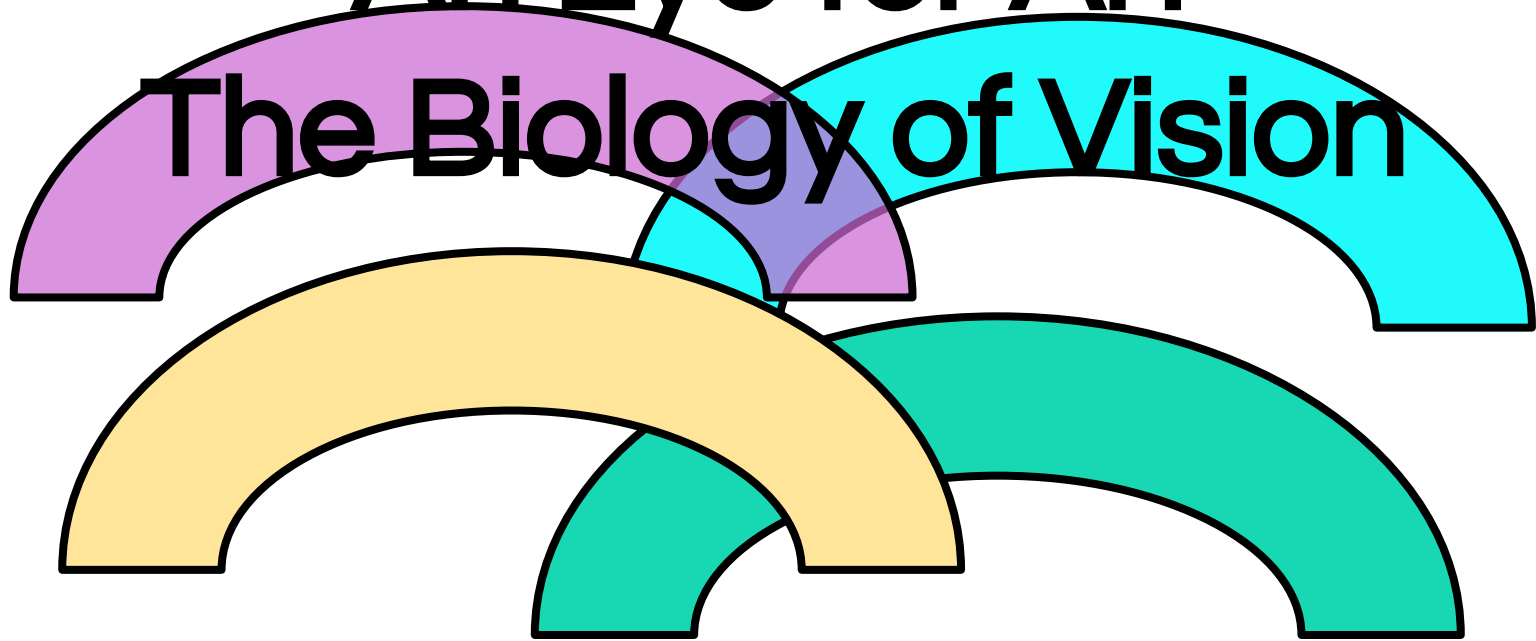




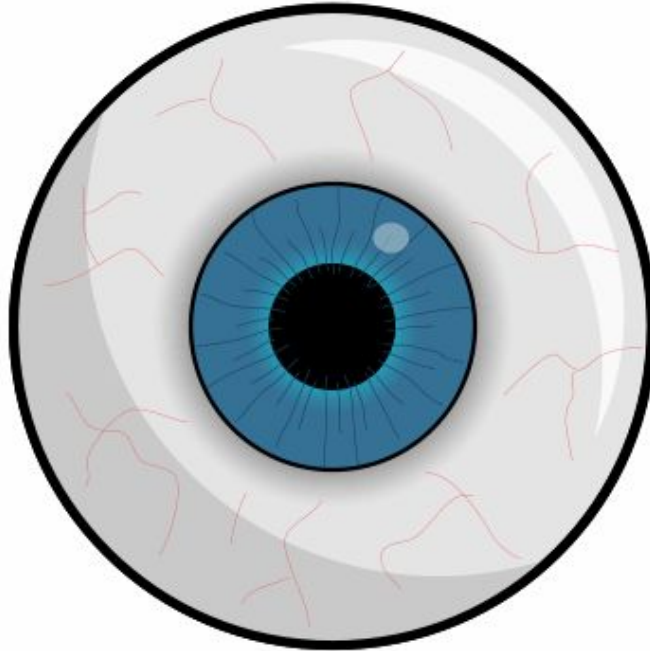
# An Eye for Art

## The Biology of Vision



By Janey Cohen, Science Education Consultant for  
the Santa Barbara Museum of Art

