Pain

Physical suffering resulting from some sort of injury or disease, experienced through the central nervous system.

Pain is a complex phenomenon that scientists are still struggling to understand. Its purpose is to alert the body of damage or danger to its system, yet scientists do not fully understand the level and intensity of pain sometimes experienced by people. Long-lasting, severe pain does not serve the same purpose as acute pain, which triggers an immediate physical response. Pain that persists without diminishing over long periods of time is known as chronic pain. It is estimated that almost one-third of all Americans suffer from some form of chronic pain. Of these, 70 million have back pain, 36 million have arthritis, 20 million suffer from migraine headaches, and at least 800,000 Americans suffer severe pain associated with the growth of cancerous tumors. An additional kind of pain is psychological pain. Recent research has shown that the chemicals produced by anxiety are similar to those that are released in response to physical injury.

Pain signals travel through the body along billions of special nerve cells reserved specifically for transmitting pain messages. These cells are known as nociceptors. The chemical neurotransmitters carrying the message include prostaglandins, bradykinin—the most painful substance known to humans—and a chemical known as P, which stands for pain. Prostaglandins are manufactured from fatty acids in nearly every tissue in the body. Analgesic pain relievers, such as aspirin and ibuprofen, work by inhibiting prostaglandin production.

After an injury, cells near the trauma site release these chemicals into the central nervous system. In the spinal cord, they are carried by the dorsal horn, and it is at this point that the body pulls away from the source of the pain. When the signal reaches the brain, it is first processed by the thalamus and then passed to the cerebral cortex. Here, the brain fully processes the information, locates its source in the body, and begins sending signals to relieve the pain.

As they travel, the pain messages are sorted according to severity. Recent research has discovered that the body has two distinct pathways for transmitting pain messages. The epicritic system is used to transmit messages of sudden, intense pain, such as that caused by cuts or burns. The neurons that transmit such messages are called A fibers, and they are built to transmit messages quickly. The protopathic system is used to transmit less severe messages of pain, such as the kind one might experience from over-strenuous exercise. The C fibers of the protopathic system do not send messages as quickly as A fibers.

In 1965, Ronald Melzack and Patrick Wall, leading pain researchers at the Massachusetts Institute of Technology, proposed what has come to be known as the gate theory of pain. This theory holds that the nervous system has the capacity to process only limited amounts of information at a time. For example, if the body is overwhelmed by multiple messages, the nervous system will “shut down” certain messages. This would explain why rubbing an injury often lessens its pain. The rubbing, in essence, competes with the injury for space in the nervous system.

One application of the gate theory is the use of small bursts of electricity to help manage pain. Experiments were first conducted on animals, whose brains were stimulated electronically at certain points, shutting down their capacity to feel pain. The animals were then operated on using no anesthetic. This method has been adapted for humans as well and has led to the development of a pain relief method known as transcutaneous electrical nerve stimulation, or TENS. In this technique, pain sufferers are jolted with tiny bits of electricity at strategic points. As predicted by the gate theory, the nerve endings at the point of the shock are overwhelmed and divert some of the space in the central nervous system to processing it, thereby relieving the original pain.
Chronic pain, on the other hand, presents its own set of problems. Treating chronic pain is difficult because by its very nature, such pain damages the central nervous system, making it weaker and more susceptible to pain. This residue of pain is called pain memory. Problems also arise when nerve cells are damaged by chemotherapy, diabetes, shingles, and other diseases. And in the case of arthritis and other inflammatory diseases, the body’s threshold for pain is lowered, thus causing increased pain from “less” stimuli.

Treatments for pain vary widely. For mild pain, the most common form of treatment is aspirin, a medication discovered in the 19th century and derived from salicin, a chemical found in the bark of the willow tree. Today, there are several aspirin-like drugs on the market for the relief of minor, inflammatory pain, including ibuprofen and acetaminophen. For more severe pain, opiates—derived from the opium poppy, a common flowering plant—are often used. Opiates work by attaching themselves, on the molecular level, to nerve cells normally used to transmit pain messages. (The place on the nerve cells where the opiates reside are called opiate receptors). Opiates work very well in relieving pain, but are quite dangerous and can become addictive.

In the 1970s, scientists began looking for natural opiate-like substances, and found that the body does indeed produce its own painkillers, which has come to be called opioids. The two most common opioids are endorphins and enkephalins. These chemicals attach themselves to the opiate receptors in nerve cells just as opiates do. It has been found that the body can be stimulated to release these chemicals by TENS and by acupuncture, a Chinese method of placing tiny needles at specific points in the body to relieve pain. Other methods for treating pain include hypnotism, massage, and biofeedback.

Further Reading

**Paired-associate learning**

Strategy used by psychologists to study learning.

Paired-associate (PA) learning was invented by Mary Whiton Calkins in 1894 and involves the pairing of two items (usually words)—a stimulus and a response. For example, words such as *calendar* (stimulus) and *shoe* (response) may be paired, and when the learner is prompted with the stimulus, he responds with the appropriate word (*shoe*).

The study of PA learning has been important for a number of reasons. Psychologists view it as representative of the kind of learning that people engage in every day. For example, when learning a new word, a person must pair the word itself with the concept it represents. This is the essence of PA learning. Another reason is that it allows researchers to study the associations between stimuli and responses. Although this stimulus-response approach has lost some of its importance in contemporary psychology, researchers—especially behaviorists—have been interested in how stimulus-response links are formed and broken.

Psychological research has revealed that when people learn paired associates, they engage in two separate mental processes. The first is the learning of the response; the second is the formation of a bond between the two words. This second process seems to produce a one-way association in many circumstances. That is, a learner is much more likely to remember the response word if given the stimulus; people have a harder time remembering the stimulus if presented with the response word.

This pattern holds true when the response has never been used as a stimulus. On the other hand, if a particular word (e.g., *cloud*) has been used both as a stimulus and as a response (e.g., *cloud*-*pen* and *bag-cloud*), the learner gets accustomed to using the word in two ways. In later testing, the subject is likely to remember the word pair correctly when presented with either word. Based on research such as this, psychologists have concluded that learners remember the word pair as a unit, not as a stimulus that simply leads to a response.

Further Reading

**Panic/Panic disorders**

An acute feeling of intense fear, accentuated by increased heart rate, shortness of breath, sweating, and mild convulsions.

Feelings of *fear* and panic are common to all species, and humans are certainly no exception. Psycho-