

1. Learning [10 points total]

Classical and operant conditioning are two key concepts central to behavioral psychology. Please give one example for each type of conditioning [5 points] and describe the differences between classical condition and operant conditioning [5 points].

2. Methodology in cognitive neurosciences [20 points total]

Functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) are research tools commonly used in cognitive neuroscience studies.

- (a). Briefly explain how each of them measures neural activity. [10 points]
- (b). List their advantages and disadvantages and compare them to each other. [10 points]

3. Memory [20 points total]

- (a). Long-term memory is typically divided into explicit memory and implicit memory. Explain both types of memory and give one example for each type of memory. [8 points]
- (b). Emotional events are remembered better than neutral ones. Which brain region plays a crucial modulatory role in this phenomenon? [4 points] Also, please make two examples with different emotional valences to exemplify the effect of emotion on long-term declarative memory. [8 points]

4. Neural Mechanism of Surprise [50 points total]

- (a). Describe the psychological experience of “surprise”. In your description, state what the experience involves in terms of emotional processing as well as cognitive information processing. Take care to distinguish between “surprise” in the common but related usage, which might refer to the happy feeling experienced during surprise parties, and the more technical usage, which refers to more general information processing. The latter usage is the one of interest here. Relevant examples are encouraged. [10 points]
- (b). In order for “surprise” to occur or be experienced, suggest what prerequisite information(s) an agent must have, and argue your reasons for your suggestion. [8 points]
- (c). Two key principles, amongst others, might govern general information processing ability in neural networks. First, neurons (or nodes) that fire together wire together. Second, wiring connection weights are updated based on error back propagation. To the best of your ability, describe how the operations of these two principles in a neural network might encode stimuli information, and how the encoded information might be used. Relevant examples or comprehensively annotated illustrations, are encouraged. [24 points]
- (d). How might a neural network with its given state of connection weights instantiate “surprise”? In your answer, be sure to provide a clear logical argument and line of reasoning to persuade the reader of a possible neural mechanism underlying the psychological experience of “surprise”. [8 points]