Have you ever wondered why *Mona Lisa* seems to wryly smile when your eyes stray from her face, or how Monet was able to so skillfully make the water in his paintings shimmer? Why do Peter Halley's paintings seem to pulsate as you enter the exhibit hall? to play on us.

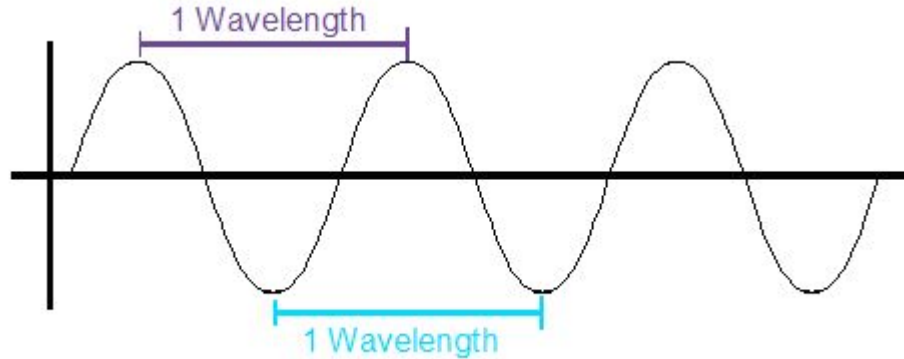


Neurobiologists have asked these same questions, and current studies about vision and the brain have led to some explanations for the "tricks" our eyes seem

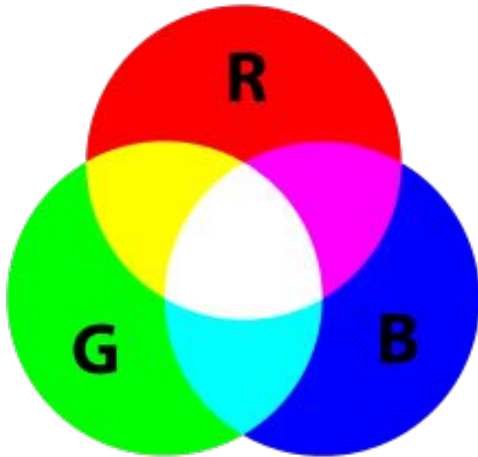
To understand the science of vision, there are four important terms to keep in mind:

**Light** is electromagnetic radiation and is a part of the electromagnetic spectrum, which ranges from radio waves to gamma waves. Electromagnetic radiation, including light, is emitted when charged particles, like electrons, move. All electromagnetic radiation travels through a vacuum at the same speed: 186,000 miles per second.

**Visible light** is a very small part of the electromagnetic spectrum, yet is special to us because we have receptors in our eyes that are responsive to just its wavelengths (between 370 and 730 nanometers).



**Color** is the result of the way an object reflects light. Within the range of visible light, different wavelengths appear to us as different colors. As light falls on an object, the surface absorbs specific wavelengths and the light that isn't absorbed is reflected, and those reflected wavelengths of light are what we perceive as color.

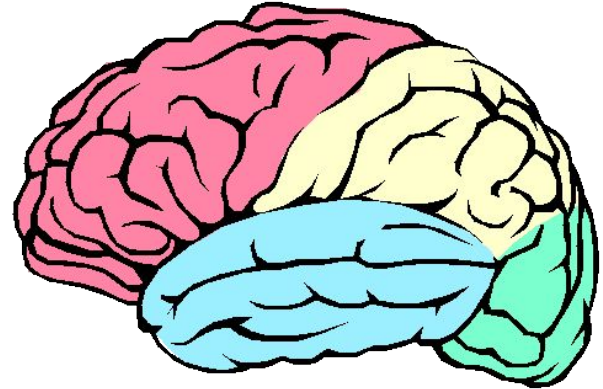


**Luminance** is the intensity of light, or the value of light being reflected. Though it is sometimes hard to tell the value when there is color, removing the color and looking at a scene in grayscale allows you to see the different values.

