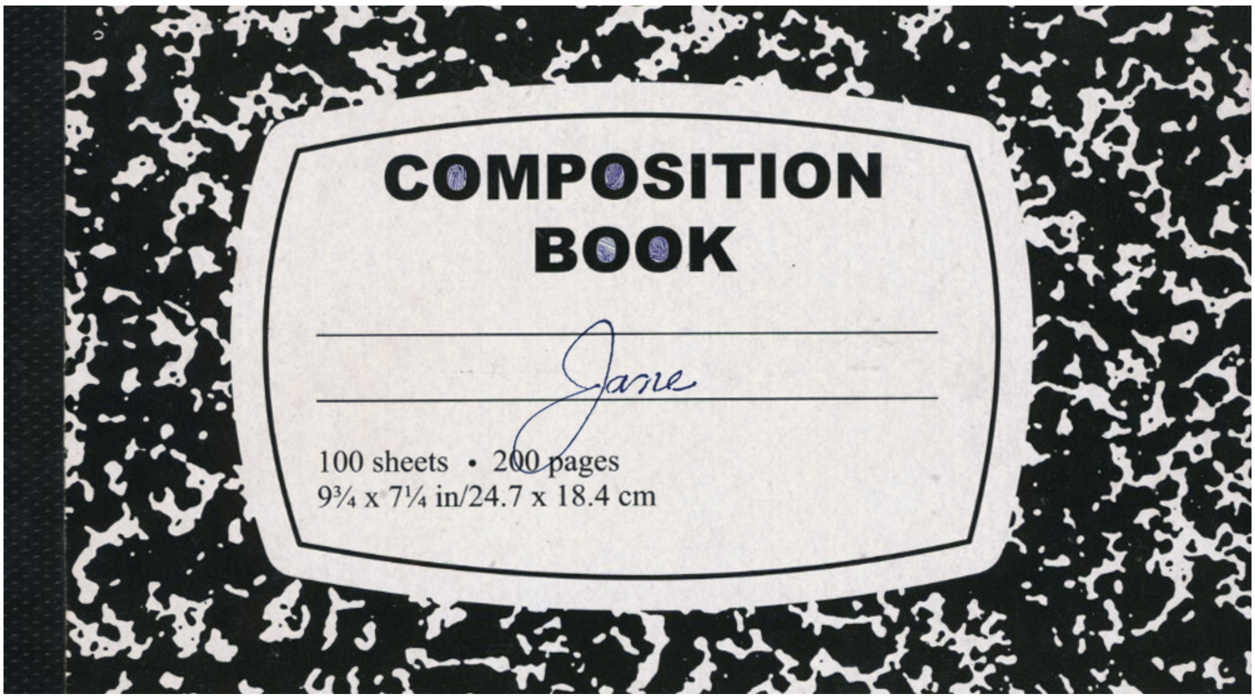
A Primer on Pictorial Composition: Parts I-VII

by Anthony Waichulis
www.anthonywaichulis.com

So what's with Jane already? A Primer on Pictorial Composition. (Part I)



Each spring I would find my college classrooms filled with a number of students intending to continue their educational journey after graduation. They would often ask about which schools or programs were "best". I would always meet their question with one of my own: "What do you intend to do after school?" It was their answer to my question that would ultimately answer their own.

In the summer of 1947, renowned psychiatrist BF Skinner published a study regarding the behavior of a group of pigeons in isolation. The research for the study involved the observation of the pigeons as they were fed at regular intervals regardless of their behavior. What observers soon witnessed was that the majority of pigeons began to exhibit consistent, seemingly superstitious behavior—believing that by acting in a particular way, or committing a certain action, food would arrive. The behavior of the pigeons in this study is not unlike the many creatives struggling to uncover the means by which to consistently produce a "successful" picture. Artists that are hungry to understand the mechanisms of image-building entertain everything from the application of complex geometric armatures to the mathematical analysis of seashells to uncover the key to producing consistently "strong" imagery. Unfortunately, the majority of educational information regarding pictorial composition is a mixture of colorful fictions, inconsistent heuristics, and aspects of personal taste passed off as "rules" or "laws". Pursuing such compositional devices often amounts to little more than the behavior exhibited by our well-fed pigeons.

Let's look at this excerpt from Pictorial Composition by John Michael Angel:

"*A simple, abstract element should be placed on the page such that the left and right margins are equal to each other, and the bottom margin is the largest of the four. The top margin can be the same width as the sides, or can be slightly smaller. However, a figurative element (a figure, a head and shoulders, a jug, a mass of flowers, a group of trees, whatever) looks better when placed slightly off-center. This gives more* *interest, more animation, and hints at an increased realism, as nature is rarely seen perfectly centered*."

This excerpt seems to confidently state that your imagery will hold "*more interest, more animation, and hints at an increased realism*" if you follow these instructions. The problem is that there is no evidence to support this claim other than the fact that some celebrated artwork in the past has been created with similar margin considerations and an "*off-center*" element. Furthermore, to state that "*nature is rarely seen perfectly centered*" demonstrates a significant lack of understanding of, or appreciation for, the mechanisms of visual perception since the center of our gaze holds the greatest acuity. Therefore, we often work to center objects of interest in the center of our gaze to elicit the greatest amount of visual information.

Unfortunately, this example is typical of many contemporary educational resources regarding pictorial composition.

So are there devices or viable information that can allow an individual to consistently generate "successful" imagery?

Of course. However, such resources are not the static, arbitrary global operations that you might be familiar with. They are dynamic, adaptable considerations that are defined by our biology. Let's first define pictorial composition and then explore how biology may define its component parts.

Pictorial composition can be defined as the specific content of an image as well as the spatial relationship of its elements with respect to aesthetic quality and communication efficacy.

Try and read this sentence:

Now try to read this one:

Now this:

Jane walked down the street.

All three sentences are constructed with same content and grammar. How they differ is in the visual elements that manifest that content and grammar. The characters of the first sentence are so thin and spatially condensed that parsing out the individual letters to successfully read the sentence is nearly impossible. The second sentence offers no contrast between the background and the foreground characters. This lack of contrast also produces a stimulus that is incapable of conveying the intended information. These first two examples demonstrate one way in which our biology may define successful communication. Light outside the visible spectrum, contrast lower than our minimum contrast sensitivity, or a stimulus that is on a scale beyond the limits of our angular resolution is not going to be of much use in regards to visual communication.

The third sentence above is constructed with a configuration of visual elements that allows for a reader, fluent in the conventions of the English language, to successfully elicit the intended meaning. The reader can quickly garner that at some point in the past, an individual named Jane had walked down a street. The sentence is a visually viable, self-contained unit of meaning that effectively conveys information according to the logic of the language's grammar.

This example does bring to mind one of the ways in which I feel that visual imagery may hold an advantage over other forms of communication (written/spoken language) in that the conventions of visual perception are more prevalent among the species than are the conventions of any other standardized form of communication. The adage, "a picture is worth a thousand words" epitomizes this idea.

For example, here is the same sentence translated into Yiddish (via an online translator).

גאַס יד אַראָפּ ןעגנאגעג ןיישזד.

While the visual elements are perceptually viable, if you cannot read Yiddish, and have no means of translation, then the intended meaning of the sentence is unavailable to you. The sentence may have optimal content as well as optimal construction—but may fail to communicate due to lack of shared conventions with a target audience. This type of problem may arise with creative efforts that seek to be extremely novel. If an effort to communicate is so novel that it completely abandons all existing convention, communication will be severely diminished.

Now, if my intention was to communicate that Jane walked down the street and I composed a sentence that read,

Walked street Jane the down.

then the sentence would be deemed problematic. The content is fine, but the arrangement of the subunits (words) within the unit (sentence) causes a diminishment in the clarity of the message. Furthermore, if I wanted to communicate that Jane walked down the street, and I wrote,

Jane is taller than Michael.

the sentence would also be problematic. The sentence is well constructed as far as the conventions of grammar are concerned, but the words do not communicate the intended information. Therefore, the construction is successful, but the content is not appropriate to communicate the intended message.

OK, that offers an introductory glimpse into the idea of communication and the respective role of biology, but what about the "aesthetic quality"?

Even with our short, simple sentence there is an aesthetic quality worth our consideration. Our behavior is constantly influenced by the aesthetic qualities of external stimuli. These qualities are the characteristics of a stimulus that elicit adaptive responses that have evolved to reinforce or discourage specific behaviors. We may prefer one type of sensory experience over another—describing one as repulsive and the other beautiful. However, aesthetic qualities should not be confused with individual tastes. Many refer to aesthetic properties as personal preferences and this, I

believe, is a serious mistake. Like most concepts involving evolution, concepts of "aesthetics" and "beauty" seems to be most productive when considered on the level of populations and not the individual. For example, it is not important that Jane may prefer Vanilla over Chocolate—but rather that Jane, if human, would most likely have a biological predilection for sugar and fat.

Paul Bloom touches on this topic in his 2010 book *How Pleasure Works: The New Science of Why We Like What We Like:*

"It is true that we can imagine cultures in which pleasure is very different, where people rub food in feces to improve taste and have no interest in salt, sugar, or chili peppers; or where they spend fortunes on forgeries and throw originals into the trash; or line up to listen to static, cringing at the sound of a melody. But this is science fiction, not reality.

One way to sum this up is that humans start off with a fixed list of pleasures and we can't add to that list. This might sound like an insanely strong claim, because of course one can introduce new pleasures into the world, as with the inventions of the television, chocolate, video games, cocaine, dildos, saunas, crossword puzzles, reality television, novels, and so on. But I would suggest that these are enjoyable because they are not that new; they connect—in a reasonably direct way—to pleasures that humans already possess. Belgian chocolate and barbecued ribs are modern inventions, but they appeal to our prior love of sugar and fat. There are novel forms of music created *all the time, but a creature that is biologically unprepared for rhythm will never grow to like any of them; they will always be noise.*"

Oliver Reichenstein, the founder of Information Architects, also addresses the problem with discussing individual tastes when exploring design and aesthetic concepts in his 2013 paper, *Learning to See*:

"*Whether I like pink or not, sugar in my coffee, red or white wine, these things are a matter of personal taste. These are personal preferences, and both designers and non-designers have them. This is the taste we shouldn't bother discussing.*"

So then what would be the aesthetic considerations for "Jane walked down the street"?

The content of the sentence seems somewhat banal. I suspect that the statement regarding Jane, her actions, and the street would not make the six o'clock news or the New York Times best-seller list without further development. It might be considered the equivalent to the trite artistic concept of an apple sitting on a table. However, there is an aesthetic component worth considering in the succinctness of the sentence's construction. The structure is just as long as it needs to be to communicate exactly what was intended. The sentence does not overwhelm our working memory with unnecessary or redundant variables that may cloud comprehension. This type of bias is known as a fluency heuristic. This is a cognitive heuristic in which, if one statement or idea can be processed more fluently, faster, or more smoothly than another, the mind infers that this statement has a higher value. In other words, the more skillfully or elegantly an idea is communicated, the more likely it is to be considered seriously, whether or not it is logical.

