Spring Brain Conference

Neuroscience Teaching Team

Proprioception - The 6th Sense

PROPRIOCEPTION – THE 6th SENSE - Students will be introduced to the 6th sense, proprioception, and will see how it helps us to interact with our environment through a demonstration.

I. What is proprioception?
   a. What are your 5 senses?
   b. What is your 6th sense?
   c. When you are in the dark, how do you know where your arms are?
   d. How your body senses where it is in space.
   e. Motor neurons in your spinal cord project to and control muscle fibers (picture)
   f. Muscle spindle is a sensor within muscles that detects length of muscles (pictures)
      i. Are located at each joint, wrapped around muscle fibers
      ii. Sensory neurons from muscle spindles project back to spinal cord, bring info about muscle length
      iii. Allows motor neurons to change muscle length accordingly
      iv. Muscle-spinal cord-muscle neuronal circuit is basis of reflex motion
      v. Same circuit allows us sense of kinesthesia/proprioception

II. Demonstration 1: What do muscle spindles do?
   a. Have students try to touch their noses with eyes closed (no problem)
      i. You can move your arms even without other sensory input
   b. We are going to use "stimulators" to artificially stimulate your muscle spindles
   c. Have student stand/sit with an arm straight out to the side
   d. With eyes closed, move finger towards nose, get as close as possible without touching, student gets very close
   e. Now use 'stimulator' to stimulate back of arm above elbow (tricep) and have student move arm towards nose again and stop before touching it
   f. Student's finger ends up way out in front of the face
   g. Muscle spindles sense how long your muscles are and tell your brain
      i. If your arm is bent, (triceps long), muscle spindles get excited and send a message to your brain that the muscle has lengthened.
      ii. If your arm is extended (triceps short), muscle spindles aren't excited and don't send any message (or a weaker message) to your brain, so brain knows muscle is shorter
      iii. Imagine muscles as rubber bands
   h. What do you think stimulator is doing to muscle spindles?
      i. It is exciting muscle spindles in triceps, telling brain that triceps is long and your arm is bent, so they tell your brain that your arm is more bent than it really is. So you "feel" that your arm is very bent and already at your nose, but really it is far away.

III. Demonstration 2: What is the result of stimulating the Achilles tendon?
   a. Parts of the Scientific Method
   b. Observation – First demonstration
   c. Hypothesis
      i. What will happen if we put the stimulators behind each leg of student while they're standing up?
      ii. Which way will they fall? (forward or backwards)
   d. Methods / Experiment
      i. Choose students to help
         1. Subject
         2. Assistant to apply 2nd stimulator
         3. 2 Spotters (front and back to catch the Subject)
      ii. Which senses do you use to keep yourself standing upright?
         1. Eliminate these so that we're only using proprioception
         2. Sight: keep eyes closed
         3. Touch: keep feet together
         4. Hearing/balance: tilt head back (explain that both senses are localized in the ear)
         5. Keep arms folded across chest
      iii. Put stimulators on Achilles tendons
   e. Results / Analysis
      i. Student falls backwards
      ii. Ask the student what it felt like and what they were thinking

f. Conclusion
    i. Why does the student fall backwards?
    ii. Stimulators excite muscle spindles in Achilles tendon, make brain think muscles longer (foot bent upwards towards leg) than they really are (student feels that they are leaning forwards), so student compensates by pushing down with the toes, or trying to *shorten* the Achilles tendon, then they fall backwards
    iii. Muscle spindles are important even for simple tasks like standing up

*** Extra background about neurons/brain may have to be given at the beginning of the Visual Motor Adaptation or Proprioception modules, depending on whether the students have already seen the Brain Anatomy demonstration.