Perception Lab #5: No Pain, No Gain

Background

Pain is vital to our survival. Although pain is defined as the perception of a noxious (i.e., tissue damaging) stimulus, pain can also occur in the absence of injury or long after an injury has healed.

Pain provides humans with information about tissue-damaging stimuli, and thus enables them to protect themselves from greater damage. Pain is protective in two ways. First, it removes a person from stimuli that cause tissue damage through withdrawal reflexes. Second, learning associated with pain causes the person to avoid stimuli that previously caused pain. In today's society, pain often initiates the search for medical assistance and helps us to pinpoint the underlying cause of disease. In addition, pain facilitates recovery from injury because sensitive body regions are protected from further injury.

Although acute pain that is associated with acute disease or injury has a protective function in that it prevents further tissue damage, occasionally persistent pains that have no useful purpose can develop. Persistent pain is not simply a symptom of injury — it persists long after recovery from injury and long after pain has a useful function. Such pain syndromes are a widespread medical problem. According to the Society for Neuroscience, “Each year, more than 97 million Americans suffer chronic, debilitating headaches, a bout with a bad back or the pain of arthritis — all at a total cost of some $80 billion” (Society for Neuroscience, 1990, p.19).

Messages about tissue damage are transmitted from the skin or other site of injury to the spinal cord by specialized sensory neurons called nociceptors. (See Figure 1.) Nociceptors respond exclusively to stimuli that damage the skin and other tissues.

Two things happen once the message reaches the spinal cord. Spinal interneurons transmit the message to motor neurons that synapse with muscles involved in withdrawal reflexes. This reflex circuit removes the injured limb from the stimulus. Simultaneously, a message travels to the thalamus, which relays the message to the somatosensory cortex. Because of the difference in distance in these two pathways, nociceptive reflexes occur before the pain message reaches the brain. Although much is known about the pathways from injured tissue to the brain, the interpretation of pain in the brain is not completely understood (Guyton, 1991).

It is hypothesized that different types of nociceptors register and then transmit these two types of pain. Small, myelinated fibers (A delta fibers) are believed to carry sharp, pricking sensations, whereas unmyelinated fibers (C fibers) are believed to carry a diffuse, throbbing pain. A delta fibers carry messages at a velocity of 6 to 30 m/second and C fibers at a velocity of 0.5 to 2.0 m/second (Guyton, 1991, p. 522). The long-lasting throbbing pain is probably the result of prolonged activity in C fibers. People who have hit their finger with a hammer or dropped something on a toe have probably experienced these two types of pain - an initial acute pain followed by a throbbing pain. See Figure 2.

