Lecture #12 Limbic System

Question 1: Which best matches, respectively - declarative memory: emotional memory?

a) Amygdala : amygdala

b) Hippocampus : hippocampus

c) Amygdala : hippocampus

d) Hippocampus : amygdala

e) Spatial memory : fact memory

HINT:

Distinguish the losses associated with damage to the two major limbic structures

EXPLANATION:

Animal studies and humans with specific neurological deficits have distinguished functions of the two major limbic centers, the hippocampus and amygdala. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze. Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock. Amygdala damage impairs emotional memory. Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location. A human with bilateral amygdala degeneration, S.M., does not show fear reactions and has been unable to learn to avoid dangerous, fearful situations.

ANSWER: ['Hippocampus : amygdala']

Lecture #12 Limbic System

Question 2: Which neurological problem is most likely to be present after a person suffers damage to the hippocampal limbic loop?

a) inability to understand the spoken voice

b) flat affect with little emotional response to upsetting events

c) psychic blindness

d) inability to remember driving directions to an unfamiliar location

e) agraphia

HINT:

Distinguish declarative memory from emotional memory

EXPLANATION:

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location and an inability to recognize people they met after the hippocampal damage. This is an anterograde amnesia, with only limited retrograde amnesia, that is, only limited loss of past memories. Humans with bilateral hippocampal lesions may still remember quite well childhood or other distant past events. Motor learning and other types of implicit memory are largely intact. The deficits in humans with bilateral hippocampal lesions may not be immediately recognized in casual conversation, because their social skills, personality, and motor skills and motor learning are largely intact.

ANSWER: ['inability to remember driving directions to an unfamiliar location']

Lecture #12 Limbic System

Question 3: Where is the subiculum interposed in the limbic circuitry?

a) Between the dentate gyrus and CA1-CA3

b) Between the amygdala and the anterior thalamus

c) Between the hippocampus and fornix or cortex

d) Between the amygdala and the dorsolateral thalamus

e) Between wide areas of cortex and the cingulate gyrus

HINT:

The subiculum is adjacent to the limbic structures with which it has major connections

EXPLANATION:

The subiculum and its associated regions (pre-, post-, etc. subiculum) provide both inputs to and output destinations from the hippocampus. It can be considered to be part of parahippocampal or entorhinal cortex, though it is often omitted from descriptions of the Papez circuit as the Papez circuit passes via multiple synaptic steps from parahippocampal cortex to hippocampus.

ANSWER: ['Between the hippocampus and fornix or cortex']

Lecture #12 Limbic System

Question 4: What is most directly a part of the ventral striatum?

a) Dentate nucleus

b) Dorsal pallidum

c) Lateral dorsal (dorsolateral) nucleus

d) Anterior nucleus (of thalamus)

e) Nucleus accumbens

HINT:

The ventral striatum can be considered either a part of the basal ganglia or part of the limbic system

EXPLANATION:

The ventral striatum closely corresponds to the nucleus accumbens. (The olfactory tubercle is also ventral striatum.) Dorsal pallidum is another name for the globus pallidus. Lateral dorsal is a thalamic nucleus with projections to parietal cortex association areas. The lateral dorsal nucleus is often considered a limbic structure. The dentate nucleus is the largest deep cerebellar nucleus. The anterior nucleus of the thalamus is a step in the Papez circuit limbic loop. The anterior nucleus sends output to the cingulate cortex.

ANSWER: ['Nucleus accumbens']

Lecture #12 Limbic System

Question 5: Which projection is thought to be responsible for expression of innate fears?

a) Amygdala to lower motor neurons

b) Entorhinal cortex to hippocampus

c) Amygdala to lateral geniculate nucleus

d) Sensory thalamus to amygdala

e) Amygdalofugal fibers to amygdala

HINT:

Innate fear responses may not require the cerebral cortex

EXPLANATION:

The amygdala receives a very wide variety of inputs from autonomic centers, brainstem areas, cerebral cortex, and most directly from sensory thalamus. It is believed that the sensory thalamus input to the amygdala is what allows a rapid, seemingly instinctive, fear response to dangerous stimuli such as snakes.