This is not to say that long sentences are any less capable of being aesthetically pleasing for a myriad of reasons. In fact, I would argue that it requires more skill to entice a reader to follow a long and winding road of text. After all, it could be argued that it may present less of a challenge to visually communicate that apple on a table as opposed to a robust Civil War scene—and displays of virtuosity indeed carry an aesthetic influence.

Take for example this lengthy gem from All the King's Men, by Pulitzer-winning poet/author, Robert Penn Warren:

"*I ate roast duck stuffed with oysters and yams and that wonderful curry they make in Savannah, which tastes good even to a man like me who loathes food, and drank rye whisky, and walked down those beautiful streets General Oglethorpe laid out, and stared at the beautiful houses, which were more severe than ever now, for the last leaves were off the arching trees of the streets and it was the season when the wind blows great chunks of gray sky in off the Atlantic which come dragging so low their bellies brush the masts and chimney pots, like gravid sows crossing a stubble field.*"

Now while this lengthy sentence may indeed exercise the working memory of a less experienced reader, it is indeed well constructed and rife with lush content. It is also unfair for me to take this lengthy text out of its original context for assessment—but I felt it necessary to further the point here. If "Jane walked down the street" is the equivalent to an apple sitting on a table then Warren's sentence is more akin to John Atkinson Grimshaw's Evening Glow.

John Atkinson Grimshaw, Evening Glow, 1884, Oil on canvas, 286 mm x 432 mm

It is with these examples that I hope it is starting to become clear that aesthetic qualities are also ultimately defined by our biology. If we had evolved differently, then we just might, as Paul Bloom states, "line up to listen to static, cringing at the sound of a melody."

Ok so now that we have a basic framework for understanding how biology defines both communication and aesthetic quality—what about content?

As demonstrated earlier, content can be ideal or problematic in regards to effective communication and/or aesthetic quality. Exploring concepts of content can be almost Sisyphean in scope, so, for now, we will limit its contribution here to the previous examples.

So then, what about spatial relationships?

Spatial relationships can influence the perception of visual content, impact communication, and affect aesthetic quality. Let's look at what altering the spatial arrangement of our previous sentence's characters might result in:

Janewa lk eddo wnth estre et.

As you can see, the content remains the same, the sequence of characters remains in line with the previous examples of a grammatically correct sentence; however, the spatial relationships now significantly impact both communication and aesthetic quality.

Some visual elements can be perceived very differently when influenced by spatial relationships. Simultaneous brightness contrast, simultaneous color contrast and contextual effects are just a few of the consequences that spatial relationships hold on visual elements.

Look at these two sentences:

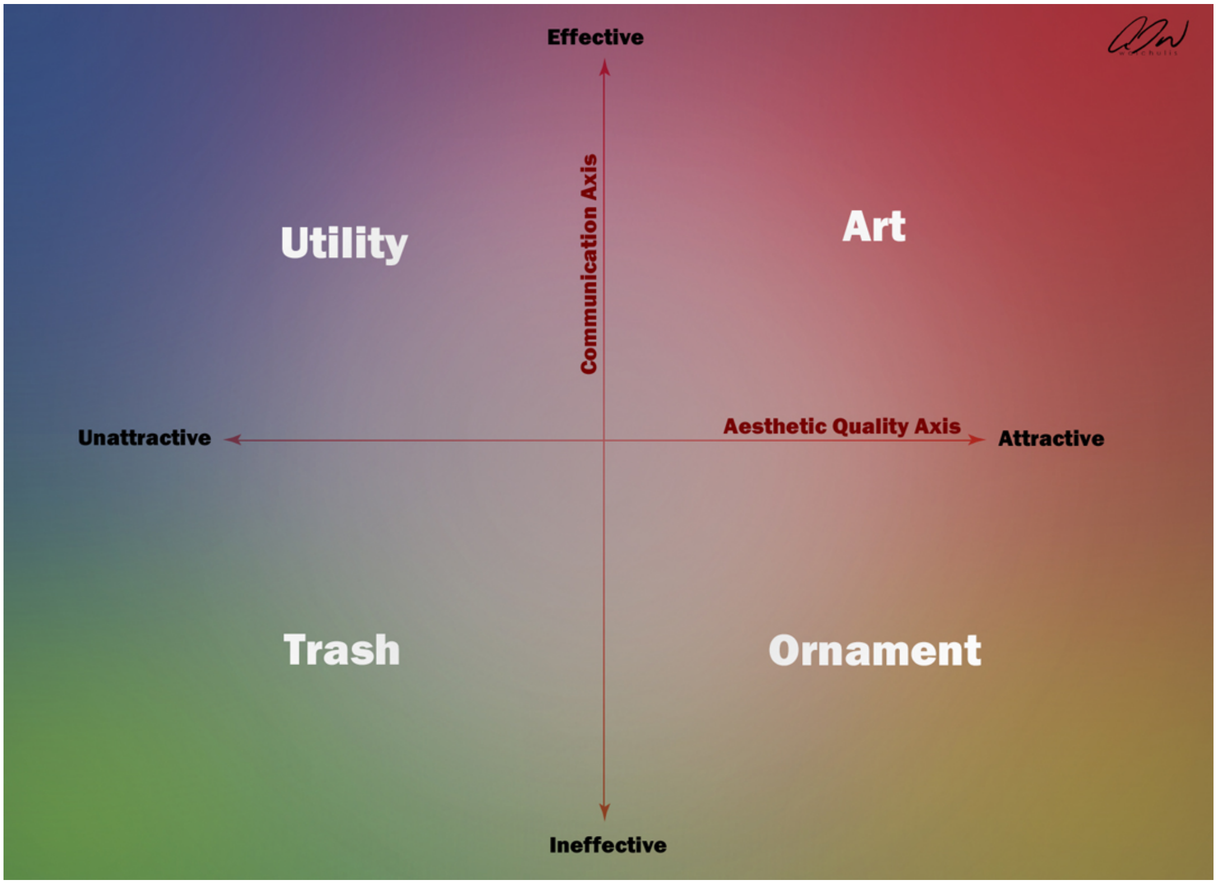
The group traveled together.

The group traveled to get her.

Both sentences contain the same letters in the same sequence but have very different meanings due to minor changes in the spatial relationships of the characters.

By studying the spatial arrangement of visual elements rather than merely the characteristics of the visual elements alone, we can find new dimensions of visual information. Just ask this Dalmatian.

With this rudimentary framework for understanding the general variables of pictorial composition, let’s take a moment to examine a graphic that can help us to understand how communication viability and aesthetic qualities may work in concert to yield a specific product.



In the above graph we can see how factors of communication and considerations of aesthetic quality can allow us to successfully categorize a product. If we find that a product communicates effectively AND is aesthetically attractive, then we would most likely consider it a work of art. In contrast, if a product can effectively convey information but LACKS aesthetic qualities, it is often deemed utility (think of a street sign). If an object holds aesthetic quality but does NOT convey any information, it may be regarded as ornament. And lastly, a product that does NOT effectively convey information, NOR holds any aesthetic quality, is often deemed trash.

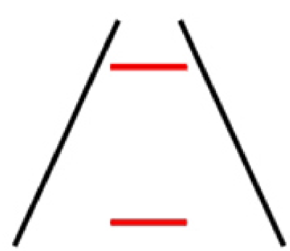
It is important to note that these categories are not as clearly defined as the central axes may imply. For this reason, I have added a background of overlapping colors to better demonstrate the nature of these quadrants (Art/Red, Utility/Blue, Ornament/Yellow and Trash/Green). As a product approaches the outermost corners of the graph, it would be considered a stronger representation of that quadrant's category. However, due to the dynamic nature of our biology, I am not sure if anything could ever truly reach the perimeter of any quadrant.

Now that I have presented a general overview of biology's role in the facilitation of viable communication and the experience of aesthetic quality, I would like to address the influence of context on all of this. However, this will require some rudimentary understanding of visual perception. It should be understood that the conflated images generated by a biological vision system do not accurately portray the physical world. The chasm between the physical and the psychophysical is significant and as such we need to acknowledge that what we "see" is a construct of evolved biology—not an accurate measurement of an external reality. The mechanics of the visual system should not be confused with devices that can garner reasonably accurate measurements of the physical world (e.g., caliper, light meter, spectrophotometer, etc.). Rather, the visual system interprets stimuli based on past experiences and stored information in an effort to yield successful behavior. It is not the external reality alone that weaves the image we "see"–rather it is the biology of the viewer.

Neurobiologist Dale Purves writes: "*Using the only information available on the retina, a wholly empirical strategy gives rise to percepts that incorporate experience from trial and error behaviors in the past. Percepts generated on this basis do not correspond with the measured properties of the stimulus or the underlying objects.*

A plausible answer to this puzzle is to simply abandon the long-held assumption that vision involves seeing or estimating physical properties. In this alternative interpretation, vision works by having patterns of light on the retina trigger reflex patterns of neural activity that have been shaped entirely by the past consequences of visually guided behavior over evolutionary and individual life time. Using the only information available on the retina (i.e. frequencies of occurrence of visual stimuli, light intensities), this strategy gives rise to percepts which incorporate experience from trial and error behaviors in the past. Percepts generated on this basis thus correspond only coincidentally with the measured properties of the stimulus or the underlying objects."

With this scaffolding of visual perception in mind, we must acknowledge that the context in which a particular stimulus is observed is a vital contributor to the resulting percept. For example, we may perceive the length of a particular line differently as the surrounding context of the line is altered (both red lines are physically identical in length.)



The Ponzo Illusion. Both red lines are of the same length but appear different due to surrounding context.

Dejan Todorović wrote in the 2010 *Review of Psychology*: "*In our everyday perception, when we look at an object, intuitively it seems* *obvious that what we are aware of are just the properties of that object itself, and not of something else, beyond the object. However, contextual effects do exist, ranging from weak but noticeable to strong and perplexing, and present major challenges to our understanding of the working of perceptual mechanisms and cognitive processes in general.*"

Let's try an experiment that might better communicate these ideas regarding context, perception and experience. See if you can "read" the following text:

Ca y o re a t is?

W at ar ou rea in ?

Y u a e not r adi g th s.

A r se by any other n me would sm l as sw et.

For Star Wars fans:

May the ce be w th y u.

The image above shows several strings of spaced letters that can be "read" as sentences. The first three sequences are used by Dr. Beau Lotto (director of *LottoLab*) to successfully demonstrate how the visual system uses past experience/frequency of occurrence data in perception. We insert the letters that our experience deems "most likely" based on the available information.

