

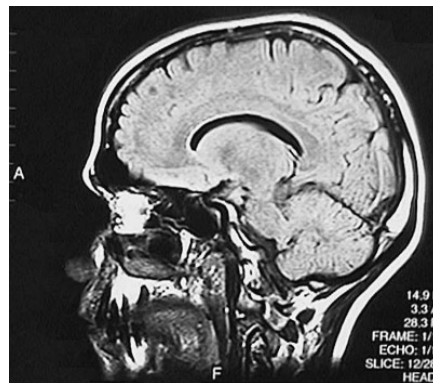
Learning with Your Brain

Should what (and how) we teach be associated with what we know about the brain and the nervous system?

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5/20/2004

Teaching With the Brain in Mind

Over the last 40 years we have learned more about the human brain than in the previous 400+ years



Heather Gordon's Brain
Graduate Student
Cognitive Neuroscience
Dartmouth College
(Rider University class of 2000)

Educators and neuroscientists have been trying to put this knowledge to work by transforming the information of basic and clinical neurosciences into practical insights for the classroom

How Does the Brain Learn?

There are MANY different theories on how people learn

- Neuroscience** – learning is based on physical changes in the nervous system
- Piaget's Developmental Theory** - building of cognitive structures based on age
- Behaviorism** – learning is the acquisition of a new behavior
- Constructivism** – personal reflection leads to learning
- Learning Styles** – learning depends on the educational experience
- Multiple Intelligences** – different types of learning abilities exist
- Right Brain/Left Brain Thinking** – different balances between hemispheres in different people
- Communities of Practice** – learning is a social phenomenon
- Control Theory** – behavior is inspired by basic human needs
- Social Learning Theory** – learning from watching others
- Social Cognition** – learning/development depends on experience

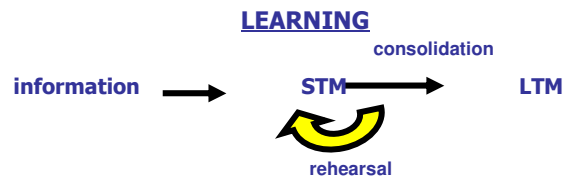
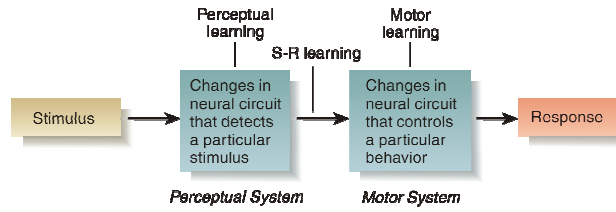
*Adapted from
<http://www.funderstanding.com>*

What Types of Things Do Humans & Animals Learn?

Some things learned are temporary and some are retained for life

What is it about our biology (i.e. brain) that allows us to learn, to recall, and to forget?

Typical Learning Figure from a Textbook



Typical Textbook defn:
Learning is a change in behavior based on experience

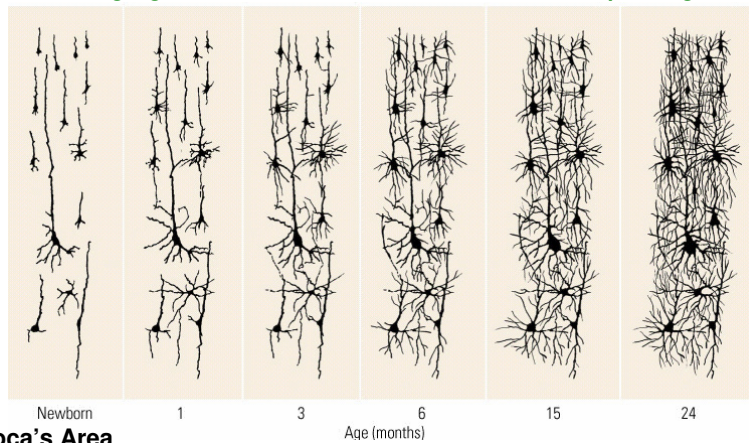
What kinds of things is the human brain designed to learn?

Real Life Examples

What kinds of things is the human brain designed to learn?

