Color Games

Section 7: How Your Color Perception can be Manipulated

No, its not moving, its just your eyes and your brain interpreting the waves. If you stare at one section, it stops moving and the other areas will keep going.

Color Management Concepts

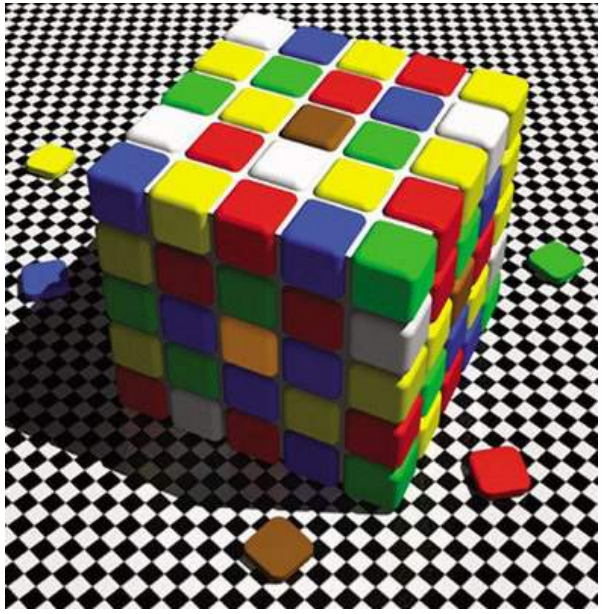
Color Games: How your Color Perception can be Manipulated

• Color and Shapes can Translate to Movement and Depth, even though it's not Real

Your mind has amazing abilities to process colors, shapes and shading in order to constantly work out your surroundings. It is truly one of the most impressive image processors we know. It can build a whole three-dimensional world from flat images, look at slightly different images and interpret depth, distance and color scheme in a second. In fact, it can do all these things more quickly than we have time to rationalize whats really going on, or if there might be something wrong before we move on to the next thing.

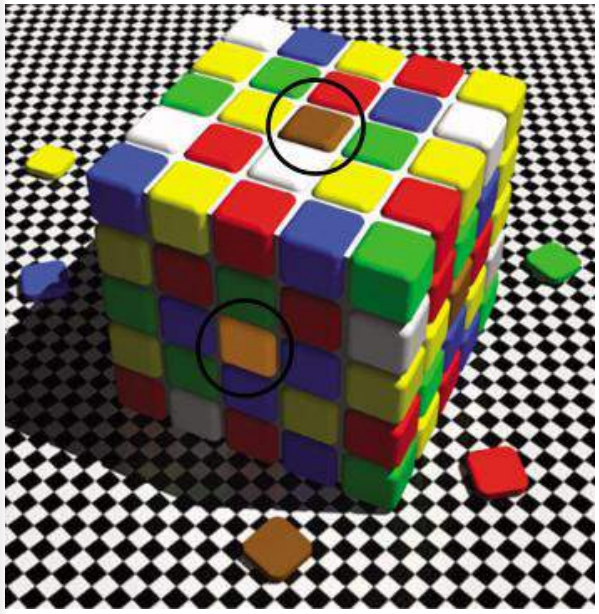
Look at Image **A**. Weather you realize it or not, your mind just build a 3-D space with a checkered plane, a colored cube, many of the colors, the depth of each colored square and which way the light is coming from, distances and angles. You did this in about one second. Now look at image **B**.

A.



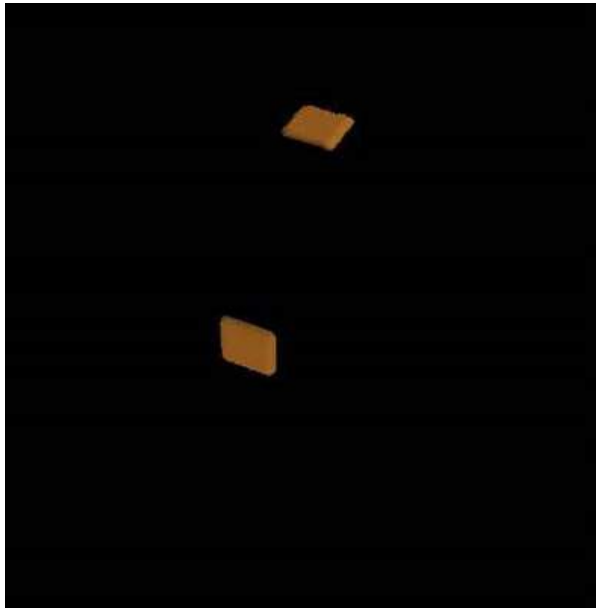
Look at the center Brown square on the top of the cube and the center orange square on the front center. Do you think they are the same color? Now look at **C**.

B.



As you can see from this isolated picture, they are the same color? How does this happen? How the brain perceives backgrounds and lighting and object orientation is fundamental to shaping what we see. We don't really even see the world for what it is — we see models of the world that have happened to work out for us as a species over millions of years of adaptive evolution.

C.



Color Management Concepts

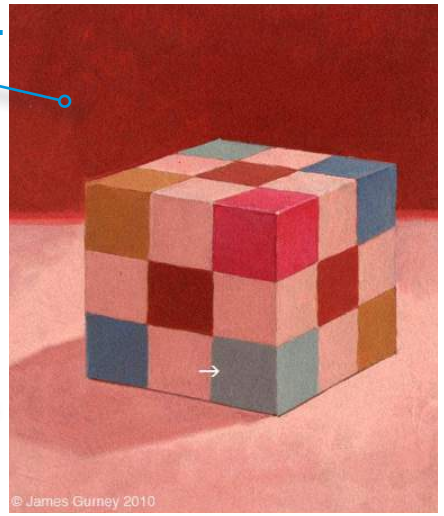
Color Games: How your Color Perception can be Manipulated

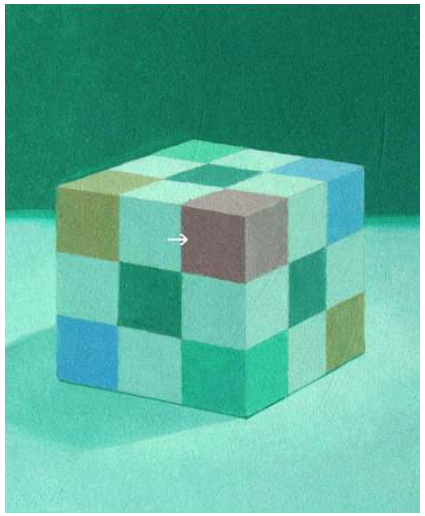
• Overall Color Tones can Fool you into Thinking Colors are Different When They are Not

Color Constancy

The photos to the right shows the same colorful cube in red light and green light (**A & B**). The squares on the cube are cyan, magenta, ochre, blue, and white. Or so they seem. What colors are those squares really, objectively?

