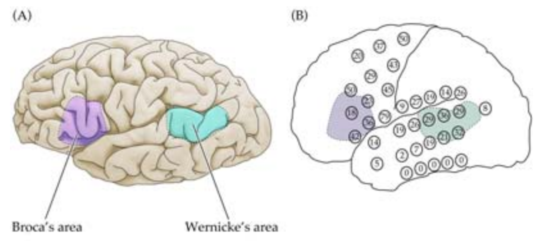
Handedness

Cortical Mapping of the Language Areas in the Left Cerebral Cortex During Neurosurgery



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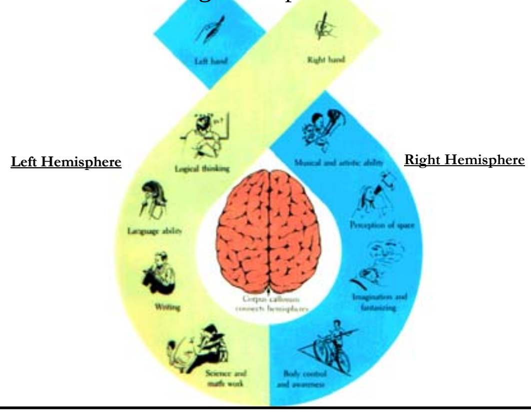
Lateralization is a general phenomenon



Lateralization

Left Hemisphere	Right Hemisphere
Verbal competence	Nonverbal areas
Speaking, reading, thinking & reasoning	Comprehension, spatial relationships, drawing, music, emotion
Processes info in sequence	Processes info. as a whole intuitive
One piece of data at a time	
Logical	

Study questions

Is language unique to humans?

Compare the functions of the right and left hemispheres. What techniques have been used to investigate cerebral lateralization (hemispheric specialization)?

Where is Broca's area? Wernicke's area? Compare Wernicke's aphasia and Broca's aphasia. What can the variety of aphasias tell us about the neural basis of language?

What similarities between sign language and spoken language suggest that they have common neural substrates?

Is hemispheric specialization unique to humans?

What is the relationship between handedness, lateralization of language, and anatomical hemispheric asymmetry?

What evidence suggests the importance of biological constraints or predispositions in language learning?

If a split-brain patient is briefly shown a pencil in her left visual field, will she be able to describe the pencil? Which hand would she use to select the pencil by feel from a set of test objects? Explain with the aid of a diagram.

Other terms to know:
- phoneme, grammar, syntax
- conduction aphasia
- planum temporale
- aprosodias

Emotion and Lateralization

Left Hemisphere	Right Hemisphere
Important for the expression of positive emotion	Important for the expression of negative emotion
Damage to the L.H. leads to loss of the capacity of joy.	Damage to the R.H. may make people euphoric.
Activation in the L.H. leads to tendencies to approach other people.	Activation in the R.H. leads to tendencies to withdraw from people.

Emotion

What is emotion?

Feeling, or affect, that can involve physiological arousal, conscious experience, and behavioral expression

Emotion as Rationality

The relation between emotional states and cognitive states is the need to draw conclusions when cognition would face combinatorial explosion of possible reasoning threads

Emotions

Basic affects
- **Surprise**
- **Happiness**
- **Interest**
- **Anger**
- **Fear**
- **Disgust**
- **Sadness**
- **Shame**

Theories of Emotion

* Emotion results from physiological states triggered by stimuli in the environment

* Emotion and physiological reactions occur simultaneously

Biology of Emotion

PET studies have shown that disgust, sadness, and happiness all activate the thalamus and prefrontal cortex

Autonomic Nervous System is activated in many emotions

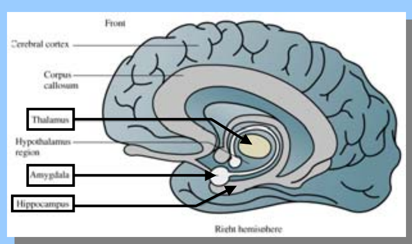
Orbitofrontal Cortex:
- **Involved in assessing the potential reward value of situations and objects**
- **Involved in processing of emotional cues**
- **Damage causes inappropriate interpersonal interactions and generally insensitive to the emotional expression of others**
- **Damage is associated excessive aggression and violence**

