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Courses » Learning about Learning: A Course on Neurobiology of Learning and Memory

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Unit 6 - Molecular basis of Memory and Learning

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Course outline

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Memory and Associative Learning/Classical Conditioning

Rescorla Wagner Model of Learning

Reinforcement learning/Operant Conditioning

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Molecular basis of Memory and Learning

● Memory in Molecular Terms - I: Protein synthesis in memory consolidation

● Memory in Molecular Terms - II: Long term potentiation

Week4 : Assignment

The due date for submitting this assignment has passed. **Due on 2019-02-27, 23:59 IST.**
As per our records you have not submitted this assignment.

This is an assignment based on Module 4 content, i.e. Molecular Basis of Learning and Memory.

Please be aware of the marks assigned to each question. A few of the questions do not carry any marks and thus do not contribute to the final score of assignment assessment. These are to facilitate your further thinking on the concepts taught.

1) A pictorial representation of the behaviour paradigm for the experiment carried out by Agranoff et al is given below. Identify the CS and the US.   *1 point*
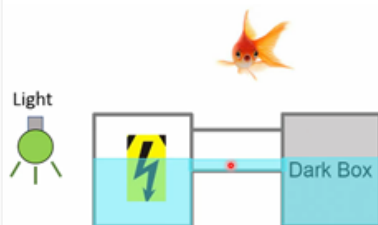
○ CS - Light, US - Shock Box

○ CS - Shock Box, US - Light

○ CS - Light, US - Dark Box

○ CS - Dark Box, US - Light

No, the answer is incorrect.
Score: 0

Accepted Answers:
CS - Light, US - Shock Box

2) In the experiment carried out by Agranoff et al, retention score is calculated by (4th day performance – 1st day performance). A high retention score indicates that the goldfish   *1 point*

○ does remember/retain the CS-US association.

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does remember/retain the CS-US association.

3) Student A and B replicated Agranoff's goldfish experiment. Student A injected protein synthesis inhibitor 1 hour from training, whereas Student B injected protein synthesis inhibitor 10 hour from training. Which of the following is/are true?   *1 point*

☐ Student A's results show that protein synthesis is not crucial for memory retention.

☐ Student A's results show that protein synthesis is crucial for memory retention.

☐ Student B's results show that protein synthesis is not crucial for memory retention.

☐ Student B's results show that protein synthesis is crucial for memory retention.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Student A's results show that protein synthesis is crucial for memory retention.
Student B's results show that protein synthesis is not crucial for memory retention.

4) Which of the following is a protein synthesis inhibitor?   *1 point*

○ NMDA/AMPA

○ Puromycin/Anisomysin

○ CaMKII

○ Dopamine

No, the answer is incorrect.
Score: 0

Accepted Answers:
Puromycin/Anisomysin

5) What are synapses?   *1 point*

○ Junctions where neurons communicate with each other

○ A network which allows memories to be encoded.

○ A region in the brain necessary to form new memories.
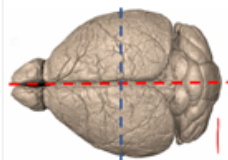
○ A protein that is required for memory retention.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Junctions where neurons communicate with each other

6) A mouse brain is shown below. Identify the axis and the section along the blue line.   *1 point*

○ Rostro-caudal axis (Head to tail) forming the Sagittal section.

○ Rostro-caudal axis (Head to tail) forming the Coronal section.

○ Dorso-ventral axis (Superior-Inferior or top of the brain to the bottom of the brain) forming the Sagittal section.

○ Dorso-ventral axis (Superior-Inferior or top of the brain to the bottom of the brain) forming the Coronal section.

No, the answer is incorrect.
Score: 0

Accepted Answers:

Dorso-ventral axis (Superior-Inferior or top of the brain to the bottom of the brain) forming the Coronal section.

7) A mouse brain is shown below. Identify the axis and the section along the red line.   *1 point*

○ Rostro-caudal axis (Head to tail) forming the Sagittal section.

○ Rostro-caudal axis (Head to tail) forming the Coronal section.

○ Dorso-ventral axis (Superior-Inferior or top of the brain to the bottom of the brain) forming the Sagittal section.