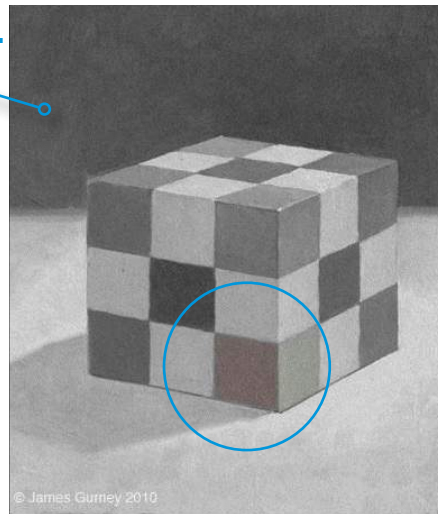
In fact, the greenish square in the bottom corner of the red-lit scene (**A**) is exactly the same color mixture as the redish square in the upper corner of the green-lit scene (**B**). Don't believe me? See below...

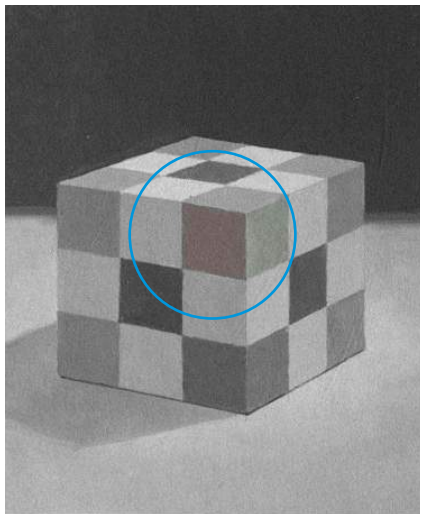




To test that claim, here's the same image file with everything but those squares turned to gray tones. Nothing else has changed. The colors of those squares are made from the same paint, applied with the same brush. (The shaded surface side is a slightly redder gray in both cases.)

This show how easily your perception is fooled by some simple color shading and how your mind tries to fill in what it thinks is the correct color.





Credit: James Gurney 2010

Still don't believe me? Here are two swatches taken from the images to compare. No tricks, just a sample from **A & B**.

Color Games: How your Color Perception can be Manipulated

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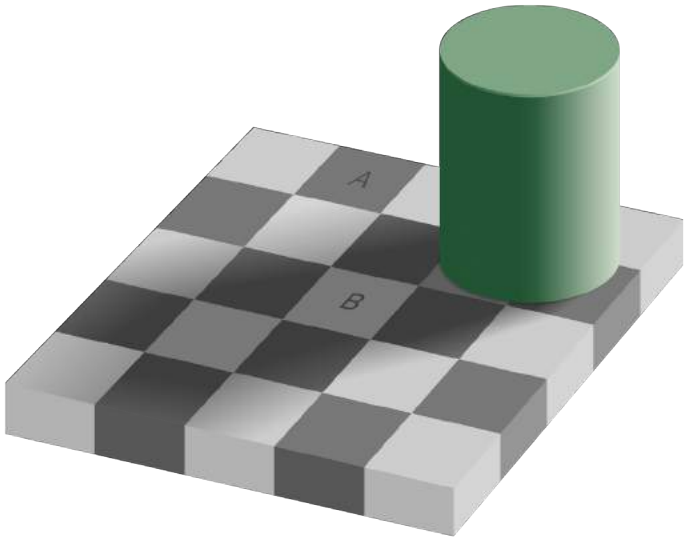
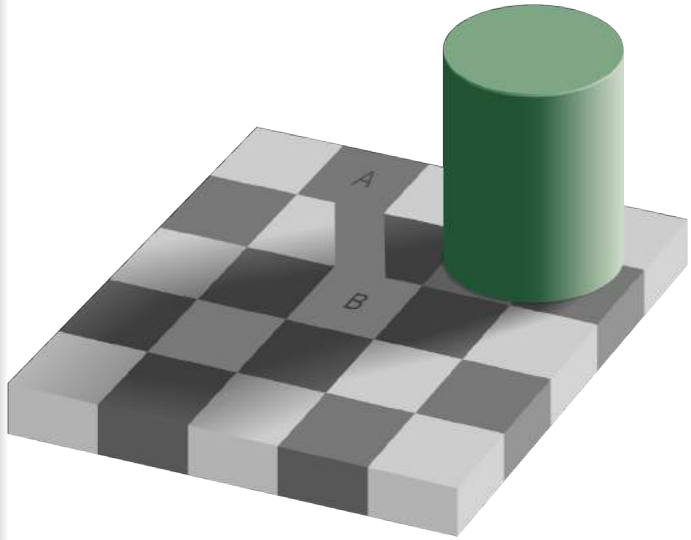
The Post Casts a Shadow

The Green post casts a shadow onto the checkerboard table. The tiles are checkered with shades of gray. Tile A is a dark tile and Tile B is a light tile. Easy to tell them apart, or is it? Has our experience in the real world caused our expectations of shadows to affect our perception of color?



Connecting the Tiles

Once the two tiles are connected by a strip, the illusion starts to break up, but still to my eyes, it seems like the patch between A & B changes color slightly. Its so hard wired into the brain to interpret shadows as darker, that its hard to see the shades of gray as the same.