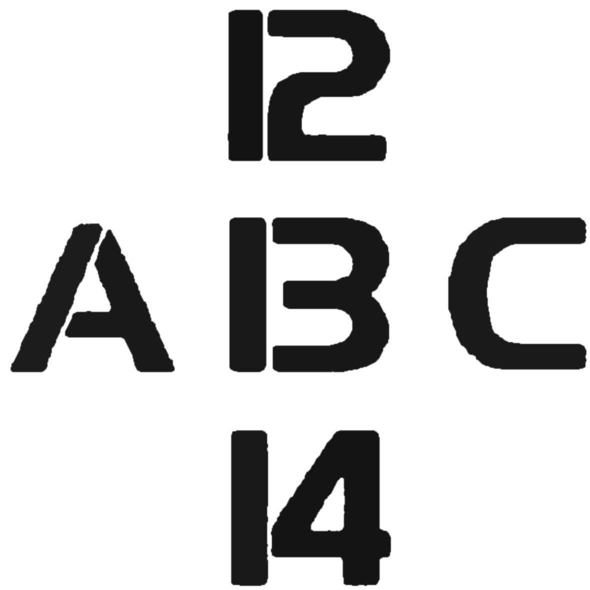
The quote from Shakespeare ("*a rose by any other name would smell as sweet*") contains the letter grouping *sm l* in the sentence which could easily become the word *smile* instead of the word *smell*. I would think it may be reasonable to suspect that some aesthetic "word-preference survey" could easily yield that, independent of context, the word *smile* would find aesthetic preference over the word *smell* (as the concept for the former may be generally more attractive than the latter for a number of biological reasons), but in the above context, if your past experience warrants, your brain opts for *smell* over *smile*.

The same holds for the more common pop-culture phrase made famous by the popular Star Wars franchise ("*may the force be with you*"*)*. You can just as easily fit in the word *peace* instead of *force*. Again, you can probably conduct a survey to find that more people would prefer the word *peace* over the word *force* in isolation, without supporting context–however, we again find the potential aesthetic preference of an individual variable surpassed by context.

Let's look at another sentence:

Ja e w ked down t e street.

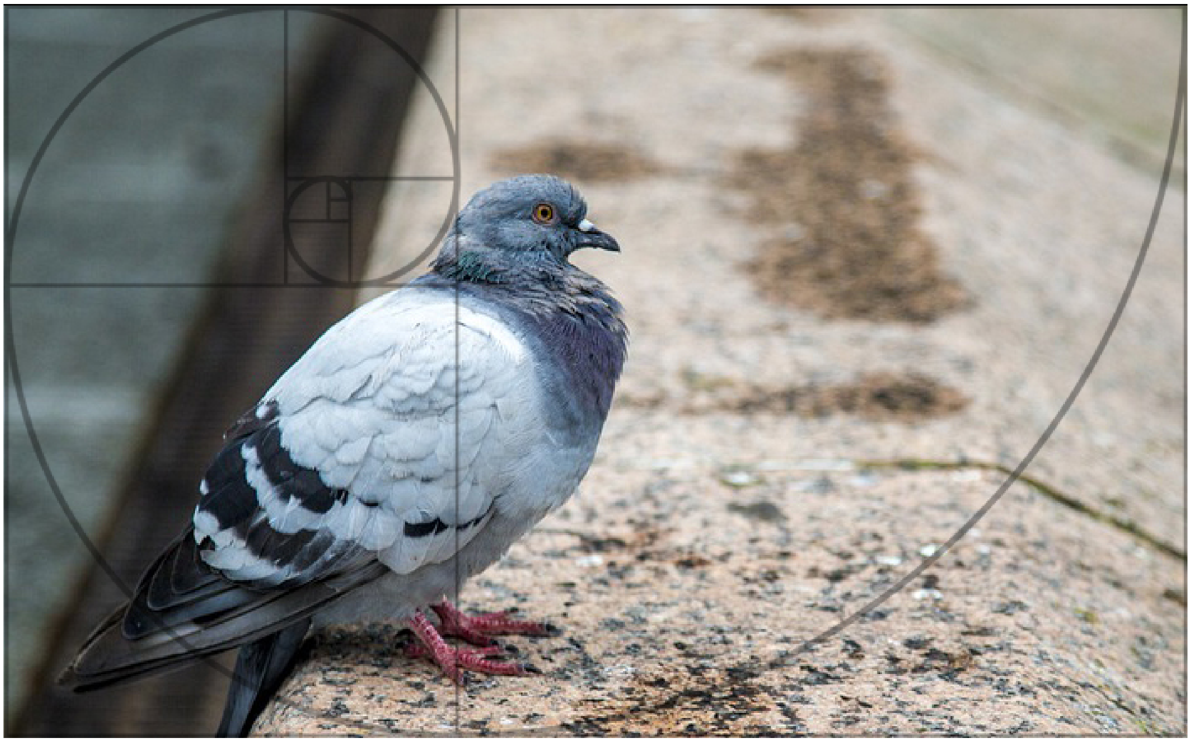
Did you read "Jane walked down the street"? Why did you not read, "***Jake*** walked down the street"? Why not "Jane ***worked*** down the street"? Well, maybe some of you have, but I would be willing to bet that the majority of you perceived the same sentence that we have been revisiting throughout this paper. You augmented the sentence with the most likely characters to coincide with the existing context.



What is being represented in the center of this graphic? Is it the number thirteen of the letter B? At the risk of flirting with the abuse of the aforementioned fluency heuristic, I think we can agree that more often than not:

Context can override ev ryth ng.

So we arrive at the end of my first installment on the concept of pictorial composition. I hope that I have clearly demonstrated the components of the definition presented at the onset of this paper. Additionally, I hope that I have been able to establish a groundwork for you to better evaluate the many contributions of contemporary compositional devices that plague art education today. I will also present practical alternatives based on actual scientific studies into aesthetic preference and visual communication. I hope you will stay with me for the journey!



Meet Jane.

“To the makers of music – all worlds, all times” A Primer on Pictorial Composition. (Part II)

“One does not meet oneself until one catches the reflection from an eye other than human.” –Loren Eiseley

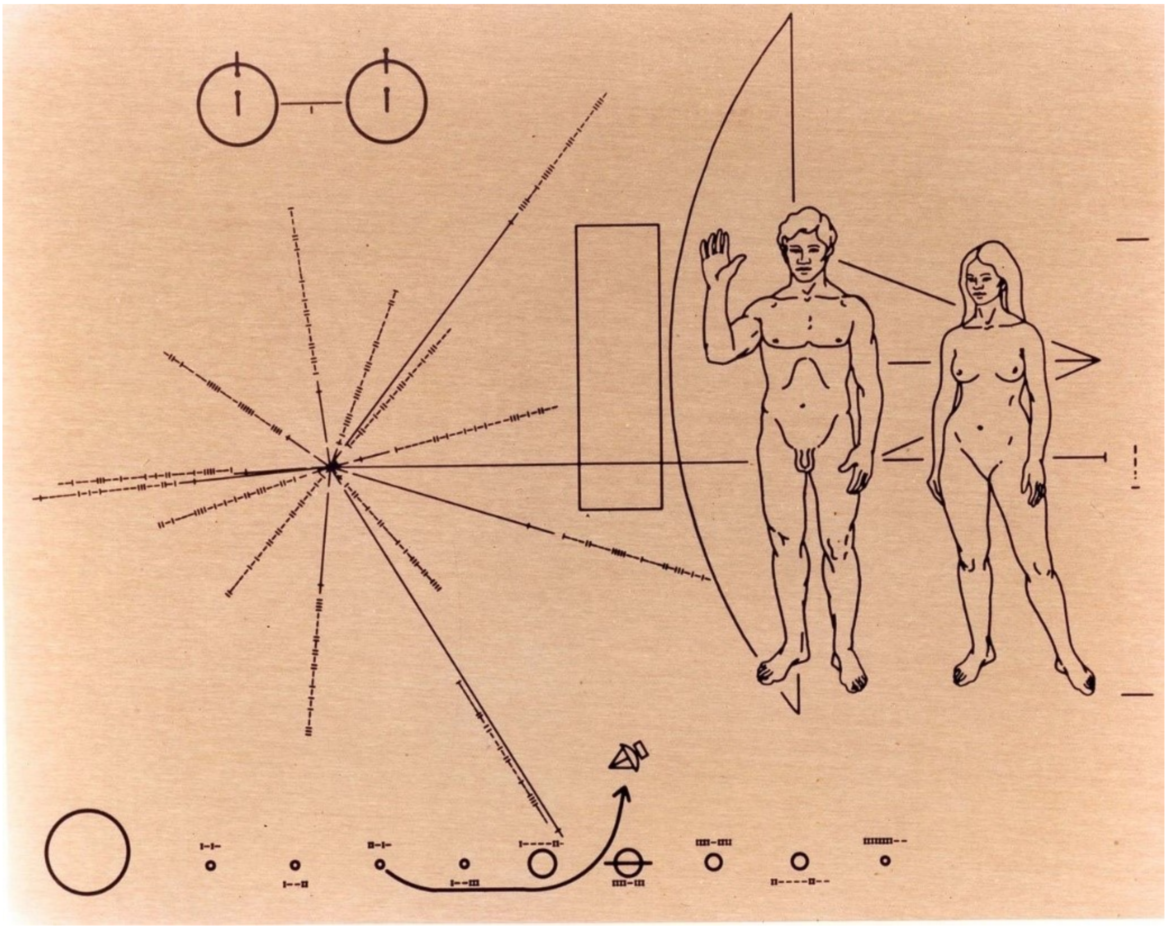
During the summer of 1977, NASA launched two robotic probes, Voyager 1 and Voyager 2, from Cape Canaveral to conduct studies of Jupiter and Saturn as well as their respective moons. The mission would have the probes fly by their targets, collect data, and slingshot out of the solar system. Knowing that these probes would eventually drift into deep space after their mission was complete, NASA decided to make an addition to the probe that would essentially transform it from a “data collector” to an “interstellar message-in-a-bottle.” With this idea in mind, NASA turned to astrophysicist Carl Sagan to assemble a message that would be appropriate for contact with "a possible extraterrestrial civilization."

Dr. Sagan responded to this challenge by assembling a team to create what would become known as the "Golden Records." Onto two twelve-inch, gold-plated copper phonograph records encased in a protective aluminum jacket, Dr. Sagan placed 27 pieces of music (90 mins), over 118 images encoded in analog form, spoken greetings in 55 languages, and a variety of nature and animal sounds (12 mins). Hand-etched on the records' surface is the inscription "*To the makers of music – all worlds, all times*." The record's case contains an illustration of a pulsar map, detailing Earth's location, and a patch of uranium 238 to infer the time elapsed since launch. The information etched on the Voyager records are expected to last at least one billion years.