## The Where and The What

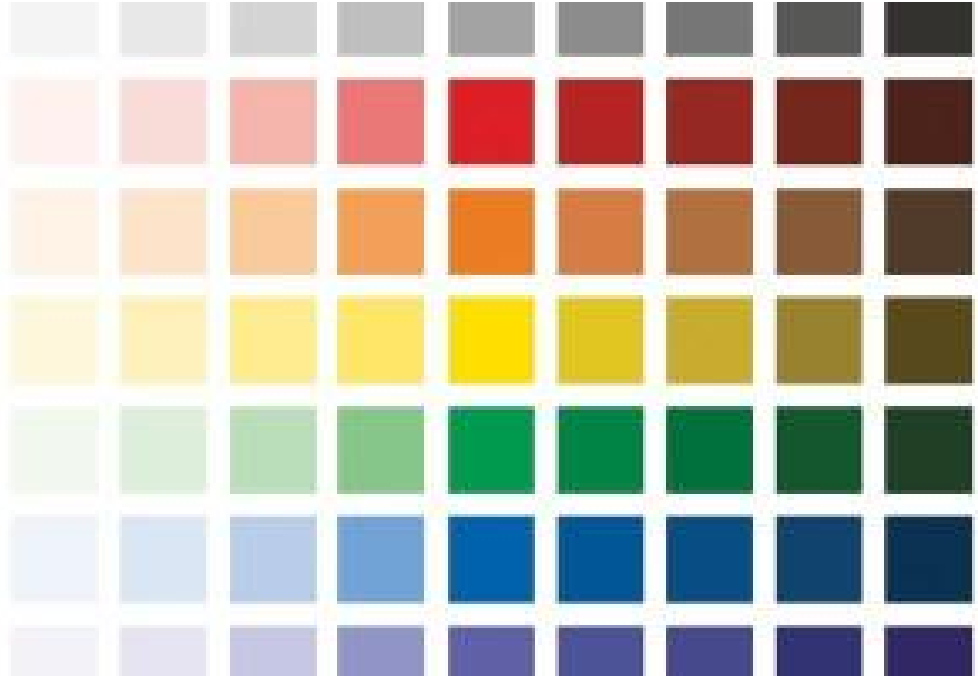
Neurobiologists have learned that there are two areas of our brain that process visual information. This is important when we think about how we see art. For a complete and thorough explanation of this (with great pictures and diagrams), see Margaret Livingstone's book, [Vision and Art, The Biology of Seeing](#).

In very simple terms, there is an area in all primates' brains that perceives motion, depth, luminance, and spatial organization (the "Where" part) and another part that is responsible for our ability to recognize objects and faces, color and complex detail (the "What" part). Within these two vision areas of the brain there are different kinds of cells that process light signals.