○ Dorso-ventral axis (Superior-Inferior or top of the brain to the bottom of the brain) forming the Coronal section.
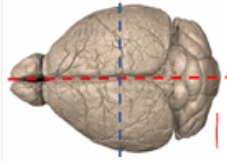
No, the answer is incorrect.
Score: 0

Accepted Answers:

Rostro-caudal axis (Head to tail) forming the Sagittal section.

8) What are the different kind of plasticity the brain undergoes to form and store memories?   *1 point*

○ Molecular plasticity

○ Synaptic plasticity

○ Neuronal plasticity

○ All of the above

No, the answer is incorrect.
Score: 0

Accepted Answers:

All of the above

9) What kind of plasticity is CaMKII involved in?   *0 points*

○ Molecular plasticity

○ Synaptic plasticity

○ Neuronal plasticity

○ All of the above
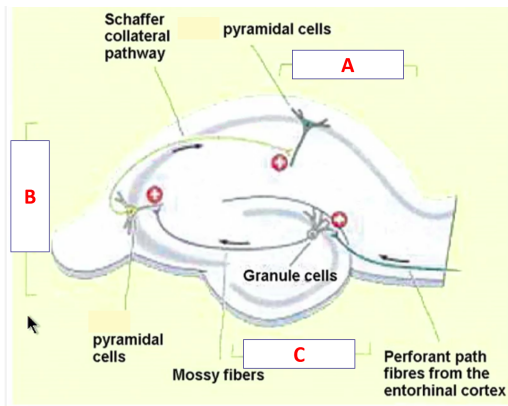
No, the answer is incorrect.
Score: 0

Accepted Answers:

Molecular plasticity

10)dentify labels A, B and C which correspond to the sub regions of the trisynaptic circuit of the   *1 point*
hippocampus.

- ○ A = Dentate Gyrus, B = CA3, C = CA1
- ○ A = CA3, B = CA1, C = Dentate Gyrus
- ○ A = CA1, B = CA3, C = Dentate Gyrus
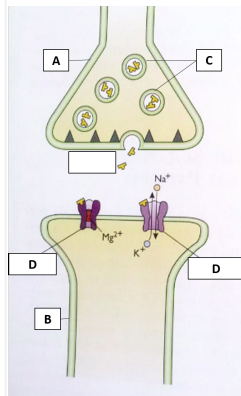- ○ A = Dentate Gyrus, B = CA1, C = CA3

No, the answer is incorrect.
Score: 0

Accepted Answers:
A = CA1, B = CA3, C = Dentate Gyrus

11)Identify the following structures: A and B corresponds to: *1 point*

- ○ A = Presynapse, B = postsynapse
- ○ A = Post synapse, B = presynapse
- ○ A = Presynapse, B = Vesicles
- ○ A = Post synapse, B = Receptors
- ○ A = Vesicles, B = Receptors
- ○ A = Receptors, B = Vesicles

No, the answer is incorrect.
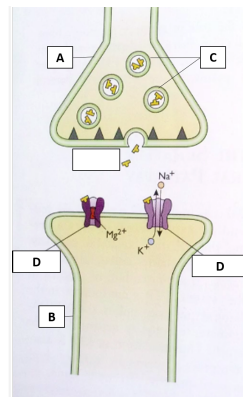**Score: 0**

Accepted Answers:
A = Presynapse, B = postsynapse

12)Identify the following structures: C and D corresponds to: *1 point*

○ C = Presynapse, D = postsynapse

○ C = Post synapse, D = presynapse

○ C = Presynapse, D = Vesicles

○ C = Post synapse, D = Receptors

○ C = Vesicles, D = Receptors

○ C = Receptors, D = Vesicles

No, the answer is incorrect.
Score: 0

Accepted Answers:
C = Vesicles, D = Receptors

13) Vesicles contain   *1 point*

○ Receptors (e.g. AMPAR, NMDAR)

○ CaMKII

○ Synapses

○ Neurotransmitters (e.g. Glutamate)

No, the answer is incorrect.
Score: 0

Accepted Answers:
Neurotransmitters (e.g. Glutamate)

14) Glutamate binds to NMDAR receptor, which opens the AMPAR receptor pore, allowing the   *1 point*
binding of glutamate to AMPAR receptor.