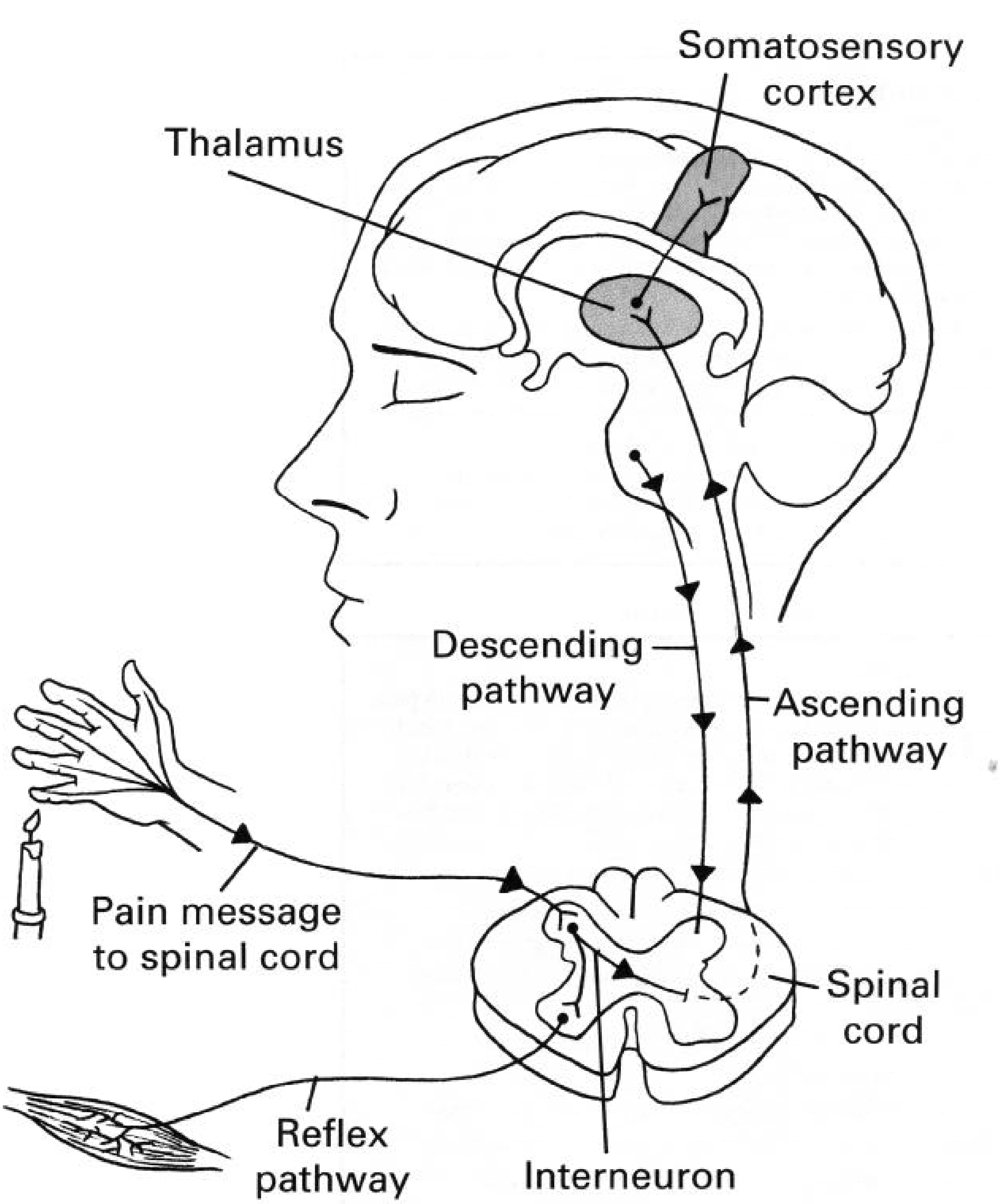

Figure 1. Transmission of pain messages to the brain.

What is life like for a person who cannot feel pain? The protective value of pain is demonstrated easily by examining individuals who are insensitive to pain. People with a rare condition called congenital insensitivity to pain lack the neural apparatus for detecting harmful stimuli. They repeatedly injure themselves because they do not avoid hot objects, intense pressure, extreme twisting, or corrosive substances, and thus end up with burns, pressure sores, missing digits, and damaged joints. Specific examples of some of these injuries are mentioned below include:

- A little boy who poked a pencil through his cheek.
- A baby girl who bit off the tip of one of her fingers and watched it bleed.
- A young woman who died of spine damage because she did not receive the normal discomfort signals from her joints telling her to change her posture—she never moved in her sleep, for example (Fields, 1987).

Pain is an unpleasant sensory experience associated with actual or potential damage to the body, or perception of such damage. It is also a very subjective experience. The perception of pain varies with the intensity of the stimulus and the affective or emotional state of the individual. Memories of events associated with extreme pain persist for a long time. This persistence should become evident to you during the first activity as you look at the ages when your worst pain occurred.

