Come to your Senses

Background

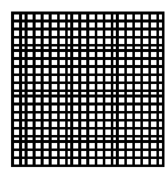
For most of the 20th century one could say that photographic evidence was irrefutable: "The camera never lies." Now it takes some expertise to detect when photographic records have been altered and one might be more likely to hear, "I'll believe when I see it with my own two eyes."

But are the senses totally trustworthy? Do they give us the kind of true representation of reality that we assume they do? This series of exercises may show you that what we really get is a pretty good approximation of reality, that our senses sometimes fail to detect what's there and sometimes make wrong guesses, and sometimes tell us about things that aren't there at all.

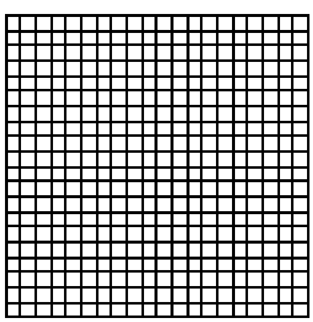
Receptor Mapping

What does it take to tell one from two? Obviously you need at least two receptors and to be able to tell whether both are being stimulated at once or only one is. You might even need a third one between those two that isn't being stimulated to be sure some big single stimulus isn't hitting them both at once. If you draw a 2 cm x 2 cm square on a patch of skin that you want to test and then divide (physically or mentally) each 1 cm x 1 cm square within it into 64 smaller sections, you could test each of the smallest sections with the tip of a single hair. This would enable you to find where the individual receptors are located. Counting them you could determine for any area tested what was the average number of receptors per square centimeter.

The square to draw on your skin would be about this big —> but you'll want a square like the one below to record your results in your laboratory notebook. Remember to work out the average number of receptors per square centimeter for each region tested.



A	B
C	D



Region tested: ....

Estimated receptors: ..../sq. cm.
Describe how determined (actually count in 1 cm x 1cm area or computed from some sampling method):

Two-Point Discrimination

Using a compass or a pair of scissors with fine points as a probe, test a partner's ability to tell when s/he is touched with one or both points of the probe. Test within the area you have mapped with the hair probe. Use the lightest possible contact to avoid confusing the results by engaging pressure receptors or pain receptors. Vary the application of one or two points randomly to avoid the subject's being able to predict the outcome instead of sensing it. (How will you determine the randomness?) The subject doesn't have to be blindfolded, just trustworthy enough not to peek. Begin with the points close together and gradually increase the distance between them until the subject can consistently identify two points when it really is two points; record for each subject and for each region tested the minimum distance required for consistently correct two-point discrimination. You can make a table in your lab notebook similar to this:

Subject Name	Body Location	Minimum distance to resolve 2 points

What region of the skin produced the most acute two-point discrimination? Which region required the greatest distance between two points for those two points to be felt as distinct? Is there a relationship between the density of receptors mapped and the distance required for two-point discrimination?

FIND THE ITCH

How good are you at finding an itch or slapping a mosquito without looking? Touch the subject with the corner of a piece of paper on a predetermined region of the skin while the subject is not looking. Then ask the subject to touch the same point with a pencil point and measure the distance between the two touches. (You did memorized the spot you touched, didn't you?) Do this several times for that general region of the skin. What is the average distance by which the subject erred? Try other locations including some of those you mapped. Is there a correlation between receptor density and the errors recorded? What kind of graph could you draw to summarize and quantify the correlations you have noticed? If you're not sure, ask someone: a classmate or the instructor, for instance.

