Chapter 14

**TOUCH AND PAIN**

1. In previous chapters we have discovered how some senses respond to the spectral properties of the stimulus. In vision, the wavelength of light determines the perception of color. In audition, the frequency of sound determines the perception of pitch. Can you imagine an equivalent phenomenon for touch?

*Hints and discussion: The question is designed to help students introspect about the nature of touch experience. Guide them to thinking about vibration, and how we can perceive vibration by touch in at least two ways. One is to rest the hand on a vibrating object (here one may consider introducing the famous Tadoma method used by Anne Sullivan with Helen Keller) but the other, and more ubiquitous, is moving the hand over a textured surface. Coarse textures produce a lower frequency vibration on the skin than do fine textures. The spectral components of this vibration thus determine perception of surface texture.*

1. Discussion of haptics often involves the idea that we perceive the properties of objects by perceiving the movements of our hands during active touch. For example, to feel an object as being circular involves feeling our hands move in a circular path as we circumscribe the object’s contour. Makers of virtual reality equipment have pioneered some haptic feedback devices for interacting with virtual objects. These devices work as an exoskeleton that restricts your movement so that you cannot move “through” a virtual object. If you touch a virtual circular object, your hand would be constrained to only be allowed to move in a circular path. Due to technical constraints, the sense of touch on the skin has not been successfully simulated in virtual reality. Imagine this then: you experience a virtual world by haptic contact alone - you move your hand around a virtual object though you cannot feel it or see it. How accurately do you think you could judge its shape?

*Hints and discussion: This is a thought experiment designed to show that perception of shape by active touch is a fairly complex process (as the book emphasizes, perception is never simple).*

1. Dr. Jonathan Cole wrote an amazing book called Pride and a Daily Marathon about Patient IW, who suffered polysensory neuropathy below the neck. This means that despite having normal motor function (the patient’s motor nerves are intact and healthy), IW cannot feel anything below the neck. Often people in this terrible condition are wheelchair bound, despite their normal motor nerves. The book detailed IW’s intensive efforts to regain motor function, by noting that IW used vision to guide all action. To stand, IW needed to visually monitor his legs and posture. Any distraction or removal of vision (i.e., turning the lights out) would cause him to helplessly collapse. The title of the book captured the degree of effort required on a daily basis just to engage in regular activities. How does this highlight the importance of touch in movement? (hint: imagine putting on a turtleneck sweater if you had no bodily sense below the neck).

*Hints and discussion: This question highlights the compelling story of Patient IW and the significance of the often under-studied senses of touch and haptics.*

1. Think of situations that cause motion sickness: Riding in a boat on the ocean, especially when below deck, riding in a car for a long distance, especially if you try to read or watch a video (note that drivers do not normally report motion sickness), going to an IMAX movie or spending time in a simulator (flight simulators, driving simulators, or other moving virtual environments). These all have in common a discrepancy between your visual and vestibular systems. In simulators and IMAX movies, the visual input specifies motion while the vestibular system specifies you are sitting still. Being below deck in a boat, it is the vestibular system that signals movement while the visual system signals that you are stationary (because you move up and down with the boat, so you remain in a fixed position relative to the interior cabin). Why do you think the visual and vestibular systems are linked in this way and why should a discrepancy result in the classic symptoms of dizziness and nausea?

*Hints and discussion: This question is designed to help students introspect about vestibular function, though it is unlikely they will know the answer. There may not be a well-established answer, but the area postrema of the medulla is a toxin detection part of the brain and regulates vomiting, but doubles as an area that integrates vision and balance. Another explanation is that the vision-balance discrepancy creates abnormal tension in the ocular muscles, and this muscle tension can affect the activity of the vagus nerve, which regulates autonomic function, and can thus lead to nausea. One can note in this explanation that it is normal for vision and balance to be closely linked because of an important skill we often take for granted: the vestibular-ocular reflex; the ability to keep our eyes continuously fixed on an object while we move around, turn our heads, etc.*