Mental state is known to have a powerful influence over pain. For example, an athlete may not notice a twisted ankle until after the competition is over. Similarly, soldiers in battle often continue to fight even after sustaining serious injury, and they may report afterwards that they experienced no pain until after battle. The scientific explanation for this phenomenon is that the brain not only receives pain messages, but also has a descending system of neurons that suppresses pain messages, as shown in Figure 1. This system inhibits cells in the spinal cord that transmit pain signals. The descending system is thus a natural pain modulation pathway. Naturally occurring opioids such as the endorphins are important neurotransmitters in some of these descending pathways (Carola, Harley & Noback, 1990, p. 432). Endorphins appear to be released by the brain in times of stress (e.g., attack from a predator) in order to minimize pain that may detract from an organism's ability to escape. Extreme exercise may also cause the release of endorphins, leading to the "natural high" experienced by serious runners (Carola, Harley & Noback, 1990, p. 432).

Physicians make use of these existing pain modulatory systems by treating severe pain with opioids derived from plants such as morphine or codeine (Society for Neuroscience, 1990, pp. 19–20). These drugs bind to the existing opioid receptors in the central nervous system (CNS) to relieve pain much as naturally occurring opioids do (See Figure 3). Physicians can also treat pain by blocking nerve conduction with anesthetics or by surgically cutting a nerve. Cutting a nerve is not recommended, however, because this causes a permanent loss of all sensations carried by the cut nerve, and, yet, surgery often does not alleviate persistent pain problems. In contrast, simply rubbing the injury, applying ice, or taking aspirin or other over-the-counter painkillers often reduces mild pains. These mechanisms work by reducing neural transmission either indirectly via inhibiting inflammation (e.g., aspirin, cold water) or via interfering with nociceptive

