Vision

Instructor Manual

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This module, *Vision*, cover the processes of how vision works. Vision is the transformation of light into neural energy, which is then processed into what we see. The module covers the parts of the eye (e.g., retina, rods, and cones) and how they work. We learn that contrast is one of the most important elements in determining what we see. Our eyes have the amazing ability to adjust to many lighting conditions and we can see in the bright sunlight or a dim room. The brain undergoes complex processes to allow us to understand what we see. We also have the ability to see a wide variety of rich and vibrant colors. There are two main theories as to how we see color, one where we combine color and another that proposes we see the contrast between colors. Vision also interacts with other senses in interesting ways.

Learning Objectives

- Relevant APA Learning Objectives (2.0)
  - Describe key concepts, principles, and overarching themes in psychology (1.1)
  - Develop a working knowledge of psychology's content domains (1.2)
  - Use scientific reasoning to interpret psychological phenomena (2.1)
  - Demonstrate psychology information literacy (2.2)
  - Incorporate sociocultural factors in scientific inquiry (2.5)
- Content Specific Learning Objectives: Module 1
  - Describe how the eye transforms light information into neural energy.

- Understand what sorts of information the brain is interested in extracting from the environment and why it is useful.
- Describe how the visual system has adapted to deal with different lighting conditions.
- Understand the value of having two eyes.
- Understand why we have color vision.
- Understand the interdependence between vision and other brain functions.

Abstract

Vision is the sensory modality that transforms light into a psychological experience of the world around you, with minimal bodily effort. This module provides an overview of the most significant steps in this transformation and strategies that your brain uses to achieve this visual understanding of the environment.

Class Design Recommendations

Vision is ideally taught over 1-class period. There are a couple of approaches you can take. First, you can focus on the module alone. The complexity of the visual system is more than enough to fill a class period. Alternatively, you could choose to go somewhat quickly through the text materials and instead spend the bulk of class in activities demonstrating various visual phenomena. The information covered is the same in either option, see "Lecture Frameworks" for alternative plans. Please also see the Noba PowerPoint slides for this module.

One class period

1st class period (50 min – 75 min):

- How Vision Works
    - What is vision?
    - The Importance of Contrast
    - Sensitivity to Different Light Conditions

Module Outline

What is Vision?

- Vision is the transformation of light into neural energy. Light enters the pupil and gets projected into the retina. From the retina, light is transformed into neural energy and encoded by our brain.
- There are two types of photoreceptors, rods and cones. Rods give us sensitivity to see in dim light. Cones are to see details in bright light and to see colors.
- The complexity of vision is in how the information is encoded by the photoreceptors so that we can make sense of what we are seeing.

The Importance of Contrast

- The eye works by the nervous system analyzing differences in the light captured by the photoreceptors and the contrasts are what get transmitted to the brain. The amount of light from any specific point is not as important as the contrast.
- Contrast is important from an evolutionary standpoint; if the brain detects a sudden difference in the amount of light (contrast) it knows that something new is there. This information could represent something good or bad.
- Our neurons exaggerate contrast to ensure the brain doesn't miss it through a process called lateral inhibition. *See figure 1.*

Sensitivity to Different Light Conditions

- We operate in a wide range of conditions every day from bright sunlight outside, to a dark room when we wake up. The eye must be able to adjust quickly between the variations in photon input.
- The rods are responsible for processing light when it is dark (there are few photons) and can fire with a single proton. However, it takes time for the rods to replenish pigment to activate again.
- When it is bright out (many photons) the cones take over. It takes more photons to make a cone fire, and their pigment replenishes very quickly.
- It takes longer for your eyes to recover when moving from bright to dark (up to 30 minutes) than from dark to light (about one second because the cones are ready to go).
- A subtle adjustment occurs when the changes in light conditions are not as drastic such as bright sunlight outside to a well-lit room. The room is not as bright, but our visual/perceptual experience is that both scenarios are well lit. Our eyes work with a range of contrast values to inform our environment.

