

## **PHY3012:**

### **THEME 2 QUESTIONS:**

**1. Describe two features in the structure of the human brain that discriminates it from a rodent's brain:**

- The presence of "Von Economo neurons" which are found in the cingulate cortex and insula.
  - They are mainly found in primates and some types of dolphins and whales, however not in rodents
- Human brains are much larger than rodents
  - Capybara - 76g
  - Human - 1500g
- Human brains have a much higher density of neurons than rodents (more compact)
  - Capybara - 1600M in 76g brain
  - Human - 86000M in 1500g brain
- Rodents also don't have a dorsolateral prefrontal cortex

**2. Describe two features in the structure of the human brain that discriminates it from a non-human primate's brain:**

- The human brain is much larger
  - Monkeys can range from 30-90g
  - Humans up to 1500g
  - The most rostral part of the human brain (frontal lobe) is up to 3 times as large in humans compared to gorillas
- The human brain has a much higher density of neurons
  - Monkey 3000-6000M in 30-90g brain
  - Human 86000M in 1500g
- The relative size of the association cortices in humans is larger compared to non-human primates, however the overall organisation of these are similar
- Humans have some fibres that can conduct and transfer information at a higher level than other non-human primates - i.e. we have much faster conduction speeds
  - This, along with the high neuron density and small distances between these neurons means that the human cortex probably has the greatest information processing capacity

**3. Are the differences between humans and monkeys brains hard-wired or acquired (was our brain a human brain when we were born or was it trained to become a human brain)?**

**Please explain the reason that led you to reach this conclusion (couple of sentences):**

- The differences are HARD-WIRED
- One reason for this is the fact that humans have the general capability to learn language. It doesn't matter which society humans grow up in, they always have this ability to learn a language. This is largely due to the greater information capacity of human brains provided by characteristics such as a high neuron density, more compact structure and faster conduction speeds
- If you were to let monkeys grow up with humans before they've reached their critical period, they still wouldn't be able to learn a language like humans because their brains are not hard-wired in this way

- 4. Do we have sufficient scientific evidence to conclude that non-human primates do not have consciousness or inner mental world?**
- No, animals have been shown to love their offspring
- 5. Please describe (in only 1-2 sentences) two types of abstract concepts that have been scientifically documented in non-human primates:**
- Two types of abstract rules that have been scientifically documented in non-human primates includes:
    - Object recognition
    - Rule-based performance
  - This was done via the Wisconsin Card Sorting Test which involves the monkeys having to follow rules that change based on colour, shape and number of symbols
- 6. How do you define the neuroanatomical extent of the 'prefrontal cortex'?**
- The prefrontal cortex is where information from different sensory modalities such as the visual, auditory, somatosensory, olfactory and gustatory systems all converge.
  - The prefrontal convergence also receives information from the thalamic nuclei (Amgdala and hypothalamus etc.) which gives information on our internal world such as motivation, expectation etc.
  - The prefrontal cortex also receives information from the brain stem and pons
  - This convergence occurs through:
    1. Cortico-cortical connections (association pathways)
    2. Thalamo-cortical fibres
    3. Projection pathways from subcortical nuclei such as LC, Raphe nuclei
    4. Corpus callosum which connects the two hemispheres
  - The prefrontal cortex sends fibres to the same areas from which it receives them
  - Essentially, the prefrontal cortex can combine/integrate information from the external world, with information from our internal vision (motivation, desire etc.) to plan for future decisions
- 7. Is the following sentence scientifically 'correct'? "The changes in the prefrontal cortex continues up to the third decade of life, then the prefrontal cortex doesn't change for about two decades, and then deterioration in prefrontal function starts from around the age of 65-70." Explain the reason for your answer in 1-2 sentences:**
- This sentence is NOT scientifically 'correct'
  - The brain or prefrontal cortex is a continuously evolving system, and so changes to it continue past the third decade of life. The development and maturation of the prefrontal cortex is one of the last structures to finish developing (around ~25 years), and is then one of the first to start deteriorating with age by decreasing in size and density of neurons, as well as shrinkage and loss of dendrites.