Some Learning Come Naturally

Language milestones are associated with dendritic sprouting



Broca's Area

Textbook picture adapted from *Biological Foundations of Language*, 1967

THE BRAIN IS THE SEAT OF ALL LEARNING

Brain Physiology

The brain is made up of billions of nerve cells called neurons. Information is passed from one neuron to the next by an electrochemical process.

Neuron connections are flexible, overlapping, and redundant.

Internal and external stimuli stimulate the formation of pathways and patterns of excited neurons.

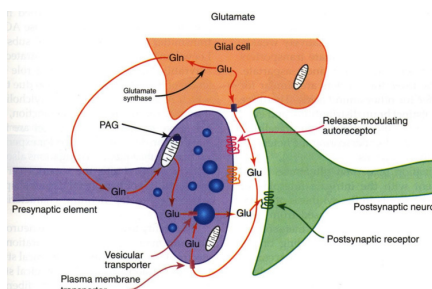
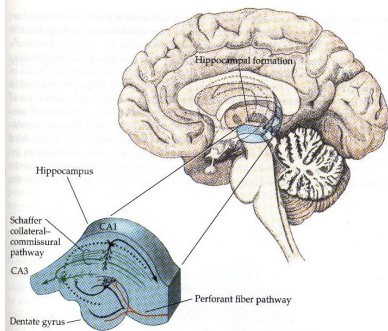
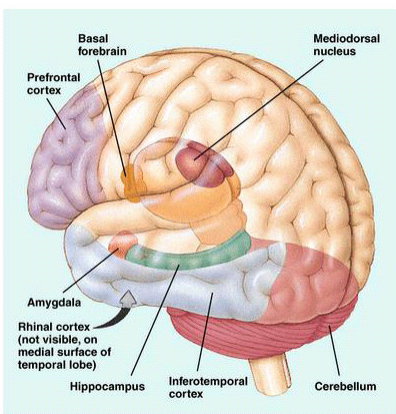


FIGURE 8.10 Depiction of an excitatory amino acid (glutamate) synapse. Glutamate, synthesized via metabolic pathways, is concentrated through a vesicular transporter into secretory granules. After release from the presynaptic terminal, glutamate can interact with postsynaptic and/or release-modulating receptors. Glutamate is then cleared from the synaptic region by the high-affinity plasma membrane transporters or by recycling through adjacent glia.

Neuronal Patterns

The more frequently pathways or patterns of neurons are used the stronger the pathways and patterns become. The stronger they become the more likely they will be made again.

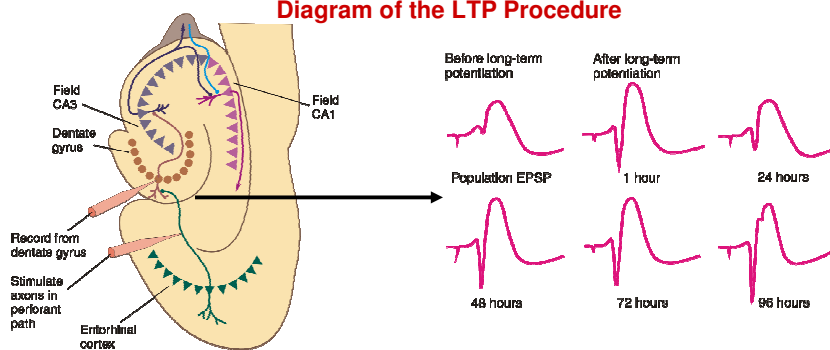
Brain Areas Contributing to Learning & Memory



- **Hippocampus** – consolidation of long-term memories for spatial location
- **Amygdala** – memory for the emotional significance of experience
- **Inferotemporal cortex** – storage of long-term visual memories
- **Cerebellum and striatum** – implicit sensorimotor memory
- **Prefrontal cortex** – memory for temporal order of events; possible role in the retrieval of memories
- **Mediodorsal nucleus** – damage leads to memory deficits; the medial diencephalic and medial temporal lobes may be in the same memory circuit
- **Basal forebrain** – serves a variety of functions with a controversial role in memory (Ach production)

What is happening in the brain when you 'learn' something?

