Learning and memory

LearningProcess of acquiring new informationMemoryspecific information stored in the brain

ability to retrieve information ONLEARNING AND MEMORY SPECIFICALLY FOR YOUFOR ONLY$13. 90/PAGEOrder NowPlasticityexperience dependent changes in structure or functionTypes of learningnon - associative learning

associative learning

procedural/skill learning

declarative learningnon associative learninginvolves learning about a single stimulus that is presented once or repeated several timeshabituationdecreased response to repeated representations of a stimulus

slower for high intensity stimuli (louder sound)

due to changes in central processing - NOT due to fatigue or adaptationvariants of non-associative learninghabituation

dishabituation

high intensity stimuli

long term habituationdishabituationstrong stimulus causes the habituated response to reemergelong term habituationlonger intervals between simuli are more effective (responses last longer and the decrease is stronger)Aplysiamodel system for learning and memory

Gill and siphon withdraw reflex - repeated touching of the siphon results in smaller response (habituation)Dishabitulation in Aplysiaafter habituation of touching siphon, touch head - this erases the siphon habituation, must do it again. Can be reinstituted by another set of repeated stimuliPlasticity of aplysia nervous system (short and long term)After training, less neurotransmitter is released into the synapse resulting in less retraction

Short term - less neurotransmitter release

Long term - fewer synapses

sensitizationresponse is greater than the baseline level because of prior stimulationsensitization in aplysiaperiodic touching of tail produces a consistent response that does NOT habituate

apply single strong stimulus - poke or shock to tail

return to periodic touching of tail - response is greater than baseline due to sensitization caused by strong stimulusDual process theory*A stimulus activates two systems

1) Stimulus response (SR) pathway - sound --> startle

2) State system - activates general arousal of animal, not always fully activated, system responsible for sensitization

consequence of the repeated presentation will reflect the sum of two competing systems

What underlies learning1)Changes in synaptic strength - more or less presynaptic neurotransmitter release, smaller or larger postsynaptic responses

2)Changes in neural structure - more or less synapses, more or less dendrites

3)Neurons - new neurons, loss of neuronsSynaptic changes that may store memoriesBefore training - normal

After training - more neurotransmitter release, wider synapse, or both.

Formation of new synapses, rearrangement of synaptic output

Leads to increased PSPChanges in synaptic strength - Donald HebbDonald

Hebb - proposed that when two neurons are repeatedly activated together, their synaptic connection will become stronger

Cell assemblies - ensembles of neurons - linked via hebbian synapse could store memory tracesLong term potentiation (LTP) at glutamate synapse2 receptors NMDA and AMPA. NMDA receptor is inactivated and blocked by Mg ion. Glutamate can flow through synapse onto AMPA receptor. When AMPA receptor is activated, it depolarizes cell. This activation leads to influx of Ca ions which leads to activation of protein kinases; starts a cascade - produces retrograde messengers (NO, arachidonic acid) which enhances glutamate release. This causes more glutamate receptors to be produced, allowing even more glutamate in. Finally, this influx overruns the Mg ions, causing them to be expelled. Thus, this opens the NMDA receptors to glutamate, allowing for even more glutamate to enterWhere does LTP occurhippocampusPathways that show LTPHiccocampal pathways

3 pathways

perforant pathway - subiculum to dentate gyrus

mossy fiber pathway - dentate gyrus to CA3 pyrimidal cells

schaffer collaterals - CA3 pyrimidal cells to CA1 pyrimidal cells

Evidence that LTP may be one part of learning and memory formationCorrelational observations

somatic intervention experiments

behavioral intervention experimentsCorrelation observationstime course of LTP is similar to that of memory formationsomatic intervention experimentspharmacological treatments that block LTP impair learningbehavioral intervention experimentsshow that training an animal in a memory task can induce LTPcerebral changes result from training - mice/rat experimentplaced in 3 different environments

standard condition - regular cage with other mice with food/water (SC)

impoverished condition - mice placed my itself (IC)

enriched condition - placed with other mice, a lot of toys and fun stuff (EC)Results of trainingAnimals in EC developed increased acetylcholinesterase (AChE) activity, a heavier cerebral cortex due to increased cortical thickness which is likely due to increased dendritic branching (more synapses). Promotes better learning and problem solving, aids recovery from conditions such as malnutrition, may protect against age related declines in memory. Measurement of dendritic branchingmore dendritic spines in the cortexNeurogenesisBirth of new neurons. occurs mainly in dentate gyrus in adult mammals

can be enhanced by exercise, environmental richness, and memory tasksConditional knockout miceneurogenesis turned off in adults - showed impaired spatial learning but were otherwise normal