

The Brain's Perception of Signals

Roscoe Nicholson and Mary Leighton
University of Chicago MSCOPE 2006-7

Project Type: Demonstration

Target Museum: Museum of Science and Industry

Target Audience: 8 yr. olds through adults

Big Idea: This demonstration will explore the relationship between body and mind, and how our senses allow us to understand the world around us. Our bodies receive stimulation from the world, which is interpreted by our brain into conscious perceptions such as images, sentences, and tastes. The audience will participate in mini-experiments that encourage them to really think about their senses and the way they perceive and make sense of the world through both their bodies and their minds. In doing so they will learn about the way sensory signals are interpreted by the brain.

The demonstrator will emphasize to the audience that the brain processes signals from our bodies and that multiple brain processes are involved in perceiving stimuli. To illustrate this concept, the audience will be invited to take part in mini-experiments which show how different inputs (sensory and conceptual) affect how the brain processes all this information. First we will show how learning new information helps the brain make sense of stimuli. Next we will demonstrate the consequences of not having sufficient information or stimuli to make an accurate discrimination. This will demonstrate both the ways that the brain "fills in the gaps" and perceptual "errors" that can be made. Finally, by 'confusing' the brain we can show the ways that the brain processes conflicting information, and how this requires greater mental effort and can lead to perceptual "mistakes."

The strengths of this demonstration are that it is interactive, can easily be made longer or shorter or adapted to different age groups, and that it fits into the goals of the Illinois Learning Standards for the life sciences.

Potential Demonstration Script

The demonstrator begins by asking the audience if they know what the senses are. The demonstrator reiterates that senses are what help us to understand the world around us. Next, the demonstrator asks the audience what part of the body makes sense of the senses. "It is the brain. The brain takes all the information from our senses and our experiences and tries to make a clear picture of the world."

"Today first we will show how giving the brain new information can create a clearer picture for us." The demonstrator will present the demonstrations on auditory and visual discrimination (Sine Wave Speech, difficult to discriminate sentences, and degraded images). Audiences will be shown that once they are presented this clarifying

information, the stimuli make more sense and will continue to make more sense.

“Next we will show how we can confuse the brain. There are a couple ways to do this. One of these ways is to give it too little information.” Demonstrator will present touch and demonstrations smell and taste demonstrations (vanilla and jellybeans). “Sometimes when we have too little information the brain is able to fill in the gaps, making a best guess of what it is seeing.” Demonstrator presents fill-in-the-gaps demonstrations. “Finally we will show how the brain can be confused by being presented conflicting information.” Audience will be shown the Stroop Color Test, temperature discrimination and colored drink taste demonstrations.

Learning demonstrations

1) Sine Wave Speech: Using sound files of computer-generated Sine Wave Speech the audience is asked to identify the sound. Not being able to make out what the sound is, they are then told that the sound is speech, and asked again if they can make out what is said. If no one can discriminate the sentence, they are shown, told or played the sentence. Knowing the sentence, the audience can make it out when played the sound clip. Examples can be found here: http://www.lifesci.sussex.ac.uk/home/Chris_Darwin/SWS/
Take-home Message: New information learned about what is being heard helps us discriminate the sentence in the sounds being played.

2) Difficult to Discriminate Spoken Sentences: The demonstrator reads a difficult to discriminate sentence (such as “In mud eels are. In clay none are.”) to the audience. Upon first hearing the sentence, audience members are not able to parse the syllables meaningfully, and think that the spoken sentence is nonsense syllables or a foreign language. When shown a placard with the sentence written out, the audience becomes able to make sense of the spoken sentence when it is repeated again.
Take-home Message: New information learned about what is being heard helps us discriminate the sentence in the demonstrator’s speech.

3) Degraded Images: Audience members are presented with degraded photographs and asked what they see. At first, few if any audience members will be able to make out anything in the photographs. Then the demonstrator will show the audience a clearer photograph or an outline surrounding the main object of the photo (examples below). Following this, the audience is able to discriminate the central object in the originally presented degraded photos.
Take-home Message: New learned information about what is being seen helps us discriminate the object in the picture displayed.

Example 1:



Example 2:



IT'S A DALMATIAN!



IT'S A COW!



Insufficient Information Demonstrations

4) Half-letter Demonstration: Audience is shown words or a phrase such as the one below:

IUMRING TO GONGIUSIONS

The audience will then be asked to try to read the phrase. Then the audience will be shown the letters uncovered:

IUMRING TO GONGIUSIONS

Take-home Message: When we have insufficient information, then the brain will try to “fill in the gaps” and make a best guess based on available information.

5) Vanilla: Take two cup of cola, and add a drop of vanilla essence to one. Volunteers are asked to taste both while holding their nose and see if they can detect a difference. When holding their nose, both drinks will taste the same. When volunteers are not holding their noses, they can distinguish the vanilla flavor.

Take-home Message: Taste comes from a combination of information from two senses. Taking away one sense can cause big changes in taste.

6) Jelly Beans: Give volunteers jelly beans while they are holding their nose, and see if they can discriminate the jelly beans’ flavor. Then let them try same task when not holding their noses.

Take-home Message: Taste comes from a combination of two sources of information. Taking away one source can cause big changes in taste.