The Reconstruction Process

- Once light information enters the brain, neurons project first into a section of the thalamus called the lateral geniculate nucleus. Then the information is split to two areas of the brain.
- The reflexive eye movements that allow you to quickly orient to and track objects of interest are processed in the subcortical regions.
- More complex computation that allow us to have a visual experience takes place in the cortex. First the primary visual cortex processes information about color and simple lines. Then the information flows to higher areas of the cortex system to process things such as edges, backgrounds, and motion. These higher lever computations often occur in very specialized areas of the brain.
- The redundancy of having two eyes pointed in the same direction gives us a binocular advantage. We have two chances of catching a signal, but more importantly have the ability to perceive depth and distance.

The Experience of Color

- Humans have the ability to see a rich and wide variety of colors. One challenge is to understand why we see what we do, especially in comparison to other animals.
- Scientists believe that variations in color perceptions across species is to provide

evolutionary advantages that are unique to each species regarding food, reproduction, and health. For example humans can detect variations in skin tone, such as when someone is embarrassed, which is important for a social species.

- There are two leading theories of color perception that were proposed in themed-19th century before we have physiological evidence for them; Trichromacy theory and Opponent Process theory of color.
- Trichromacy theory proposes that the eye has three kinds of color sensitive cells based on the observation that any one color can be made by combining colors from three lamps. The principle behind this theory is used in TVs, computers, and any colored display. We now know that humans have three types of cones that are sensitive to different wavelengths of light (blue, green, and red cones).
- The Opponent Process theory of color came from the observation that some colors don't exist. You can't make reddish-green or bluish-yellow. The theory is that colors are coded via three opponent channels (red-green, blue-yellow, and black-white). Each channel compares the difference of the two colors rather than a combination. When one color is stronger, that one is perceived, and the other is suppressed. When both colors of the opponent channels are equal, we see grey.
- The colors we see may be unique to humans. But we must ask if all humans experience color in the same way. Color-blind people lack one of more sets of cones, for example. But do all people with "normal" color processing see the same thing.
- It is impossible to really know if the red you see is the same as the red someone else sees. But there is evidence that there are cultural differences in the perceptions of color.
- Cultures categorize colors differently, for example we see green and all shades of green are categorized as such, but one tribe in New Guinea categorizes green shades of living leaves and dying leaves differently.
- Current brain imaging research suggests that people's brains change when they learn new color categories.

Integration with Other Modalities

- Vision interacts with the other senses and systems to help us make sense of the world. For example the vestibulo-ocular reflex occurs when your head moves and your eyes move in the opposite direction to hold your gaze.
- Synesthesia is when one sensory signal gives rise to two or more sensations. The most common type is grapheme-color synesthesia. This is when you hear a word or letter and you see a color. Synesthesia can also be the blending of sound or taste with color.

Concluding Remarks

- Science is just getting started with a functional understanding of how vision works. There are many advances in medicine to help people see.
- Vision is more than just seeing and understanding what is happening. It is also the ability to predict what is coming next and to keep up with the world.

Difficult Terms

lateral inhibition
output signal
photoactivation
photoreceptors

Lecture Frameworks

Overview

Vision is likely a difficult module for many students. It is biology heavy, explaining how the visual system works. The terms and systems are complex. Be prepared to have lots of student questions. Students will benefit from reading this module before class.

First Class Period

- Discussion/warm-up (5-10 minutes)
  - Ask students why they think the senses are important to our understanding of the world. Spend a few minutes talking about the importance of all the senses then guide the discussion to vision and its importance.
- Lecture – How Vision Works (40-60 minutes): Refer to slides for the following:
  - Introduce the process of vision. Talk about how light enters the eye through the

photoreception and photoactivation process. Discuss the neural activity and the role of rods and cones.

