



Multi-Modal Perception

Instructor Manual

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The purpose of this instructor's resource module is to assist in teaching a lesson on multimodal perception. The content of the lesson centers on how we not only perceive the world through each individual sense (unimodal), but, more importantly, how we perceive the world through multiple senses (multimodal), often simultaneously. It also focuses on how our senses can deceive and mislead us due to multimodal processing. Throughout this instructor's resource module, we attempt to design a lesson that is both engaging and informative, by mixing direct instruction, active learning, demonstrations, and examples.

Learning Objectives

- **Relevant APA Learning Objectives (Version 2.0)**
 - Describe applications of psychology (1.3)
 - Use scientific reasoning to interpret psychological phenomena (2.1)
 - Engage in innovative and integrative thinking and problem solving (2.3)
- **Content Specific Learning Objectives**
 - Define the basic terminology and basic principles of multimodal perception.
 - Describe the neuroanatomy of multisensory integration and name some of the regions of the cortex and midbrain that have been implicated in multisensory processing.
 - Explain the difference between multimodal phenomena and crossmodal phenomena.
 - Give examples of multimodal and crossmodal behavioral effects.

Abstract

Most of the time, we perceive the world as a unified bundle of sensations from multiple sensory modalities. In other words, our perception is multimodal. This module provides an overview of multimodal perception, including information about its neurobiology and its psychological effects.

Class Design Recommendations

This lesson can be taught in one 60-75 minute class period. However, if you prefer to expand it to more than one class period, there is more than enough information contained in the lesson module to cover two class periods. Please also refer to the Noba PowerPoint slides that accompany this outline.

Class period (60 min – 75 min):

- Perception Unified
- Questions About Multimodal Perception
- Biological Bases of Multimodal Perceptions
 - Multisensory neurons and neural convergence
 - Crossmodal receptive fields
 - Multimodal processing in unimodal cortex
- Behavioral Effects of Multimodal Perception
 - Multimodal Phenomena
 - Audiovisual speech
 - Crossmodal Phenomena
 - Visual influence of Auditory Localization
 - Auditory Influence on Visual Perception
 - Crossmodal Speech

- Conclusion

Module Outline

Perception Unified: Most often we think of perception as unimodal (i.e., one sense at a time). However, most research suggests that we engage in unimodal and multimodal perception constantly and often simultaneously. For example, the picture of a car accident in the PowerPoint presentation would force us to confront visual stimuli, auditory stimuli, olfactory stimuli, and possibly tactile stimuli. Research suggests that we integrate these different modalities in order to understand the world (e.g., a car crash).

Questions About Multimodal Perception: There are several questions that arise when attempting to understand multimodal perception. For instance, how would the overall effects of perception be different if perceptual processing were only unimodal? Answer: research has shown that the cumulative effects of each individual sense added together fail to measure up to the enhanced benefit of them working in concert (e.g., the superadditive effect of multisensory integration). In essence, in situations where you can engage multimodal perception (e.g., a conversation at a loud party), you will draw on multiple senses at the same time (in this instance, not only attempting to hear another person (auditory), but also reading their lips (visual) to understand what they are saying). In other words, the more modalities that are engaged, the more information can be understood (in most situations). On the other hand, if one modality is sufficient to comprehend the situation, the chance for multisensory perception decreases. This is known as the Principle of Inverse Effectiveness.

Biological Bases of Multimodal Perceptions

- *Multisensory neurons and neural convergence:* Numerous locations in the brain are related to multimodal perception. For example, the superior temporal sulcus is related to processing both the auditory and visual components of speech. The superior temporal sulcus is referred to as a multisensory convergence zone (i.e., other neurons send information from different senses to these convergence zones to be processed). This is described in further detail in the lesson module.
- *Crossmodal receptive fields:* A **receptive field** is a set of neurons that responds only to stimuli presented in a very specific region of the space immediately surrounding the perceiver.

