Chapter Two: Perception and Visual Communication

Now that you understand the basics of the visual system, we’re ready to move on to perception. We’ll consider some generalizations about human perception along with the theories that have generated them—theories that will prove relevant to visual communication.

Definition of perception

Perception can be defined as attaching significance to visual information. It entails a higher level of neural processing than the contrast, motion, and orientation processing done to the visual signal in the primary visual cortex. Perceptual processes include but are not limited to identifying faces, judging relative sizes of objects, naming colors, and the initiation of fear responses to organisms or situations perceived as threatening. The important thing to remember about perception is that it’s “in the eye of the beholder”; actually, it’s not in the eye at all, but in the brain, in areas associated with vision in the parietal and temporal lobes. Perception is an essentially constructive process. People do not see the world in the same way a mirror reflects the world; their brains create their perception of the world through processes that are not entirely predictable.

While it has become easier to study the structure of low-level visual processes with the aid of tools such as PET (positron emission tomography) CAT scans (computer assisted tomography) and MRI (magnetic resonance imaging), most perceptual processes are difficult to define and explain because of their complex nature. Simply recognizing a face recruits at least four major brain regions (Figure 1):

![Figure 1: fMRI-based reconstruction of brain areas active in a facial recognition task](http://www.ruhr-uni-bochum.de/igsn/admission/)

Therefore, to draw conclusions about human perception, psychologists must resort to giving people perceptual tasks and measuring their performance.

Relevant findings and theories in perception

Color, form, depth, and motion

Studies of humans and animals have determined that the building blocks of perception, or its vocabulary, if you would prefer to think of it in those terms, are color, form, depth, and motion. Many of these are sorted and determined by individual neurons in V1. But they are passed to higher brain areas to form the bases of perception.
Color

We have already discussed color as far as the rods and cones in the eye are concerned. But the perception and naming of colors is a more complicated process.

Color is actually a chemical response within the cones in our eyes to different wavelengths of light. As you probably know, we can only perceive a certain range of wavelengths, from 400 to 700 nanometers, called the visible spectrum. Within the visible spectrum, waves of light (colors) are categorized according to three physical properties that have perceptual analogs: wavelength (colors), intensity or amplitude (brightness), and purity or degree of mixing with light waves of different wavelengths (saturation). If you have played around with Photoshop™ or other image editors, you're used to seeing Hue, Brightness, and Saturation in your color controls menu. That is one model of colors and color mixing. Others include the RGB or Red Green Blue color model, developed by the physicist Sir James Maxwell; this is the color model used for most electronic documents. Print documents mostly use a model called the CMYK (Cyan Magenta Yellow Black) which involves working from the intersections of the RGB model. For more information on color theory and modeling, see http://www.cs.brown.edu/courses/cs092/VA10/HTML/start.html. Also, John Shipman from the TCC will be lecturing to us on color theory via his Python color mixing application XHue.

The terms “red,” “green,” and “blue” bring up another important aspect to color, and that is the division of the visible spectrum into what we call “colors.” It might surprise you to discover that the languages of the world break up the visible spectrum in very different ways. Berlin & Kay studied the color vocabularies of 20 languages and found that their vocabularies ranged from two terms to 12 terms (English has 11). The two-term languages have terms corresponding to “black” and “white”: Of course, these languages have ways of describing parts of the visible spectrum that we would call “blue” or “red,” but instead of using a basic term, they employ a specialized reference, something akin to English “vermillion” or “cobalt” (Figure 2).

![Figure 2: Color terms of a two-term and three-term language as compared to English](Adapted from Language Files, 9th edition, p. 233.)

Color is a powerful psychological index, and every culture associates colors with abstract categories such as luck, death, and strength. These effects will be discussed in the chapter on cultural considerations in visual communication. You’ve probably heard, also, that pink is a calming color, or that the color red enrages bulls (who can’t actually see red). Psychological studies have proven inconclusive on these effects. However, marketing research indicates that Americans consistently assign certain values or concepts to certain basic colors. Some of these associations are as follows, according to June Campbell’s article on marketing and color at http://www.4hb.com/0107psysocolormarket.html:

- **Red:** passion, speed, danger
- **Blue:** reliability, coolness
- **Yellow:** warmth, happiness
- **Orange:** playfulness, warmth
- **Green:** growth, abundance
The form of an object includes its lines and contours. In Chapter One we discussed briefly how your brain produces stereovision from averaging signals from both visual fields, and how it detects the orientations of all linear features in view. Here we are primarily going to consider the work of psychologists who have identified some robust principles of form perception.

