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Extra Credit

Question 7.7:
In the model the VSPatchPosD1 layer receives weights from specific units through the USTime_In layer that become active during the presentation of the reward. These units encode a temporal representation with a time of delivery for the expected reward which is believed to happen in the OFC. By receiving these units, the VSPatchPosD1 layer will learn to predict the expected time of the reward. This is what allows the network to anticipate rewards which ultimately mitigates the dopamine bursts when the reward is what was expected. This illustrates how PV is crucial for adapting the phasic dopamine responses based on reward prediction errors. When a reward is predicted, the activation of VSPatchPosD1 inhibits the phasic burst in the dopamine cells which reduces the dopamin signal to reflect the difference between predicted and actual outcomes. This in turn optimizes learning and behavioral responses based on reward expectations.

Question 7.8:
Understanding the idea that extinction is not the unlearning of the CS-US association but an overlay of new learning is critical to this model. The strong weights from the Stim_In to layers like CE1AcqPosD1 and BLAmgPosD1 suggest the idea that the original CS_US associations are largely preserved even after extinction. These weights illuminate the idea that the neural representations of the CS strongly predict the US which maintains the potential to trigger CS related responses. Extinction is believed to involve learning that prevents CS from predicting the US in current context rather than erasing the original learning. This idea is reflected in the activity of some of the other pathways like BLAmygPosD2 which inhibit the output of pathways like BLAmygPosD1. This allows the conditioned responses to be suppressed without erasing the underlying associative memory. Because of this when the context changes, the original learning can re-emerge which shows that it is preserved and can still influence behavior when it is not actively inhibited by extinction specific pathways.

Question 7.9:
A separate extinction mechanism is useful because it allows an organism to adapt to changes in the environment without losing the underlying memory of previous associations which can still be useful in different contexts/conditions. This is crucial because environments become dynamic and organisms need to adjust behaviors based on circumstances while still being able to revert to previous conditions. By coding the extinction in a context dependent state, the brain can effectively switch between behavioral strategies depending on the state of the current environment. This means that behavior will no longer be appropriate in only one context and can be suppressed without being permanently unlearned.

Question 7.9a:
Aversive outcomes are often seen as a threat to survival which springs quick learning mechanisms that drive some of the avoidance behaviors. Conversely, appetitive learning is typically associated with rewards and positive outcomes where the stakes aren't as immediate. This distinct pathway will allow the brain to process these types of information with the urgency and sensitivity that is appropriate to the consequences. Regarding the separate positive responses in the VTAn layer for aversive outcomes, if the signals are conveyed to downstream units that also receive signals from the same layer, this will lead to confusion between the positive and negative motivational issues. For example, if a burst of dopamine is received, it is typically associated with rewards in response to aversive outcomes and leads to inappropriate behavioral responses. This could mean that it will approach a threat instead of avoiding it. These separate pathways ensure that the motivational significance of each type of outcome is preserved and properly guides behavior based on the needs of the organism.

Optional Question:
The model continues to elicit partial dopamine bursts when presented alone after trials with a conditioned inhibitor because the initial learning predicts a reward. This learning causes a dopamine response due to the strong previous association of CS A with reward, which is maintained by neural pathways. The trials where CS A is paired with or without a reward (CS X) helps maintain some of the reward predictive values of CS A when the reward is absent. This illustrates the neural dynamic where the previous learning is not overridden completely but modified by some of the new associative learning which allows the organism to retain flexibility in responses based on context.