- Discuss the importance of contrast. If your primary goal is for students to fully understand the complex processes, plan to spend quite a bit of time on lateral inhibition. If your primary goal is for students to gain a basic understanding of the process, know that this section is a bit confusing and plan to emphasize the overall point (our neurons use contrast for us to see and there are back-ups built in to the process) rather than the minutiae.
- Discuss sensitivity to light and how our eyes adjust going from dark to light or light to dark.
- Discuss the neural paths through different parts of the brain that allow us to see.
- ACTIVITY: Thumb perception - Have students hold their thumbs out in front of them making a thumbs up. Then tell them to close one eye. Next ask students to switch. Then have them switch back and forth. They should all see their thumb jumping because each eye has a different perspective of their thumb. This is especially noticeable if students also pay attention to the thumb's position relative to other objects in the background.

- Lecture - Color and Perception: Refer to slides for the following:
    - Discuss the two theories of color perception:
        - Trichromancy theory is the idea that the three types of cones we have (blue, green, and red) combine color to make any color. This is the process behind TVs and other screens.
        - Opponent Process theory of color is the idea that we have three opponent channels (red-green, blue-yellow, and black-white). These are opponent colors because they do not exist (e.g., you can have a reddish-blue but not a reddish-green). If you have equal parts of the two colors you get grey. If you have unequal parts, you see the stronger color.
        - Ask students for some examples of how they categorize colors. What if someone is colorblind; how does that affect color knowledge? Then talk about cultural differences. Ask how many students speak a second language (this will really only work if you are at an institution with a multilingual population). Ask students to name different color words for blue (in Japanese blue and green are the same, in Russian there are different words for dark and light blue). You could also ask for yellow or green. How many words are there in other languages to describe what English really

only has one word for? What does this perception in color difference mean?

- ACTIVITY (Refer to slides): Show the slide with the red and blue target on it. Tell students to look at the target. After one minute switch to the next slide and ask students what color target they see on the blank screen. *They should see a green or yellow target.* (They may need to look at the blank screen for a few seconds before anything happens.)
- The following slide discusses the integration of vision with other senses and how they work together.
- ACTIVITY: This is another quick activity to demonstrate how vision interacts with other senses. Ask students to draw a picture for close synonyms. Then have the students compare similarities in their pictures with their neighbors' pictures. Then with the whole class talk about what similarities were found, why people drew similar images, and certain colors seem to represent certain concepts among a wide range of people.
  - Example: ecstasy and rapture - Most people draw ecstasy like a sunburst or a sun rising, and rapture like some sort of spiral or squiggle.

- Conclusion
  - Final slide: Discuss where science is today and new research directions.
  - Answer any final questions.
  - You can also use discussion questions from the text here.

Activities & Demonstrations

Cultural Differences

- Ask students for some examples of how they categorize colors. What if someone is colorblind, how does that affect color knowledge. Then talk about cultural differences. Ask how many students speak a second language (this will really only work if you are at a university with a multinational population).
- Ask students to name different color words for blue (in Japanese blue and green are the

same, in Russian there are different words for dark blue/light blue).

- You could also ask for yellow or green. There are languages in Africa that lump some yellows in with browns (as in, colors of thing that are old, dried up like leaves) and yellows of things like bananas whereas we have trouble categorizing yellow from yellow green.
- How many words are there in other languages to describe what English really only has one word for? What does this perception in color difference mean?

Synesthesia Activity

To demonstrate how vision interacts with other senses. Ask students to draw a picture for close synonyms. Then have the students compare similarities in their pictures with their neighbors. Then with the whole class talk about what similarities were found, why people drew similar images, and why certain colors seem to represent certain concepts among a wide range of people.

Example: ecstasy and rapture - Most people draw ecstasy like a sunburst or a sun rising, and rapture like some sort of spiral or squiggle.

Inattentional Blindness

- This video activity is about what you pay attention to when you see. The eye is seeing the light reflections of everything in these videos – the changes aren't hidden (e.g., shirt color changes) – but we have other processes helping to determine what we pay attention to. Our attention as to what is important is selective. There are several different videos with these types of changes. These are two of the best.
- Color changing card trick: **http://youtu.be/v3iPrBrGSJM**
- *Whodunnit?* **https://www.youtube.com/watch?v=ubNF9QNEQLA**
- Each of these videos are only a few minutes long. For the color changing card trick, you can simply show the video. There is text within that will direct students. If you want to have a bit of discussion stop the video as soon as the first pass is done, (before the text: "This is NOT about the cards").

