

# Mock Exam

## **1. What are the central ideas of cognitive science?**

Cognition is equivalent to computation / information processing

The mind is an information processor

Information processors represent and transform information

Mental representations of information

Processes that act on and manipulate these representations

## **2. Name examples for computations performed by the mind.**

sensation, perception, attention, memory, language, mathematical reasoning, logical reasoning, decision making, problem solving, ...

## **3. What is monism?**

Basic concept of the nature of mind:

only one kind of state or substance in the universe

Aristotle (384-322 BC): mind and body  $\leftrightarrow$  form and matter

Different shapes are different physical states, no nonphysical or spiritual substance

#### 4. What is voluntarism?

Mind consists of elements assembled into higher cognitive components through the power of will (= voluntary effort of the mind)

Periodic table of mental elements

Introspection („inward looking“)

Two types of conscious experience

Immediate experience: direct awareness of something

Mediate experience: mental reflection

„Tridimensional theory of feeling“

Pleasure – Displeasure

Tension – Relaxation

Excitement – Depression

Creative synthesis (law of psychic resultants)

#### 5. What is the role of glial cells?

Answer 1: Provide physical and metabolic support to neurons, including neuronal insulation and communication, and nutrient and waste transport. Maintain homeostasis, cleaning up debris, and forming myelin. Also responsible for upholding Brain-Blood-Barrier.

Answer 2: (just for microglia)

The microglia cells remove damage around unnecessary neurons or synapses from the Brain. They react to infections and injuries and regulate inflammatory responses.

#### 6. Describe one of the major “neural activity generation” models.

Neural Computation - Use mathematical techniques to analyse neural data in a way that allows us to relate it to mathematical models. Neural circuits computational and quantitative approaches are also important in cognitive science

#### 7. Elaborate which neural structures are correlated with plasticity and how they react in a learning paradigm.

The structures of the nervous system are the synapses, weights and perceptrons. Brain plasticity, also known as neuroplasticity, is a term that refers to the brain's ability to change and adapt as a result of experience.

**Functional plasticity:** The brain's ability to move functions from a damaged area of the brain to other undamaged areas

**Structural plasticity:** The brain's ability to actually change its physical structure as a result of learning

Example: Updating de weight

#### 8. What is the peripheral nervous system?

Body's link to the world. The peripheral nervous system refers to parts of the nervous system outside the brain and spinal cord. It includes the cranial nerves, spinal nerves and their roots and branches, peripheral nerves, and neuromuscular junctions. Consists in Autonomic Nervous System and Somatic Nervous System.

**central nervous system** (brain + spinal cord) and the **peripheral nervous system**.

In other words, the brain and the spinal cord, they are **oligodendrocytes** (central nervous system).

These **oligodendrocytes** wrap axons with their processes, that means a single oligodendrocyte can wrap multiple axons and thus multiple neurons.

Here, you can see here again the nodes of Ranvier

In the peripheral nervous system, however, there are so called **Schwann** cells (peripheral nervous system), which are exclusively wrapping around a single axon.

See here's, the cell nucleus and from the very same cell and now it wraps nicely around this axon.

This is exclusively happening in the peripheral nervous system.

## 9. What are cortical columns?

Is a group of neurons in the cortex of the brain that can be successively penetrated by a probe inserted perpendicularly to the cortical surface, and which have nearly identical receptive fields.(Wiki)

Is a part of the cortex (minicolumn).

Minicolumn - Basic function unit of the cortex. Neurons of the minicolumn receive inputs and outputs that constitute the computation unit of the cerebral cortex.

Cortical columns are groups of organised minicolumns, macrocolumns (that are made of neurons).

## 10. Hox genes are very important in development. Describe briefly their role.

Hox genes determine motor neurons. Development of the body. Anterior to Posterior.

Answer 2: Hox genes encode and specify the characteristics of position, ensuring that the correct structures form in the correct places of the body.

## 11. Describe the differences between EEG and ECoG/iEEG.

These are all electrophysiology methods

EEG: (on skin/bone): Measures potentials in the skull.

EEG signals are: (high when awake)

- Excited
- Relaxed
- Drowsy
- Asleep

Slow fluctuations:

- Deeply asleep
- In Coma

While: ECoG:

Measures signals in open brain:

- Electrodes put in Werniche's Areas
- Broca's Area

## 12. Genetically encoded calcium indicators are used to monitor neural activity.

Explain briefly how this works.