○ True

○ False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

15) For coincidence detection at the post synapse, the NMDA receptor requires: *1 point*

○ Binding of neurotransmitter, glutamate

○ Electrical activity at the post synapse

○ Both a and b

○ None of the above

No, the answer is incorrect.
Score: 0

Accepted Answers:
Both a and b

16) Coincidence detection allows for   *1 point*

    ○ Associative activity

    ○ Dissociative activity

    ○ Electrical activity

    ○ All incoming signals

No, the answer is incorrect.
Score: 0

Accepted Answers:
Associative activity

17) When testing rodents in water maze behaviour, we test their ability to form or retain   *1 point*

    ○ reflexive memory

    ○ associative memory (a single CS-US pairing)

    ○ spatial memory

    ○ motor memory

No, the answer is incorrect.
Score: 0

Accepted Answers:
spatial memory

18) Performance in water maze is tested during probe trial where a flag marks the location the   *1 point*
rodent is supposed to swim toward

    ○ True

    ○ False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

19) Water maze is a spatial memory task that requires the hippocampus.   *1 point*

    ○ True

    ○ False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

20) Over training hippocampal lesioned rodents in water maze overcomes their inability to learn   *0 points*
to find the platform location.

    ○ True

    ○ False

No, the answer is incorrect.
Score: 0

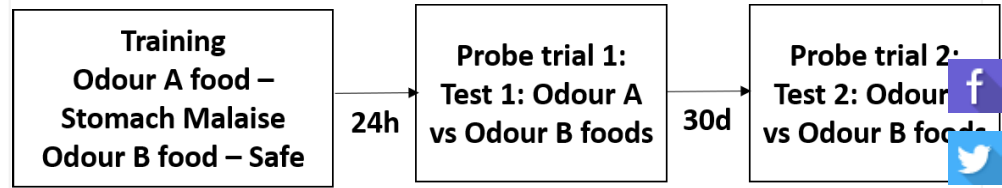**Accepted Answers:**
True

21) Use the information below for questions 21-22:   *1 point*
A group of researchers are working to elucidate the role of gene X in systems consolidation of memory.

The group utilizes a behaviour paradigm where the rodents are made to associate a particular odour A in their food with an unpleasant stomach malaise, whereas another odour B in their food indicates that it is safe for consumption. During the memory retrieval test (probe trial), the rodents are presented with odour A food and odour B food. The amount of food consumed is used as a behavioural readout for memory retention. The schematic of the behaviour paradigm.

| Training
Odour A food –
Stomach Malaise
Odour B food – Safe | 24h | Probe trial 1:
Test 1: Odour A
vs Odour B foods | 30d | Probe trial 2:
Test 2: Odour
vs Odour B foods |

If the gene X is indeed required for systems consolidation, which of the following graphs would accurately represent the food consumption/memory retention?
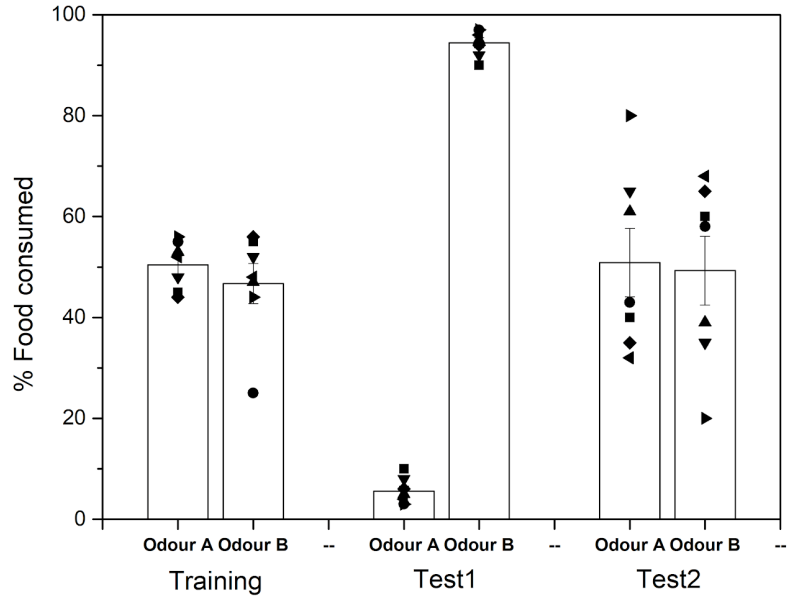
○