ANSWER: ['Sensory thalamus to amygdala']

Lecture #12 Limbic System

Question 6: Which kind of memory formation is not much affected by hippocampal damage?

a) Spatial locations

b) World events

c) Maze learning

d) Drawing while viewing through a mirror (mirror drawing)

e) Newly met people

HINT:

Distinguish declarative memories from implicit, motor, or other types of memory

EXPLANATION:

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location and an inability to recognize people they met after the hippocampal damage. This is an anterograde amnesia, with only limited retrograde amnesia, that is, only limited loss of past memories. Humans with bilateral hippocampal lesions may still remember quite well childhood or other distant past events. Motor learning and other types of implicit memory are largely intact. The deficits in humans with bilateral hippocampal lesions may not be immediately recognized in casual conversation, because their social skills, personality, and motor skills and motor learning are largely intact.

ANSWER: ['Drawing while viewing through a mirror (mirror drawing)']

Lecture #12 Limbic System

Question 7: What is the main output of the anterior thalamic nucleus?

a) Cingulate gyrus

b) Mammillary body

c) Fornix

d) Parahippocampal cortex

e) Entorhinal cortex

HINT:

The anterior thalamus is a component of the limbic system

EXPLANATION:

The anterior thalamus is the main thalamic relay for the limbic system. The anterior thalamus projects to cingulate cortex, where posterior cingulate is most closely associated with the hippocampus and anterior cingulate associated with the amygdala. The medial dorsal nucleus of the thalamus as also considered a limbic thalamic relay, connecting limbic centers to the prefrontal cortex.

ANSWER: ['Cingulate gyrus']

Lecture #12 Limbic System

Question 8: What is the main output of the dentate gyrus?

a) Hippocampus proper (CA1-CA3)

b) Mammillary bodies

c) Ventral thalamus

d) Cerebellar cortex

e) Parahippocampal cortex

HINT:

The dentate gyrus is within the hippocampal formation

EXPLANATION:

The detailed trisynaptic circuit through the hippocampus begins with the perforant path from entorhinal cortex (or subiculum) crossing the hippocampal sulcus to terminate on granule cells in the dentate gyrus of the hippocampal formation. (The hippocampal formation includes the dentate gyrus and the hippocampus proper) Dentate gyrus neurons project as mossy fibers to pyramidal cells of hippocampus CA3. CA3 projects to pyramidal cells of CA1 as Schaffer collaterals. CA1 projects out of the hippocampus via the fornix and subiculum.

ANSWER: ['Hippocampus proper (CA1-CA3)']

Lecture #12 Limbic System

Question 9: Which part of cerebral cortex outside the temporal lobe relates most closely to the amygdala?

a) Parietal cortex

b) Anterior cingulate cortex

c) Occipital cortex

d) Posterior cingulate cortex

e) Insular cortex

HINT:

Consider the cortical gyrus that is divided into an amygdala region and a hippocampal region

EXPLANATION:

The cingulate cortex is often divided into an anterior portion that relates to the amygdala and a posterior portion that relates to the hippocampus. The prefrontal cortex and anterior cingulate cortex have extensive interconnections with the amygdala, mainly relayed by the thalamus, as do parts of the temporal lobe. The temporal lobe is the main conduit into the hippocampus, which connects back to the posterior cingulate cortex via the fornix projection to the mammillary bodies, and then the mammillothalamic tract to the anterior thalamus areas that project to posterior cingulate cortex. Insular cortex also has interconnections with the limbic system and specifically the amygdala, but these are less well understood or robust than the amygdala connections with the anterior cingulate cortex.

ANSWER: ['Anterior cingulate cortex']

Lecture #12 Limbic System

Question 10: Which nuclei of the amygdala are regarded as its input and processing center?

a) Basolateral

b) Central

c) Medial

d) Dentate

e) Denticulate

HINT:

The largest nuclear group of the amygdala is its input group

EXPLANATION:

The basolateral nuclear group of the amygdala is the largest group, subdivided in many ways. Its overall function appears to be receiving and processing inputs. Inputs to basolateral amygdala arise from hypothalamus and other autonomic centers, from prefrontal cortex, and from thalamic sensory relay nuclei for rapid fear responses. The second largest nuclear group of the amygdala is the central group, which is regarded as the output group of nuclei. The central nuclear group has widespread connections to brainstem autonomic and neuromodulatory centers, to ventral striatum, and to prefrontal cortex and anterior cingulate cortex.

ANSWER: ['Basolateral']

Lecture #12 Limbic System

Question 11: What type(s) of deficit(s) most likely result(s) from amygdala damage?

a) Failure to recognize facial expressions of fear

b) Loss of Spatial memory and maze learning

c) Uncontrolled anger and loss of sexually motivated responses

d) Loss of Spatial orientation and awareness of compass directions

e) Failure to recognize familiar faces (prosopagnosia)

HINT:

Distinguish declarative memory from emotional memory

EXPLANATION:

Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock. Amygdala damage impairs emotional memory. A human with bilateral amygdala degeneration, S.M., does not show fear reactions and has been unable to learn to avoid dangerous, fearful situations. She is unable to recognize facial expressions of fear, but still able to recognize other facial expressions.