7) Touch Discrimination: Volunteers will be touched with one or two points of a geometric compass while blindfolded. They will be asked to discriminate whether they are being touched by one or two points of the compass. At certain points on the body where touch receptors are spaced far apart, when touched by two close compass points, participants will perceive the two points as one.

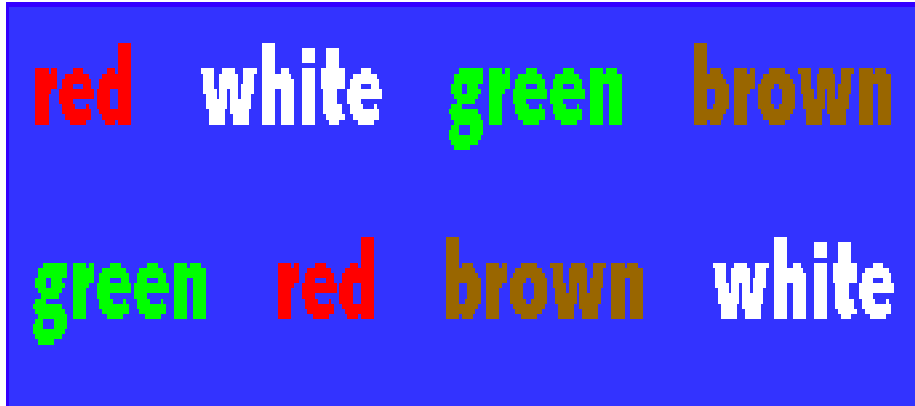
Take-home Message: Sometimes the brain can’t get all the information it needs from the body to make an accurate discrimination.

Conflicting Stimuli Demonstrations

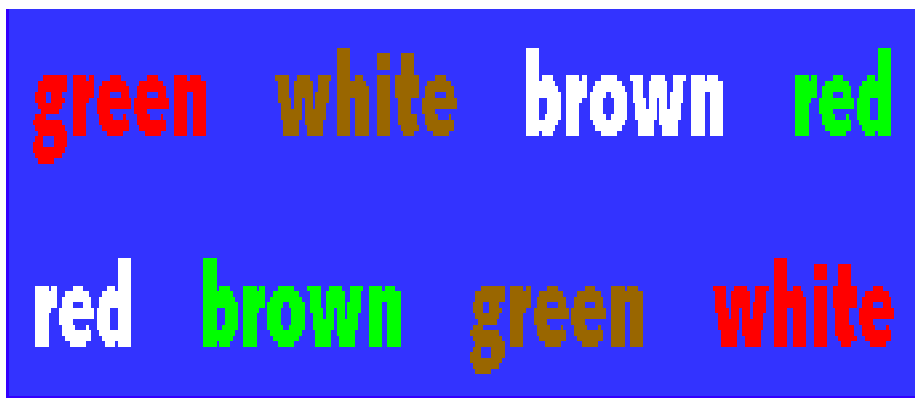
8) Stroop Test: On a computer screen or flashcards, selected audience members are asked to read names of colors as quickly as possible. Some of the names of colors are written in the color corresponding to the word. Other words are written in a different color than the displayed color word. Audience members are then shown that reaction times to words whose color corresponds with the written word are significantly faster than reactions to stimuli where the color and the color word do not match, and/or that they are more prone to errors with mismatched colors and color words. An online demonstration of the test can be found here:

<http://faculty.washington.edu/chudler/java/ready.html>

Take-home Message: When the brain gets information that conflicts, the two types of information can confuse the brain and slow it down.



VERSUS



9) Temperature Discrimination: Selected audience members are asked to put one hand in cold water and one hand in very warm water. After a short period of time, they are asked to put both hands in the same tub of luke-warm water. They are then asked to report what they feel in each hand. The hand that was in the cold water will feel hotter, while the hand in the very warm water will feel colder, despite both being in water of an identical temperature.

Take-home Message: The brain adjusts its perception of temperature by comparing new temperatures to the previously experienced temperatures.

10) Different Colored Drinks: When presented with two drinks with one colored orange but flavored raspberry, and the other colored red but flavored orange, the volunteer assigns flavor according to the color.

Take-home Message: One source of information (vision) can create expectations that can strongly affect how we perceive something with another sense (taste).

Science Behind the Idea

There are multiple flows of information in the brain that influence our conscious perception of the world. Sensory modalities, concepts, memory and attention are processed simultaneously and become integrated in brain regions such as the temporal and frontal lobes to form a coherent perceptual field. In the course of this, the processing of incoming information from one modality can be influenced directly or indirectly by inputs from another modality. Thus directing attention to certain features of a stimulus affects our conscious perception of it, and the memory of this experience affects subsequent perceptions (even months later). Under some conditions, brain regions such as the anterior cingulate cortex must make sense of conflicting inputs.

Evaluation

We will evaluate this demonstration on the floor at MSI. After giving the demonstration, an evaluator will ask participants which parts they enjoyed the most, areas for improvement and other questions. A separate evaluator will also gauge the audience reactions to this demonstration while it is being given.

Connection to MSI Exhibits

This demonstration was designed to complement the forthcoming Body Human Exhibit at the Museum of Science and Industry

Relevant Illinois State Educational Goals

- Goal 12A: Know and apply concepts that explain how living things function, adapt and change.
- Goal 12B: Know and apply concepts that describe how living things interact with each other and with their environment.