The Real Shade

Here are two samples taken directly from Tile A and Tile B that show the two are the same. I had a hard time with this and my eyes will simply not accept it when I look at the illusion, but the facts are in:

Tile A

Tile B

Color Games: How your Color Perception can be Manipulated

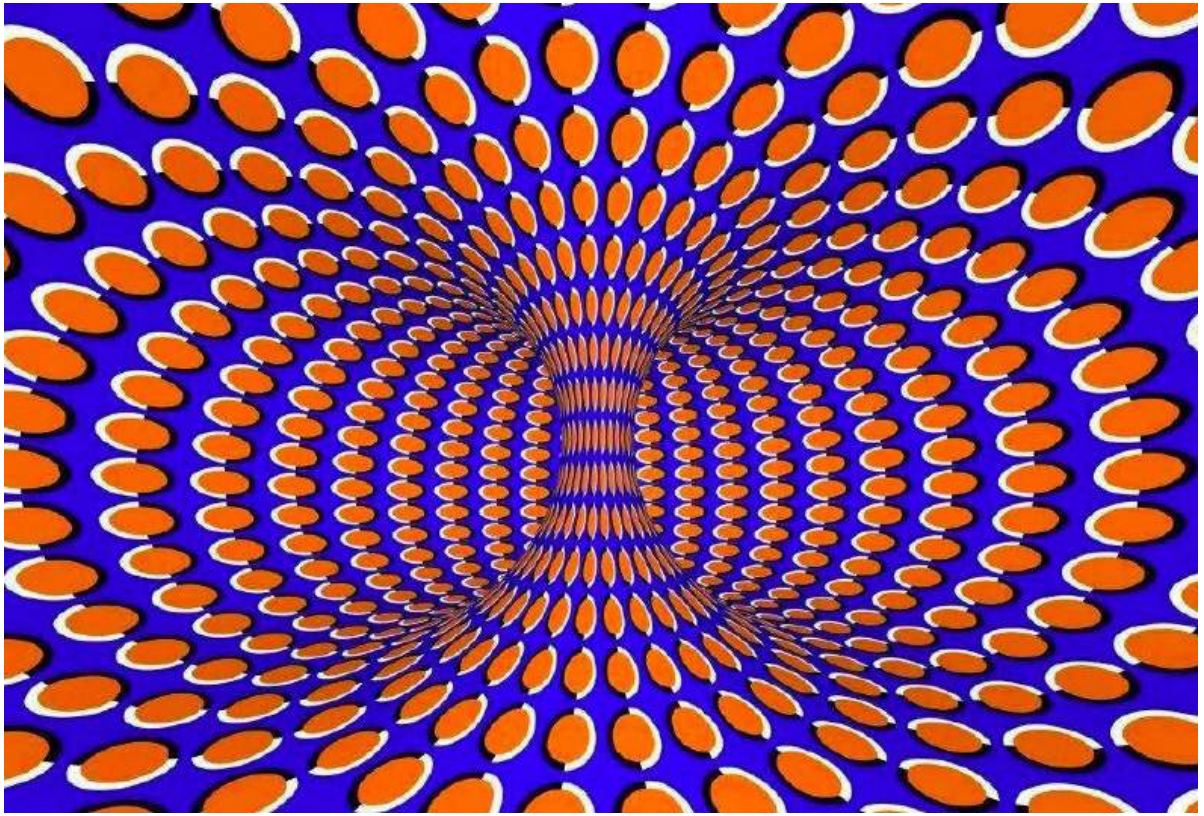
- **Color and Shapes can Translate to Movement and Depth, even though it's not Real**

Moving Images that Don't Move

Looking at a moving illusion is always a little unsettling. On one hand, your brain knows that the image is a still image and can't be moving, but on the other hand, your eyes comprehend movement.

But, what makes a moving illusion appear to move? Moving illusions are still a bit of a mystery. One theory speculates on how our brain perceive different colors. We perceive some colors faster or slower than other colors, giving the illusion of movement even in some still images. You will notice that if you stare at any one point in the image, that spot seems to stop moving.

These types of images exploit our ability to fool ourselves into believing that shadows and colors can convey three dimensions even though we know its a flat image. We have conditioned ourselves to fill in spacial information even though none really exists. It developed as a survival technique, to adapt to our surroundings, but as you can see, we can be fooled quite easily.



Color Games: How your Color Perception can be Manipulated

• Color and Shapes can Translate to Movement and Depth, even though it's not Real

I happen to be a fan of 3D sidewalk chalk artist. Some of the optical illusions that are being created by these artists are quite astounding from a color and mathematics standpoint. They have managed to fool the eye and create engaging and imaginative art that makes us realize how we are easily fooled by perspective and color.

On Top of the World

In a makeshift raft, three people look at falling off the end of the earth into a chasm far below.

How this was Accomplished:

Their works are created using a projection called anamorphosis, and create the illusion of three dimensions when viewed from the correct angle. Art of this style can be produced by taking a photograph of an object or setting at a sharp angle, then putting a grid over the photo, another, elongated grid on the footpath based on a specific perspective, and reproducing exactly the contents of one into the other, one square at a time.

If the viewer stands in the right spot, the perspective grid lines up to their point of view and creates the illusion.

Art Credits: Edgar Müller

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The Snail and the Lady

Below: From this angle, the woman looks as if she about to have a very slimy day as the snail crawls toward her and onto the stone bench to perhaps grab her with its eye stalks. She seems to look alarmed, but we know that something is up because our experience tells us that snails simply don't get that big.

How this was Accomplished:

As we walk around the shot, the illusion begins to unfold in front of us. As it turns out, you have to be standing in the right place to be fooled by the drawing. Its a clever example of how our visual perspective can me manipulated by color and depth. Notice how the bike post was utilized to make one of the snail's eye stalks and how the colors make the illusion work.