ANSWER: ['Failure to recognize facial expressions of fear']

Lecture #12 Limbic System

Question 12: What is the main destination of the fornix?

a) Parahippocampal cortex

b) Entorhinal cortex

c) Mammillary body

d) Anterior thalamus

e) Stria terminalis

HINT:

The fornix is a step in the Papez circuit limbic loop

EXPLANATION:

The Papez circuit is the most basic limbic loop. All areas of cerebral cortex project to cingulate cortex. Cingulate cortex projects to parahippocampal cortex. Parahippocampal cortex projects via multiple steps to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project to the anterior thalamus via the mammillothalamic tract. The anterior thalamus projects to cingulate cortex, completing the loop.

ANSWER: ['Mammillary body']

Lecture #12 Limbic System

Question 13: Which was a deficit in the famous hippocampal patients H.M. and R.B.?

a) Wernicke's aphasia

b) Loss of social skills in conversation

c) Loss of visuomotor skills

d) Forgotten childhood events

e) Failure to recognize the scientists studying them

HINT:

Distinguish declarative memories from implicit, motor, or other types of memory

EXPLANATION:

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location and an inability to recognize people they met after the hippocampal damage. This is an anterograde amnesia, with only limited retrograde amnesia, that is, only limited loss of past memories. Humans with bilateral hippocampal lesions may still remember quite well childhood or other distant past events. Motor learning and other types of implicit memory are largely intact. The deficits in humans with bilateral hippocampal lesions may not be immediately recognized in casual conversation, because their social skills, personality, and motor skills and motor learning are largely intact.

ANSWER: ['Failure to recognize the scientists studying them']

Lecture #12 Limbic System

Question 14: What is the ultimate destination of most entorhinal cortex projections?

a) Fornix

b) Parahippocampal cortex

c) Amygdala

d) Anterior thalamus

e) Dentate gyrus

HINT:

Recall the initial synaptic step in the hippocampal trisynaptic ciruit

EXPLANATION:

The detailed trisynaptic circuit through the hippocampus begins with the perforant path from entorhinal cortex (or subiculum) crossing the hippocampal sulcus to terminate on granule cells in the dentate gyrus of the hippocampal formation. (The hippocampal formation includes the dentate gyrus and the hippocampus proper) Dentate gyrus neurons project as mossy fibers to pyramidal cells of hippocampus CA3. CA3 projects to pyramidal cells of CA1 as Schaffer collaterals. CA1 projects out of the hippocampus via the fornix and subiculum.

ANSWER: ['Dentate gyrus']

Lecture #12 Limbic System

Question 15: Which neurological deficit is revealed in animals after lesions of the hippocampus?

a) inability to learn a new spatial discrimination

b) inability to recognize a previously learned object or task

c) failure to respond to social cues

d) inability to detect odors

e) loss of sexual behaviors

HINT:

Distinguish the type of declarative memory that can be tested in animals

EXPLANATION:

Lesion studies in animals have distinguished functions of the two major limbic centers, the hippocampus and amygdala. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze. Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock.

ANSWER: ['inability to learn a new spatial discrimination']

Lecture #12 Limbic System

Question 16: Animals subjected to large, bilateral lesions of the temporal lobes exhibit which behavior (Kluver-Bucy syndrome)?

a) Loss of discrimination learning

b) Diminished sexual activity

c) Emotional over-reaction

d) Loss of rank in social hierarchy

e) Aversion to oral stimulation and eating

HINT:

Loss of social rank may relate to loss of a limbic center for fear responses

EXPLANATION:

Kluver-Bucy syndrome results from widespread temporal lobe damage that affects the amygdala, hippocampus, higher visual centers, and connections with prefrontal cortex executive function areas. Kluver-Bucy syndrome includes loss of emotional responses, loss of social rank, or occasionally a rise in rank due to fearless aggression, oral examination of inappropriate objects, and indiscriminate hypersexuality.

