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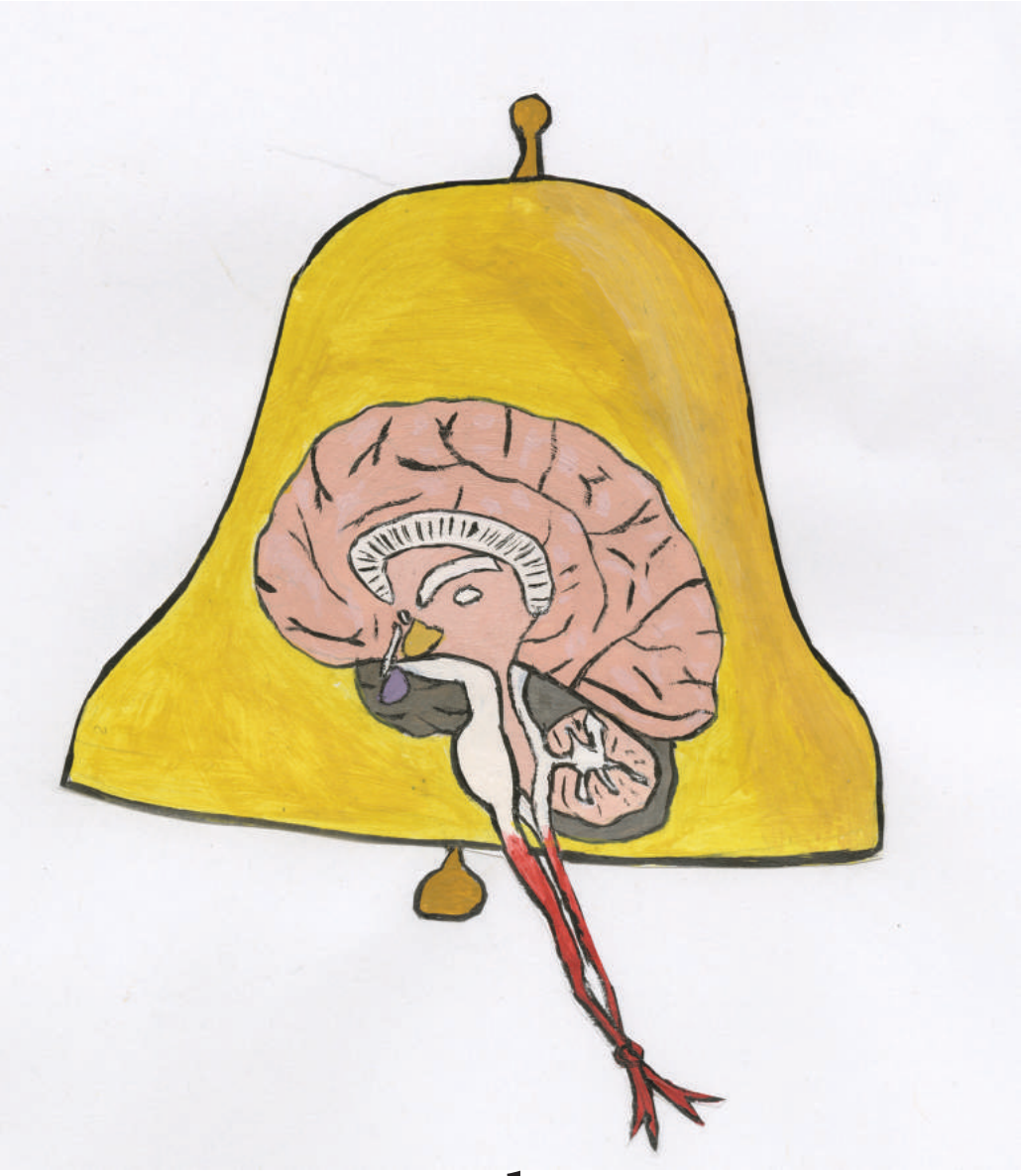

Pain on the Brain

Theories Over the Ages

By Oluwadamilare Ogunjimi
Artwork by Eva Bednarski

Pain. With finals quickly approaching, this is a sensation that we, as Oberlin students, are all very familiar with. For many centuries, humankind has tried to determine just what pain is and how we feel it. The three historically prevalent theories on how we process pain that we'll be looking at are Renee Descartes' Specificity Theory; Canadian psychologist Ronald Melzack and British neuroscientist Patrick David Wall's Gate-Control Theory of Pain, the current leading paradigm; and Melzack's new theory, one that solved all the questions that the Specificity theory and the Gate-Control theory could not: the neuromatrix.