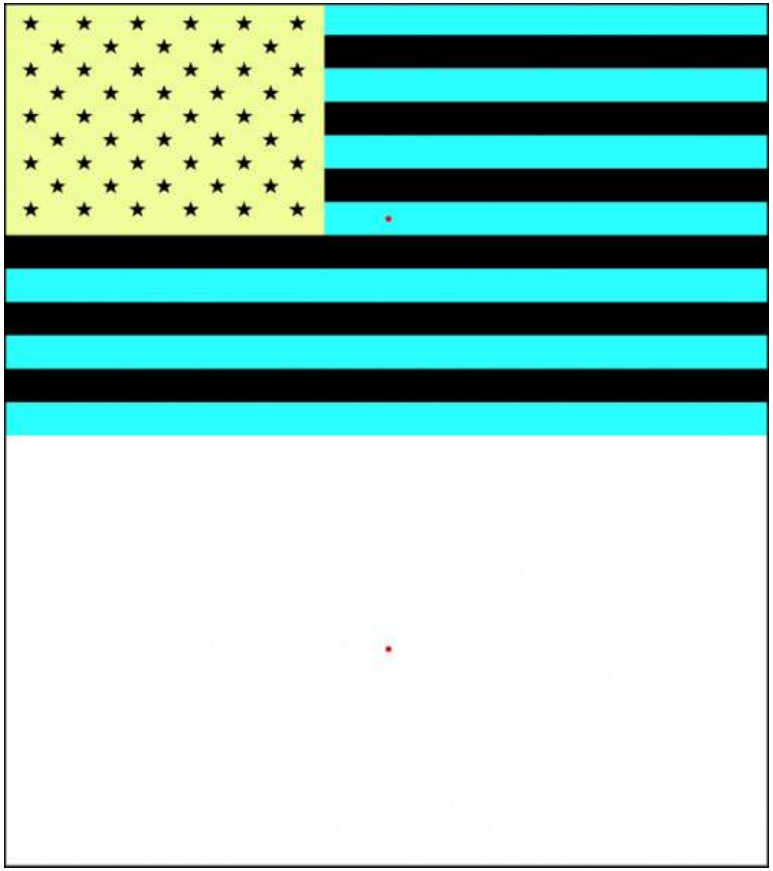
Art Credits: Julian Beever

Color Management Concepts

Color Games: How your Color Perception can be Manipulated

• After Image and how your Color Vision gets Fatigued

Your eyes are amazing devices for physically sensing color. But have you ever thought about the fact that they get tired? Have you ever noticed that when you put those rose colored glasses on, everything seems to shift back to normal and does look so rosy anymore? Well, there's a reason for this, and simply put, its got to do with the cells in your eyes that register the colors you see. They can get tired and make mistakes.



Negative After Image Effect

Did you know that your eyes can give you any color's complement? Simply stare at the color you are starting with, then move your eyes slightly to the side on a white background and the complement will appear. It only lasts for a short time, so try it on the image on the left.

Try this tried-and-true complement activity. Stare at the red dot centered in the flag for about 15 seconds, then at the bottom red dot. See the Flag? Notice how the colors are correct now?

After image exploits a simple ocular defect: staring at one color for too long will "burn out" the eye's retinal cones and create a ghost image in the inverse color. Staring for a few seconds, an inverse afterimage appears, either causing color overlaps, vibrating adjacencies, or unexpected color fields.

Negative afterimages are caused when the eye's photoreceptors, primarily known as rods and cones, adapt to over stimulation and lose sensitivity. Normally, the overstimulating image is moved to a fresh area of the retina with small eye movements known as microsaccades. However, if the image is large or the eye remains steady, these small movements are not enough to keep the image constantly moving to fresh parts of the retina. The photoreceptors that are constantly exposed to the same stimulus will eventually exhaust their supply of photo-pigment, resulting in a decrease in signal to the brain.

If you stare too long at the same thing, it will cause your color cells to fatigue and your color perception will slightly shift.

Color Management Concepts

Color Games: How your Emotions can be Manipulated through Color

Colors and What They Mean to People

A lot of research has been done regarding people's response to color. Here is a summary of some of that research. Use it to help guide your decisions while designing and shopping.

Red

Energetic, Love, Excitable, Arousing, Pulsating, Fast, Passionate, Active, Loud

Red stimulates the human body and makes the heart beat faster, blood pressure rise, and hormone levels elevate. Red grabs consumers' attention and wakes the senses. Red warms people and products. A red cup of soup will seem warmer than a blue cup. This has lead to the success of red and white packaging for Campbell's soup. Intense reds are powerful and strong and appeal to men seeking these same attributes. Red is seen as the sexiest color, as proven by its use in decadently sinful cheesecake packaging for Sara Lee, or used on deep red, lips.

Yellow

Imagination, Youthfulness, Happiness, Joy, Optimism, Enlightenment, Intelligence

Yellow is most frequently associated with the warmth of the sun and bright light. It pops out of a sea of other colors and is easily contrasted from competitor packaging. Taxicabs use yellow to help customers identify them among the congestion of traffic. One of the most endearing popular culture icons, the smiley face, is a lively, bright, uplifting yellow. In a successful attempt to break the monotony of the telephone operator's job, yellow was added to the phone book to create the Yellow Pages. Research has proven that type is most legible and most memorable when it is printed with black ink on yellow. Yellow is used extensively in packaging to make other colors appear brighter and more active.

Blue

Reliability, Protection, Trustworthy, Respect, Loyalty, Integrity, Dependability, Confidence

Blue is the most liked color among women and men. Police officers often wear blue uniforms to command respect, demonstrate authority, convey a peaceful and calm personality, and to help calm those they interact with. Blue is the most acceptable color for business and political attire. Since most interactions with blue are positive, it is a popular color for packaging. The positive words consumers associate with blue are transferred to the product packaged in it. A consumer that is apprehensive about an expensive purchase of a car, furniture, or clothing, will usually choose to buy the color blue because of its permanence and stability. Blue is not a trendy color, so it is less likely to go out of style.