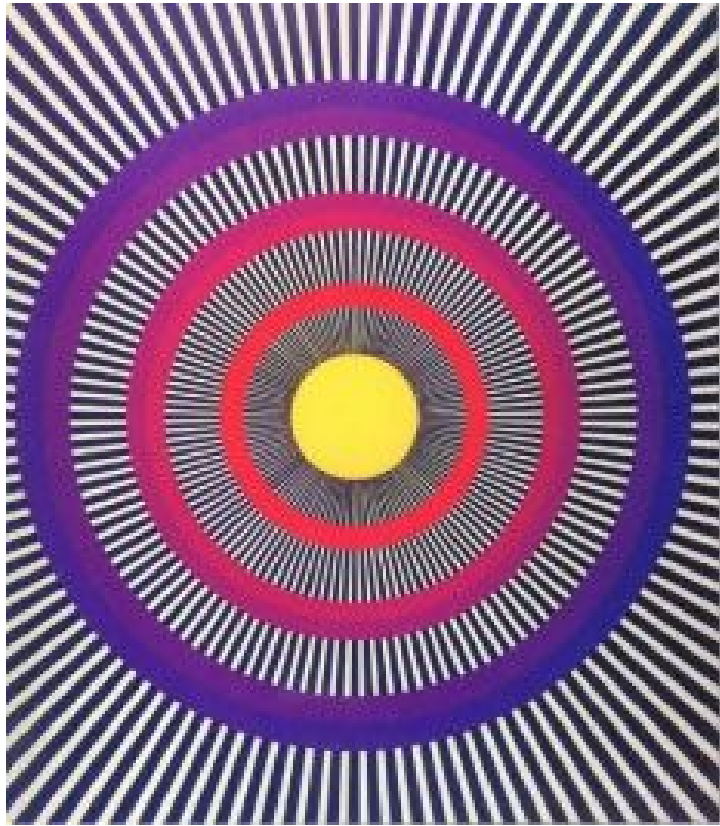


## Jittery Images

So what makes a still image appear to move? According to Dr. Livingstone, it has to do with **luminance** or the **value** of the colors. When colors are of similar values, the viewer perceives slight vibrations. This is because the “Where” part of the brain cannot establish position when the contrast in luminance is low. The “What” system sees the objects in the picture, but they appear to be jittery.



[color value chart](#)



Enigma, Isia Leviant

One famous example that shows this is the painting, *Enigma* (left) After looking at this image for several seconds, you should notice that the colored circles start to swirl. This is caused by the juxtaposition of areas of high contrast with areas that are of equal value.

While not quite as energetic as Leviant's painting, you can also see shimmering movement in the water of Monet's painting, *Waterloo Bridge*, below. In this and other paintings, Monet used colors of the same luminance to achieve this effect.

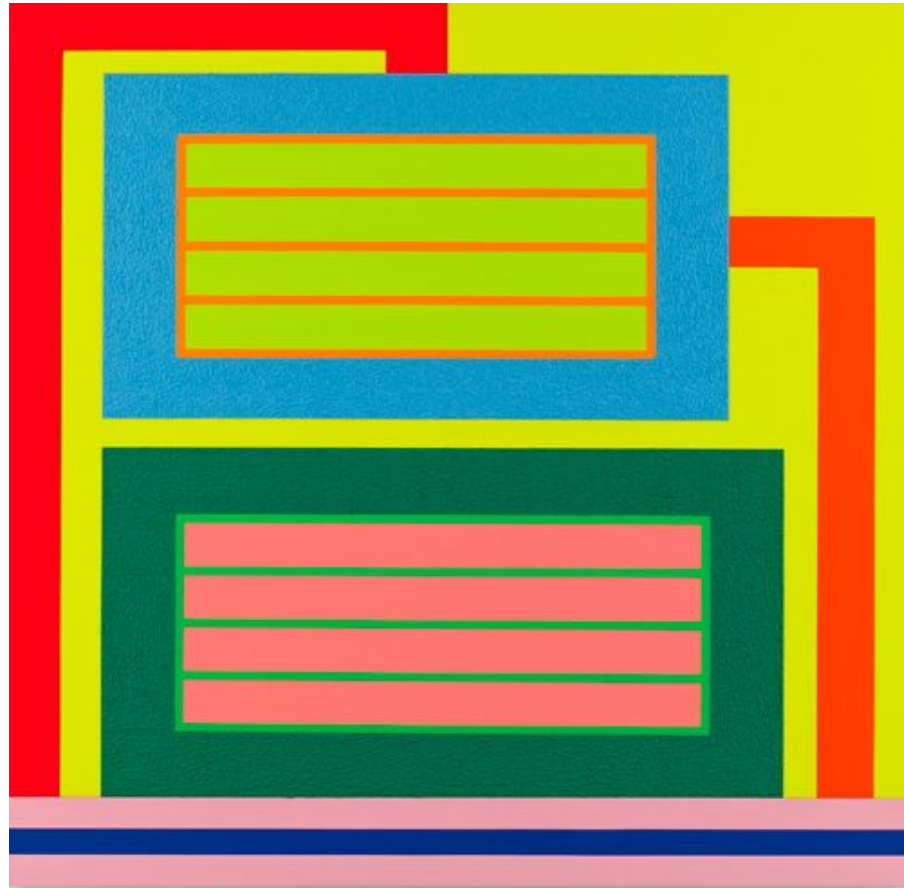


Claude Monet, *Waterloo Bridge*, 1900. Oil on canvas.  
Bequest of Katharine Dexter McCormick in memory of her husband,  
Stanley R. McCormick.