Carl Sagan noted that "t*he spacecraft will be encountered and the record played only if there are advanced space-faring civilizations in* *interstellar space. But the launching of this 'bottle' into the cosmic 'ocean' says something very hopeful about life on this planet.*"

On August 25, 2012, data from Voyager 1 indicated that it had become the first human-made object to enter interstellar space, traveling "*further than anyone, or anything, in history*." As of 2013, Voyager 1 was moving with a velocity of 17 kilometers per second (11 mi/s) relative to the Sun. Voyager 2 is expected to enter interstellar space by 2016.

For those that are interested you can explore the Golden Records in much more detail here: **http://goldenrecord.org/** as well as pinpoint the probe's current locations here: **http://voyager.jpl.nasa.gov/where/**
Dr. Sagan's idea for the content of the Voyager records was essentially an expansion on the illustrated plaques that he had created for an earlier probe mission. Two probes, Pioneer 10 and 11, also launched from Cape Canaveral in the 1970s, each carrying 152 x 229 mm (6 x 9 inch) gold-anodized aluminum plaques that feature the nude figures of a human male and female along with several symbols that are designed to provide information about the origin of the spacecraft.

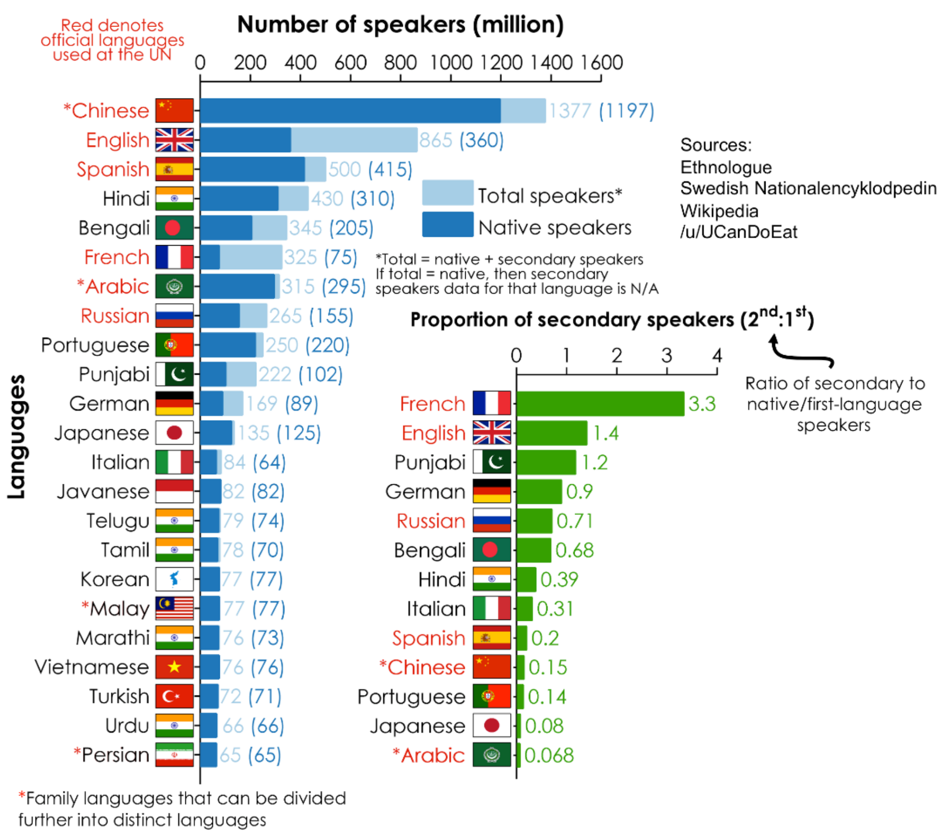


Pioneers' pictorial message was designed to provide information identifying the spacecraft's' time and place of origin. The plaque was designed by Carl Sagan and Frank Drake and illustrated by Linda Sagan.

Let's think about this for a moment. If you had to compose a message to be sent out into space to communicate with a potential extraterrestrial intelligence, how would you go about it? Can you even begin to imagine the vast myriad of problems that one would encounter in trying to convey information to an entity that does not share a similar biology to ourselves?

Put that Sisyphean task aside for a moment and consider the less problematic task of communicating a message to your fellow humans. What product can you create that would successfully convey information to as many people as possible?

Before you reply, “*I would just speak or write a clear statement*” consider the significant diversity of language on our planet. Here is a breakdown of some of the languages spoken by the over 7 billion people currently inhabiting our world:



Another option, however, and the focus of this series might be the use of visual imagery.

If you have traveled internationally, then you have probably made great use of simple graphics or icons that conveyed important information when familiar terms and phrases of a conventional language were absent. Here are a few examples:

Simple images like these can indicate danger, safety, sanctuary, gender, food, water as well as many other important concepts. While these images would not be recognized and understood in all cases, such abstracted icons or visual symbols can effectively communicate basic concepts by appealing directly to our object recognition systems when a conventional language barrier is present.

(If you are interested in exploring "universal" icons, you can browse further with ***The Noun Project***, a free, public, visual dictionary of the international icons and signage that we often take for granted. **https://thenounproject.com/)**

Again, it should not be taken that such visual forms of communication are without significant limitations. Let's take a look at the sentence that we kept revisiting in the first installment of this series:

Jane walked down the street.

How can we communicate this visually? (Assuming that Jane is a human female in this context.)

Here is one way that we can communicate something close without significant abstraction:

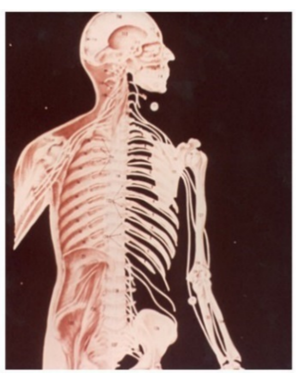
While the balloons might seem a bit distracting at first, they are actually quite helpful here. Visually we can determine from this image that a human female is indeed walking along a street or other paved route (the placement of the balloons and the slight tilt of the balloon string should actually promote the idea of movement in a particular direction). The placement of the figure is telling in regards to a recent past as well as a pending future (this is a concept we will visit in depth with later installments of this series). Due to the figure's configuration, location, and surrounding context, we may infer that the individual pictured had moved from the right side of the image in the recent past and will continue to walk into the space pictured on the far left. One major hurdle though is that we have no way to elicit (visually) that her name is indeed Jane. This aspect would remain problematic unless there is some context in which she would be recognizable (for example, if she were a well-known character or celebrity figure (e.g., Santa Claus)), or if her name was indicated in some way so as to reveal her identity. Most likely, though, the latter would require the employ of a conventional language—and for now, we are trying to avoid that.

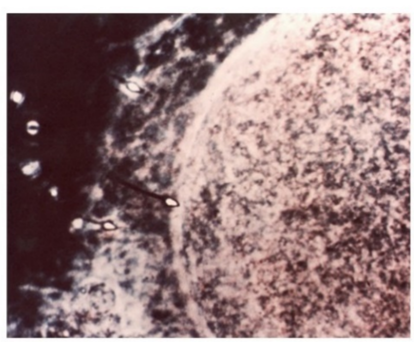
In any case—before we go too far down this road (pardon the pun), let's return to our space probes to see how a few very smart people tackled the problem of communicating with visual imagery.

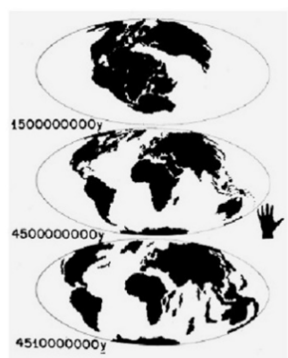
Carl Sagan approached the opportunity for a more robust interstellar message-in-a-bottle by assembling a team of scientists and experts to contribute ideas. His team included such individuals as Philip Morrison, professor of physics at MIT, Frank Drake, Jon Lomberg and Amahl Shakhashiri of the National Astronomy and Ionosphere Center, G. W. Cameron, professor of astronomy at Harvard Leslie Orgel of the Salk Institute for Biological Research, Wendy Gradison, of the Laboratory for Planetary Studies at Cornell, M. Oliver vice-president for research and development at the Hewlett-Packard Corporation, Steven Toulmin, professor of philosophy and social thought at the University of Chicago, as well as Isaac Asimov, Arthur Clarke, Timothy Ferris and Robert Heinlein—all science fiction writers with backgrounds in the sciences.

Frank Drake, Jon Lomberg, and Amahl Shakhashiri focused on assembling the images for Voyager's Golden Record. At the onset, the team members were facing a challenge that most visual artists contend with each day: To include as much information as possible while maintaining a simplicity that would allow for successful communication to the widest possible audience. As the team began to assemble content, the quantity of images to be included quickly grew past the original plan. Jon Lomberg stated, "The original idea was to have six pictures. It was thought that we might show Earth, the DNA molecule, and a few shots of humans and animals."

But as one might expect, the project expanded to include over a hundred images. Here are a few examples:







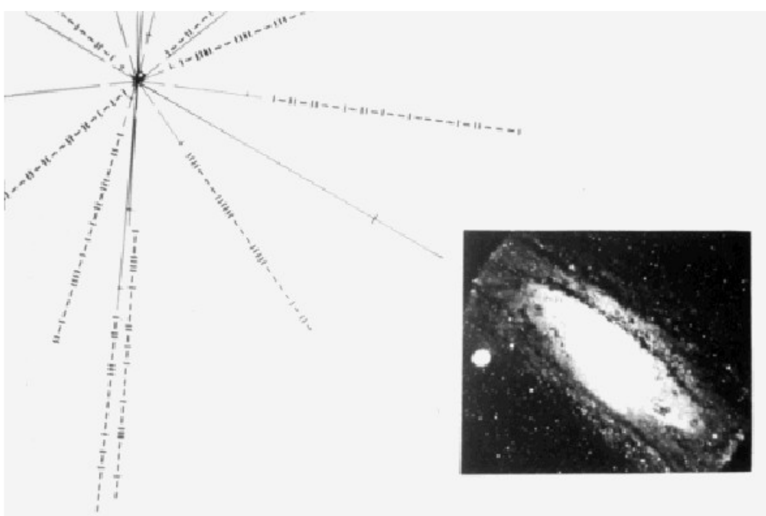
From left to right: 'Human Anatomy 1', 'Conception', and 'Diagram of Continental Drift.'

‘House (Africa) and ‘Sunset with birds’

This ‘Family portrait’ included on the Golden Record, shows five generations of a Midwestern family, with the sixth generation represented by portraits on the wall.