Gestalt psychology built on the work of Max Wertheimer in the first part of the 20th century. The word “gestalt” means “form” but also implies the moment of realization of form, such as the moment that the 3D image suddenly emerges from a stereogram. The central tenet of gestalt psychology is that the whole is more than the sum of its parts, and this definition refers to our brain’s tendency to fill in missing visual information in order to create a coherent perception of form. Gestalt psychology has four component principles that we will find applicable to the task of designing visual documents.

1. Law of proximity: Closely-grouped items are perceived as a form.
2. Law of similarity: Similar items are perceived as a form.
3. Law of continuity: Items that extend a form predictably are considered part of that form.
4. Law of closure: Forms with missing parts are “completed” by the brain.
5. Law of common fate: Items that are perceived as moving together are considered part of the same form.

Figure 2 illustrates all but the Law of Common Fate. The trick with the Law of Continuity example is to realize that you prefer to perceive the form as two crossing wavy lines rather than two touching “Q-tips”:

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**Figure 2: Gestalt Laws**
A final important thing to understand about the perception of form is that we try to fit forms we encounter into categories of related forms. This habit obviously serves us well in detecting predators and locating desirable forms such as pools of water in the desert. Each category we have is linked to a word, and each category has a **prototype**. A prototype is the most typical member of the category. Researchers disagree about how prototypes are formed and activated in the brain, but no one questions their existence. For instance, if I say the word "bird" to you, and you concentrate on the image that appears in your mind’s eye, you will most likely see something close to a robin. This is the prototype bird that most North Americans see because this is the kind of bird they encountered most frequently when learning this word as a child. Now, you might see Big Bird or a penguin, but that would likely be the result of **priming**, meaning you had just seen *Sesame Street* or been discussing *March of the Penguins* with someone. More evidence for prototypes comes from this phenomenon (Figure 5):

![Figure 5: Pine trees from http://www.ca4h.org/4hresource/clipart/plants/pics/tree%20pine.gif](http://www.ca4h.org/4hresource/clipart/plants/pics/tree%20pine.gif)

You recognize these as pine trees even though you have never seen these particular trees before; in fact, they do not exist in the real world except as an artist’s rendering. The reason you are able to recognize novel objects as members of established categories is because those categories are built of featural descriptions. Again, researchers disagree about exactly how these descriptions are created, but the process involves you matching the novel objects’ (in this case, the pine trees’) visible features to the features that characterize the prototype of the pine tree category in your memory.

**Depth**

The Gestalt principles above actually help us determine the most important division of our environment: **figure and ground**. If we see some dark polygons moving in close proximity and in the same direction behind some foliage in the evening, we group them together and assume this is an animal. Our interest in determining the type of animal, based either on curiosity as wildlife watchers or on self-preservation instincts, makes that form the figure and everything around and behind it the ground against which its trajectory and proximity are judged. So, while Gestalt laws such as proximity and common fate help us construct form, our shifting of brain resources to pay attention to this form to the exclusion of its surroundings is what really makes it the figure.
Photographers often compose their photographs to help us recognize the figure they wish us to focus upon against the ground of the rest of the image. They do this by exploiting a set of characteristics connected to depth perception, including centering, size, color, contrast, layering, spacing, textural variation, and movement. By the way, these are also the characteristics that you use to “cheat” in establishing depth in monovisual situations (when you are only using one eye):

- **Centering:** Centering the figure against the ground replicates the experience of focusing your eyes on something; it also replicates the perspective you would have of the scene if you were standing right in front of the figure.
- **Size:** Larger objects appear closer and are better candidates for figure than distant objects, which are better candidates for ground.
- **Color:** Brighter colors attract attention while dimmer or darker colors fade into the ground.
- **Contrast:** A bright object against a dark background or a dark object against a bright background will be perceived as a figure. Also, brighter objects attract attention because they are usually closer in our environment.
- **Layering:** If an object partially obscures another, the fully visible object will be perceived as figure.
- **Periodicity:** Repetitive features such as fenceposts, and ripples appear farther apart in the foreground and much closer together in the distance. This effect can help focus attention on a figure.
- **Textural variation:** We tend to focus on objects of greater variability in texture, so if a white kitten is presented against a smooth white background, we will select the kitten as figure.
- **Movement:** Items in motion will be selected as figure over items at rest, which will be perceived as ground. Even in a static image such as a photograph, motion can be indicated by long exposure, leaving blurry “tracks” on the image of the figure’s movements.