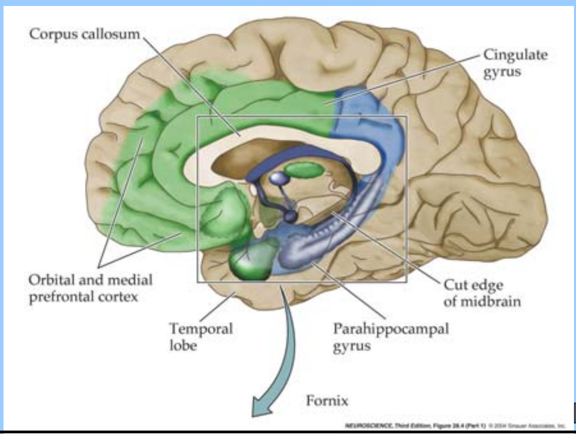
Happiness and sadness activate hypothalamus

Fear activates amygdala (quick processing)

Disgust activate the insula (related to gustatory reaction to unpleasant tastes and smells)

Important brain structures for emotion





Behavioural Neurology, 1998, 11:233 - 244

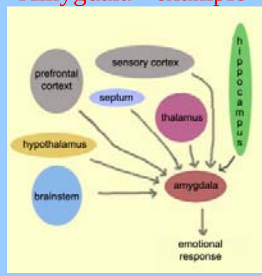
Differential contribution of right and left amygdala to affective information processing

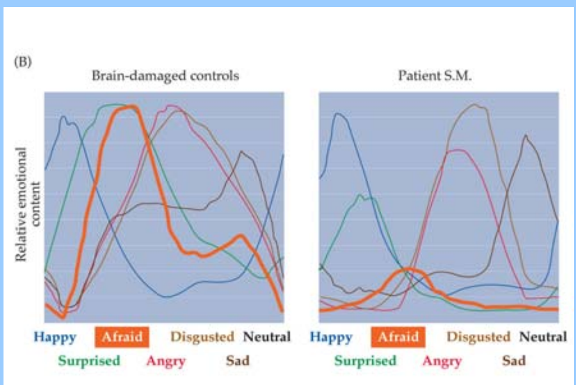
Hans J. Markowitsch

Right: more negative

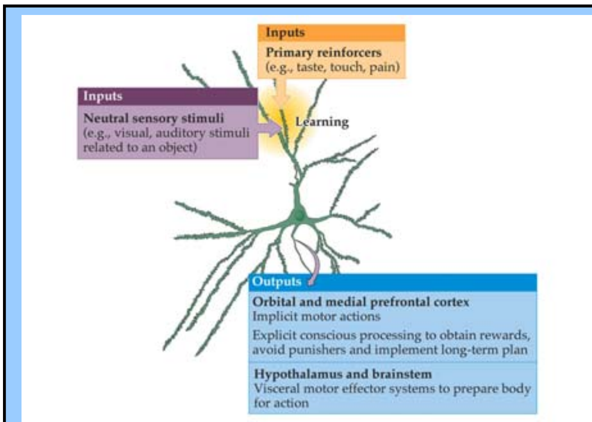
Left: activated by more positive stimuli, language related

Amygdala - example





Box D Fear and the Human Amygdala: A Case Study (Part 2)



28.6 Model of associative learning in the amygdala relevant to emotional function.

Emotion-communication (not just info processing)?

Emotions as communication:

- Emotions are the fastest way that we can communicate with members of our group
- Emotions are signals between animals of the same species that communicate one's brain state to another
- Emotions may predate language itself as a form of communication
- Facial expression is inevitable like language and universal like language

Positive and negative emotions can coexist and are governed by different types of behavior.

Evidence for separate systems in the brain for approach emotions, such as happiness, and withdrawal emotions, such as fear.

The left frontal lobes are more active in approach emotions, and the right frontal lobes are more active in withdrawal emotions.

People who have more activation in the left frontal lobe tend to be more optimistic than people who have dominant right frontal lobe activity.

Clinically depressed people tend to have low left frontal lobe activity.

Culture affects the way we express our emotions.

Each of us learns a set of 'display rules' from our culture that dictate how we will express our emotions publicly.

- (Americans versus Asians - only differences found when they were watching in groups)

Culture also affects how sensitive we are to the emotional expressions of others.

People from cultures with very restrained display rules are generally better at accurately detecting emotions in others.

- The harder the culture makes it to display emotions, the better the culture is at detecting emotions.