**INSTRUCTOR GUIDE TEMPLATE**

**ACTIVITY TITLE: Rubber Hand Illusion**

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| \***Theme**: | Neuroplasticity in somatosensation |
| \***Objective**(s):*(What key learning do you want students to come away with?)*  | How our senses connected and how the brain interprets multi-sensory information through temporary re-wiring (neuroplasticity)  |

 **LESSON OUTLINE:**

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| **1. Introduction:***Plan a script of what you will say to start.**- What will this be about? Why’s it interesting?* *(Hook)* | Q: Close your eyes. Can you tell where your arm is? You can usually tell where your arms or legs are, and you can tell that my arm does not belong to you! In a few minutes, you will experience a perturbation to the sense of body ownership.  |

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| **2. Building Background:***List questions you can use to immediately engage your audience and prepare their thinking for your activity.**-What prior knowledge might they have about/related to your topic?* *-What prior knowledge (background) do they need for your activity?* | Q: How many senses do we have? A: Five (Sense of smell, taste, touch, seeing, and hearing) Q: Other than the five you just mentioned, there is a sixth sense. Do you know what this is?A: a sense of knowing where your body is. (both when you are still and when you are moving)Our brain combines all these multisensory information to represent the world that we live in. So it is very important that our brain does its best to distinguish between the senses and between ourselves and the external world. But sometimes you can be fooled by your senses.  |

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| **3. Lesson & Activity:***Outline the key components of your lesson.***Plan/Note**:- key ideas/ vocabulary- scaffolds - images/media- extension questions\*Consider how to best deliver your content! \*Plan interactive components that encourage active thinking in your students. | Let the participant place one of her arms on the side of the rubber hand and the other of her arms on the other side, divided by a board. First, do a control experiment in which you tap the rubber hand with a pen/ruler. Ask the participant how she feels. Then, switch to a paintbrush and stroke the rubber hand slowly for about 1-2 minutes. Ask the participant what she feels and whether she can feel brushstroke. “I am not touching your real arm, but you still feel the brush on your arm!”The longer you stroke the fake arm with the brush, the more the participant should feel like the rubber arm belongs to her. Now, with a pen/ruler, smack the rubber arm and see how the participant responds. “Do you feel pain?”Q: What two senses does your brain combine to make you think the rubber hand is yours?A: seeing, touching. In this experiment, the visual information is overwriting the tactile information, tricking your brain to believe that the rubber hand belongs to you. Q: So you think the rubber arm belongs to you! Which one of the senses that we have is being altered?A: proprioception. (remember the sixth sense I talked about before?)Studies have shown that during the period of illusion, premotor cortex, which is known to process multisensory information, is activated. This suggests the basis of proprioception, or self-attribution, is the ability to integrate information from multisensory stimuli. Q: What could you do to make your brain realize that the rubber hand was NOT yours? A: move or look at your own handQ: Even though I was smacking the rubber arm, not yours, you still felt pain. You would not have felt if I started out with smacking and then brush stroking. What does this tell you about our perception of pain?A: As our brain perceives the rubber arm as it belongs to us, it integrates a different circuitry for noxious pain. Q: It seems like we can manipulate how our senses are integrated in our brain through our experience. What is the word for when your experience changes how your brain and your senses work? A: neuroplasticity. Our brains are not “hard-coded” per se. Only for just a few minutes, your brain was re-wired to accommodate for the new and confusing stimulus, rubber hand.  |

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| **4. Wrap Up:***- Review key ideas**- Share takeaways and final thoughts**- Discuss connections to other questions and ideas. Extensions.**- Ask: Who could you teach what you learned here today?**- Ask/Suggest: What can I do to learn more?* | Q: Can you think of other cases in which this sense of body ownership is disturbed?A: 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.  |

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| **MATERIALS NEEDED: *\*\*(please list all items and quantities necessary for preparation)*** |
| Rubber hand, paint brush, sharpie,ruler, board(divider)  |

\*\*attach any printouts to end of document here

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| **Other Notes**  |
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**Extra Resources:**

See youtube video of the general protocol of this demonstration: <https://www.youtube.com/watch?v=sxwn1w7MJvk>

The difference from this video will be 1) we will begin with a control before using the paintbrushes, where we will tap and hit the rubber hand with a pen and/or ruler, then ask the participant if they felt any sensation besides minor shock.

And 2) we will be using a simple sharpie pen or ruler to smack the rubber hand at the end of the procedure, rather than a hammer, which can be unnecessarily scary.

<http://science.sciencemag.org/content/305/5685/875.full>