Lesson Summary: The ability to identify with and understand another person's situation, feelings, or motives is called empathy. Recent developments in neuroscience have focused on a system within the brain called "mirror neurons" as a likely explanation for emotional empathy. In this lesson students explore emotions and the behavioral aspects of empathy through mirroring the emotions of other students while watching emotionally evocative videos.

Grade Level 9-12

Lesson Length
1 class period

Standards Alignment: Minnesota Science Standards

- Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review: Benchmark codes: 9.1.1.1.2
- Scientific inquiry uses multiple interrelated processes to investigate and explain the natural world: Benchmark codes: 9.1.1.2.1, 9.1.1.2.2 & 9.1.1.2.3
- Organisms use the interaction of cellular processes as well as tissues and organ systems to maintain homeostasis: Benchmark codes: 9.4.1.1.1 & 9.4.1.1.2

Objectives—Students will be able to

- Describe importance of emotions and mirror neurons on social survival and homeostasis.
- Carry out an inquiry-based experiment on the evoked emotional responses and the perception of those responses.
- Build observational skills for recognizing accurate emotional states in social situations.

Assessment Options

- Explain how the neural information regarding emotion flows to and from the brain.
- Explain how the emotions influence muscle movement of the face.
- Explain why accurate reading of another person's emotions builds social cohesion and promotes evolutionary fitness.
- Explain the scientific understanding of brain function behind the TV show "Lie to Me." How is Dr. Cal Lightman (main character) able to crack each case? How might you use some of these techniques in your life?

Teacher Notes

Some things to consider before doing this lesson:

1. Are these videos appropriate for your class? A few of these videos could be considered shocking and should probably be viewed beforehand to ensure they are appropriate for your class.
2. Does the room have technology appropriate for multiple small groups to view videos, either computers or hand-held devices?
3. Alternatively, the class can view the same video simultaneously projected to the front of the room.

Materials

- Engagement video on mirror neurons. The videos are in two formats: one in **.mov** format for Mac and **.wmv** format for Windows.
- Seven evoking videos:
  Video 1: happy ukulele boy - www.youtube.com/watch?v=ErMWX--UJZ4
  Video 2: happy baby laughing - www.youtube.com/watch?v=5P6UU6m3cqk
  Video 3: surprising basketball blooper - www.youtube.com/watch?v=kHz8-1UFaKQ
  Video 4: scary commercial - www.youtube.com/watch?v=Gkmj5aiLM5g
  Video 5: disgusting beetle eating - www.youtube.com/watch?v=Uj9CysSSsps&NR=1
  Video 6: sad commercial - www.youtube.com/watch?v=dpf2hsZGsJM&feature=related
  Video 7: scary commercial - www.youtube.com/watch?v=Y4Zn9LR5D1M
- One student-accessible computer or mobile device (mP3, iTouch, etc) per 3-5 member student group with the appropriate media files on them Loaded videos should be “mirror neurons engagement video ” and video1, video2,...video7.
- Alternatively, a media projector and accessible computer loaded with these videos for viewing videos simultaneously as a whole class. Loaded videos should be "mirror neurons engagement video" and then video1, video2, …video7
- Ear-phone attachments, so viewer hears video fee but other others in group cannot

Engage

To begin the activity, show students pictures (at the end of this document) of faces displaying the basic emotions. Ask students to identify the emotion and explain what clues led them to that conclusion. Reiterate student thoughts to begin to build a vocabulary for talking about emotions.

Discuss with students how they are able to recognize emotional responses and why these are important. Have students list all of the emotional states they can.

Narrow down the list to 4-8 “primary” emotions that correspond to a facial expression like the ones used by the scientist in the engagement video. Describe the facial expressions associated with each emotion. Be as detailed as possible with the descriptions, e.g. corners of mouth go up, inside of eyebrows go down, etc.

Explore

1. Assemble the class into groups of three.
2. One student from each group will sit down so they can fully see the video. These students are the *viewers*. The other students will split into two groups: *primary observers* and *secondary observers*.
3. Primary observers watch the viewer from their group in such a way that they can fully see the viewers face but not see the projection screen. These observers will document the changes in the viewer’s facial expression and label what they see with one of the listed emotions from step 2.
4. Secondary observers watch the primary observers in such a way that they can fully see the primary observers’ faces but not the computer screen or the primary viewer’s face. These observers will document the changes in the primary observer’s facial expression and label what they see with one of the listed emotions from step 2. If there are any groups of two this secondary observer will be omitted.

Explore Results

After all the data is collected, have the small groups discuss their individual results. Then bring the class back together to discuss results as a group.

Discuss what the data shows.

1. Are there any patterns in the data on the emotions being expressed? Why would these occur? Why did emotions expressed by the primary observer mimic those expressed by the viewer even though the primary observer did not look at the screen? Why would such a behavior be beneficial?
2. Are there similarities in the emotions expressed in response to any one video? Can some of the listed emotions be combined in a single category?

Extension

1. Try this experiment with the primary viewers holding a pencil in their teeth. What happens to their ability to express emotions? Why do you think this happens?
2. Brainstorm with your group and briefly describe an experiment that could test this phenomenon more accurately. Make a list of things you need to consider before testing. Try to be as complete as possible. Hint: How could you use a camera or a fun house mirror? How does your experiment test brain function?

Explain

Show the short film clip entitled “mirror neurons engagement video.” The video could be shown to the group by using a media projector or, if conducting the lesson in a media lab, you could have students watch the video at individual workstations. How does this information change your interpretations of your data?