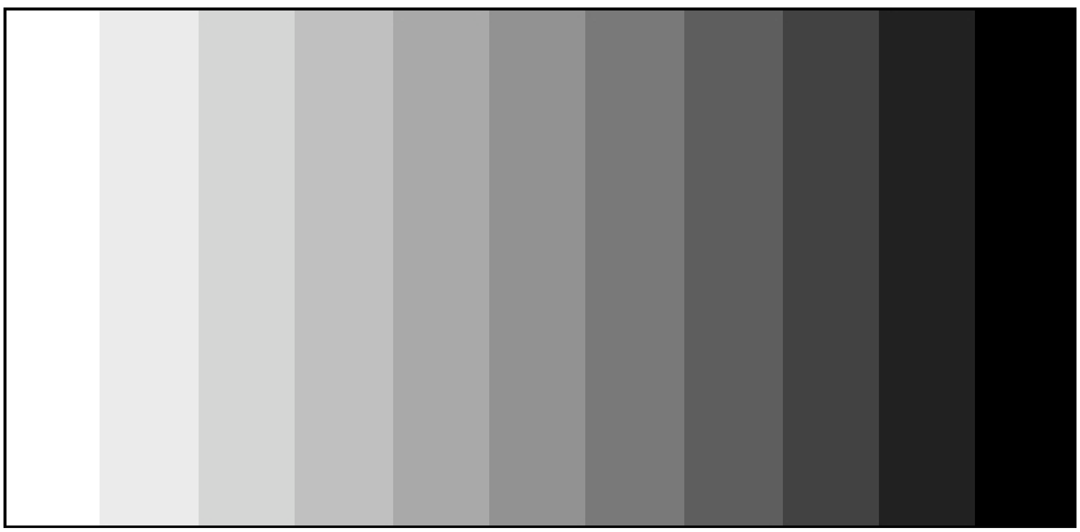
AFTER-IMAGES

We're all familiar with the briefly persistent spot that we continue to "see" after being zapped by a photographic flash. That after-image remaining after the original stimulus has ceased occurs because of the contrast between the relative inactivity of those retinal cells that received a very strong stimulus (and had their rhodopsin bleached) and become incapable of responding to new stimuli until they recover (by re-synthesizing their rhodopsin molecules again) and less stimulated cells nearby. It isn't necessary to stimulate rods and especially cones so strongly to produce such effects.

In class you may be directed with some visual targets like the one above either on paper or on a computer screen. For each one: focus your eyes on the black spot at the center of the target and fix on it for a minute or longer. Then close your eyes or simply look away toward a plain background and describe what you "see." Note what happens to the color values of brightness and hue. Can you understand the color effects? Did you know that cones cells come in three varieties, each with a different pigment (similar to the rhodopsin found in rod cells) that is most sensitive to either the upper, middle or lower regions of the visible spectrum (red—orange—yellow—green—blue—indigo—violet)?

EDGINESS INTENSIFIED

Look carefully at the inner bands of grey and describe what you see. Do all of the bands appear to be uniformly light or dark from top to bottom and from left to right? Or does each band seem to have a darker and a lighter side? Your eyes are lying to you if you perceive anything but a uniform density within each vertical band. You can verify that each grey band is uniform by covering up the band on either side of it. with your hands.



The gradient effect is a side effect of a neural mechanism that normally aids vision by making it easier to "see" edges by increasing the contrast between to adjacent areas with little inherent contrast. A phenomenon called lateral inhibition produces the illusion and is one effect of some nerve cells being able to inhibit instead of stimulate other nerve cells. The sharpening of vision that results is just one of the benefits of having inhibitory nerve cells. There are so many other benefits that the inhibitory neurons in the brain outnumber the excitatory ones significantly. You can verify that each grey band is uniform by covering up the band on either side of it.. When you have finished you might want to go back and make a tiny black dot in the center of the middle (6th) band of grey. Make a prediction about what kind of after-image will be produced after you focus on that dot for a minute or so.

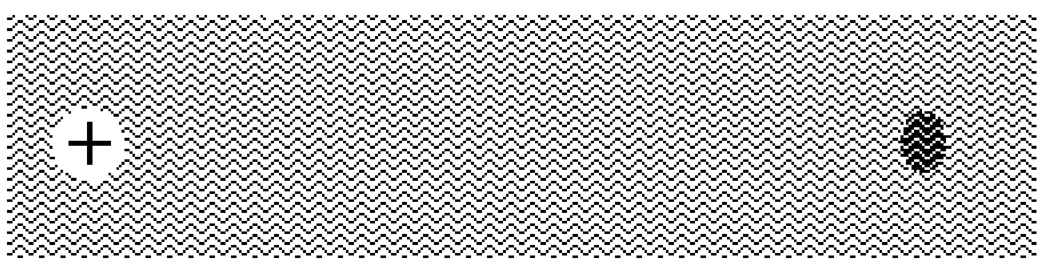
BLIND SPOTS

In each of your eyes there is an area oddly named the optic disk. It is located a few degrees outside of the center of the field of vision of each eye (to the right of center in the right eye). It is an area where there are neither rods nor cones. It ought to produce a black hole in your field of vision, but it doesn't. Actually it does, but your brain fills in the void with what it "thinks" ought to be there, either from memory or by extending patterns from outside the blind spot into its interior. You can demonstrate the presence of the blind spot and the brain's attempts to obviate or compensate for it by using the following graphics. First close your left eye and focus your right eye on the intersection "—|—" just below in FIGURE A. Then move your head back and forth, changing the distance between your eye and the paper, until you notice that the "$" disappears. This won't happen if you look over toward the "$"; you have to keep fixed on the intersect. Notice how far your eye is from the page when that happens. Then, keeping the same distance between eye and page, focus on the intersection near the left end of FIGURE B. Describe what happened to the "$" and to the break in the horizontal line. Now predict what will happen if you treat FIGURE C. the same way and describe the result.

FIG. A.

FIG. B.

FIG. C.



