QUIZ 2 (230912)

NAME:_____________

Problem 1. Find as many brain areas as you can that are involved in the following situations. Make sure to defend your answer with reasoning.

(1) "Hmm I'm trying to keep in mind all the brain areas I learned today. I'll put aside my other thoughts for a while."
(2) "It is harder to concentrate on my book when there are loud noise and flashing lights."
(3) "Though it might be effortful, I'll move along this path if it brings me closer to obtaining what I want"
(4) "I want to eat some tacos and quesadillas . I am hungry, and I also noticed a taco restaurant nearby."
(5) "She/He is so attractive. I want to get their number." (But while trying to ask, the speaker freezes.)
(6) "How dare you eat my banana! I will make you pay for it."

Problem 2. Label the following statements with **True** or **False**. If the statement is false, explain how you can revise it to be **True**.

(1) Working memory, attention, and executive functions are examples of cognitive function.
(2) A hypothetical minimal brain allows an animal to defend itself and seek rewards.
(3) The occipital cortex is necessary for residual vision.
(4) The superior colliculus is a layered structure of the cortex.
(5) The name "periaqueductal gray" was given because it surrounds a channel containing cerebrospinal fluid.
(6) The name "substantia nigra" was given because it appears darker than neighboring areas.
(7) The name "hypothalamus" was given because it is located just above the thalamus.
(8) The more flexible you are, the stronger the coupling is between sensory inputs and motor outputs.
(9) Superficial layers of the optic tectum receive sensory input, and the deep layers send motor outputs.
(10) The recurrent network model captures the essence of the organization of the brain proposed by Paul Broca.

Problem 3. (The minimal brain) Below is a simple 4-layer model of the minimal brain.

Superior Colliculus

Retinal Input: $R_n \rightarrow$	$y_1 = \sigma(R_n - 1)$	
Hypothalamic Input: $H_n \rightarrow$	$y_2 = \sigma(2H_n + y_1 - 3)$	
Aversive Input: $F_n \rightarrow$	$y_3 = \sigma(F_n - 1)$	
	$y_4 = (2y_2 - 1)_+$	$\rightarrow S_n = y_4$: Substantia nigra
	$y_5 = \big(y_3 - 0.5H_1(y_2)\big)_+$	$\rightarrow P_n = y_5$: Periaqueductal Gray

$S_n, P_n \rightarrow$ Action: A_n

where $x_+ = \begin{cases} x & x > 0 \\ 0 & x \leq 0 \end{cases}$. Similarly, we can define $x_- = \begin{cases} 0 & x > 0 \\ -x & x \leq 0 \end{cases}$. Then, $x = x_+ - x_-$. For example, $(1)_+ = 1$ and $(-2)_- = 2$.

The first layer determines whether the retinal input (external context) is above the threshold 1. The second layer determines whether the linear combination of external and internal context signals are greater than 3. Our final signal is $y_2 - 1$, where a positive value signals desirability and a negative value signals danger.

Assume that $R_n, H_n, F_n \sim Uniform([0, 2])$. $A_n = \begin{cases} H_{0.3}(S_n - wP_n) & S_n - wP_n > 0 \\ -H_{0.3}(S_n - wP_n) & S_n - wP_n \leq 0 \end{cases}$ is the action that is "approach" when positive and "withdraw" when negative.

Problem 4. (Attention as a filter) Attention can work as a filter helping to select relevant information and ignore less pertinent signals. Where is your attention these days?