Neural convergence occurs when two neurons send their signals to a third neuron: the third neuron's receptive field is the combination of the other two neurons' receptive fields.

- *Multimodal processing in unimodal cortex:* It has long been thought that there are areas in the brain only responsible for specific tasks. However, areas that were once thought to be specialized (e.g., the **primary visual cortex** being responsible solely for visual stimuli) have been found to also receive information from other areas of the brain (e.g., the **primary auditory cortex**, responsible for auditory stimuli) to help process information.

Behavioral Effects of Multimodal Perception

- *Multimodal Phenomena* occur when multiple sensory inputs (e.g., auditory and visual) combine to affect perception. There are several types of **multimodal phenomena**, but one of the most classic examples is called the **McGurk Effect**. In the McGurk Effect, a person watches a video clip of someone saying "gaga" (the visual stimuli), but the auditory stimuli is the sound "baba." What we think is being said is "dada," because the combination—or "binding"—of these two stimuli distort our perception of the situation (see description of the McGurk Effect Activity below for more information).
- *Crossmodal Phenomena* occurs when one **sensory modality** (e.g., visual) changes or influences the perception of another sensory modality (e.g., auditory). These most commonly occur in three different categories: (1) visual influence of auditory localization, (2) auditory influence on visual perception, and (3) **crossmodal** speech. For example, the Ventriloquism Effect best illustrates how visual stimuli influence auditory localization. When we watch and listen to a ventriloquist, we are fooled about the location of the sound because we are visualizing (seeing) what the puppet is saying, but hearing what the ventriloquist is saying (i.e., in a different location). In such cases, the visual stimulus overrides the auditory stimulus as to its location.

Conclusion: This lesson is just an introduction to multimodal perception. We have only covered a few concepts in this field. Much more can be discussed if needed. As a general conclusion, given that multimodal perception is a relatively new field of study, it is likely that many more multimodal phenomena are yet to be discovered, and this topic will continue to be researched and discussed in class.

Difficult Terms

Crossmodal phenomena
Crossmodal receptive fields
Integrated
McGurk effect
Multimodal phenomena
Multisensory enhancement
Multisensory neurons
Neural convergence
Primary auditory cortex
Primary visual cortex
Sensory modalities
Unimodal cortex
Ventriloquist effect

Lecture Frameworks

Overview: This can be a difficult lesson to teach because of the highly unfamiliar concepts used in sensation and perception psychology. However, it can also be an extremely fun and engaging lesson because much of the content is perception based, and you can have students experience many of the phenomena.

- **Warmup Activity—OMG, an Accident!** This is a great way to start the class and introduce the idea of multimodal perception. A complete description of the activity is described in the Activities/Demonstrations section below.
- **Direct Instruction of Perception Unified**
 - In order to discuss multimodal perception, you must first briefly discuss the different sensory modalities. Actively solicit student feedback for each of these modalities. You do not need to spend too much time on this but you may wish to dispel the myth that humans have only five senses by mentioning, for example, the senses of body position, temperature, and pain.
 - *What is multimodal perception?* The effects on the perception of events and objects in the world that are observed when there is information from more than one sensory modality. Have students reflect on the warmup activity and describe all the senses they used.
- **Direct Instruction of Questions About Multimodal Perception**