ANSWER: ['Loss of rank in social hierarchy']

Lecture #12 Limbic System

Question 17: What is the main output of the mammillary body?

a) Fornix

b) Cingulate gyrus

c) Entorhinal cortex

d) Parahippocampal cortex

e) Anterior thalamus

HINT:

The mammillary body output is a step in the Papez circuit limbic loop

EXPLANATION:

The Papez circuit is the most basic limbic loop. All areas of cerebral cortex project to cingulate cortex. Cingulate cortex projects to parahippocampal cortex. Parahippocampal cortex projects via multiple steps to the hippocampus. The hippocampus projects via the fornix to the mammillary bodies. The mammillary bodies project to the anterior thalamus via the mammillothalamic tract. The anterior thalamus projects to cingulate cortex, completing the loop.

ANSWER: ['Anterior thalamus']

Lecture #12 Limbic System

Question 18: Which structure has the stria terminalis (or terminal stria) as one of its prominent outputs?

a) Lateral nucleus of the hypothalamus

b) Bed nucleus

c) Hippocampus

d) Orbitofrontal cortex

e) Amygdala

HINT:

The fornix relates more closely to memory; the nearby stria terminalis relates more closely to emotions

EXPLANATION:

There are three major amygdala outputs. The dorsal output, or stria terminalis, projects to the hypothalamus and septal area. The larger ventral output, or ventral amygdalofugal pathway, projects to many areas, including the hypothalamus, ventral basal ganglia (nucleus accumbens), and medial dorsal thalamus. The third amygdala output is via nearby cortical relays to other cortical areas and beyond.

ANSWER: ['Amygdala']

Lecture #12 Limbic System

Question 19: Which part of cerebral cortex outside the temporal lobe relates most closely to the hippocampus?

a) Occipital cortex

b) Parietal cortex

c) Insular cortex

d) Posterior cingulate cortex

e) Anterior cingulate cortex

HINT:

Consider the cortical gyrus that is divided into an amygdala region and a hippocampal region

EXPLANATION:

The cingulate cortex is often divided into an anterior portion that relates to the amygdala and a posterior portion that relates to the hippocampus. The prefrontal cortex and anterior cingulate cortex have extensive interconnections with the amygdala, mainly relayed by the thalamus, as do parts of the temporal lobe. The temporal lobe is the main conduit into the hippocampus, which connects back to the posterior cingulate cortex via the fornix projection to the mammillary bodies, and then the mammillothalamic tract to the anterior thalamus areas that project to posterior cingulate cortex. Insular cortex also has interconnections with the limbic system and specifically the amygdala, but these are less well understood or robust than the amygdala connections with the anterior cingulate cortex.

ANSWER: ['Posterior cingulate cortex']

Lecture #12 Limbic System

Question 20: Fear memory is to amygdala as\_\_\_\_\_\_is to\_\_\_\_\_\_?

a) Face recognition : amygdala

b) Fear memory : hippocampus

c) Face recognition : hippocampus

d) Spatial memory : hippocampus

e) Spatial memory : amygdala

HINT:

Animal studies have elucidated roles of the two major limbic centers

EXPLANATION:

Lesion studies in animals have distinguished functions of the two major limbic centers, the hippocampus and amygdala. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze. Animals with bilateral amygdala lesions do not show fear responses and do not learn fear conditioning tasks, such as freezing to a tone that signals an impending electric shock.

ANSWER: ['Spatial memory : hippocampus']

Lecture #12 Limbic System

Question 21: Which best matches, respectively - spatial memory : declarative memory?

a) Hippocampus : hippocampus

b) Amygdala : amygdala

c) Amygdala : hippocampus

d) Event memory : specific relay thalamic nuclei

e) Hippocampus : amygdala

HINT:

spatial memory can be considered a form of declarative memory

EXPLANATION:

Humans with bilateral hippocampal lesions, such as H.M. and R.B., are unable to acquire new declarative memories. That is, they cannot learn new facts, events, people, or places. This deficit includes an inability to learn directions to a new location. Animals with bilateral hippocampal lesions cannot learn new spatial navigation tasks, such as radial arm mazes and the Morris water maze.

ANSWER: ['Hippocampus : hippocampus']

Lecture #12 Limbic System

Question 22: Which neurological problem is most likely to be present after a person suffers damage to the amygdala?

a) flat affect with little emotional response to upsetting events

b) psychic blindness

c) inability to remember driving directions to an unfamiliar location

d) agraphia

e) inability to understand the spoken voice

HINT:

Distinguish declarative memory from emotional memory

EXPLANATION:

Amygdala damage impairs emotional memory. A human with bilateral amygdala degeneration, S.M., does not show fear reactions and has been unable to learn to avoid dangerous, fearful situations. S.M. appears emotionally flat. She is unable to recognize facial expressions of fear, but still able to recognize other facial expressions.

ANSWER: ['flat affect with little emotional response to upsetting events']