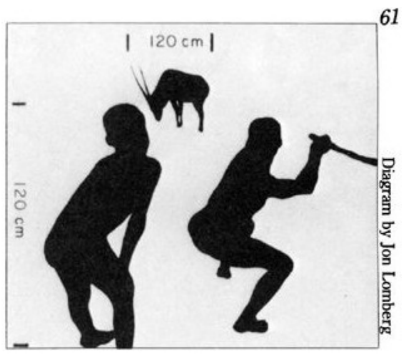
As the collection of images came together, team members realized that they had to address a significant issue inherent to the use of imagery as communication. The concept of a ‘picture’ is by no means universal, not even on our own planet. Let us not forget the curious story from Henri Breuil, a French Catholic priest and amateur archaeologist, which describes a Turkish officer who was incapable of recognizing a drawing of a horse, "*because he could not move round it*." Being a Muslim, the officer was entirely unfamiliar with depictive art. Such stories could easily lead many to argue that the eliciting of meaning from a two-dimensional representation is not an innate human ability. As such, Lomberg and his team felt that it may be necessary to teach a potential recipient how to "understand" the imagery both encoded on and etched into, the record and its casing.

Lomberg approached this problem in two ways. First, he made sure that the first two pictures included on the record are of engravings that are also featured on the Golden Records' cover. He stated, "*As engravings, they can be perceived by senses other than vision. We hope that beginning with these will give the recipients a way of comparing a photograph with an object they can touch.*"

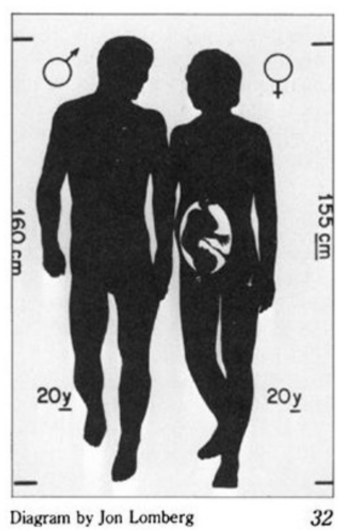


The second image encoded on the record is this 'Solar location map'.

Second, Lomberg added silhouette abstractions of included imagery to assist in the separation of image foreground and background information. He stated, “A *silhouette maximized the figure/background contrast and might show how we separate the various objects in a photograph by their outlines. It’s a way of saying ‘This is what we want you to see in this picture.’ So in a number of places I drew silhouettes of photographs and inserted them in sequence.*”



These images appeared in sequence: ‘Sketch of Bushmen’ and ‘Bushmen hunters.’ Lomberg hoped that by including silhouettes of photographs, the images would be easier to understand.



A vetoed image on the left was replaced by an abstract silhouetted image on the right, ‘Diagram of male and female’.

Throughout the image selection process, both Sagan and Lomberg addressed questions regarding why there was not more 'Art' in the growing image collection. While the answers primarily cited time constraints, Lomberg also added, "*...we thought extraterrestrials would have enough trouble interpreting photographs of reality or simple diagrams without our including a photograph of a painting, which is itself an interpretation of reality. Even though we have some acknowledged 'great art' in the pictures, the criterion for the picture message was informative, not aesthetic, value.*"

Dr. Lomberg's statement here is especially poignant in the context of this series on pictorial composition. As I have introduced in the previous installment, aesthetic qualities are the characteristics of a stimulus that elicit adaptive responses that have evolved to reinforce or discourage specific behaviors. While it may seem somewhat possible that another form of intelligence would be able to decode meaning from mathematical statements or simple visual stimuli, it may be a tad egocentric to think that another intelligence may share our same aesthetic responses. Like Paul Bloom stated in his 2010 book, *How Pleasure Works: The New Science of Why We Like What We Like,* "t*here are novel forms of music created all the time, but a creature that is biologically unprepared for rhythm will never grow to like any of them; they will always be noise.*"

So, now that you are thinking about communicating visually in this regard, how would you visually communicate that "Jane walked down the street" with visual imagery? Is it even possible? Again, remember that you are attempting to communicate to others that share your same biology. As we stated in the previous installment—do not think in terms of vanilla or chocolate—but it terms of our biological predilection for fats and sugars. Give this problem some serious thought as exploring the problem will steer you in the direction of building an effective framework for successfully understanding pictorial composition.

Henri Breuil and Alfred Yarbus Walk into a Bar...A Primer on Pictorial Composition. (Part III)

"Science shows us truth and beauty and fills each day with a fresh wonder of the exquisite order which governs our world." -Polykarp Kusch

Thus far we have established a clear definition of pictorial composition and how it is that our biology determines its success. Hopefully, at this point, you are starting to think about composition more in terms of biology instead of prescriptive geometry.

I would like to build on the last two installments by looking at two additional issues concerning our biology. First, I would like to explore whether the ability to elicit meaning from an image is innate or "learned". Quite a bit of research has been carried out on this topic, and the data should prove insightful for our continuing quest. Secondly, I would like to examine how we visually "experience" a picture in more depth. The results of exploring these two issues should further strengthen our understanding of pictorial composition and improve our ability to assess the functionality of current approaches to it.

In my last installment, I introduced a story from Henri Breuil, a French Catholic priest and amateur archaeologist, which described a Turkish officer who was incapable of recognizing a drawing of a horse, "*because he could not move round it*." Being a strict Muslim, the officer was entirely unfamiliar with depictive art and as such, he could not garner meaning from the image. It is easy to see how such stories might lead many to conclude that eliciting meaning from a two-dimensional representation is not an innate human ability. But would that conclusion be correct?

Studies into innate form perception and pictorial perception might suggest otherwise:

"*Clearly some degree of form perception is innate. This, however, does not dispose of the role of physiological growth or of learning in the further development of visual behavior. Accordingly we turned our attention to the influence of these factors.*

…We tested infants with three flat objects the size and shape of a head. On one we painted a stylized face in black on a pink background, on the second we rearranged the features in a scrambled pattern, and on the third we painted a solid patch of black at one end with an area equal to that covered by all the features. We made the features large enough to be perceived by the youngest baby, so acuity of vision was not a factor. The three objects, paired in all possible combinations, were shown to 49 infants from four days to six months old. The results were about the same for all age levels: the infants looked mostly at the "real" face, somewhat less often at the scrambled face, and largely ignored the control pattern. The degree of preference for the "real" face to the other one was not large, but it was consistent among individual infants, especially the younger ones. The experiment suggested that there is an unlearned, primitive meaning in the form perception of infants as well as of chicks.

…The last experiment to be considered is a dramatic demonstration of the interest in pattern *in comparison to color and brightness. This time, there were six test objects: flat disks six inches in diameter. Three were* patterned-a *face, a bull's-eye and a patch of printed matter. Three were* plain-red, *fluorescent yellow and white. We presented them, against a blue background, one at a time in varied sequence and timed the length of the first glance at each. The face pattern was overwhelmingly the most interesting, followed by the printing and the bull's-eye. The three brightly colored plain circles trailed far behind and received no first choices. There was no indication that the interest in* pattern *was secondary or acquired*. "-Fantz, R., 'The origin of form perception', Scientific American, 1961, 204, pp. 66–72

“While a picture is not totally arbitrary, it does involve a good deal of conventionalization in its production, and learning is involved in its interpretation. However, the learning that is involved is often rapid and “instantly generalized.” -Knowlton, James Q. “On the definition of “picture”.” AV Communication Review 14.2 (1966): 157-183.

An often-cited paper by Julian Hochberg and Virginia Brooks from Cornell report the case of a 19 -month-old who had been raised in a pictureless environment. This child could appropriately name pictures of all the familiar objects whose names he had previously learned, and he could do this upon his first exposure to these pictures. “*It seems clear from the results that at least one human child is capable of recognizing pictorial representations of solid objects (including bare outline-drawings) without specific training or instruction. This ability necessarily includes a certain amount of what we normally expect to occur in the way of figure-ground segregation and contour-formation. At the very least, we must infer that there is an unlearned propensity to respond to certain formal features of lines-on-paper in the same ways as one has learned to respond to the same features when displayed by the edges of surfaces*” -Hochberg, Julian, and Virginia Brooks. “Pictorial recognition as an unlearned ability: A study of one child’s performance.” The American journal of psychology 75.4 (1962): 624-628.

However, some cross-cultural studies demonstrate that difficulty arises more so from pictorial depth perception as opposed to representations of simple objects. While many anecdotal reports, like those of the abovementioned Henri Breuil, suggest that learning is required to recognize pictures in general—research with communities that have little experience with pictures indicates that the greatest difficulty arises in perceiving depth in pictorial material. Subjects who encounter such difficulty would often show a strong preference for "split-type drawings" which depict essential characteristics of an object without pictorial depth.

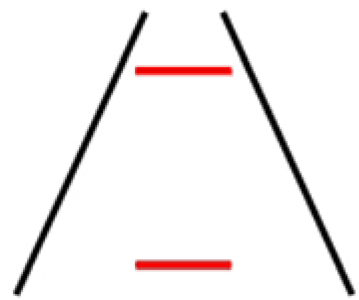
"*Data collected among the Baganda of Uganda indicates that pictorial perceptual skills are positively and significantly related to relative amounts of exposure to Western culture. Both urban and relatively more acculturated rural residents make overall more correct identifications of pictorial objects and more consistent use of cues to pictorial depth than more traditional Baganda. These results offer support for the proposition that visual perceptual skills are related to culturally constituted experience." -Kilbride, Philip L., and Michael C. Robbins. "Pictorial depth perception and acculturation among the Baganda*." American Anthropologist 71.2 (1969): 293-301.

"*Reports of difficulty in pictorial perception by members of remote, illiterate tribes have periodically been made by missionaries, explorers, and anthropologists. Robert Laws, a Scottish missionary active in Nyasaland (now Malawi) at the end of the 19th century, reported: "Take a picture in black and white and the natives cannot see it. You may tell the natives, 'This is a picture of an ox and a dog,' and the people will look at it and look at you and that look says that they consider you a liar. Perhaps you say again, 'Yes, this is a picture of an ox and a dog.' Well, perhaps they will tell you what they think this time. If there are a few boys about, you say: 'This is really a picture of an ox and a dog. Look at the horn of the ox, and there is his tail!' And the boy* *will say: 'Oh! Yes and there is the dog's nose and eyes and ears!' Then the old people will look again and clap their hands and say, 'Oh! Yes, it is a dog.' When a man has seen a picture for the first time, his book education has begun."*

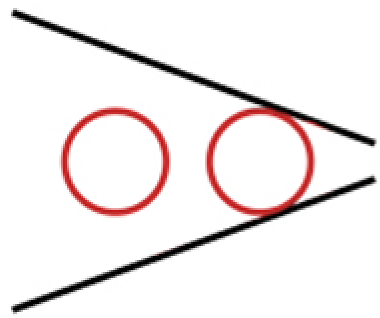
Mrs. Donald Fraser, who taught health care to Africans in the 1920's, had similar experiences. This is her description of an African woman slowly discovering that a picture she was looking at portrayed a human head in profile: "She discovered in turn the nose, the mouth, the eye, but where was the other eye? I tried by turning my profile to explain why she could only see one eye, but she hopped round *to my other side to point out that I possessed a second eye which the other lacked." There were also, however, reports of vivid and instant responses to pictures: "When all the people were quickly seated, the first picture flashed on the sheet was that of an elephant. The wildest excitement immediately prevailed, many of the people jumping up and shouting, fearing the beast must be alive while those nearest to the sheet sprang up and fled. The chief himself crept stealthily forward and peeked behind the sheet to see if the animal had a body, and when he discovered that the animal's body was only the thickness of the sheet, a great roar broke the stillness of the night."* -Deregowski, Jan B. "Pictorial perception and culture." Scientific American(1972). Nov.:82-88.