Background Materials

Question 1. What are mirror neurons?

Mirror neurons form a circuit of neurons in the fronto-parietal cortex that become active both when one observes behaviors in others and when one performs that behavior oneself. In human brains, mirror neurons are thought to help explain many behaviors including learning language, imitating movement, and experiencing empathy. The ability to respond to others’ intentions and emotional states may also be a function of the mirror neuron system.

The current understanding of mirror neurons is that when an individual perceives an emotion of another person, a small number of mirror neurons begin to fire that would be activated if that individual themselves was experiencing the emotion. Thus one can perceive the experiences of others by watching them.

A great resource for understanding mirror neurons and how they relate to this experiment can be found in a PBS **Science Now** program. The video is designed for classroom viewing; the web site contains a quick explanatory essay www.teachersdomain.org/resource/hew06.sci.life.reg.mirrorneurons

Question 2. How does your brain recognize and interpret emotions?

All sensory information from one’s sensory and internal organs enters the brain at different locations but is transmitted and processed for emotional content by two interlinked systems: the limbic system and the prefrontal cortex.

The key structure in the limbic system, the amygdala, receives information from the body and the senses first and then quickly processes it for emotional content. The outputs of the amygdala can trigger quick motor reactions in facial muscles to form the facial expressions we interpret as emotional responses. It can also trigger full body motor responses such as flight, fight, tend, or defend. The outputs of the amygdala control the automatic bodily responses that are involved in emotions by affecting the homeostatic control center of the hypothalamus, which in turn controls the hormonal secretions and the sympathetic nerves of the body. The quick activation of the sympathetic nerves that innervate the internal organs gives a person the raw feelings like catching his/her breath when being surprised or his/her heart racing when fearful. All this happens without taking the additional time to engage the rational decision-making parts of the cortex first.

Information is also processed and interpreted in a longer route that ends in the prefrontal cortex. The prefrontal cortex is involved in the final phase of emotional processing so that after the initial automatic, emotional reaction, humans engage the rational observation and decision-making area of cortex to choose the course of action that can best react to the full context of the emotional information. This does require additional synapses and hence time to be able to cognitively recognize an emotion. Hence, making the "I feel sad" statement only comes after the introspective process of examining one's thoughts and feelings of a lowered stomach in a given sad situation.

Question 3. How do emotions control facial expressions?

The muscles of facial expression are controlled by a pair of nerves that originate in the brain stem. The neurons that control the facial muscles receive input from both the motor area of the cortex and the areas of the brain involved in emotional processing.

The emotional input from the limbic areas and autonomic nervous system are the cause of fast and involuntary facial movements in response to emotional stimuli. The cortical input produces the voluntary facial movements representing the desired face we show to the world. Cortical input can also suppress the involuntary expressions.

For an in-depth review of this system, please see emedicine.medscape.com/article/835286-overview

Question 4. How does what we learn in this experiment apply to real life? What is the relationship between social interactions and homeostasis?

Facial expressions are an important channel of nonverbal communication. Many animal species display facial expressions but they are particularly evident in primates and especially in humans. Facial expressions convey subtle ideas in person-to-person communication related to the emotional states of the people involved. In social groupings, accurate interpretation of the message being communicated prevents unnecessary conflict, establishes social hierarchies, and facilitates bonding within the group.

The recognition and appropriate response to the non-verbal expressions of emotions of others aid in survival within the society. Emotionally directed communication and cooperation provide the feedback signals for homeostatic control of social organization. Homeostasis ensures the continuation of the life of the organism and perpetuation of the social group.

Correct recognition and response to non-verbal cues rely on mirror neurons. These mirror neurons may be important for understanding the actions of other people, and for learning new skills by imitation. Some researchers also speculate that disruptions in these mirror systems may underlie some cognitive disorders, particularly autism.

Examples of facial expression kindly provided by
Paul Ekman, Ph.D./ Paul Ekman Group, LLC.

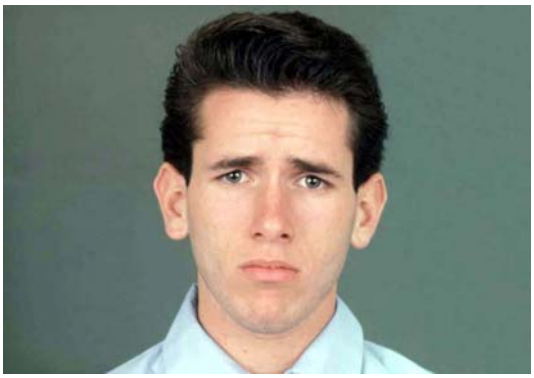
Disgust

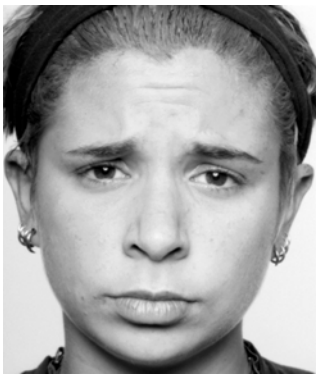
Fear

Surprise



Happy



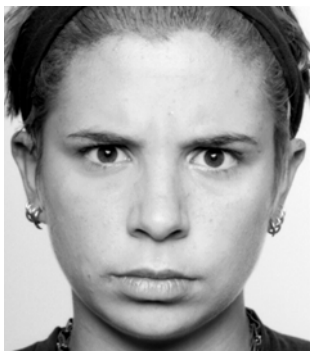


Sad



Neutral





Angry