NATURE OF STIMULUS

What one quality is shared by all stimuli? What is the basic nature of a stimulus? Consider the cutaneous reception of heat and cold. What does it really record? Not temperature as such. There is no analog or digital readout that says 98.6°F or 37°C when you touch another human being (assuming for the moment that their surface temperature is equal to the statistical average of internal body temperature). If you reach out and touch in sequence a wooden part and then a metal part of your desk or chair, you will probably say they are different temperatures. In fact, assuming they've been in the room for some time, neither is in direct sunlight nor has been in contact with you or any other warm body or a chunk of ice, they are almost certainly the same temperature. Metal is more efficient than wood at conducting heat away from your body, thus it "feels cooler." Report your sensations immediately after immersing an index finger in a glass of hot (50° C or 122° and again after a minute. Report also your sensations immediately after immersing the other index finger in a glass of cold (10°C or 50°F) and again after a minute. You can multitask, doing both immersions at the same time, or one after the other. If you didn't immerse them in the two different glasses simultaneously, do that now. After a minute insert both fingers into a glass of warm water (30°C or 86°F) and record your sensations. What do these wetted experiences tell you is the nature of stimulus?

Hemispheres in Conflict

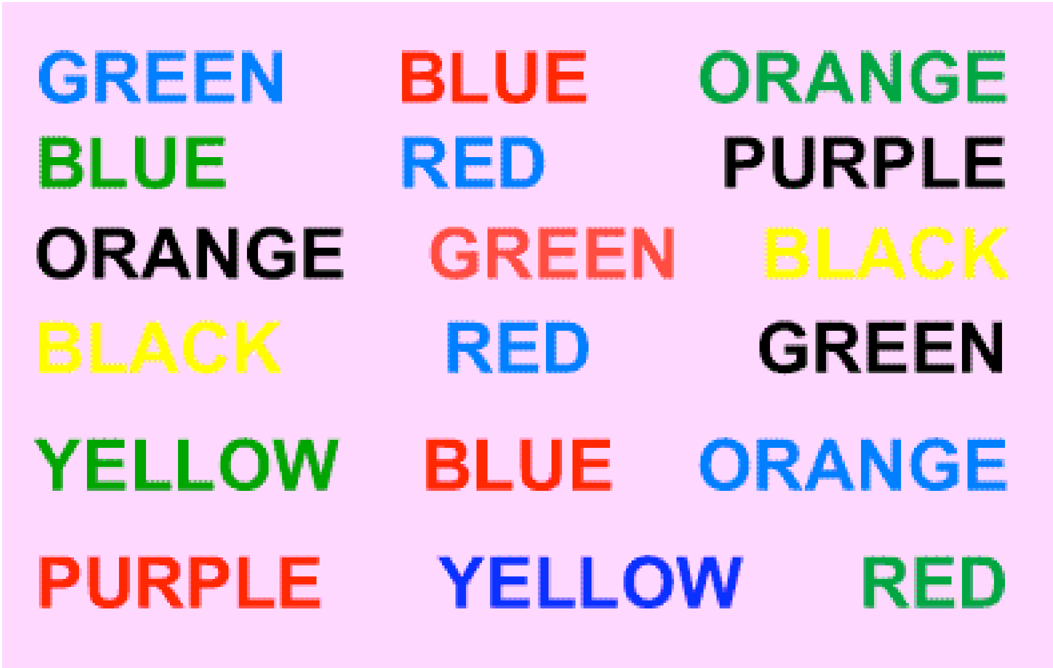
Do not read the words given below, but say the name of the color of the letters in each word. If you are doing this from a black and white hard copy, color in the words with crayon or colored pens or pencils. At the bottom of the page is the list of colors to use for the three words in each line. The right side of the brain is often best and brightest in recognizing forms, patterns and colors, but the left side of the brain controls speech. What the left side of the brain chooses to say may be influenced more by what it sees reading than what it gets told by the right side. Much of what has been asserted about left-right brain activity has been drawn from studies of mostly right-handed white males. Females, lefties and native speakers of non-European languages may have different results.

GREEN	BLUE	ORANGE
BLUE	RED	PURPLE
ORANGE	GREEN	BLACK
BLACK	RED	GREEN
YELLOW	BLUE	ORANGE
PURPLE	YELLOW	RED

Final Report

Describe in several well formed paragraphs, each consisting of complete and coherent sentences, how these experiences have affected your view of your senses and the quality of perceptions derived from them.

blue	*red*	*green*
green	*blue*	*black*
black	*red*	*yellow*
yellow	*blue*	*black*
green	*red*	*blue*
red	*purple*	*green*



GREEN blue	BLUE red	ORANGE green
BLUE green	RED blue	PURPLE black
ORANGE black	GREEN red	BLACK yellow
BLACK yellow	RED blue	GREEN black
YELLOW green	BLUE red	ORANGE blue
PURPLE red	YELLOW purple	RED green