## **“Equaluminance”**

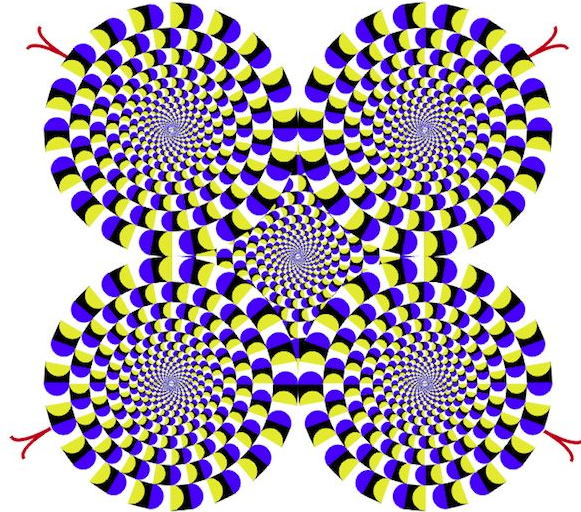
(having the same light value) also explains why we perceive the colors vibrating or pulsating when we look at Peter Halley’s works using Day-Glo paints.



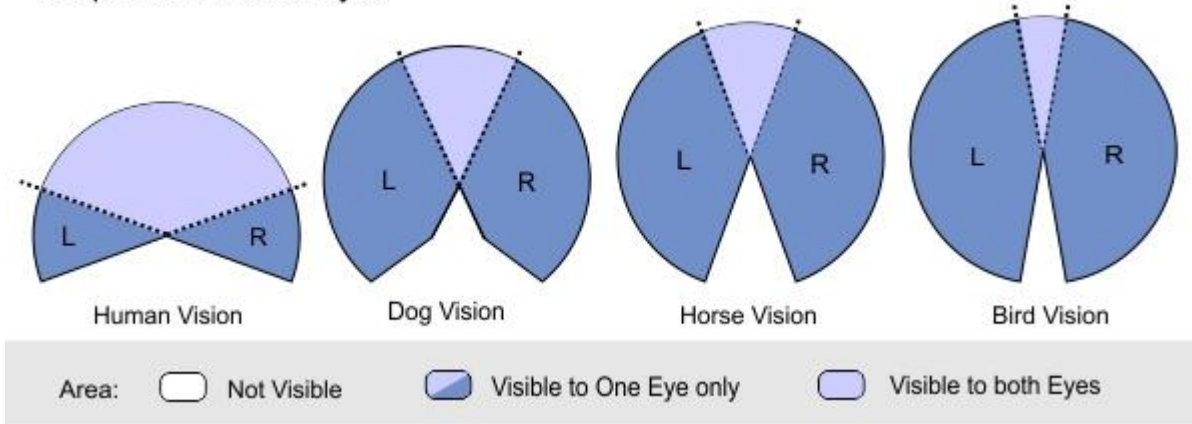
*Accretive Cognition, Peter Halley*

## Central and Peripheral Vision

As you are reading these words, does the *Snake Illusion* below seem to be moving? Does it stop when you look directly at it? This is because when you focus directly on an image, you are using central vision, and when you look away, you are using peripheral vision. Small movement of your eyes (called saccades) cause the image to look like it is moving or swirling when seen through your peripheral vision.



## Peripheral vision of Eyes



The center of your gaze sees fine detail, and your peripheral vision captures low-resolution images better. Central and peripheral vision are processed in the two separate parts of the brain that we have already discussed.

You may have noticed that when you look at stars in the night sky, they appear brighter and more in focus when you do not look directly at them.



*Mona Lisa*, Leonardo DaVinci

Another example requires you to spend some time looking at Leonardo DaVinci's *Mona Lisa*. Look directly from her mouth and then up to her eyes several times. Does she seem to slightly smile as you look away from her mouth? Neurobiologists interested in this phenomenon looked closely and concluded that there are low-resolution values painted onto her smile that only your peripheral vision picks up.

Was this done purposefully or a mysterious accident? No one will know, but it does add another layer of intrigue to the much-studied *Mona Lisa*.



