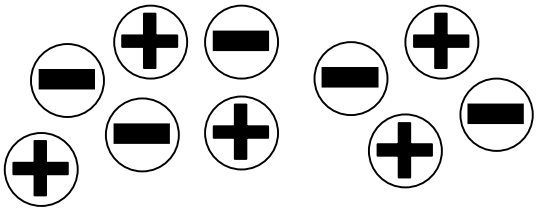
**The Different Effects of Excitation and Inhibition**

This exercise helps to understand the effects of excitation and inhibition in the nervous system. The effects of excitation are easily understood – one neuron activates another neuron. However, when inhibition is introduced into circuits, analysis becomes more complicated especially when the number of inhibitory neurons increases in pathways. The combination of excitation and inhibition in circuits can become impossible to understand. One way to understand these effects is to consider excitation and inhibition simply in terms of algebraic signs. We are all familiar with the effect of multiplying positive and negative numbers, which is the point of the exercise below.



1. In Example below 1, how many ways can you produce a **+** result? A negative result?
2. In example 2, how many ways can you produce a **+** result?
3. In Example 3, what is the result without the box; with the box?

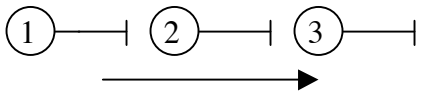
**1.** ____ × ____ = ⊕

⊖

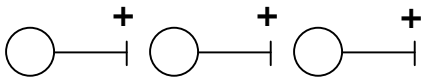
**2.** ____ × ____ × ____ = ⊕

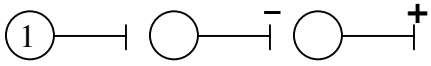
**3** ⊖ × ⊖ × ⊕ × ⊖ × ⊕ =

• Using the multiplicative property of signs, it is easy to determine the result of any number and combination of excitatory and inhibitory neurons that are sequentially arranged into a circuit.




• **Concept 1 – Disinhibition**: Circuits can have excitatory (positive) results when all cells in the circuit are excitatory, as shown in example A. However, circuits also can have excitatory results (output) when the appropriate combination of excitation AND inhibition occurs. In example B, what must be the sign of cell 1 for this circuit to have a positive (excitatory) result? Example B is known as *disinhibition* because a positive result is achieved by preventing (negating) the inhibitory influence of a second cell.

A. 


B. 


• **Concept 2**: Complex circuits containing large numbers of nerve cells can be understood readily using the same multiplicative principles. Here is a circuit in the brain that controls some aspects of movement. Several diseases that affect movement, such as Parkinson's Disease, are caused by abnormal function of this circuit.

What is the overall effect of excitatory and inhibitory connections in the circuit (see diagram):
Cortex - Putamen – Globus Pallidus – VL – Cortex
Do you notice anything special about how this is achieved?

Now let's look at the second part of the circuit, which seems to be more complicated. It is represented by the connections:
Cortex – Putamen – GPe – STN – GPi – VL – Cortex
Can you quickly determine the overall effect of this complicated circuit?