So with this in mind, we can perhaps we can better understand why it is that the universal that we find in many corners of the world do not seem to contain strong depth cues. This type of information would serve us well should we find ourselves working to design imagery that would target the very young or simply as many members of the species as possible.

Now some may be quick to counter that pictures that contain depth cues must be more inherently complex than simple representations that do not require depth cues, and as such–would be more difficult to process. While in some cases this indeed may be true—there are studies that demonstrate a similar dynamic in performance for extremely simple line configurations.



The seemingly simple line configuration presented by Italian psychologist Mario Ponzo in 1911 is an effective demonstration of perception at odds with the physical world. The standard Ponzo illusion is configured so that a horizontal line or another figure that is nearer to the interior apex of two converging lines has a tendency to be perceived as greater in length or size as opposed to an identical line or another figure within the converging lines but more distant from the apex. If the standard Ponzo figure is interpreted as a distance or linear perspective cue abstract, then an observer will interpret the “inducing lines” of the Ponzo configuration as parallel lines which are in fact converging into the distance in accordance with the effects of linear perspective. In this context, it would be appropriate to assume that two similar objects at different distances can provide equal-sized retinal images only if the more distant object is larger than, the nearer. Variations on the illusion demonstrate similar effects. In the above variation, we can see that the circle on the right appears larger than the one on the left. As with the standard illusion, both shapes are identical in size.



While some experiments in the past have manipulated Ponzo line configurations and other geometric "illusions" to downplay the contributions of linear perspective (e.g., Coren & Girgus 1978; Yamagami 1978), many tests were performed that confirmed the impact of depth cues in influencing Ponzo effect judgments (e.g., Gogel, 1975; Kilbride & Leibowitz, 1975; Leibowitz, Brislin, Perlmutter, & Hennessy, 1969; Miller, 1997; Newman & Newman, 1974; Patterson & Fox, 1983; Schiller & Wiener, 1962). I submit that the alterations to the Ponzo configuration that purport to confound intuitive explanations involving linear perspective do not refute the contributions of perspective cues—but seem to reinforce the connection by demonstrating a significant diminishment of the effect as distance and perspective cues are further abstracted.

An additional bolster to the idea of Ponzo's effect magnitude being reliant on contextual distance/perspective cues can be found with cross-cultural experiments regarding the illusion in Uganda. (Leibowitz & Pick 1972). Reactions to the geometric configurations varied between study groups who were accustomed to "industrialized" environments and groups living in more natural, rural environments. Students from a local university responded to the illusion very similarly to U.S. university students, while the rural villagers saw no illusion at all.

Furthermore regarding depth cues and size, when I first read the Deregowski's Scientific American article, I remember taking a particular interest in the report of how the people reacted when the picture of the elephant was projected onto a sheet. When the chief approached the sheet it seemed that he was surprised at the thickness—possibly implying that the scale of the projection must have been reasonably similar to the size of an actual elephant. In considering this, it made me suspect that the problems with pictorial depth cues might be related to size constancy and the way in which we use size to communicate pictorial depth. In a 2011 paper, Stephen E. Palmer et. al. writes "*In earlier research, Konkle and Oliva (in press) found that the preferred visual size of a picture of an object is proportional to the logarithm of its known physical size. They showed that, when viewing pictures of objects of different physical sizes within a frame, smaller sizes within the frame were preferred for smaller objects in the real world (e.g., strawberries or a key), whereas larger sizes in the frame were preferred for larger real-world objects (e.g., a piano or chair). They called these effects `canonical size' in analogy with Palmer et al's (1981) `canonical perspective' effects, showing that people systematically prefer some perspective views of objects over others.*"

Overall, the findings support a clear bias toward canonical size in aesthetic preferences for framed 2-D images. This bias seems to be conceptually related to another ecological bias reported by Sammartino and Palmer (submitted) for objects that are *characteristically located above the viewer in the world to be located high in the picture frame (eg ceiling-mounted light fixtures and flying eagles) and for objects that are characteristically located below the viewer in the world to be located lower in the picture frame (e.g., bowls on tables and swimming stingrays). We call these effects `ecological' because they appear to be driven by people preferring images in which the spatial properties of the image of the depicted object within its frame fit the ecological properties of the physical object relative to the viewer. Canonical-size effects on aesthetic judgments thus indicate that people tend to prefer images in which the size of the object's image within its frame fits their knowledge of its actual physical size*." – Linsen, S., Leyssen, M. H. R., Gardner, J. S., & Palmer, S. E. (2011). Aesthetic preferences in the size of images of real-world objects. Perception. 40 (3), 291-298. T

For an even better look at many of these studies I recommend the following paper as it covers many of the ones listed here: **Bovet, Dalila, and Jacques Vauclair. "Picture recognition in animals and humans."** Behavioral brain research 109.2 (2000): 143-165.
At this point I would like to move forward on to how exactly we interact with a picture, or a "complex stimulus" and I cannot think of a better place to start than with the work of Alfred Yarbus.

Alfred Lukyanovich Yarbus was a Russian psychologist who studied eye movements in the 1950s and 1960s. He pioneered the study of saccadic exploration of complex images, by recording the eye movements performed by observers while viewing natural objects and scenes. In this very influential work, Yarbus showed that the trajectories followed by the gaze depended on the task that the observer has to perform. The gaze tends to jump back and forth between the same parts of the scene, for example, the eyes and mouth in the picture of a face. If an observer were asked specific questions about the images, his/her eyes would concentrate on areas of the images of relevance to the questions. His book Eye Movements and Vision, published in Russian in 1965 and translated into English by Basil Haigh in 1967, has had a profound influence on recent approaches to the study of eye movements and vision.

While Eye Movements and Vision is fascinating from cover to cover, chapter seven–*Eye Movements during Perception of Complex Objects*–is especially insightful for those of us studying pictorial composition.

While I wish I could quote this chapter in its entirety, I will limit myself to a few key bits that offer the most bang for the buck. I encourage everyone reading this paper to try to read this entire chapter (again, chapter seven), if not the entire book for yourself. It is incredibly insightful and may significantly alter your notions regarding how we interact with pictures.

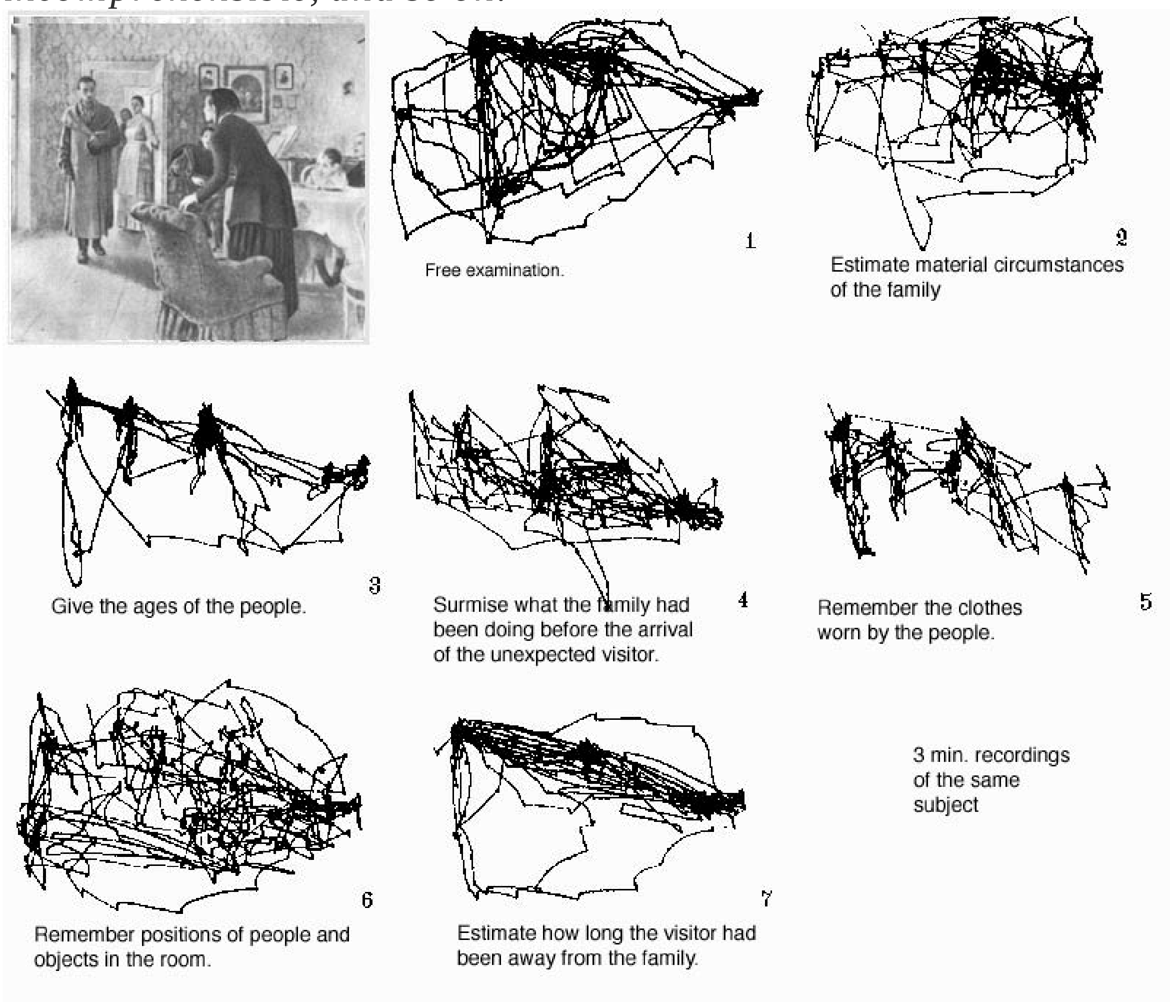
Examples of Yarbus' eye-tracking data from studies conducted using a classic painting by Russian artist Ilya Efimovich Repin. Painted in 1884 in support of social reform, the image depicts a soldier returning home from exile in Siberia, greeted by his mother as his wife shyly lingers behind the door.

