INSTRUCTOR GUIDE

ACTIVITY TITLE: MAGIC MIRROR

Theme:	Neuroplasticity and the senses
Objectives: *(What key learning do you want students to come away with?)*	Explore how our senses are connected and how the brain interprets multi-sensory information through temporary re-wiring (neuroplasticity)

LESSON OUTLINE:

1. Introduction: *Plan a script of what you will say to start.* *- What will this be about? Why's it interesting? (Hook)*	**Close your eyes. Can you tell where your arm is?** ● Your muscles and tendons should help identify where your arms or legs are, even without your sight. You can easily tell that my arm does not belong to you! ● In a few minutes, you will experience a perturbation to this sense of body ownership.

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: Before we begin, do you know how many senses humans have?** ● 5: 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?** ● It's **proprioception**, or a sense of knowing where your body is, both when you are still and when you are moving. ● Our brain takes in information from all of these senses to represent the world that we live in. These sensory inputs help distinguish our body from the external world. ● But sometimes you can be fooled by your senses!

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.	**First, let's do a control experiment.** ● *Ask the participant to put each of their arms on either side of the divider. The left hand should be on the side without the mirror. Make sure they can see their right hand in the mirror and instruct them to keep looking at the reflection.* ● *Ask the participant to look at their right hand in the mirror and to try some small finger movements with just their right hand (i.e. raise and lower each finger). Ask what they feel (this should be a bit confusing; if not make sure that they are positioned correctly with no view of their left hand).* ● *Gently brush both of their hands simultaneously with a folded pipe cleaner. Ask the participant what they feel (should feel light brushing on both hands). Then, stop and ask what they feel (should feel nothing).* **Now, I will brush for a longer period of time.** ● *Brush both hands gently and regularly for 1-2 minutes. Ask the participant what they feel (should feel brushing on both hands).* ● *Now, keep brushing but occasionally don't stroke the left hand (the one that is not reflected in the mirror) every few trials.* ● *Ask the participant if they still feel the brushing on both hands (should be yes). Reveal that you were no longer brushing the left one!* ● *After the reveal, you can also do the opposite. Keep brushing both but occasionally don't brush the right hand (the one that is reflected in the mirror) every few trials. If they are looking in the mirror, this will also create sensory confusion because they will feel the pipe cleaner on their left hand but it will look in the mirror like they are not being touched.* **What two senses does your brain combine to make you think the rubber hand is yours?** ● Sight and touch. ● In this experiment, the visual information is overwriting the tactile information, tricking your brain into believing that your left hand is still being brushed when you were really just seeing the reflection of your right hand! **Which one of your senses is being altered by this experiment?** ● Proprioception (remember the sixth sense we talked about before?) ● Studies have shown that during the period of illusion, an area of the brain called the **premotor cortex**, which is known to process multisensory information, is activated. This suggests the basis of proprioception is the ability to integrate information from multisensory stimuli. **What could you do to make your brain realize that the reflection was NOT showing your left hand?** ● Move or look at your own hands! **What does our brain do when our senses disagree?.**

	● Sometimes our senses tell different stories. Have you ever thought you heard someone call your name but when you look around you can't tell who it was? Our brains are constantly trying to make sense of the world but that can be tough when there is conflicting information. Human brains tend to put more trust in visual input and this is especially the case when the conflicting information is uncertain/unclear (e.g. would this work if someone was squeezing your hand instead?). .

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?*	The world is complicated and noisy! Our brains work hard to try to understand what's going on around us by using information from all of our senses. When our senses disagree, our brain can usually decide which is right. But sometimes (i.e. illusions) we can trick in into making a mistake! **Can you think of other cases in which this sense of body ownership is disturbed?** Two examples: ● Some people who have amputated their limbs feel they still have their arms or legs. This phenomenon is called "phantom limb." ● Empathy allows us to feel physical symptoms just by observing a friend in pain.

MATERIALS NEEDED: ***(please list all items and quantities necessary for preparation)***
Cardboard box with mirror taped to 1 side (divider), pipe cleaner

Resources:
● https://www.youtube.com/watch?v=sxwn1w7MJvk ● http://science.sciencemag.org/content/305/5685/875.full