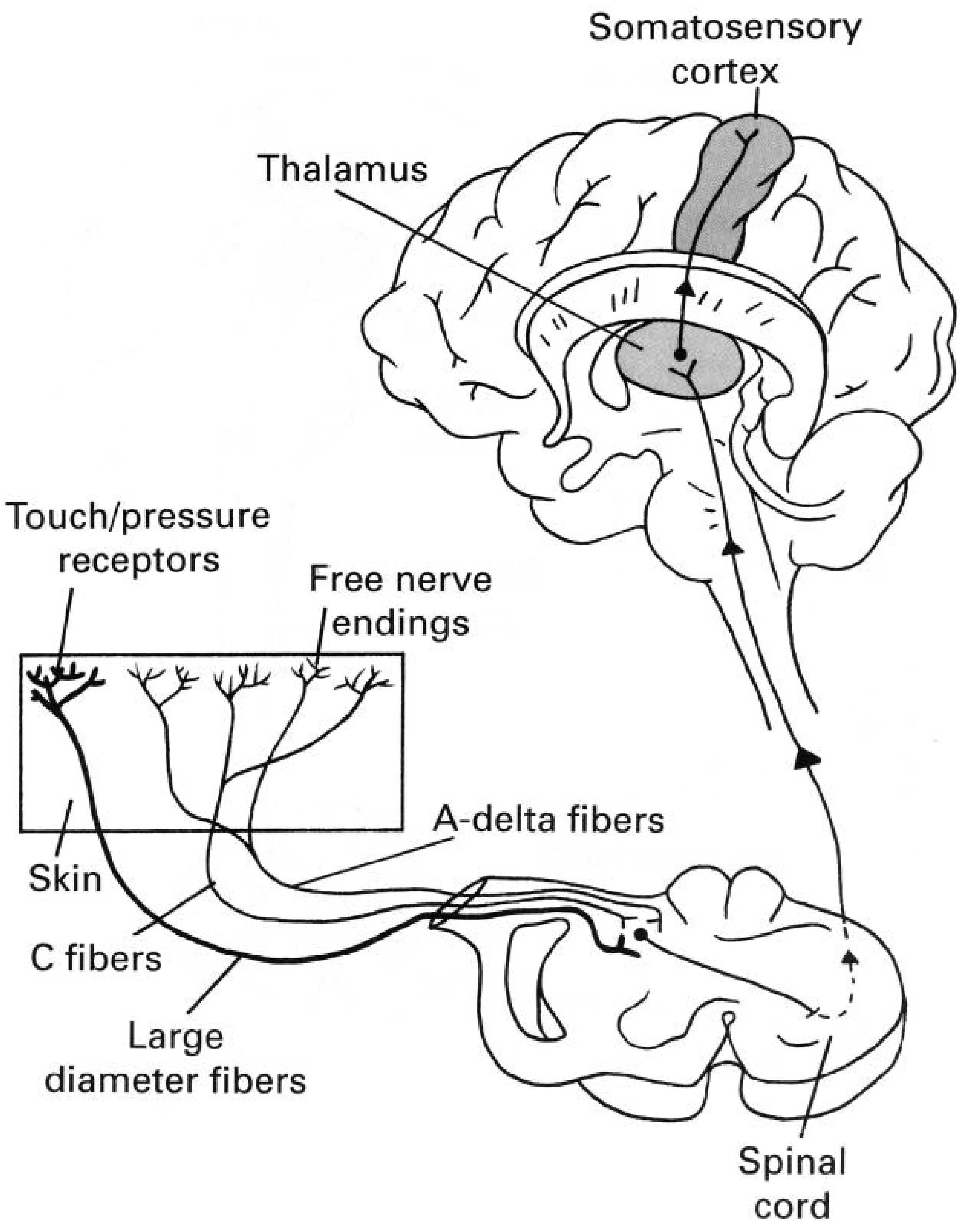

Figure 2. Different types of nerve fibers carrying pain sensations.