    - Ask the students how the host did the trick. They will likely say that he changed cards when we couldn't see his hands because of how the camera cropped and panned. They will be right, but the more important message is about how our attention can be directed.
    - Then ask if anyone saw other changes. And show the rest of the video.

    - Finally ask if anyone saw the gorilla in the back of the room. A tribute to Simons and Chabris, psychologists and authors of *The Invisible Gorilla*.

- For the *Whodunnit?* video, tell students to solve the crime. Stop the video after the question “Did you notice the 21 changes?” Ask if anyone noticed changes and list any remembered.

    - At this point you can continue playing the video and see the changes. Or go back to the beginning and ask students to see how many they can write down. This time let the clip play until the end.
    - This video was part of a London ad campaign to watch out for cyclists. The site with all the “Do the test” videos has since been taken down. The clips can all be found on YouTube.

- Simons, Daniel J., and Christopher F. Chabris. "Gorillas in our midst: Sustained inattentional blindness for dynamic events." *Perception-London* 28.9 (1999): 1059-1074.

Additional Activities

Ono, H. (2006). Depth and motion perceptions produces by motion parallax. *Teaching of Psychology, 33* (3) 199-201.

- This activity allows students to learn how moving their head along with a stimulus (moving bar on a screen) can make the stimulus appear stationary.
- **http://www.yorku.ca/hono/parallax_demo**

Supplementary Materials

Downey, C. (2013, October). Design with the blind in mind. [Video file] Retrieved from **http://www.ted.com/talks/chris_downey_design_with_...**

What would a city designed for the blind be like? Chris Downey is an architect who went suddenly blind in 2008; he contrasts life in his beloved San Francisco before and after — and shows how the thoughtful designs that enhance his life now might actually make everyone's life better, sighted or not. Run time 11:40

Ebeling, M. (2011, March). The invention that unlocked a locked-in artist. [Video file] Retrieved from **http://www.ted.com/talks/mick_ebeling_the_inventio...**

The nerve disease ALS left graffiti artist TEMPT paralyzed from head to toe, forced to communicate blink by blink. In a remarkable talk at TEDActive, entrepreneur Mick Ebeling shares how he and a team of collaborators built an open-source invention that gave the artist — and gives others in his circumstance — the means to make art again. Run time 7:49

This is a really neat project in that we think about ways that other senses take over from vision impairment, but how often do we think of ways that vision can take over for other loss.

Nirenberg, S. (2011, October). A prosthetic eye to treat blindness. [Video file] Retrieved from **http://www.ted.com/talks/sheila_nirenberg_a_prosth...**

At TEDMED, Sheila Nirenberg shows a bold way to create sight in people with certain kinds of blindness: by hooking into the optic nerve and sending signals from a camera direct to the brain. Run time 10:01

Sinha, P. (2009, November). How brains learn to see. [Video file] Retrieved from **http://www.ted.com/talks/pawan_sinha_on_how_brains...**

Pawan Sinha details his groundbreaking research into how the brain's visual system develops. Sinha and his team provide free vision-restoring treatment to children born blind, and then study how their brains learn to interpret visual data. The work offers insights into neuroscience, engineering and even autism. Run time 18:23

This is a really neat project in that we think about ways that other senses take over from vision impairment, but how often do we think of ways that vision can take over for other loss.