Yarbus states: "*Analysis of the eye-movement records shows that the elements attracting attention contain, in the observer's opinion, may contain, information useful and essential for perception. Elements on which the eye does not fixate, either in fact or in the observer's opinion, do not contain such information.*"

Yarbus goes further to state that detail, brightness factors, or even a favorite color will not determine the degree of attention unless those elements "*give essential and useful information*" within their context. In addition, "A*nalysis shows that the outlines have no effect on the character of the eye movements. In the movements of the eye, we have no analogy with the movements of the hand of a blind person, tracing the outlines and contours. Outlines and contours are important for the appearance of the visual image, but when the image has appeared and is seen continuously, the observer has no need to concern himself especially with borders and contours. Borders and contours are only elements from which, together with other no less important elements, our perception is composed, and the object recognized.*"

"*…Records of eye movements show that the observer's attention is usually held only by certain elements of the picture. As already noted, the study of these elements shows that they give information allowing the meaning of the picture to be obtained. Eye movements reflect the human thought process; so the observer's thought may be followed to some extent from records of eye movements (the thought accompanying the examination of the particular object). It is easy to determine from* *these records which elements attract the observer's eye (and, consequently, his thought), in what order, and how often. "*

However, it should be noted that "*The observer's attention is frequently drawn to elements which do not give important information but which, in his opinion, may do so. Often an observer will focus his attention on elements that are usual in the particular circumstances, unfamiliar, incomprehensible, and so on*."



"...In conclusion, I must stress once again that the distribution of the points of fixation on an object, the order in which the observer's

attention moves from one point of fixation to another, the duration of fixations, the distinctive cyclic pattern of examination, and so on are determined by the nature of the object and the problem facing the observer at the moment of perception." -Yarbus, A. (1967). Eye movements and vision (B. Haigh & L. A. Riggs, Trans.). New York: Plenum Press

Now while Yarbus' work with eye tracking is extremely insightful—current research and technologies allow us to look much deeper at how we experience a picture. Such study offers us a glimpse, not only into how we might garner meaning from complex stimuli, but how we might be influenced by an image's aesthetic qualities as well.

It is important to note that our understanding of the neural underpinnings of perception is largely built upon studies employing 2-dimensional images. Percept surrogates have been used for many years to study cortical regions along the ventral and dorsal visual processing streams. Even simplified monochrome shapes, silhouettes, and line drawings can be shown to elicit significant responses in regions of the occipital and temporal cortex that respond more strongly to intact object images (object-selective cortex).

Studies of more specific areas of the brain go further to help us understand why certain spatial preferences might arise (Battaglia et al, 2011) Such research explores how observers of a still image of an action may extract dynamic information by extrapolating future position from the motion implied by the photograph (Kourtzi and Kanwisher, 2000).

This concept will be something that we will revisit a bit later when discussing center and inward bias (Palmer et. al., 2008).

We will also look at the fruits of a newly emerging sub-discipline of empirical aesthetics dubbed “Neuroaesthetics”. This new branch of investigation takes a scientific approach to the study of aesthetic perceptions of art, music, or any object that can give rise to aesthetic judgments. Neuroaesthetics uses neuroscience to explain and understand the aesthetic experiences at the neurological level. It is a popular area of research and has been steadily gaining multidisciplinary interest and contributions from neuroscientists, art historians, artists, and psychologists.

As this installment is already quite lengthy, I will refrain from going into to all of this in detail now. In closing allow me to stress once again the importance of considering our biology in the role of “picture building.” It may be initially difficult to put aside the many prescriptive geometric heuristics that have been deployed by so many artists in the past, but I believe that we can achieve more efficient and effective results in the here and now by embracing the fruits of so many scientific disciplines. It is an exciting time for both science and art.

In the next installment, we will be looking at many historical devices “used” in pictorial composition, assess the claims that surround their use, and examine if current research confirms their effectiveness.

PS—Feel free to use the contact link above or the comment section below to share any questions or suggestions regarding this ongoing series.

A Spurious Affair. A Primer on Pictorial Composition. (Part IV)

"*Too often we hold fast to the clichés of our forebears. We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought.*" — John F. Kennedy [Commencement Address at Yale University, June 11 1962]

In the first installment of this series, we examined an excerpt from a contemporary resource on pictorial composition. While the text was indeed well written and offered a seemingly clear algorithmic approach to picture building, closer examination revealed that the content was based on the all-too-common cliché compositional heuristics that typically treat coincidence and correlation as causation. With this installment, I would like to begin a journey into the heart of many popular heuristics of pictorial composition and evaluate their functionality through the lens of our developing biological framework.

Before embarking on this journey I would like to revisit our definition of pictorial composition once more:

Pictorial composition can be defined as the specific content of an image as well as the spatial relationship of its elements with respect to aesthetic quality and communication efficacy.

Thus far I have offered a cursory overview of aesthetic quality, communication efficacy, and pictorial content, but I have not yet addressed what is meant by "elements" in this definition. Allow me to rectify that issue before moving forward. "Elements" in this regard can refer to either the subject matter (content) of a pictorial composition or to the visual building blocks of pictorial content. While the former can be just about anything that we can imagine, the latter offers a more manageable list for examination. Wikipedia defines "visual elements" as:

"*The various visual elements, known as elements of design, formal elements, or elements of art, are the vocabulary with which the visual artist composes. These elements in the overall design usually relate to each other and to the whole artwork. The elements of design are:*

Line *— the visual path that enables the eye to move within the piece*
Shape *— areas defined by edges within the piece, whether geometric or organic*
Colour *— hues with their various values and intensities*
Texture *— surface qualities which translate into tactile illusions*

Tone *— Shading used to emphasize form*
Form *— 3-D length, width, or depth*
Space *— the space taken up by (positive) or in between (negative) objects*
Depth *— perceived distance from the observer, separated in* foreground, *background, and optionally middle ground*.”

While this list of visual elements is fairly standard, there are some subtle issues that we should address to avoid potential confusion moving forward.

For example, line can be effectively defined in a number of ways here. However, the defining of a line as a “facilitator of eye movement” is, unfortunately, misleading. While discontinuity indeed attract our gaze, and saccades most often occur in straight lines, eye movements do not “follow” line direction in the manner that one might infer from the above definition.

In his 1967 publication *Eye Movement and Vision*, Russian psychologist Alfred Yarbus (introduced in the last installment) wrote: “*…outlines themselves have no effect on the character of the eye movements. In the movements of the* eye *we have no analogy with the movements of the hand of a blind person, tracing the outlines and contours. Outlines and contours are important for the appearance of the visual image, but when the image has appeared and is seen continuously, the observer has no need to concern himself specially with borders and contours. Borders and contours are only elements from which, together with other no less important elements, our perception is composed and the object recognized. Clearly the outlines of an object will attract an* *observer's attention if the actual shape of the outline includes important and essential information.*"

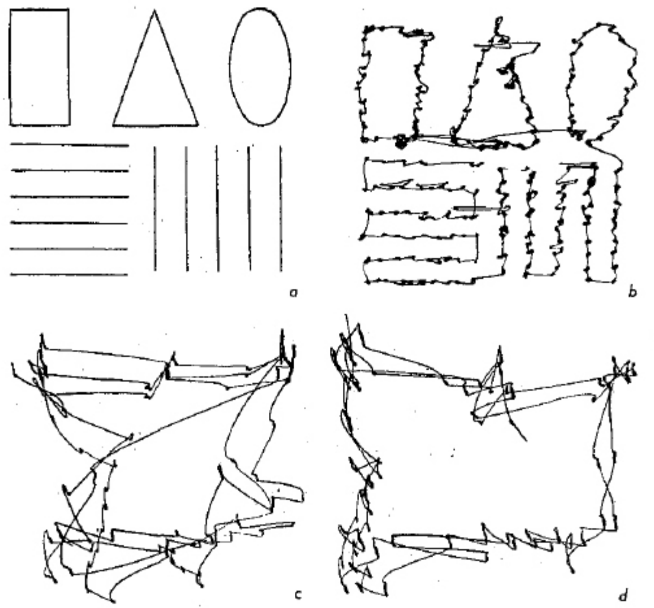


Fig. 53. Record of eye movements during examination of geometrical figures. a) Geometrical figures presented to the subject for examination; b) record of eye movements during which the subject tried to trace the lines of the figures with his eye smoothly and without saccades; c) record of eye movements during free (without instruction) examination of the figures for 20 sec: d) record of eye movements during examination of the figures for 20 sec after the instruction "look at the figures and count the number of straight lines."

Unfortunately, the fact that there exists no strong evidence for the claim that our eyes follow individual lines in a pictorial composition does not stop countless drawing, painting, and photography resources from perpetuating the idea.

From **expertphotography.com**:
"Leading lines are one of the most effective and under-utilised [sic] compositional tools available to photographers. They're used to draw a

viewers [sic] attention to a specific part of the frame, whether it's a person, or a vanishing point in the background of the frame.

Our eyes are naturally drawn along lines and paths in photos, as they tend to make us feel as if we're standing within the photo itself. It's important to understand how to use leading lines effectively, because if they're used incorrectly, they will be more detrimental than anything."

From **Drawing Secrets Revealed – Basics: How to Draw Anything**:

"Lines such as a river, fence or walkway can be very effective visual aids because they guide your viewer's eye through the different elements of your drawing and around the whole work. These types of lines are called "leading lines". These lines can take your eye right to the focal point of a drawing of just guide your eye through the whole composition."

Remember this image from our second installment "To the makers of music – all worlds, all times" A Primer on Pictorial Composition. (Part II)"? We discussed how the placement of the figure was telling in regards to a recent past as well as a pending future. Due to the figure's configuration, location, and surrounding context, we may infer that the individual pictured had moved from the right side of the image in the recent past and will continue to walk into the space pictured on the far left.

Now a good argument can be made that particular configurations of lines may influence our gaze in certain contexts. For example, linear configurations that may be used to imply optic flow may steer our fixation towards whatever may occupy the convergence of the flow in an effort to elicit valuable information. We will see this concept again and again in our exploration of pictorial composition. **Massive amounts of neuronal resources in the human brain are devoted to predicting what will happen from moment to moment. This fact has led many to regard the brain as a dynamic prediction machine.** Jeff Hawkins writes in his book On Intelligence: "*Your brain receives patterns from the outside world, stores them as memories, and* *makes predictions by combining what it has seen before and what is happening now… Prediction is not just one of the things your brain does. It is the primary function of the neo-cortex [sic], and the foundation of intelligence.*" More to our point, David Rock, author of *Your Brain at Work*, writes: *You don't just hear; you hear and predict what should come next. You don't just see; you predict what you should be seeing moment to moment.*" With this in mind, you can see how an individual may prefer those compositions that provide enough information so as to facilitate predictions about what will happen in the moments following the one captured in the frozen percept surrogate. Some studies of the brain go further to explore spatial preferences in this regard (Battaglia et al, 2011). Such research explores how observers of a still image of an action may extract dynamic information by extrapolating future position from the motion implied by the image "*A still photograph of an object in motion may convey dynamic information about the position of the object immediately before and after the photograph was taken (implied motion)*" -(Kourtzi and Kanwisher, 2000).