Activity: Dependent fluorescence:  
Measuring Voltage: Graph: XXXX

Using Ca<sup>2+</sup>-> low concentration for inactive neurons and increases with high activity  
-The Voltage signal is very fast

Ca Imaging: +Ca<sup>2+</sup> -GFP light  
-Ca<sup>2+</sup> -GFP no light

### **13. What is the BOLD effect?**

The Bold effect and Functional fMRI  
Functional MRI -> visualises brain activity

->Bold effect is able to differentiate oxygenated or deoxygenated blood, so we can measure the difference in signal on the amount oxygenated and the blood.

If there is blood - there is metabolism ->the oxygen is consumed from the blood. The fewer oxygen consumption in blood, the more metabolism has happened there. (lower oxygen-> Higher metabolism)

### **14. Connectivity analysis can be performed on multiple levels.**

**Name the levels and their scale.**

#### **Connectivity analysis**

**Microscale:** of the brain and you can see which neurons are connected via physical connections between synapses(sub micrometre scale)

**Mesoscale:** Trace the links ( anterograde and retrograde tracing) between neurons(100 micrometre scale)

**Macroscale:** Many connective patterns across the hemispheres and complex interactions between the areas

### **15. Who was Phineas Gage?**

Had an iron rod in his head -> damage to his left frontal lobe. Part of lesion studies about personality

Friends said "gage was no longer gage"

### **16. What is the WADA test?**

The WADA test is conducted before an epilepsy surgery. It checks if the blocking of the two hemispheres doesn't lead to severe damage.

### **17. What are hair cells?**

Hair cells are the **sensory cells of the auditory and vestibular systems**. Hair cells are the sensory cells of the internal ear, essential for the senses of sound and balance.

### **18. What is olfaction?**

The sense of smell, or olfaction, is the special sense through which smells are perceived. The sense of smell has many functions, including detecting hazards, and pheromones, and plays a role in taste.

**19. List all five tastes humans are able to perceive. Indicate which tastes rely on binding the tastant to the receptor.**

Sour, salty (rely on ion/na<sup>+</sup> channels)

Bitter, sweet, umami (bind the tastant to the receptor)

**20. The Homunculus is a special representation of the primary somatosensory cortex. Describe its unique appearance and the relationship to the primary somatosensory Cortex.**

Different parts of the body have a higher sensibility and are overrepresented in the brain.

The homunculus is the embodied representation of this.

**21. Voltage-gated sodium channels are important in pain mediation. Which voltage-gated sodium channel is essential in pain sensation? Describe its involvement briefly.**

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**22. Describe the two kinds of photoreceptors in our retina.**

Rods - black & white

Cones - colours - different lengths can perceive different colours (short cones - blue, middle cones - green, long cones - red)

**23. Explain how color emerges on a camera chip.**

A chip can only see black&white. Because of the high correlation between adjacent pixels one uses small bandpass filters above each pixel (bayern pattern): small filter, that lets only specific wavelength/color trough

**24. Which brain structure is important in acquiring new motor tasks?**

Cerebellum and motor cortex

The cerebellum is for coordination and the motor cortex is for voluntary actions (using skeletal muscles) i.e. the motor cortex cannot control the the heartbeat)

**25. What is implicit memory?**

Two types of memory short-term/working memory and long-term memory

Two types of Long-term memory: declarative/explicit and non-declarative/implicit memory

Non-Declarative/Implicit Memory: is the unconscious storage and recall of information

- Based on implicit learning
- can be summarised as remembering how to do something
- primarily used in learning motor skills
- when one does better in a given task only due to repetition, no new explicit memories
- have been formed but one is unconsciously accessing aspects of the previous experiences

**26. What is the N400 wave?**

It's the brain's reaction to semantic violations. Brainwave emitted as a reaction to semantic violations 400ms post stimulus and can be measured as a negative polarity peak

**27. Describe the Libet experiment.**

Subjects were asked to record the time when they wanted to move. Experiments show that the movement began before (30 milliseconds) before the subject's conscious intention to move.

He found that the unconscious brain activity of the readiness potential leading up to subject movements, began approximately half a mili-second before the subject was aware of a conscious intention to move. These studies of timing between actions and the conscious decision bear upon the role of the brain in understanding free will.