Outside Resources

Video: Acquired knowledge and its impact on our three-dimensional interpretation of the world - 3D Street Art
http://www.youtube.com/watch?v=GwNeukAmxJw

Video: Acquired knowledge and its impact on our three-dimensional interpretation of the world - Anamorphic Illusions
http://www.youtube.com/watch?v=tBNHPk-Lnkk

Video: Acquired knowledge and its impact on our three-dimensional interpretation of the world - Optical Illusion
http://www.youtube.com/watch?v=YjmHofJ2da0&feature=related

Web: Amazing library with visual phenomena and optical illusions, explained
http://michaelbach.de/ot/index.html

Web: Anatomy of the eye
http://www.eyecareamerica.org/eyecare/anatomy/

Web: Demonstration of contrast gain adaptation
http://www.michaelbach.de/ot/lum_contrast-adapt/

Web: Demonstration of illusory contours and lateral inhibition. Mach bands
http://michaelbach.de/ot/lum-MachBands/index.html

Web: Demonstration of illusory contrast and lateral inhibition. The Hermann grid
http://michaelbach.de/ot/lum_herGrid/

Web: Further information regarding what and where/how pathways
http://www.scholarpedia.org/article/What_and_where_pathways

Suggestions from the Society for Teaching's Introductory Psychology Primer

Wells, E. (2013). Sensation & Perception. In S.E. Afful, J. J. Good, J. Keeley, S. Leder, & J. J. Stiegler-Balfour (Eds.). *Introductory Psychology teaching primer: A guide for new teachers of Psych 101.* Retrieved from the Society for the Teaching of Psychology web site: http://teachpsych.org/e-books/intro2013/index.php

POSSIBLE ASSESSMENTS (Out of Class)

One common problem in sensation is the large amount of anatomical structures that must be learned. Students can help study these features by scrolling through interactive sites. These are great for independent knowledge acquisition and to gain familiarity with the anatomical structures. (LO 1.2)

- For the eye: http://www.lensshopper.com/eye-anatomy.asp
- For the ear: http://hyperphysics.phyastr.gsu.edu/hbase/sound/ear.html

Have students compare and contrast any two systems (i.e. vision vs. audition) to further reinforce the process of sensation. This helps students relate to the concept of sensation, perception and how it relates to all of our senses. Assessing sensation and perception when one has suffered an injury or interruption in the process: Randomly assign a case study from "The Minds Eye" by Oliver Sacks. Students should be able to answer questions regarding the sensory or perceptual processes affected. (LO 1.2)

I also like to use an excerpt from the book, "Island of the Colorblind" by Oliver Sachs as a means of getting students to understand the concept of sensation and perception. You could also show them a video of these phenomena available on youtube. This is a 6 part series and will allow you to talk about sensation and perception as well as nature vs. nurture (if that is a theme in your classroom as it is in mine). The video or excerpt could be used in class or as an out of class assessment, possibly as a means to prepare for a potential essay topic.

- http://www.youtube.com/watch?v=CM06G26X-rQ

(In Class)

The brain uses the information it receives to piece together a fairly accurate representation of the external world. One method the brain uses to make meaning from the sensations it receives is through algorithms and past experiences; similar to the way we solve cryptograms. There are a number of websites where students can try their hand at solving these puzzles, such as http://www.cryptograms.org/play.php or http://www.rinkworks.com/brainfood/p/crypts1.shtml Students could either complete the same one or pick their own. Then have the class explain what rules of the English language they used, as well as what past experiences lead to the solution. This allows students to understand that the brain performs a similar task in perception. Students really enjoy this activity and it only takes a few minutes within a lecture. I use it to introduce perception. (LO 1.2)

ACTIVITIES & TECHNIQUES (In Class)

Explain the process of perception using the neural "algorithms" within the brain. (LO 1.2) Gestalt laws of organization:

- These organizational processes can be explained nicely using real examples from art. Students like this way to present perception because they can relate to the art and many have prior knowledge of the pieces I choose.
    - Similarity-Anything from the technique of "Pointillism"
        - Georges Seurat-"Sunday Afternoon on the Island of La Grande Jatte"
    - Proximity-Anything from the technique of Impressionism
        - Monet-"Sunset in Venice". The shadow of the church is a great example of proximity, as well as the refection of the sky in the water.
    - Closure
        - Escher-"Sky and Water", "Ribbon Faces"
    - Figure Ground
        - Anything by Salvador Dali (e.g., "The Image Disappears", "The Slave Market")
    - Good Continuation
        - Anything having camouflage as a theme. Camouflage works because of the principle of good continuation. Usually photography is a great example - http://www.michaelbach.de/ot/fcs_face_in_beans/index.html