Orange

Creative, Friendly, Outgoing, Cheerful, Freshness, Health, Energy, Youth, Happiness, Adventure

Orange is associated with nature and the heat of the sun. Being a warm, bright color, orange grabs a viewer's attention and is used as a warning color. Neon, blaze, or bright orange are used on products targeting the outdoor person. Hunters rely on orange clothing to make them visible to other hunters from great distances. Dangerous parts of heavy equipment and machinery are often painted bright orange to warn operators or workers to be cautious. Orange represents people who are supposed to be creative, playful, humorous, and fun. Orange encourages the flow of oxygen intake to the brain and stimulates creativity. Because of these qualities, orange is the favorite color of many children, teenagers, and athletes. The playful, energetic qualities also make it an excellent choice for children's games and toys, and inexpensive novelty products. Orange can be seen as a value-priced color, so marketers must be cautious not to use too much of it on products that are meant for an upscale, more status-oriented target market.

Green

Nature, Calming, Environmental, Fresh, Healthy, Calm, Peaceful, Quiet, Relaxing, Life, Growth,

The majority of consumers choose green as their second favorite color. Women tend to like green more than men. Green, being a cool color, is one of the most calming of all colors. In nature green goes with most any color. Green foliage goes well with red, yellow, orange, blue or purple flowers. At a stoplight, green calmly allows motorists to proceed. Communities prefer green road signs whenever possible because they blend into the surrounding environment with little obstruction. Darker greens symbolize wealth, prosperity and status. Printed money is primarily green for this reason.

Credit: http://www.craigkunce.com/df.color.html

Color Management Concepts

Color Games: How your Emotions can be Manipulated through Color

Purple

Regal, Mysterious, Royal, Luxurious, Sensuous, Spiritual, Dignified, Extravagant, Magical

Purple is not a mainstream packaging choice because of the mixed messages it sends to consumers. Some scientists believe that this message has been subconsciously passed down through generations and still affects consumers' food and packaging choices. The exceptions are food products targeted to young audiences and purple colored food such as grape juice, eggplant, and grape flavored candy and beverages. Kids have shown a preference for oddly colored foods. However, these colors are usually associated with the flavor of the food, such as green apple or purple grape candy and juice drinks.

Brown

Earthy, Home, Durability, Warm, Comforting, Approachable, Masculine, Rugged, Natural

To the consumer, brown is down-to-earth, simple, and says, "hearth and home comfort." Brown is considered a neutral color and is often used to color high priced products and services. Consumers feel more comfortable buying expensive furniture, picture frames, handbags, jackets, and shoes in brown because, like blue, brown is less likely to go out of style. All shades and tints of brown are associated with the solid, secure foundation of the earth. Apparel marketers must be careful, however, because consumers can also associate brown with dirt—not a favorable impression when you are selling clothes.

Black

Authoritative, Overpowering, Elegant, Classy, Conservative, Dignified, Serious, Dramatic, Oppressive, Powerful

Consumers associate black packaging with sophistication and expense. An important occasion is labeled as a black-tie affair. And an important person or dignitary is driven in a black limousine. Black is a powerful statement, the absence of other colors that cuts through to the message. The color black relates to the hidden, the secretive and the unknown, and as a result it creates an air of mystery. It keeps things bottled up inside, hidden from the world.

Gray

Stable, Sad, Muted, Conventional, Mature, Responsible

Gray is conventional, reliable and practical. It is a mature and responsible color, often associated with the gray hair and old age. Gray can strangle and suppress energy, but it also provides a stable base, that can contribute with new and positive energy. Gray is very controlled. It has a stabilizing effect on other colors it comes in contact with, downplaying the stronger and brighter colors and enlightening the softer colors. The gray color is rarely a perfect blend of black and white. It often has elements of other colors, such as blue, green, pink, purple or yellow in it, which uplifts and activates it.

Pink

Romantic, Intimate, Feminine, Loving, Caring, Considerate, Intuitive

The color pink represents caring, compassion and love. The pink color stands for unconditional love and understanding, and is associated with giving and receiving care. Since pink is a combination of red and white, both colors add a little to its characteristics. It gets the lust for action from the red color, and the white color gives it an opportunity to achieve success and insight. Passion and power from the color red, softened with the purity and openness of the white color completes pink color meanings. The deeper the pink color, the more passion and energy it radiates.

Turquoise/Aquamarine

Natural, Water, Cool, Refreshing, Spiritual, Creative

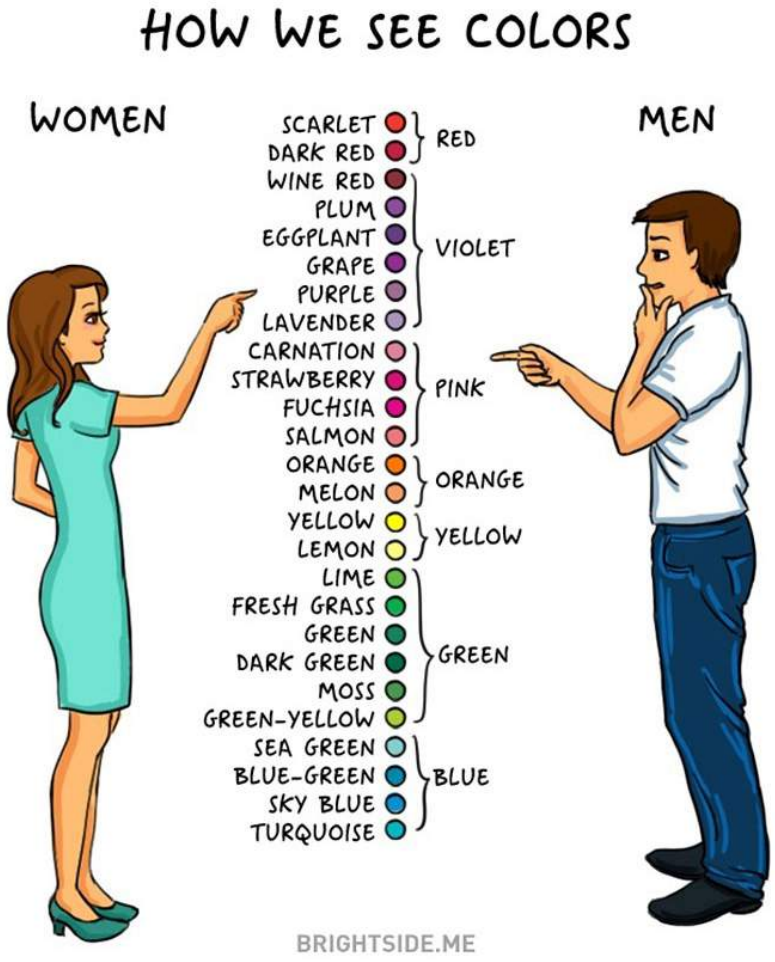
The color aqua soothes your soul and creates an instant sense of home and belonging. It is the color of water, the oceans and to some, the sky. It is a color of nature. Turquoise encourages inner healing through its ability to enhance empathy and caring. It is the color of self reflection and spiritual energy.