- Introduce the main questions that drive research on multimodal perception:
 - How does the perceptual system determine which unimodal stimuli must be integrated?
 - What are the effects of multimodal perception that would not be present if perceptual processing were only unimodal?
 - How does the brain take information from different neural systems (optic, auditory, etc.) and combine it?
- For each question, first ask students what they believe the answers to these questions are and then use this as a starting point for discussion.
- **Direct Instruction of Biological Bases of Multimodal Perceptions:** You will need to first describe multisensory neurons and neural convergence. This may include a definition of the superior colliculus, crossmodal receptive fields, and multimodal processing in unimodal cortex. It's always helpful to provide real-world examples. For example, if we are driving down a road and we hear a car honk, we automatically assume the car closest to the sound made the honk. This is because visual information is processed through the superior colliculus, but because the superior colliculus also takes in other modalities (e.g., sound), the sound of the honk helps determine the location of the honk.
- **Behavioral Effects of Multimodal Perception**
 - *Discussion of the multimodal phenomena audiovisual speech:* Ask students how visual information about speech interacts with auditory information about speech? Write their answers on the board. Next, have students describe any image that they want (e.g., a scene from a movie or the classroom itself), then have them describe and discuss how their visual observations may have been influenced by audiovisual speech.
 - Show The McGurk Effect BBC Video. A complete description of the activity is described in the Activities/Demonstrations section below.
 - *Direct instruction and discussion of crossmodal phenomena:* Start by asking students what they believe crossmodal phenomena are. Next, provide basic definitions and some examples of how visual stimuli can influence auditory localization, how auditory stimuli can influence visual perception, and how crossmodal speech occurs.
 - Activity: The Ventriloquist Illusion: This activity is meant to demonstrate how visual stimuli can influence auditory perception. A complete description of the activity is described in the Activities/Demonstrations section below.

- **Activity: The Double Flash Illusion:** This activity is meant to demonstrate how auditory stimuli can influence visual perception. A complete description of the activity is described in the Activities/Demonstrations section below.
- **Activity: What do These Sound Like?** A complete description of the activity is described in the Activities/Demonstrations section below.
- **Conclusion:** Provide a summary of what you have talked about in the lesson.
- **Classroom Assessment Activity (CAT):** In this CAT, have students reflect on the lesson by the process of direct paraphrasing. Ask students to write a layman's "translation" of something they have just learned—geared to a specified individual or audience—to assess their ability to comprehend and transfer concepts. After class, take a moment to categorize student responses according to characteristics you feel are important. Analyze the responses both within and across categories, noting ways you might address student needs. Provide feedback on their translations the following class.

Activities & Demonstrations

Warmup Activity—OMG, an Accident! This activity is designed to introduce students to the theory of multimodal perception. It is a starting point for engaging students in discussing all the factors involved in auditory, olfactory, and visual perception.

- Time: 2-3 minutes
- Materials: All materials are in the accompanying PowerPoint presentation
- Directions:
 1. Let students know you are going to briefly show them a picture and you want them to try and remember everything they see.
 2. Show picture for 10 seconds.
 3. Now ask students a couple of questions:
 - First, describe what you saw.
 - If you had physically witnessed the accident, what do you think you would have heard?

- What do you think the moment would have smelled like?
4. Give students time to think about the questions, then have an open discussion about what they observed.
 5. Debrief students on the purpose of the activity.

The McGurk Effect Video: This is a great way to introduce the McGurk Effect (McGurk & MacDonald, 1976). Don't discuss the effect until after showing the video. In the video, an actor replicates the McGurk Effect by saying "baba"; however, the audio dubbed over the lips is a vocalization of "fafa." Students will think that the actor is saying "fafa" because they are watching the actor's lips.

- Time: 5 minutes, including brief discussion
- Materials: This clip is located at <https://www.youtube.com/watch?v=G-IN8vWm3m0>
- Directions: First show the video. Next, ask students if they experienced the McGurk Effect. Then ask students why or why not. This will lead into a discussion of how the multimodal phenomenon of audiovisual speech.

Activity—Double-Flash Illusion: This activity is a replication of a classic experiment by Shams, Kamitani, and Shimojo (2000), called the double-flash illusion. The purpose is to have students experience how auditory stimuli sometimes influence how we remember visual stimuli.

- Time: 4 minutes
- Materials: All materials are in the accompanying PowerPoint presentation
- Directions:
 1. First, ask students to focus on the center of the screen.
 2. Next, at the extreme edge of the screen, a white dot will appear, along with an auditory event (beeping).
 3. Now, ask students how many white dots they saw. Have students write the number down and pass it to you.
 4. Debrief students: Often, students will report seeing two white dots when the flash is accompanied by two beeps. The number of heard beeps influences the number of seen flashes.