Related Background Readings (instructors):

- Verstegan, I. (2005). Arnheim, Gestalt, and Art, New York, NY: SpringerWeinNewYork. http://www.springerlink.com/content/978-3-211-28864- 1/
- Arnheim, R. (1943). Gestalt and art. *The Journal of Aesthetics and Art Criticism, 2*, 71-75.
- Solso, R. L. (2005). *The psychology of art and the evolution of the conscious brain*. Cambridge, MA: MIT Press.

Illusions are a great resource to help explain perception because we are able to see the visual system attempting to correctly solve the puzzle and creating an inconsistent perception. These are easy to incorporate into a lecture (Most of them taking only a few minutes) and could also be used to assign as an out of class assessment. Michael Bach's website is a treasure trove of visual illusions. This site offers the most current scientific explanations for each illusion. You can select just the right illusion to incorporate into the lecture. What I like about his website is he gives the best explanation for why the illusion exists in a concise and straightforward way. http://www.michaelbach.de/ot/ (LO 1.3)

- Color perception
  - For color perception, using the opponent processing theory, you can use the following image to give students a direct view of the different channels in our brain that code for different colors. There are a number of different images available on the internet. http://gettingstronger.org/wp content/uploads/2010/04/Negative-flag.gif
  - If you are talking about color perception, particularly the retinex theory of color, you can use the Munker illusion. http://www.michaelbach.de/ot/col_Munker/index.html This is a great illusion because it is dynamic and really stresses the point that our color perceptions can change depending on the context of the information received.
- Depth Perception
  - In order to have students understand how the visual system interprets depth, particularly using the binocular cue of retinal disparity, you could incorporate the fun activity of "The Magic Eye" or Stereogram images. These images contain the same information but it is visually offset (i.e. has an inherent retinal disparity) and these different images are then superimposed. Looking at them, students perceive an incoherent image. Only when students force the fusion of the two disparate images does a clear, coherent picture emerge. Therefore, they can see what the brain is able to do naturally. A large index of stereograms are available at this website: http://www.moillusions.com/category/stereograms-optical-illusions
- Auditory illusions are available to help students understand auditory perception. To help students understand how prior knowledge can affect perception use the sound files listed on the following website http://www.lifesci.sussex.ac.uk/home/Chris_Darwin/SWS/
  - Sine-wave speech is a synthesized speech pattern developed by combining a number of different sinusoids. Without prior knowledge, the sounds may be unintelligible. However, when they know what the words are, suddenly they can comprehend the sine-

wave speech. First have students try to decipher the sine-wave speech (“SWS” file). Then play the file listed “demonstration” and replay the corresponding SWS file. Now, students should be able to clearly comprehend the SWS. This is a really quick demonstration, stresses the importance of interpretation in perception, and the students always enjoy it.

- Taste illusions are easily created with food coloring and a food item. I have used orange juice before and it has worked nicely. Orange juice colored differently will have a profound effect on taste. I have students rate the three different drinks (which are really orange juice without any additive color, OJ with orange food coloring to make it darker, and OJ with a little red food coloring) on different characteristics-real orange taste, sweetness, bitterness, etc. Students will typically rate the three drinks differently. After the demo, I have them rate the taste of two glasses of water with orange and red added to show them that the taste of the orange juice was not physically affected by the addition of the food coloring. Instead, their taste was affected by the visual perception of the drinks. This works better if you have a small class. I have used it in a larger class as an opening activity before class begins and it requires about 8-10 minutes.
    - Based on research by Hoegg and Alba (2007): http://www.jstor.org/discover/10.1086/-510222?uid=3739800&uid=2&uid =4&uid=3739256&sid=56205845433).
- Sensory thresholds and sensory adaptation
    - Sensory threshold or Absolute threshold: Finding a gustatory threshold using water and sugar. Have students add 1/8 teaspoon of sugar to a gallon water jug until they reach the point that they can detect the sugar. It will take approximately 1 teaspoon in a gallon of water to be able to tell the difference. **Note:**this is time consuming and I don’t often have the chance to incorporate it into my lecture.
    - Sensory adaptation: A number of different classroom activities are listed that can even be adapted depending on the time available in class. **Note:**I never seem to have enough time to get to these activities because sensation and perception always require more time than I typically allocate.
        - Based on O’Drobinak, D. M., & Woods, C. B. (2002). Compelling classroom demonstrations that link visual system anatomy, physiology, and behaviour. *Advances in Physiology Education, 26,* 204-209. http://advan.physiology.org/content/26/3/204.full.