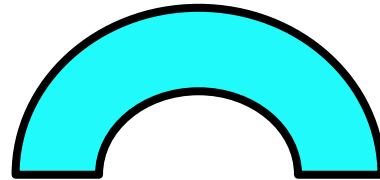
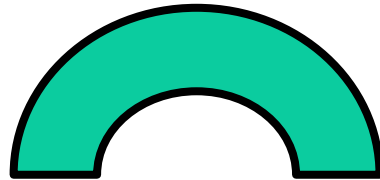
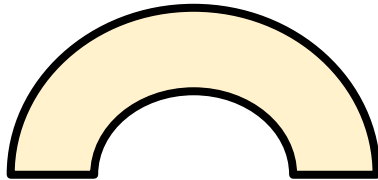
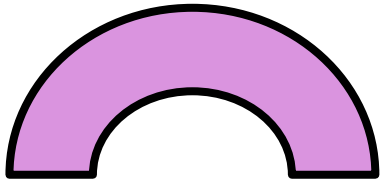
The biology of vision gives us all an eye for art. Research by neurobiologists continues. These studies have a perfect application to the appreciation of art. The research done by Dr. Margaret Livingstone can explain how the Impressionists were able to create shimmering water effects, and why *Mona Lisa's* smile intrigues us.

Sources:

"What Is Light?" - *An Overview of the Properties of Light*. N.p., n.d. Web. 09 Jan. 2016.

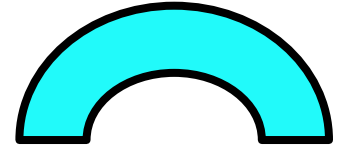
"How Your Eyes Trick Your Mind." *BBC Future*. N.p., n.d. Web. 09 Jan. 2016.

Livingstone, Margaret, and David H. Hubel. *Vision and Art: The Biology of Seeing*. New York: Harry N. Abrams, 2008. Print.



# Connections to Standards

## From the National Visual Arts Standards



### **Creating / Conceiving and developing new artistic ideas and work.**

Anchor Standard #1. Generate and conceptualize artistic ideas and work. Anchor Standard #2. Organize and develop artistic ideas and work. Anchor Standard #3. Refine and complete artistic work.

VA:Cr2.1. Explore and invent art-making techniques and approaches.

VA:Cr2.1. Experiment and develop skills in multiple art-making techniques and approaches through practice. VA:Cr2.3. Identify, describe, and visually document places and/or objects of personal significance.

### **Responding / Understanding and evaluating how the arts convey meaning.**

Anchor Standard #7. Perceive and analyze artistic work.

Anchor Standard #8. Interpret intent and meaning in artistic work. Anchor Standard #9. Apply criteria to evaluate artistic work.

VA:Re8.1. Interpret art by referring to contextual information and analyzing relevant subject matter, characteristics of form, and use of media.

VA:Re9.1. Apply one set of criteria to evaluate more than one work of art.

VA:Re8.1. Interpret art by analyzing characteristics of form and structure, contextual information, subject matter, visual elements, and use of media to identify ideas and mood conveyed.

VA:Re9.1. Recognize differences in criteria used to evaluate works of art depending on styles, genres, and media as well as historical and cultural contexts.

VA:Re8.1. Interpret art by distinguishing between relevant and non-relevant contextual information and analyzing subject matter, characteristics of form and structure, and use of media to identify ideas and mood conveyed.

VA:Re.IIIa Construct evaluations of a work of art or collection of works based on differing sets of criteria.

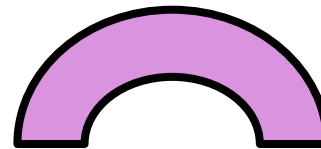
## Connections to Standards (continued)

From the National Visual Arts Standards

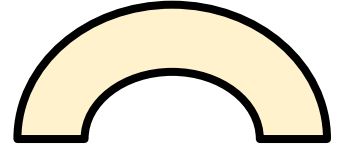
**Connecting / Relating artistic ideas and work with personal meaning and external context.**

Anchor Standard #10. Synthesize and relate knowledge and personal experiences to make art.

VA:Cn.1. Apply formal and conceptual vocabularies of art and design to view surroundings in new ways through art-making. VA:Cn.1. Document the process of developing ideas from early stages to fully elaborated ideas.







## Connections to CCSS

### K-5

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

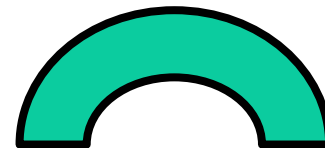
Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

## Connections to CCSS



### 6 – 12

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Come to discussions prepared, having read or studied required material; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.

Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.

Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.

Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing. Interpret information presented in diverse media and formats and explain how it contributes to a topic, text, or issue under study

Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.

Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.



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Artwork and lesson created by Janey Cohen, Science Education Consultant for the Santa Barbara Museum of Art

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