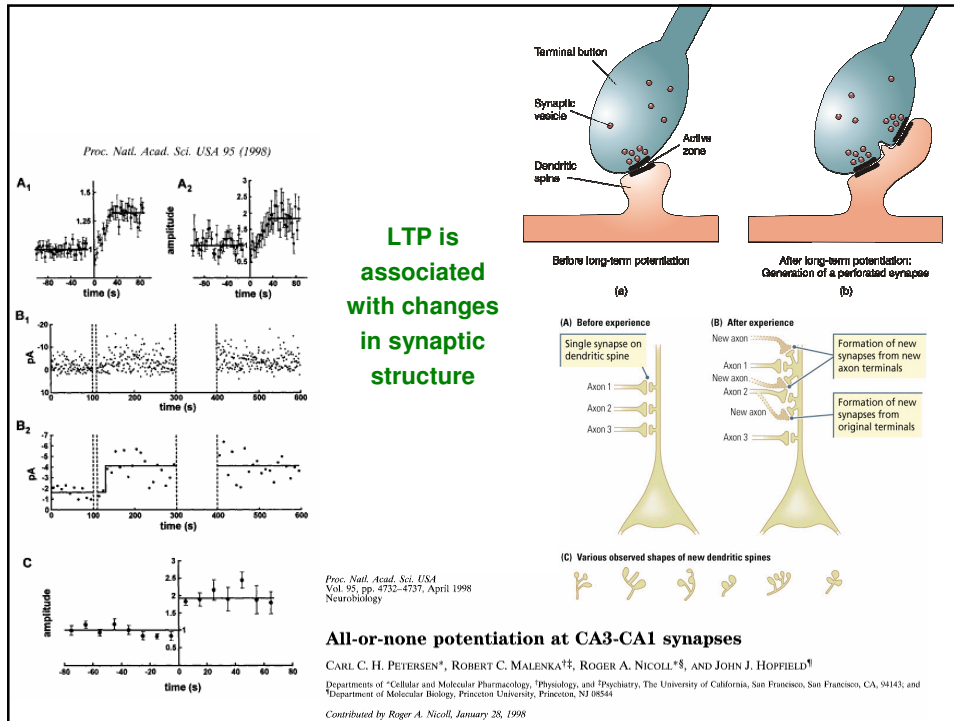
Diagram of the LTP Procedure



High frequency electrical stimulation of the perforant pathway

Record from cells within the dentate gyrus: Subsequent perforant pathway stimulation results in progressive increases in population PSP's

LTP may not underlie learning but it is the best model available



<p>Synaptic Self: How Our Brains Become Who We Are Joseph LeDoux 2002</p>	<p>Designing Brain Compatible Learning Terence Parry & Gayle Gregory 2003</p>	<p>How the Gifted Brain Learns David A. Sousa 2003</p>
<p>Teaching to the Brain's Natural Learning Systems Barbara K. Given 2002</p>	<p>Becoming a "Wiz" at Brain- Based Teaching Marilee Sprenger 2001</p>	<p>We're Born to Learn: Using the Brain's Natural Learning Process to Create Today's Curriculum Rita Smilkstein 2003</p>

“.....some neuroscientists are beginning to accuse educators of engaging in pseudoscience or worse, becoming ‘snake-oil salesmen’ for products and programs that have no real scientific foundation?”

***Pamela Wolfe, Ph.D.
Quoted in 2003***



Can Learning Change the Human Brain?

reading intervention can lead to changes in brain development especially in anterior (inferior frontal gyrus) and posterior (middle temporal gyrus) reading systems

Biological Psychiatry 55:926-933, 2004

Amphetamine or cocaine limits the ability of later experience to promote structural plasticity in the neocortex and nucleus accumbens

Kolb et al. (2003) Proc. Natl. Acad. Sci. USA 100, 10523-10528

Living in an enriched environment as a young mouse provides some protection against the effects of drugs later in life

Journal of Neuroscience 23(35):10999-11007, 2003

It is important to remember that all learning is brain-based

Education is practical neuroscience

This does not mean that every teacher needs to become a neuroscientist or memorize 100 neurotransmitters and 50 brain areas responsible for cognition. But it does mean that teachers can become more effective with some knowledge of how the brain senses, processes, stores, and retrieves information.