Activity—The Ventriloquist Illusion

- Time: 5-6 minutes, including discussion
- Materials: You will need to download the YouTube video at https://www.youtube.com/watch?v=u7u1o1dTw_s
- Directions: Tell students that you are about to show them a video clip of a famous ventriloquist. Then ask them the questions below:
 1. Why did you like this video?
 2. Does the puppet have a personality?
 - Why?
 3. How did the auditory influence visual localization?
- Debrief students by discussing the research on the “ventriloquist illusion” (Vroomen & De Gelder, 2004). As described in the module, “When a ventriloquist appears to make a puppet speak, she fools the listener into thinking that the location of the origin of the speech sounds is at the puppet’s mouth. In other words, instead of localizing the auditory signal (coming from the mouth of a ventriloquist) to the correct place, our perceptual system localizes it incorrectly (to the mouth of the puppet).” Explain why this might happen.

Activity—What does this person sound like? This activity is meant to demonstrate the crossmodal speech phenomenon. Often we have expectations of how people should sound based on how they talk and how they look. In this activity, students will be confronted with their stereotypes and perceptions.

- Time: 3-5 minutes
- Materials: Download two YouTube videos prior to class or use a hyperlink in your PPT— one female video: (<https://www.youtube.com/watch?v=vNa1PHCy8qg>),
- and one male video: (<https://www.youtube.com/watch?v=GQc6uYAhC3o>)
- Directions: Before defining what the crossmodal speech phenomenon is, show the two YouTube videos. When showing each video, make sure that the sound is turned off. After each video, have students describe what they think the two people sound like. Next, replay each video with the sound turned on. Now, discuss the crossmodal speech phenomenon.

Additional Activities

Angelo, T. A., & Cross, P. K. (1993). *Classroom assessment techniques: A handbook for college teachers*. San Francisco, CA: Jossey-Bass.

- As a form of informal assessment, you can do the CAT “Student Generated Test Questions.” This CAT will help students understand specific concepts of multimodal perception by requiring them to create 1-2 test questions based on the class lesson that are consistent with how you write questions in your class. They can be definitional questions, or applied questions. Once students are done, collect their test questions, provide feedback on them, then incorporate some of the questions into your next assessment.

Double Flash Illusion Demonstration

- If you don’t have time to do the Double Flash Illusion in your lesson, you may want to direct students to this website to have them explore and experience the Double Flash Illusion themselves.
- Link: <http://www.cns.atr.jp/~kmtm/soundInducedIllusoryFlash2/>

The Rubber Hand Illusion Video

- This 3:12 minute video is a great demonstration of the rubber hand illusion.
- Link: <http://www.youtube.com/watch?v=sxwn1w7MJvk>

Discussion Points

1. Could the processing of unimodal information ever be useful? Why or why not?
 - The extensive network of multisensory areas and neurons in the cortex implies that much perceptual processing occurs in the context of multiple inputs.
2. Some researchers have argued that the Principle of Inverse Effectiveness (PoIE) results from ceiling effects: multisensory enhancement cannot take place when one modality is sufficient for processing, because in such cases performance is already at the “ceiling.” On the other hand, other researchers claim that the PoIE stems from the perceptual system’s ability to assess the relative value of stimulus cues, and to use the most reliable sources of information to construct a representation of the outside world. What do you think? Could

these two possibilities ever be teased apart? What kinds of experiments might one conduct to try to get at this issue?

- This discussion point is advanced and should only be used if this lesson is part of a greater Sensation and Perception course. However, it is a good question to ask of students to plant the seed for potential research ideas.
3. Imagine a person who has been blind since birth, and who is able, by virtue of the sense of touch, to identify three dimensional shapes such as spheres or pyramids. Now imagine that this person suddenly receives the ability to see.
- Would the person, without using the sense of touch, be able to identify those same shapes visually?
 - Can modern research in multimodal perception help answer this question?
 - Why or why not?
 - How do studies about crossmodal phenomena inform us about the answers to these questions?
- This is a great series of questions that students will likely find engaging. They are based on a conversation between William Molyneux and John Locke.