Credit: http://www.craigkunce.com/df.color.html

Color Games: How your Color Perception can be Manipulated

• How you think about Color can be very Sexist!

Study after study shows that women are much more tuned into color than men are. No one is quite sure why women seem to be better at color recognition than men, some muse that it's evolutions way of helping the fair sex be better at gathering the best fruit and vegetables, some think that female hormones actually change the brain to process colors better for women, and still we really don't seem to know. I think its mostly about communication.



Men Think about Color Differently than Women

Turns out that if your a man, color communication is a bit more generic for you than for women. Men tend to paint colors in broad strokes, while women are finer with their distinction between the colors, especially with reds.

It may be a genetic difference between the X and Y Chromosomes:

"The results of the study by Verrelli and Sarah Tishkoff of the University of Maryland appear in the American Journal of Human Genetics. Their research focused on the gene that allows people to perceive the color red, a gene that is found only on the X chromosome. They found that the gene has maintained an unusual amount of variation that is about three times that of other genes.

Verrelli explains that variation in the red gene is created via the exchange of genetic material with a neighboring gene that detects green. The scientists speculate that enhanced color perception was important when women were the primary gatherers in the hunter-gatherer phase of human existence. It would have allowed them to better distinguish among fruits, foliage and insects. Therefore, nature supported the variation, despite some negative consequences to men.

Because women have two X chromosomes, women can receive one chromosome with the typical configuration of the red vision gene while the other chromosome receives a slight variation. It is the combination of a normal and variant gene, which occurs in about 40 percent of women, that may provide a broader spectrum of color vision in the red-orange range.

By contrast, men have one X chromosome, and any variation in the single red gene that they receive reduces their ability to distinguish between red and green. This accounts for the relatively high percentage of men - 8 percent - who have a color vision deficiency."

While this is interesting, it doesn't explain all the differences when generalizing between the sexes and color perception. Its also ironic that most Color Scientists are men and can score just as high as women on color recognition tests.

Credit: https://www.asu.edu/news/research/womencolors_090104.htm

Color Management Concepts

Color Games: How your Color Perception can be Manipulated

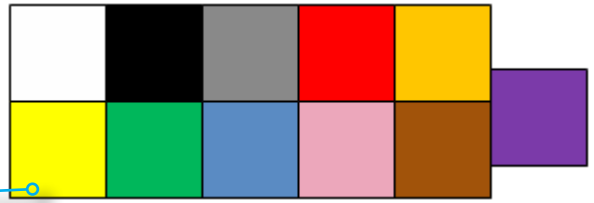
- **Test your Friends to see what is Red, Blue or Purple!**

Turns out, we has human beings do seem to have a physiological way of catagorizing color, but we don't identify the exact same color as purple, blue or red. If you pull out a swatch book or use some paint swatches and show them to your friends and ask them to identify the blue-est blue, the best red or the most grape-alicous purple, you will get some interesting answers,

11 Basic Colors

Based on the seminal paper in the study of chromolinguists by Berlin and Kay in 1969. They did linguistic studies of color names in a multitude of different languages and came to the following conclusion:

"... a total basic inventory of eleven basic color categories exists from which the eleven or fewer basic color terms of any given language are always drawn. The eleven basic color categories are white, black, red, green, yellow, blue, brown, purple, pink, orange, and grey."

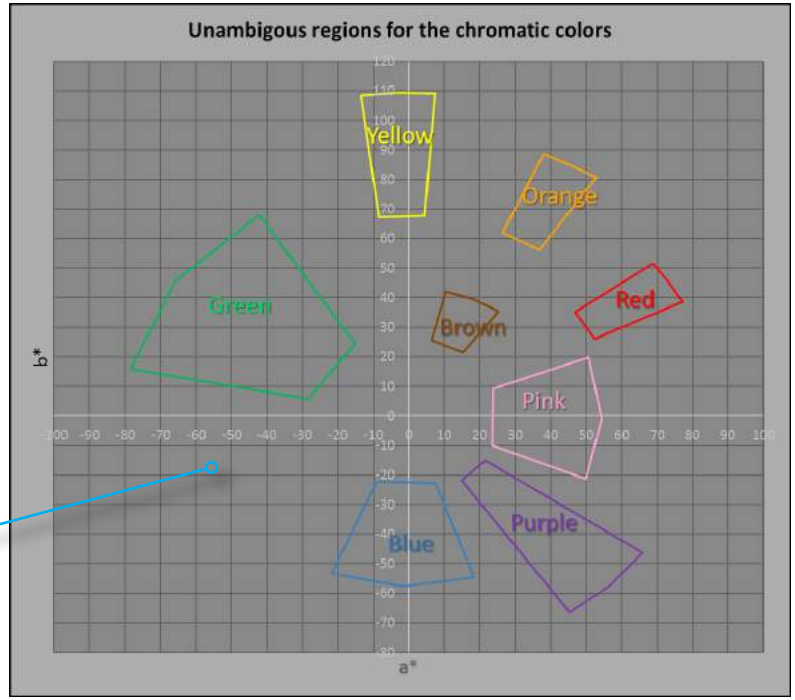


I think that's pretty amazing. There are many independent roots of languages, and for some reason, they eventually all settle on eleven words for basic color names. The words are different, of course, but they all kinda translate. You don't run into a basic color word in Swahili that translates into "a sorta brownish shade of red, but not so dark". There must be something fundamental to the human eye or the neural pathways to the human brain that segregates color into these eleven groups.