○

○
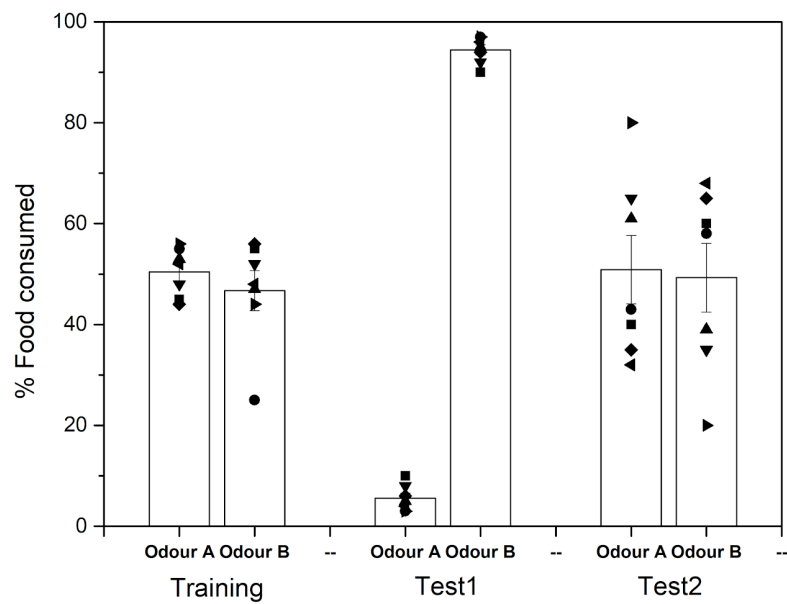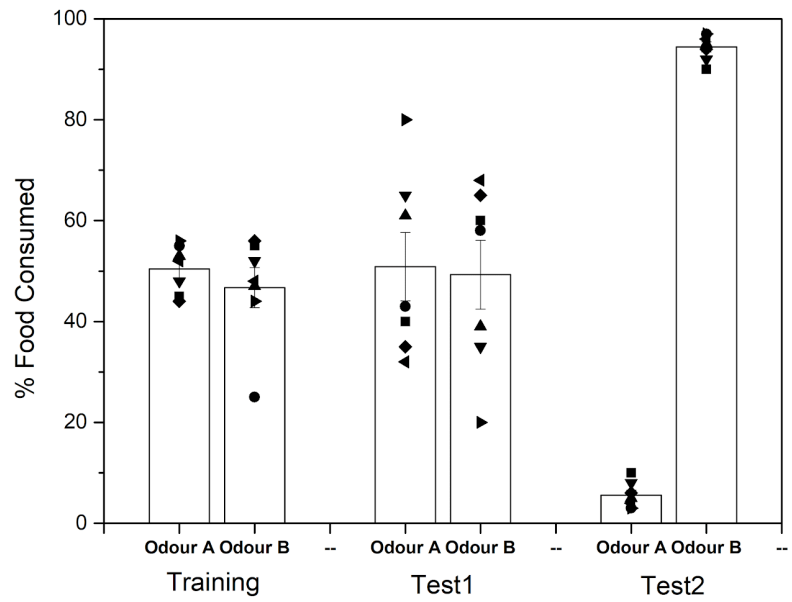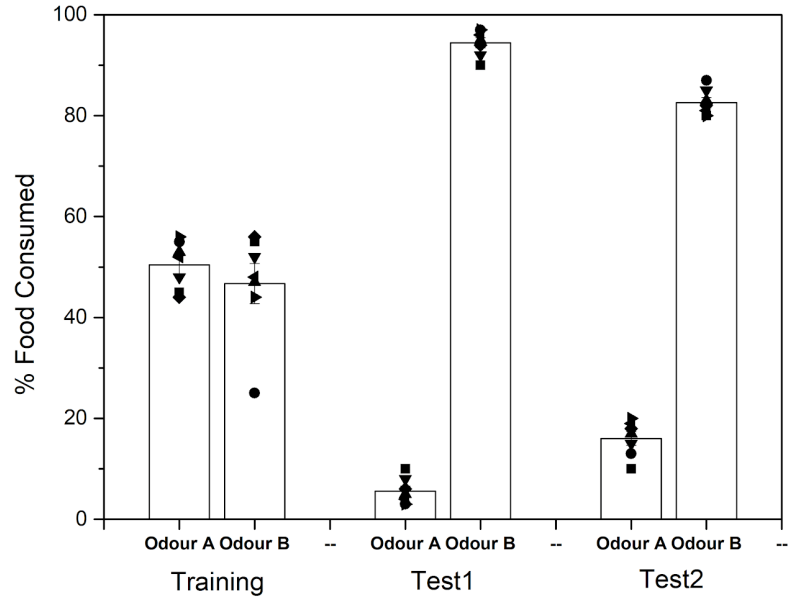
○ Insufficient information.

