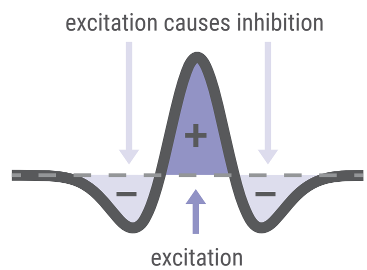
WHY DOES THE BRAIN GAUGE WORK?

The Brain Gauge tests the building blocks of higher cognitive processes. For example, one of the cortical metrics that is derived from Brain Gauge measures is **lateral inhibition**. Lateral inhibition is a mechanism that governs or modulates the interactions between groups of cells in the brain; it is a key element of learning, memory and neuro-plasticity. If lateral inhibition is interrupted, higher cognitive functions become disrupted, though not always in a consistent manner. Probing a fundamental mechanism of information processing, such as lateral inhibition, will yield more consistent results when testing neurologically compromised populations.

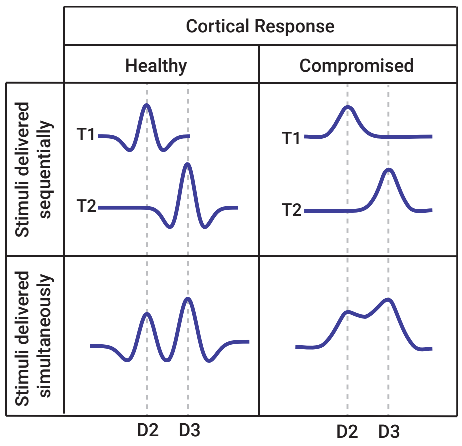
WHAT IS LATERAL INHIBITION?

Lateral inhibition is the process by which an input to part of the brain causes an area of the brain to become excited. This input can come from many places, both from sensory input and/or other parts of the brain. The center of the excited region tries to turn off, or inhibit, the regions next to it (i.e., lateral to the area of excitation). This leads to contrast enhancement of the input, much like you would focus an old television with a contrast dial. This phenomenon was first proposed by Nobel prize winner Georg Von Bekesy in the 1950s and based on observations of sensory percept. Over the next 60 years, a number of researchers, including our group, demonstrated that lateral inhibition plays an important role at many different levels of information processing.



WHAT IS THE BEST WAY TO MEASURE LATERAL INHIBITION?

Although lateral inhibition has been observed in the brain with a number of experimental methods, all are highly invasive and not suitable for human testing. No medical imaging method is capable of detecting disruptions in lateral inhibition. However, lateral inhibition can be measured with a simple sensory test. The sense best suited for this type of test is the sense of touch, or the somatosensory system.



The somatosensory system is best suited for this task because well-controlled inputs can be delivered to two adjacent regions in the brain. Lateral inhibition, if effective, will work to contrast enhance the differences between those two regions. Consider the figure at left, which is based on years of experimental results. When two adjacent inputs are delivered to a healthy cortex, it is fairly easy to distinguish each one, regardless of whether they were delivered at the same time (simultaneously) or at different times (sequentially). However, if the cortex is compromised, differentiating between two inputs is achievable if they are delivered sequentially, but very difficult if the inputs are delivered simultaneously.

200+ concussed individuals completed a series of amplitude discrimination tasks, a vibrotactile test in which the subjects determined the larger of two stimuli. Amplitude discrimination was tested using both sequentially and simultaneously delivered stimuli in order to assess lateral inhibition. The results demonstrate that the ratio of the two values (simultaneous/sequential) is almost **double** the ratio for healthy controls ($p<0.001$ for comparison of concussed vs. non-concussed individuals). Note that with this method, baseline measures (those obtained before the injury is sustained) *are not needed* because lateral inhibition does not impact the sequential task as much as it impacts the simultaneous task: each individual can be tested for this “baseline” after they are concussed. Additionally, we see time course of this ratio sensitive to changes 21-60 days post-concussion.