Now if you take those fun little PMS books or paint swatch samples and line up your friends to look at them, you will get different picks for what is the best blue, red, yellow or even Pink. Brown...forget it!

Turns out there is a range to the 11 colors that most human beings will identify as a particular hue and agree that its blue or orange.

	Low L*	High L*	Low C*	High C*	Low h	High h
Red	41	49	59	86	27	37
Orange	62	72	67	96	57	67
Yellow	81	90	68	109	86	86
Green	31	72	29	80	122	168
Blue	31	71	24	58	-112	-71
Purple	25	52	26	81	-56	-35
Pink	62	81	25	54	-23	21
Brown	29	41	26	43	55	76



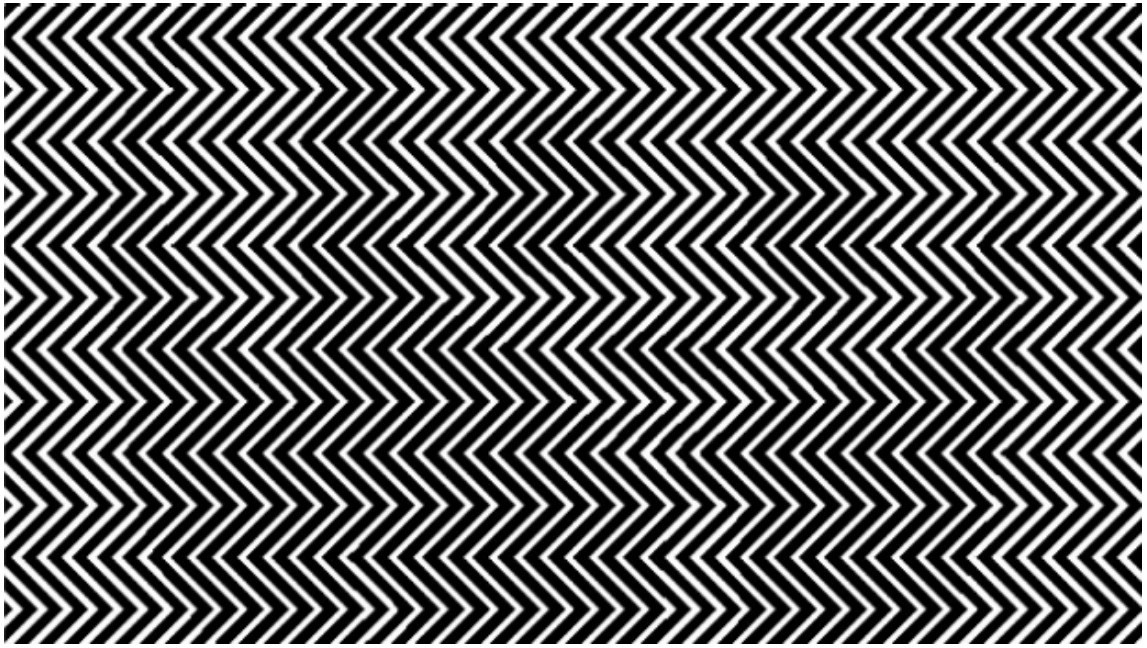
Color Games: How your Color Perception can be Manipulated

• How your Visual Resolution can miss Obvious Messages

Believe it or not, your eyes can actually see more than the nerves than move the message to the brain. The brain does a huge amount of work to automatically interpret the world around you. Your blinds spots in your eyes, the blood vessels and even spacial information are filled in by your brain to try to interpret the images in front of you. Its so automatic that you rarely notice until something goes wrong.

The Striped Panda Bear

Russian artist Ilja Klemencov is the creator behind the optical illusion below (called "They Can Disappear"). The work—comprised of black and white zig-zagged lines that reveal a panda when you look at it the right way.



The hypnotic (and somewhat dizzying) image is actually from a few years ago, but has gone viral after reappearing recently on Reddit. If you're having trouble spotting the appropriately elusive panda, there are a few tricks: take a step back, rotate the image to a near 90 degree angle, or try to focus on a point just slightly away from the image.

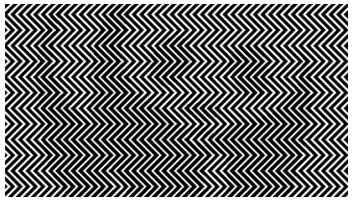
What can the Eye Discern?

While the panda can be easily seen by some observers, others struggled to see the black and white bear. For those having trouble seeing the panda, the advice is to take a step back from the screen and squint. Better? Professor Barton Anderson, from the University of Sydney, said no matter what the excuse, everyone can see the panda behind the zigzagged lines. "All people can see these images," Professor Anderson told news.com.au. "If they say that they can't, just tell them to view the image from a distance, or to blur their eyes by squinting, taking off their glasses, or putting on someone else's glasses to induce blur.

"The eyes are actually made of photoreceptors and neurons, and are best considered as pieces of 'extruded' brain. Some of the processing is done in the eyes, and some (a lot more) is done in the brain."

The trick of these visual illusions is the relationship between our eyes and brain.

According to Inside Science, the way some people notice an image in an illusion quicker than others, boils down to picture "fooling" the brain and taking advantage of "shortcuts."



Color Management Concepts

Color Games: How your Color Perception can be Manipulated

• Can the Human Eye be Quantified like a Digital Camera?

How many megapixels equivalent does the eye have?

The eye is not a single frame snapshot camera. It is more like a video stream. The eye moves rapidly in small angular amounts and continually updates the image in one's brain to "paint" the detail. We also have two eyes, and our brain combines the signals to increase the resolution further. We also typically move our eyes around the scene to gather more information. Because of these factors, the eye plus the brain, assembles a higher resolution image than possible with the number of photoreceptors in our retina. So the megapixel equivalent numbers refer to the spatial detail in an image that would be required to show what the human eye could see when you view a scene completely.

The Dynamic Range of the Eye

The Human eye is able to function in bright sunlight and view faint starlight, a range of more than 10 million to one. But this is like saying a camera can function over a similar range by adjusting the ISO speed, aperture and exposure time.