Take a look at this photograph and try to determine as many of the above principles, including Gestalt principles, that you are using to decide on what is figure and what is ground (Figure 3):

![Figure 3: From http://photoinf.com/Golden_Mean/Petteri_Sulonen/Space_Figure_Ground.htm](http://photoinf.com/Golden_Mean/Petteri_Sulonen/Space_Figure_Ground.htm)

You most likely used contrast, color, and textural variation, as well as centering. Although the apple core is not absolutely centered, it is close to the center of the bottom of the image, and thus gives the impression of being closer and more important that items in the back or top of the image.

### Movement

The perception of movement has some interesting applications for visual communication. Sometimes you are creating documents that contain motion, such as video or animation. But most of the time you are creating static images. Yet, these images can contain elements that are perceived as or linked to movement in various ways. An extreme example is the phenomenon of peripheral drift, where small blocks of decreasing darkness are interpreted by the eye as motion.
away from the darkest block. An excellent example can be found on Akiyoshi’s illusion pages, in the “rotating snakes” illusion (Figure 4):

Figure 4: Akitaoka’s Rotating Snakes Illusion illustrating peripheral drift
From http://www.ritsumei.ac.jp/~akitaoka/rotsnake.gif

The explanation for this interesting effect is not clear, but researchers believe it may be due to a hypersensitivity to motion in the rods populating the periphery of your vision; obviously, a selective advantage would be conferred on any mammal that could detect a predator sneaking up on it from the side.

More normal invocations of motion in static images include imitating viewing patterns, symbolic motion, and implied motion:

- **Imitating viewing patterns**: In Western cultures, psychologists have established habits in the ways people move their foveas over an image in order to take it all in—left-to-right and top-to-bottom. Positioning a sequence of images or text blocks along these trajectories facilitates reading because it mimics normal patterns of eye movement over a page.

- **Symbolic motion**: Certain shapes are perceived as indicating motion—wavy lines, jagged lines, triangles, and arrows, for instance.

- **Implied motion**: In a photograph of a running child, the angles of her arms and legs, the distance of her feet from the ground, and the blur created behind her by the speed of the shutter all imply motion. These elements can be replicated graphically as well as photographically.
Semiotics

We have already mentioned three theories of perception and considered them briefly: color theory, Gestalt theory, and prototype theory. Another important theory of perception expands our notion of significance as it has been defined thus far in this chapter. We have been treating significance as a relatively low-level principle that governs the matching-up of visual information with established categories such as colors and prototypes. A higher-level version of significance looks at how color, form, depth, and movement are matched up with values and other culturally-determined categories. We strayed briefly into this realm when we discussed the values associated with certain colors by North Americans. But Semiotics provides a simple structure that is very powerful for helping determine the cultural significance of perceived forms.

Semiotics is a subdiscipline of both philosophy and aesthetics. It was founded by men such as Ferdinand de Saussure and C.S. Peirce. French philosopher and social critic Roland Barthes is probably the most well-known semiotician; he did famous "readings" of cultural signs such as Greta Garbo’s face and pro wrestling in the 1950s and 1960s. Semioticians call forms that are significant at the cultural level signs. They categorize cultural signs into three categories:

- **Iconic signs:** these look like the concept they represent (the pine tree drawings)
- **Indexical signs:** these have a logical connection to the concept they represent (a clock indexes time)
- **Symbolic signs:** these have an arbitrary, culturally-agreed-upon connection to the concept they represent (the word “dog” symbolizes a dog; the American flag symbolizes the United States of America)

Barthes claims these signs can be combined into elaborate codes that control the way we deal with certain concepts: i.e., apple pie, aprons, babies, and the Beav’s mother all formed a code of "motherhood" that affected Americans strongly in the middle part of the 20th century.

**What visual communicators can learn from perceptual theories**

The basic lesson from studies of perception is that visual documents, even photographs, are not windows to reality. The brain, personality, and cultural upbringing powerfully influence the process by which a person makes meaning from visual images. Keep these points and tools in mind as we proceed:

- Gestalt theory
- Color, form, depth, and movement
- Prototypes
- Cultural signs (iconic, indexical, and symbolic)

**Exercise**

Read Annie Dillard’s essay “Seeing.” Then, observe something in your environment and record your sensory impressions. Try to use all the resources that Dillard mentions—not just sight, but sound, taste, touch, memory, emotion—all of the other senses that blend into the process of “seeing” something.