No, the answer is incorrect.
Score: 0

Accepted Answers:

22**)**n continuation with the above question, a student decides to replicate the Research Group's **1 point** behavioural experiment with a different set of knockout rodents (KO) for gene X. However, the student observes that systems consolidation of the odour memory does takes place in both wild type and KO animals. What may be the possible confound?

○ The KO is restricted to a region in the brain that is NOT involved the memory.

○ The knocked out gene is responsible for cellular consolidation.

○ The KO animals developed compensatory mechanism for the functions of the lost gene.

○ Both A and C are possible confounds.

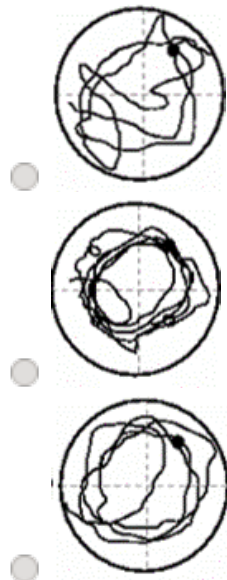**No, the answer is incorrect.**
Score: 0

Accepted Answers:
Both A and C are possible confounds.

23**)**Which of the probe trial traces shown below correspond to a rodent that has learnt the water **1 point** maze platform location?

○

○

○

No, the answer is incorrect.
Score: 0

Accepted Answers:

24) You are training rodents in the water maze task, and you observe that over 3-4 days, the latency (time taken to find the platform) has drastically reduced. You conclude that the rodents have learnt to do the task, but still conduct a probe trial where you remove the platform. They do not seem to be searching for the platform at its designated location. What do you conclude? **0 poi**

- ◯ Such a result is not possible since the latency is an accurate read-out of their navigational memory
- ◯ The rodents had strategized to find the platform faster (for example, swimming in concentric circles till they hit upon the platform) but not memorized the map to it
- ◯ They have suddenly forgotten how to perform in the task
- ◯ A visible mark/flag indicating where the platform is located, is a necessary part of the water maze task, and without the platform and the flag marking it, the mice cannot see where the platform is and thus fail to find it

No, the answer is incorrect.
Score: 0

Accepted Answers:
The rodents had strategized to find the platform faster (for example, swimming in concentric circles till they hit upon the platform) but not memorized the map to it

25) Systems consolidation refers to: **1 point**

- ◯ Neurons that fire together, wire together.
- ◯ the transformation of information-rich memories into overall gist or summary of the memories over a period of time, i.e. loss of specific details of memories.
- ◯ how memories initially dependent on the hippocampus, becomes independent of the hippocampus.
- ◯ tagging memory neurons with a molecular probe.

No, the answer is incorrect.
Score: 0

Accepted Answers:
how memories initially dependent on the hippocampus, becomes independent of the hippocampus.

26) Long-term potentiation (LTP) is the term used for: **0 points**

- ◯ A changed electrical response from a postsynaptic neuron over many hours
- ◯ An extremely high firing rate in a presynaptic neuron
- ◯ A lack of response in the postsynaptic neuron
- ◯ The suppression of neurotransmitter reuptake

No, the answer is incorrect.