In any one view, the eye can see over a 10,000 range in contrast detection, but it depends on the scene brightness, with the range decreasing with lower contrast targets. The eye is a contrast detector, not an absolute detector like the sensor in a digital camera, thus the distinction. The range of the human eye is greater than any film or consumer digital camera.

The Sensitivity of the Human Eye (ISO Equivalent)

At low light levels, the human eye integrates up to about 15 seconds (Blackwell, J. Opt. Society America, v 36, p624-643, 1946). The ISO changes with light level by increasing rhodopsin in the retina. This process takes a half hour our so to complete, and that assumes you haven't been exposed to bright sunlight during the day. Assuming you wear sunglasses and dark adapt well, you can see pretty faint stars away from a city. Based on that a reasonable estimate of the dark adapted eye can be done. Based on testing with camera ISO speeds and what the human eye perceives, it comes to about an ISO of 800. But during the day, the eye is much less sensitive, over 600 times less, which would put the ISO equivalent at about 1.

How Many Pixels?

The megapixel equivalent numbers below refer to the spatial detail in an image that would be required to show what the human eye could see when you view a scene. At 90 degrees or [* 60 arc-minutes/degree * 1/0.3 * 90 * 60 * 1/0.3 = 324,000,000 pixels or **324 megapixels**]. At 120 degrees [* 120 * 60 * 60 / (0.3 * 0.3) = **576 megapixels**]. But these numbers are based on a person looking at everything within a scene. If you realize that we only can focus on a small area (with the Fovea) at a time, it comes down to about **7 megapixels** in resolution.

Of course the problem with all this is that we don't see and record images like a digital camera. We don't even take anything like a snapshot with perfect memory. We can remember certain things and some people have excellent memories of colors and faces, but in fact, a photographic memory has never been proven.

In reality, our perception of events, or the story of a time and place in our lives, is often fleeting and subject to change based on emotions, memory, experience, relevance to us, conversations and time. So even though we might be able to calculate out what the anatomy of the human eye can discern, taking that perfect snapshot with our current anatomy, does not translate directly to a megapixel display.

Credit: http://www.clarkvision.com/articles/eye-resolution.html

Color Games: How your Color Perception can be Manipulated

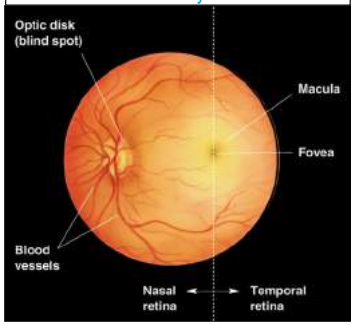
- **Did you know that you are partially blind?**

Why every Human being has a blind spot and how to find yours.

For the most part, the human eye gives the brain an accurate picture of what's going on in the world. There are limitations. Although many birds and insects can see ultraviolet, and some creatures can see infrared, humans are stuck looking at so-called 'visible' light only. This cuts down human's view of the world, not letting them see trails left behind by some mammals, and not letting them fully appreciate the colors of certain flowers, which have evolved to put on quite a show in ultraviolet while remaining plain in visible light. The human eye also can't distinguish between polarized and non-polarized light, while many cephalopods and some birds can.

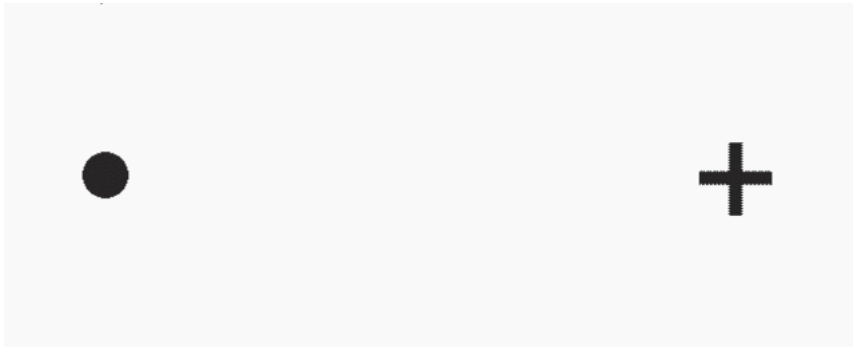
Still, the eye sends back signals that let humans navigate through the world pretty successfully. Many assume that what they see is actually what's out there. That's not entirely true. Each human eye has a blind spot, and the brain has to fill in what is there by looking at the surrounding area.

Picture of the human eye's interior retina



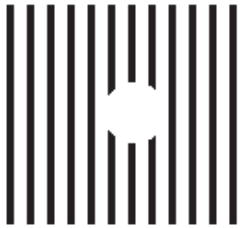
Light gets into they eye by passing through the pupil. It hits the retina at the back of th eye. The retina is covered with light-sensing proteins. They relay what they sense to the optic nerve which carries the information back into the brain as described earlier in this document. The problem is, the optic nerve ends in the field of the retina itself. This is a little like having to plug the power cable for a TV directly into the screen. It creates a dark spot. Most of the time, the other eye will see what's happening in its partner's blind, but if the blind spots overlap while looking at a certain object, or if the person is only looking through one eye, the brain just fills in the spot looking at the surrounding picture.

In other words, we are constantly tricking ourselves into believing that we don't have a blind spot!



How to find your blind spot:
There's a way to find your blind spot. Cover your left eye and look at the dot on the left in this image. Be aware of the cross on the right, but don't look at it - just keep your eye on the dot. Move your face closer to the image, and farther away. At some point, you should see the cross disappear. Stay at that point and close your right eye. Stare at the cross, and you should see that the dot has disappeared. It doesn't just happen with a white background. Try the same with colored paper, and your mind will fill in the background color of the paper when the mark gets in your blind spot. You don't see as much of the world as you think.

To be a bit more precise in showing you how your mind constantly tricks you, try the same experiment with the below image and notice how your mind will "fill in" the missing info for you and you don't even have to think about it.



credit: http://io9.gizmodo.com/5804116/why-every-human-has-a-blind-spot---and-how-to-find-yours