**LESSON PLAN NAME: Rubber Hand Illusion**

**Topic:** Neuroplasticity, Sensory processing

**Developed by:**

**Grades:** 4th through high school (K-5 adaptable)

**Vocabulary words:** proprioception, neuroplasticity

**Materials:** Rubber hand, paint brush, sharpie,ruler, board(divider)

**Time needed: 15-30 minutes**

**Summary:** This lesson introduces how the brain interprets information obtained from our sensory system. Humans have more than 5 familiar senses (sight, touch, smell, hear, and taste) and the ability to integrate these multisensory information is a key to the sense of body ownership, known as proprioception. Proprioception, or the sense of where our body is in space, both during stillness and movement, is directly related to self-consciousness. The students will experience the perturbation of their proprioception through the activity and their sense of sight overriding their sense of touch. Our brains are not “static” per se,

**Prerequisites for Students:** Helpful if students know what the brain does and have a concept of cells.

**Learning Goals:**

* Learn what proprioception is.
* Oftentimes one sensory information can overwrite the other.
* Understand that our brains are plastic, able to rewire and influence our conscious experiences.

**Background for instructor:**

* Refresh basic knowledge what the brain does - specifically that it communicates with the rest of the body to find out all kinds of information (5 senses).
* Refresh basic knowledge of proprioception.
* Refresh basic knowledge of neuroplasticity.

**Set-up:** Divide a desk by a divider and ready the rubber hand and paintbrush. Or you can put a divider between two desks and put the rubber hand on one desk.

**Lesson Outline:**

1. Two persons are required. One person administers the test, the other is the volunteer.

2. Ask the volunteer to put out one of their arms on one desk. Slowly stroke the rubber hand with the paintbrush. Ask the volunteer to look at the rubber hand. Ask if she feels anything(e.g. stroking).

3. Next, instead of stroking, smack the rubber hand with a sharpie or a ruler. Ask the volunteer if she felt pain.

4. Ask what she could do to remove such illusion. The volunteer can either look away from the rubber arm and look at their own arm or move her body.

**Explanation:**

Proprioception, or the sense of where our body is in space is tightly linked to the body ownership. Proprioception is possible because our brains integrate multi-sensory information in a way that makes sense of the world around us. However, sometimes one type of sensory information can override another like in the case of rubber hand illusion. Here, visual information is overriding tactile information. Thus, to remove the illusion, you can look at your own arm or move your body a little bit so that your brain can process information “correctly.” When the rubber hand is smacked, the volunteer would feel pain even though the rubber hand does not belong to them. When you take sufficient amount of time gently stroking the rubber hand, your brain may think the hand is yours, so that a different sense(a.k.a pain) is read by your brain. These activities demonstrate that our brains rewire at least temporarily to create different interpretations of the world around you. The ability for neurons to rewire is called neuroplasticity and our experiences can change how neurons are connected or modulated.

**Additional activities for classroom setting:**

Have students talk about examples of neuroplasticity. You can prepare slides/videos of the phantom limb phenomenon.

**Wrap-up, final thoughts**: Other examples of neuroplasticity. Some people who have amputated their limbs feel they still have their arms or legs. This phenomenon is called “phantom limb.”

Or in the second part of the experiment, you could feel the pain even though your arm was unharmed. Empathy allows us to feel physical symptoms just by observing a friend in pain.

As said above, these examples demonstrate neuroplasticity because our brain recruits unrelated circuitry for interpreting different types of sensory information. Neuroplasticity tells us that the rewiring happens even in adulthood. It’s not in just during the critical period. Other instantiations of neuroplasticity include improved bodily functions after stroke through physical therapy and synesthesia.

**NOTES:**