Outside Resources

Article: A review of the neuroanatomy and methods associated with multimodal perception:

<http://dx.doi.org/10.1016/j.neubiorev.2011.04.015>

Journal: Experimental Brain Research Special issue: Crossmodal processing

<http://www.springerlink.com/content/0014-4819/198/2-3>

TED Talk: Optical Illusions

http://www.ted.com/talks/beau_lotto_optical_illusions_show_how_we_see

Video: McGurk demo

<http://youtu.be/aFPtc8BVdjk>

Video: The Rubber Hand Illusion

<http://www.youtube.com/watch?v=sxwn1w7MJvk>

Web: Double-flash illusion demo

<http://www.cns.atr.jp/~kmtm/soundInducedIllusoryFlash2/>

Evidence-Based Teaching

Gallagher, S. P., & Hoefling, C. L. (2013). A size–distance scaling demonstration based on the Holway–Boring experiment. *Teaching of Psychology, 40*, 212-216. doi:10.1177/0098628313487454

- In this empirically-tested activity, students are asked to replicate the classic Holway-Boring experiment by estimating the size of illuminated circles at two different depths. Gallagher and Hoefling found that when students participate in this classic experiment, they had a better understanding of the concept than those who did not.

Kreiner, D. S. (2009). Problem-based group activities for teaching sensation and perception. *Teaching of Psychology, 4*, 253-256. doi:10.1080/00986280903173157

- This article contains 14 separate group problem-based activities. These address receptive fields, depth perception, auditory system, speech perception, vision, visual pathways, etc.

Links to ToPIX Materials

Activities, Demonstrations, Handouts

<http://topix.teachpsych.org/w/page/19981023/Perception%20in%20the%20Classroom>

Books and Films: Fixing My Gaze: A Scientist's Journey Into Seeing in Three Dimensions

<http://topix.teachpsych.org/w/page/39235989/Sensation-and-Perception#sthash.BN93lumH.dpuf>

Books and Films: Seeing Voices

<https://books.google.com/books?id=yjZDrTe6ROgC>

Books and Films: Sleights of Mind: What The Neuroscience of Magic Reveals About Our Everyday Deceptions

<http://topix.teachpsych.org/w/page/39235989/Sensation-and-Perception>

Current Events/News

<http://www.npr.org/sections/health-shots/2013/02/11/171409656/why-even-radiologists-can-miss-a-gorilla-hiding-in-plain-sight>

Videos/Audio: Collection on Sensation and Perception Clips

<http://clipsforclass.com/sandp.php>

Videos/Audio: Hollow Face Illusion

<http://topix.teachpsych.org/w/page/19981005/Hollow%20Face%20Illusion>

Videos/Audio: How to Create an Illusion of Depth

<http://topix.teachpsych.org/w/page/19981024/Perception%20Video>

Videos/Audio: The McGurk Effect

<https://www.youtube.com/watch?v=aFPtc8BVdJk&feature=youtu.be>

Teaching Topics

Teaching The Most Important Course

https://nobaproject.com/documents/1_Teaching_The_Most_Important_Course.pdf

Content Coverage

https://nobaproject.com/documents/2_Content_Coverage.pdf

Motivating Students

https://nobaproject.com/documents/3_Motivating_Students_Tips.pdf

Engaging Large Classes

https://nobaproject.com/documents/4_Engaging_Large_Classes.pdf

Assessment Learning

https://nobaproject.com/documents/5_Assessment_Learning.pdf

Teaching Biological Psychology

https://nobaproject.com/documents/6_Teaching_Bio_Psych.pdf

PowerPoint Presentation

This module has an associated PowerPoint presentation. Download it at https://nobaproject.com//images/shared/supplement_editions/000/000/179/Multi-Modal%20Perception.ppt?1447455183.

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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