(Out of Class)

Related Student Reading: I assign this outside of class as a way to get students thinking about perception and as a possible essay topic for an exam.

- Griggs, J. (2010). Windows to the mind. *New Scientist*, 34-39. smc.neuralcorrelate.com/files/inpressfiles/newscientist_100918.pdf

Many students are interested in subliminal advertising or subliminal persuasion. You could incorporate a discussion about the difference between the two. To get the ball rolling you could show them a video clip from Derren Brown (http://www.youtube.com/watch?v=f29kF1vZ62o). (LO 3.1, 5.2)

- A good review of subliminal advertising is Broyles, S. (2006). Subliminal advertising and the perpetual popularity of playing to people's paranoia. *Journal of Consumer Affairs, 40,* 392-406.
- Subliminal perception occurs when our behavior is influenced by a stimulus below our threshold. What should be noted to the students is that subliminal perception occurs in highly controlled environments, usually in the lab. **Note:**I will oftentimes use this for an out of classroom assessment/homework assignment to get students to think critically.
    - Reading: Kazin, A. E. (Ed.), *Encyclopedia of psychology, 7,* 497-499. New York: Oxford University Press

RELEVANT TOP ARTICLES (Annotated Bibliography)

- Haws, L. & Oppy, B. J. (2002). Classroom demonstrations of auditory perception. *Teaching of Psychology, 29,* 147-150.
    - When educators include sensation and perception into their introductory psychology course, vision is more oftentimes discussed with little or no coverage of audition. In this article, the authors give four related demonstrations that allow students to experience auditory perception under different situations and can ultimately enhance the topic of perception in general.

- Horner, D. T. (1997). Demonstrations of color perception and the importance of contours. *Teaching of Psychology, 24,* 267-268.
    - This article is a great resource for helping students to understand how one theory of color vision is not enough to explain color processing and color perception. Using visual adaptation and afterimages, the article first explains a demonstration that supports the Young-Helmholtz trichromacy theory of color vision. Changing the stimulus slightly will begin to show that the Young-Helmholtz theory cannot explain every color perception we have. In this case, the opponent processing theory may help to better explain the after image experienced. The color theories are difficult to understand but including these demonstrations allows for a more active engagement in the concept of color perception.

PowerPoint Presentation

This module has an associated PowerPoint presentation. Download it at https://nobaproject.com//images/shared/supplement_editions/000/000/287/Vision.pptx?1416603256.

About Noba

The Diener Education Fund (DEF) is a non-profit organization founded with the mission of re-inventing higher education to serve the changing needs of students and professors. The initial focus of the DEF is on making information, especially of the type found in textbooks, widely available to people of all backgrounds. This mission is embodied in the Noba project.

Noba is an open and free online platform that provides high-quality, flexibly structured textbooks and educational materials. The goals of Noba are three-fold:

- To reduce financial burden on students by providing access to free educational content
- To provide instructors with a platform to customize educational content to better suit their curriculum
- To present material written by a collection of experts and authorities in the field

The Diener Education Fund is co-founded by Drs. Ed and Carol Diener. Ed is the Joseph Smiley Distinguished Professor of Psychology (Emeritus) at the University of Illinois. Carol Diener is the former director of the Mental Health Worker and the Juvenile Justice Programs at the University of Illinois. Both Ed and Carol are award- winning university teachers.

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