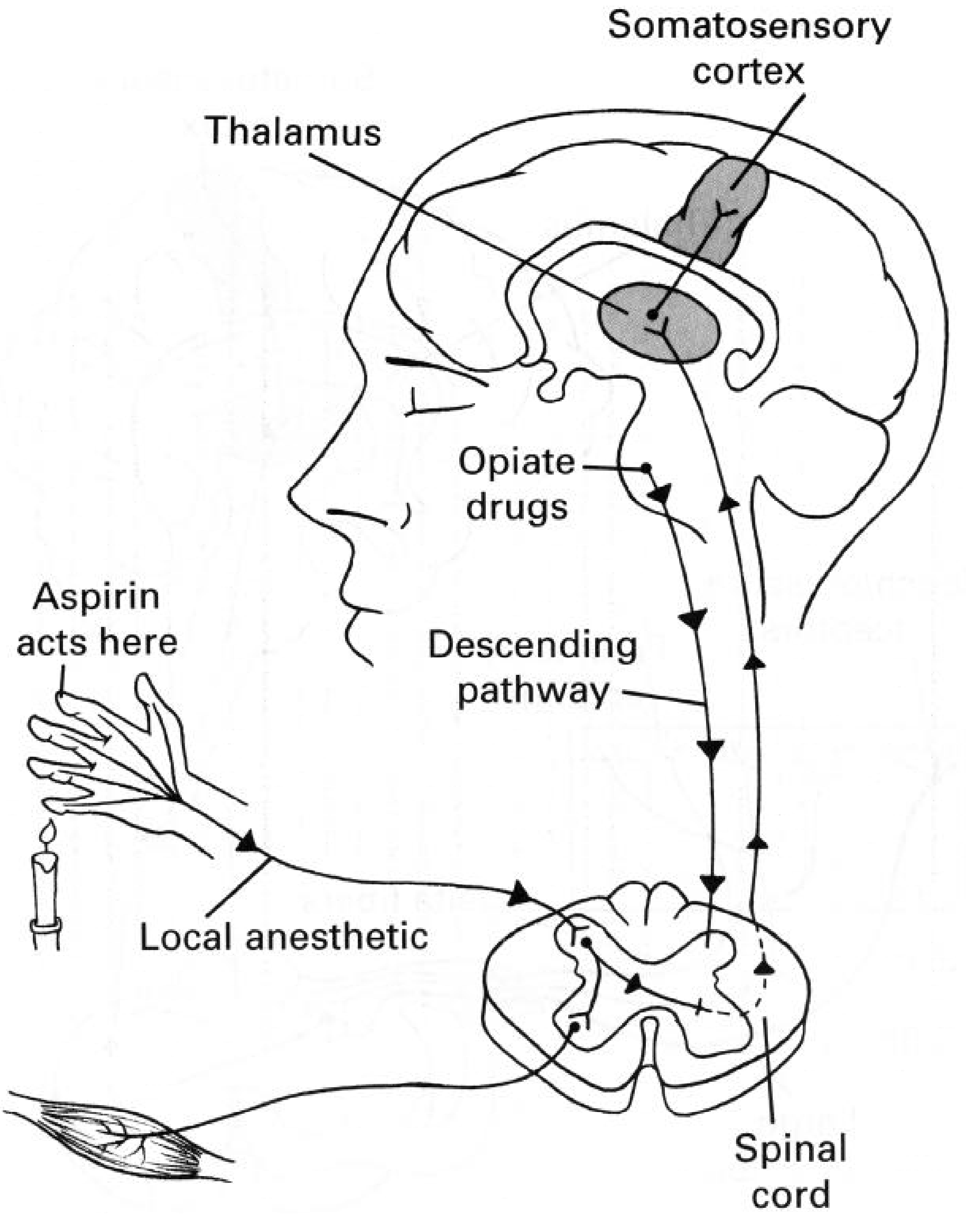

Figure 3. Sites of action of different painkillers.

messages in the spinal cord (e.g., rubbing the skin activates touch fibers that inhibit nociceptive neurons in the spinal cord).

Lab Activity I: Work in groups of four.

1. Discuss with your group the worst pain that you have ever experienced. Make a list of these pains. Record the following data:
   - n The age when the pain occurred.
   - n The cause of the pain.
   - n The location on the body where the pain occurred.
   - n The method used to relieve the pain. Pain relief could be what you did, such as take aspirin or rub the injury, or what a doctor did, such as administer opioids or other painkillers.

2. Make another list of any pains that you have experienced in the last day or two. Record the following data:
   - n The cause of the pain.
   - n The location on the body where the pain occurred.
   - n The method used to relieve the pain.

3. As a class, we will talk about your responses to #1 and #2.

Lab Activity II: Work individually but have a partner to discuss your reactions with.

Nancy will demonstrate the finger web pinching before you perform it. Instructions for pinching finger webs are given below.

1. Extend your hand out in front of you and find the webbing between your first and second fingers.
2. Place your thumbnail on one side of the web. Place the opposing finger on the other side.
3. Pinch quickly and forcefully. You **must** pinch firmly enough to reach the pain threshold. If you do not pinch hard enough, you will feel only pressure, not pain.
4. Immediately after you have pinched, describe what you feel. Record this in your notebook.
5. Pay attention to the sensation in the finger web for 15 seconds after the pinch. After 15 seconds, describe what you feel. Is the second feeling different from the first? How?

Lab Activity III: Work in pairs.

Projected Pain. In this third and final activity, you will be able to experience the pleasure of projected pain.

1. Obtain a shallow pan and fill it with ice and some water to make a slurry.
2. Roll up one of your sleeves (if necessary) and place your elbow in the pan of ice water.
3. Keep your elbow in the ice water and describe the progression of the sensation you experience to your lab partner. The lab partner should record these descriptions in a lab notebook.
4. At first, you will feel some discomfort in the region of the elbow. Later, pain sensations will be felt elsewhere. Try to think about why you feel pain/discomfort in the region that is not submerged in the ice water. Try to relate these feelings to those you get when you hit your funny bone. Record in your notebook whatever ideas you have about how about to explain these phenomena in terms of what you've read above and learned so far about the sensory nervous system.