Quiz 2 Biological Psychology – How does Biology explain Behavior?

Question 1

After a gruelling hour of attempts, you managed to set a new high score on Dance Dance Revolution at the arcade and you celebrated your achievement. Which brain region is least likely to be involved in this scenario?

- ☐ ~~A. Basal Ganglia~~
- ☐ ~~B. Occipital Lobe~~
- ☐ ~~C. Anterior Cingulate Complex~~
- ☑ D. Wernicke's Area
- ☐ ~~E. Nucleus Accumbens~~

D. Wernicke's Area is involved in the comprehension of speech, which is unlikely to be involved in an arcade game that is based on music, rhythm and directional arrows as instructions. Basal ganglia (control of movement), occipital lobe (processing visual information), ACC and nucleus accumbens (decision making, reward, emotion and pleasure) are more likely to be involved in this scenario.

Question 2

Why are action potentials, and thus information, propagated in only one direction?

- [x] Inactivation of sodium (Na+) channels forces action potential to propagate in one direction.
- [ ] ~~The action potential can propagate in both directions across the membrane as it transverses axons.~~
- [ ] ~~The activation of potassium (K+) channels prevents action potential from travelling backwards.~~
- [ ] ~~The nodes of Ranvier and myelination of axons force action potential to travel unidirectionally.~~

Inactivated sodium channels enter the refractory period following their activation, where they cannot be opened and the neuron cannot fire. This prevents action potential to be initiated in regions of the membrane that have just produced an action potential.

Activation of Potassium Channels: While potassium channels do help repolarize the membrane after an action potential, they are not the primary reason for unidirectional propagation. Their activation does contribute to the refractory period, but it's the sodium channel inactivation that plays the crucial role.

Nodes of Ranvier and Myelination: These structures play a role in the speed of action potential conduction (saltatory conduction) but do not directly determine the directionality of the action potential.

Propagation in Both Directions: Action potentials can theoretically propagate in both directions if initiated in the middle of an axon, but in a normal physiological context, they typically move in one direction due to the inactivation of sodium channels behind the action potential.

Question 3

Please read the following statements about the action potential. Which of the following are false?

1. At resting potential, the outside of the axon is +70mV relative to the inside of the axon.
2. When the electrical potential in an axon passes the threshold, the axon immediately undergoes hyperpolarization.
3. Potassium channels are open during the repolarization phase.
4. An action potential affects the axon all at once.

- ☐ ~~1. only.~~
- ☐ ~~2. only.~~
- ☐ ~~1. and 2. only.~~
- ☑ 2., and 4. only.
- ☐ ~~1., 2., and 4. only.~~

At resting potential, the outside of the axon is +70mV relative to the inside of the axon: True. Charge is relative, hence the outside of the axon is positive compared to inside.

When the electrical potential in an axon passes the threshold, the axon immediately undergoes hyperpolarization: False. When the electrical potential in an axon passes the threshold, the axon undergoes depolarization, not hyperpolarization.

Potassium channels are open during the repolarization phase: True. During the repolarization phase, potassium channels are open, which allows potassium ions to move out of the cell, restoring the resting potential.

An action potential affects the axon all at once: False. An action potential travels along the axon as a wave of depolarization and repolarization, not all at once.

Question 4

Which of the following statements about neurons are true?

A) Neurons only excite the neurons they communicate with,
B) When Neurons are activated, they send electronic signals from the Axon to the Dendritic terminals, which are connected to the next neuron's Axon
C) Neurons without Myelin Sheath have faster neural signalling, due to greater energy efficiency and the Sheath not impeding signalling conductivity.

- [x] None of the statements are true.
- [ ] ~~A only~~
- [ ] ~~B only~~
- [ ] ~~B and C only~~
- [ ] ~~All of the statements are true.~~

Neurons can be inhibitory. Signalling occurs from dendrite to axon, and myelin sheath speeds up signalling.

Statement A (False): Neurons can both excite and inhibit the neurons they communicate with, depending on the type of neurotransmitter they release and the type of receptors on the postsynaptic neuron.