During the 17th century, Renee Descartes presented to the world the Specificity Theory of pain. Within this theory, every area of the body with the sense of touch, or a tactile modality, has several dedicated neural pathways. There is a different pathway/combination of pathways for every sensation, including pain. When one of these areas touches something, there is a mechanical stimulus which must overcome a low threshold to activate nearby mechanoreceptors, meaning that it doesn't take much to activate these mechanoreceptors. These primary mechanoreceptors project the stimuli to secondary mechanoreceptors in the spinal cord or brain stem, depending on where the primary mechanoreceptors, and thus the initial stimuli, are located. The secondary mechanoreceptors project the stimuli to "higher" mechanoreceptors in the brain. In the brain, the "higher" mechanoreceptors translate the stimuli into the appropriate sensation, such as pain. This movement of the stimuli from mechanoreceptor to mechanoreceptor is much like a relay race, in which the signal encoding the stimuli is a baton and each mechanoreceptor is a runner. When talking about pain, the mechanoreceptors are referred to as nociceptors and the mechanical stimulus is a noxious stimulus, leading to the noxious experience that we call pain.

Descartes's Specificity Theory is relatively simple and makes a

good distinction. It lays a clear-cut line between nociception, the nerves' transduction of noxious stimuli (the stimuli's movement from the initial point of injury, through the nerves, to the brain), and the brain's perception of pain (the noxious experience). Despite this distinction, the Specificity Theory also makes it seem like the brain just passively receives, translates, and processes any and every tactile stimulus. It belittles the brain's role in the experience of pain. It neglects our ability to numb a pain by distracting ourselves until we forget that it's even there. It doesn't recognize the many cases of chronic pain syndromes that include very real pain without an initial injury. It doesn't even take into consideration the phenomenon of phantom limb pain.

Recognizing the brain's vital role in the noxious experience was of great concern to Melzack and Wall. They realized that there is some type of filtering of stimuli that prevents the brain from just translating and processing every noxious stimulus it receives. To address this concern, they developed the Gate-Control Theory of pain. As the name suggests, within our nervous system is a "gate." This gate is the substansia gelatinosa, located in the dorsal horn. The brain is connected to this gate by way of large fibers. These large fibers send large signals to the gate, telling it to "close." Small fibers connect the gate to the peripheral nervous system. These small fibers carry small signals that tell the gate to "open" when there is an injury. When there is an injury, there need to be enough small signals from the peripheral nervous system to overpower the large signals coming from the brain to open the gate. A more traumatic injury leads to more small fiber signals, not only opening the gate but also leading to a more painful experience. Small fibers also exist in the central nervous system, allowing for pain to be felt from stimuli that originate from injuries in the central nervous system (i.e. the spine and brain).

Unlike the Specificity Theory, the Gate-Control Theory gives the brain a more active role in nociception. Ideally, the brain can send more large fiber signals to reclose an already open "gate." Despite this added insight, the Gate-Control Theory is still based on the assumption that pain requires an initial injury. It still overlooks cases where patients feel very real pain that has no associated initial injury, such as in chronic pain disorders and patients with phantom limb pain. Atul Gawande, in his book *Complications*, refers to a patient who suffers from severe back pains; however, no medical test has revealed anything out of the ordinary in his spine, lower back, or the rest of his body. The Gate-Control Theory provides no answer for what is going on in such cases.

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To pick up the Gate-Control Theory's slack, Melzack developed yet another pain system theory in 1993. This theory is currently the newest and most up-to-date (although the literature suggests that it is still incomplete). This system is known as the neuromatrix. The theory behind the neuromatrix is that the body is a unity, a single network that identifies itself as "self" and everything else (i.e. other people and the environment) as "other." This feeling of unity comes from the brain and can't come from the peripheral nervous system or the spine. Melzack suggests that these body-self processes are genetic in origin but are shaped by one's environment. These body-self processes occur in the neuromatrix, a series of neural loops between the thalamus and the cortex and between the cortex and the limbic system. The processing and nerve impulses that occur in the neuromatrix are called the neurosignature. Within the brain is a sentient neural hub that turns the neurosignature into experiences, or the flow of awareness. There is, within the neuromatrix, the active neuromatrix, which provides us with the sensation of proprioception, a constant awareness of where our limbs are located relative to the rest of our body. Active neuromatrices provides patterns of movements that lead to certain goals. Melzack explains phantom limb pain as an active neuromatrix trying to send or receive signals to or from the amputation site. These signals grow in strength until it creates a burning sensation. Cramping is supposedly the result of an action neuromodule trying so hard to move the now absent muscles that the output signal becomes a cramping pain. Within the Neuromatrix Theory, brain processes are usually initiated by inputs, but can also act without any inputs. In regards to pain, this statement means that pain usually comes from an initial injury, but the brain is perfectly capable of creating pain on its own.

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Although the Neuromatrix Theory requires further testing and more detail, it has managed to answer every available question that its predecessors could not. The brain is a powerful thing, a sentient neural hub that can do whatever it wants, whenever it wants. It can cause pain for no apparent reason or it can simply stop feeling pain. Maybe Melzack has given us Obies a way to escape the pain of finals.