Score: 0

Accepted Answers:
A changed electrical response from a postsynaptic neuron over many hours

27) Optogenetics is a biological technique that involves   **0 points**

   ◯ the use of a magnetic field to control cells in living tissue, typically neurons, that have been genetically modified to express Magneto protein

   ◯ the use of DREADD technology (Designer Receptors Exclusively Activated by Designer Drugs), sensitizing neurons for activation by a specific drug-like molecule

   ◯ the use of temperature/heat to control cells in living tissue, typically neurons, that have been genetically modified to express temperature-sensitive ion channels

   ◯ the use of light to control cells in living tissue, typically neurons, that have been genetically modified to express light-sensitive ion channels

No, the answer is incorrect.

Score: 0

Accepted Answers:
the use of light to control cells in living tissue, typically neurons, that have been genetically modified to express light-sensitive ion channels

28) Proteins have a wide range of half-lives, ranging from minutes to years. Many memories can   **1 point** last a life-time.It might seem that the only mechanism by which proteins can be involved in memory formation is if they are never degraded
In light of this, what does the molecular switch hypothesis suggest?

   ◯ that a continuous activation of a cascade of different molecules maintains the memory for a lifetime events

   ◯ Activated molecules self-catalyse their own activation, and a neuronal activity dependant shift in the rates of protein-activation and deactivation can generate ans maintain a stable pool of activated molecules regardless of the turn-over rate of individual proteins

   ◯ that permanent structural changes at the synapses lead to stable life-time memories

   ◯ once a memory molecule is generated and involved in the formation of memory, it never degrades

No, the answer is incorrect.

Score: 0

Accepted Answers:
Activated molecules self-catalyse their own activation, and a neuronal activity dependant shift in the rates protein-activation and deactivation can generate ans maintain a stable pool of activated molecules regardless of the turn-over rate of individual proteins

29) In an attempt to find an animal model for H.M's condition, Kim and Fanselow's conducted an   **1 point** experiment where they trained rodents to associate a context with a mild foot shock, i.e. contextual fear conditioning. They used different groups of rodents such that the hippocampus was lesioned at different time point, i.e. 1 day, 7 days, 14 days and 28 days (HPC lesion). Non-lesioned rodent groups were used as controls. The results are plotted below. Which of the following is the correct conclusion from the experiment and the graph?
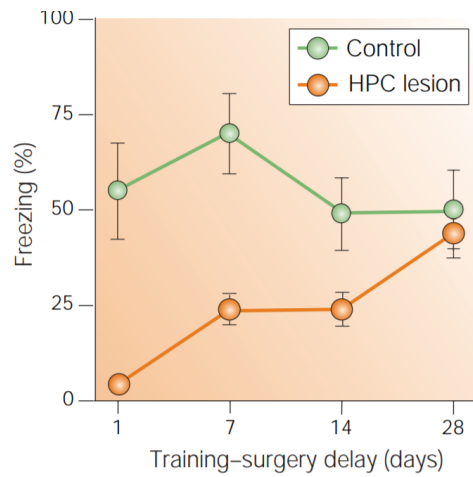
○ Acquisition of contextual fear memories does not require the Hippocampus since both Hippocampus-lesioned and control animals acquire the context fear memory and freeze equally o retrieval.

○ The retrieval of the contextual fear conditioning is hippocampus dependant at the recent time-point (retrieval 24 hours after training) but eventually after 28 days (remote time-point),the rodent does not require the hippocampus for retrieval

○ The hippocampus is always required for the retrieval of context-fear memories, even after 28 days (remote time point)

○ Only the acquisition of context-fear association requires the hippocampus, the retrieval of these memories, either at recent (1 day later) or ar remote time (28 day later) does not require the hippocampus

No, the answer is incorrect.
Score: 0

Accepted Answers:
The retrieval of the contextual fear conditioning is hippocampus dependant at the recent time-point (retrieval 24 hours after training) but eventually after 28 days (remote time-point),the rodent does not require the hippocampus for retrieval

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