Statement B (False): When neurons are activated, they send electrical signals from the axon hillock to the axon terminals. The axon terminals release neurotransmitters that cross the synaptic cleft to the dendrites of the next neuron, not directly to another neuron's axon.

Statement C (False): Neurons with a myelin sheath actually have faster neural signaling due to the insulation provided by the myelin, which allows for saltatory conduction (jumping of the action potential between nodes of Ranvier). Neurons without myelin sheaths conduct signals more slowly.

Question 5

The Mad scientist Frankenstein was visiting a nearby morgue to acquire parts of the brain for his monster. His Monster's body is complete, up to the spinal cord (and an incomplete face), to give his Monster the best chance of coming to life, which parts of the brain should he try to acquire?

- [x] Brain Stem
- [ ] ~~Midbrain~~
- [ ] ~~Cerebral Cortex (the 4 lobes)~~
- [ ] ~~Hippocampus~~

The brain stem is crucial for basic life functions such as breathing, heart rate, and consciousness. It also serves as a conduit for neural signals between the brain and the rest of the body. Acquiring the brain stem would give the monster the best chance of sustaining basic life functions.

Midbrain: The midbrain is part of the brain stem and plays a role in motor movement, auditory and visual processing, but it does not control the essential life functions as directly as the brain stem.

Cerebral Cortex (the 4 lobes): While the cerebral cortex is important for higher-level functions like thinking, reasoning, and voluntary movement, it is not essential for basic life-sustaining functions.

Hippocampus: The hippocampus is primarily involved in memory formation and spatial navigation. While important for cognitive function, it is not critical for basic life support.

Question 6

Which of these contributes to the formation of the blood-brain barrier?

- [x] Glia
- [ ] ~~Axons~~
- [ ] ~~Myelin~~
- [ ] ~~Synapses~~

While glia perform a variety of support functions in the human nervous system, a key one is the formation of the blood-brain barrier and myelin. Axons are branches on neurons for transmitting signals to other neurons, and synapses are the point of communication between two neurons.

Axons are the long, threadlike parts of a neuron that transmit electrical impulses away from the cell body. They do not contribute to the formation of the blood-brain barrier.

Myelin is a fatty substance that surrounds and insulates axons, speeding up the transmission of electrical signals. It is not involved in the formation of the blood-brain barrier.

Synapses are the junctions between neurons where communication occurs via neurotransmitters. They do not contribute to the blood-brain barrier.

Question 7

Which of the following best describes the relationship between the central nervous system and the somatic nervous system?

- ☐ ~~The central nervous system regulates the somatic nervous system.~~
- ☐ ~~The somatic nervous system regulates the central nervous system.~~
- ☑ The two systems cooperate with each other.
- ☐ ~~The somatic nervous system is a subcomponent of the central nervous system.~~

The SNS is a part of the peripheral nervous system rather than the central nervous system that controls the voluntary movements of the skeletal muscles.

Central Nervous System (CNS): Comprising the brain and spinal cord, the CNS is responsible for processing information and directing responses throughout the body.

Somatic Nervous System: This system is part of the peripheral nervous system and controls voluntary movements by transmitting signals from the CNS to skeletal muscles. It also conveys sensory information from the body back to the CNS.

Question 8

Brain functions are sometimes described as being localised. This means that…

- ☐ ~~1) A certain function (e.g. touch) would only produce activation in one area of the brain.~~
- ☐ ~~2) A certain function (e.g. smell) can only ever be handled by one area of the brain. Once destroyed, we cannot regain that function.~~
- ☐ ~~3) Lower level structures (e.g. midbrain, cerebellum) always perform more basic and primitive functions than higher level structures (e.g. cerebral cortex)~~
- ☐ ~~All of the options (1, 2 and 3) are correct.~~
- ☑ None of the options (1, 2 and 3) are correct.

1. Wrong as activation is greatest in the area that is localised to touch, however that doesn't mean that the rest of the brain is not activated e.g. thalamus.
2. Wrong as some level of adaptation or compensation can happen, although not always the case.
3. Wrong as the cerebellum has been shown to be involved in some higher level functions too – not always the case that lower level = primitive.