Returning to our examination of visual elements, the definitions for shape, color and texture above seem adequate. The definition of tone, on the other hand, may be a tad problematic for those pulling information from multiple texts. I would guess that what the author of the Wikipedia entry meant to insert here was the term value instead of tone. Value can be defined simply as *relative lightness or darkness*. Tone, a term often used synonymously with value, actually describes a color mixed with both black and white. Many dictionaries will define value and tone as synonyms–however, different texts may use the terms to mean different things. If we look to the origin of these words, the difference becomes more apparent (from **Online Etymology Dictionary**).

value (n.) late 14c., "degree to which something is useful or estimable," from Old French value "worth, price, moral worth; standing, reputation" (13c.), noun use of fem. past participle of valoir *"be worth," from Latin* valere *"be strong, be well; be of value, be worth".*

tone (v.): 1811, from tone (n.). Related: Toned; toning. To tone (something) down originally was in painting (1831); general sense of "reduce, moderate" is by 1847.

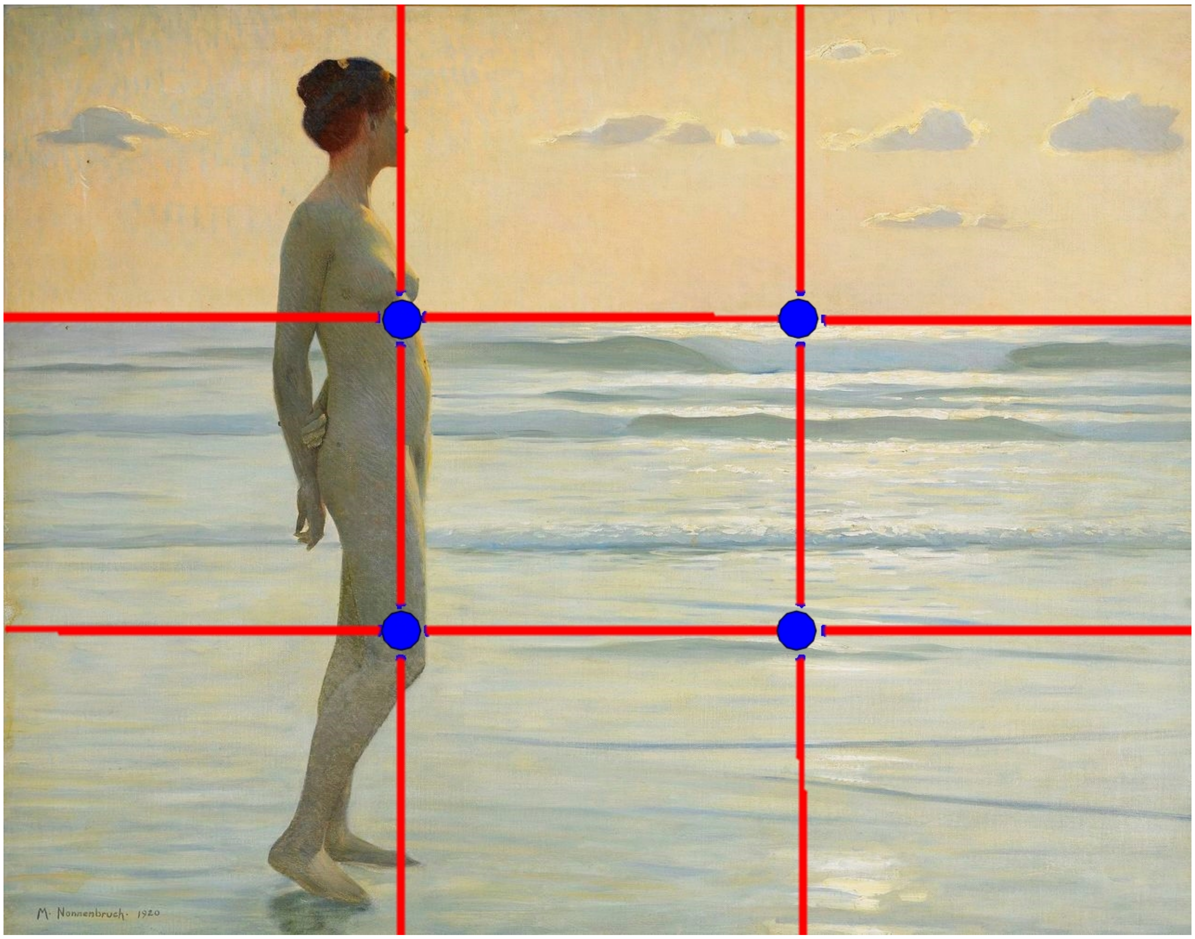
Considering the origin of these terms, one can see how value may more accurately describe a judgment of relative lightness or darkness while tone may better describe a reduction of color purity with a neutral gray.

I am not exactly sure what is meant by the above definition of form: 3-D length, width, or depth. Form can be better defined as perceived volume (quantity of three-dimensional space) through the specific configuration of line and/or value.

The above definition of space seems fine, but I would augment depth as the perceived distance from the observer as defined by particular depth cues. The degree of perceived depth can be generalized into three regions; foreground, middleground, and background.

So now that we have all of the variables from our definition of pictorial composition adequately defined—let's proceed with our review of existing compositional devices. We'll start with one of the most common: The Rule of Thirds.

The rule of thirds is a heuristic which applies to the process of composing visual images. The “rule” proposes that an image should be imagined as divided into nine equal parts by two equally spaced horizontal lines and two equally spaced vertical lines, and that important compositional elements should be placed along these lines or their intersections.



The earliest documentation of the rule of thirds was from 18th-Century painter, engraver, and writer John Thomas Smith with his 1797 book, Remarks on Rural Scenery. In a chapter titled Of Light and Shade, Smith discusses a work by Rembrandt in which “*two-thirds of the picture are in shadow*.” He writes, “*Two distinct, equal lights, should never appear in the same picture: One should be principal, and the rest subordinate,* *both in dimension and degree: Unequal parts and gradations lead the attention easily from part to part, while parts of equal appearance hold it awkwardly suspended, as if unable to determine which of those parts is to be considered as the subordinate.*" Smith goes on to state, "*Analogous to this "Rule of thirds", (if I may be allowed so to call it) I have presumed to think that, in connecting or in breaking the various lines of a picture, it would likewise be a good rule to do it, in general, by a similar scheme of proportion; for example, in a design of landscape, to determine the sky at about two-thirds ; or else at about one-third, so that the material objects might occupy the other two : Again, two-thirds of one element, (as of water) to one third of another element (as of land); and then both together to make but one third of the picture, of which the two other thirds should go for the sky and aerial perspectives. This rule would likewise apply in breaking a length of wall, or any other too great continuation of line that it may be found necessary to break by crossing or hiding it with some other object : In short, in applying this invention, generally speaking, or to any other case, whether of light, shade, form, or color, I have found the ratio of about two thirds to one third, or of one to two, a much better and more harmonizing proportion, than the precise formal half, the too-far-extending four-fifths—and, in short, than any other proportion whatever.*"

“De Heilige Familie bij Avond” (The Holy Family at Night)-formerly titled “The Cradle” by Rembrandt Harmenszoon van Rijn. You will see that John Thomas Smith does nothing to call attention to the actual intersections of these divisions (as opposed to the emphasis on the armature intersections found with heuristic today) but that a general proportion motif of 2:1 should be favored. Unfortunately, there is no good evidence for either. In any case, the genesis of this particular heuristic unfolds as most do: an observed correlation between arbitrary variables within a celebrated work is treated as causation.

So is there any communicative or aesthetic merit to this heuristic?

Fortunately for contemporary artists, there are some brilliant minds using scientific methodologies as well as current technologies to test these long-standing heuristics. In 2014, Psychologists Stephen Palmer and William Griscom, and research assistant Yurika Hara presented “Why the “Rule of Thirds” is Wrong” at the Vision Sciences Society Annual Meeting. Here is the abstract from that effort:

“Perhaps the best-known prescriptive rule of pictorial composition is the “rule of thirds” (ROT), which posits that: (a) the best positions for the focal object within a rectangular frame lie along the vertical and horizontal lines that divide the frame into thirds, with maxima at the four intersections of these third-lines, and (b) the worst positions lie along the vertical and horizontal axes of symmetry, with the minimum being at the frame’s center. We tested these predictions by measuring people’s preferences for placement of a single object at the nine points defined by the 3×3 grid of intersections among the horizontal and vertical third-lines and symmetry-axes. We measured forced-choices between two pictures of the same object (fish/dog/eagle) facing in the same direction (forward/leftward/rightward) at all possible pairs of positions in the 3×3 grid. The results strongly contradicted both of the ROT’s main claims.”

Additional studies related to the Rule-of-Thirds (ROT):

Sammartino, J., Palmer, S.E. (2012). Aesthetic issues in spatial composition: Effects of vertical position and perspective on framing single objects. Journal of Experimental Psychology: Human Perception and Performance, 38(4), 865-879.

Palmer, S. E., & Gardner, J. S. (2008) Aesthetic issues in spatial composition: Effects of position and direction on framing single objects. Spatial Vision, 21, 421-449.

Palmer, S. E., & Guidi, S. (2011). Mapping the perceptual structure of rectangles through goodness-of-fit ratings. Perception, 40(12) 1428-1446.

I would like to take a moment to mention that the many spin-offs of the rule-of-thirds—like the rule-of-fifths, sevenths, elevenths, or whatever, are just as misguided as the original. Aside from possibly being useful in encouraging artists to consider off-center focal-object locations when those placements “work” in the context of the entire image, they hold no independent communicative or aesthetic advantage.

So why do so many believe that the rule-of-thirds (ROT) heuristic is effective? They do so for the same reason that people believed that rats could spontaneously generate from garbage. For centuries, people based their beliefs on their interpretations of what they saw going on in the world around them without testing their ideas to determine the validity of those beliefs — in other words, they didn’t use the scientific method to arrive at answers to their questions. Rather, their conclusions were based on intuition and untested observations. Now it should be stated that much of scientific evidence is based upon a correlation of variables, however, scientists are careful to point out that correlation does not necessarily mean causation. The assumption that A causes B simply because A correlates with B is often not accepted as a legitimate form of argument. There are many instances where we find effective communication and pleasing aesthetic qualities within an image that seems to adhere

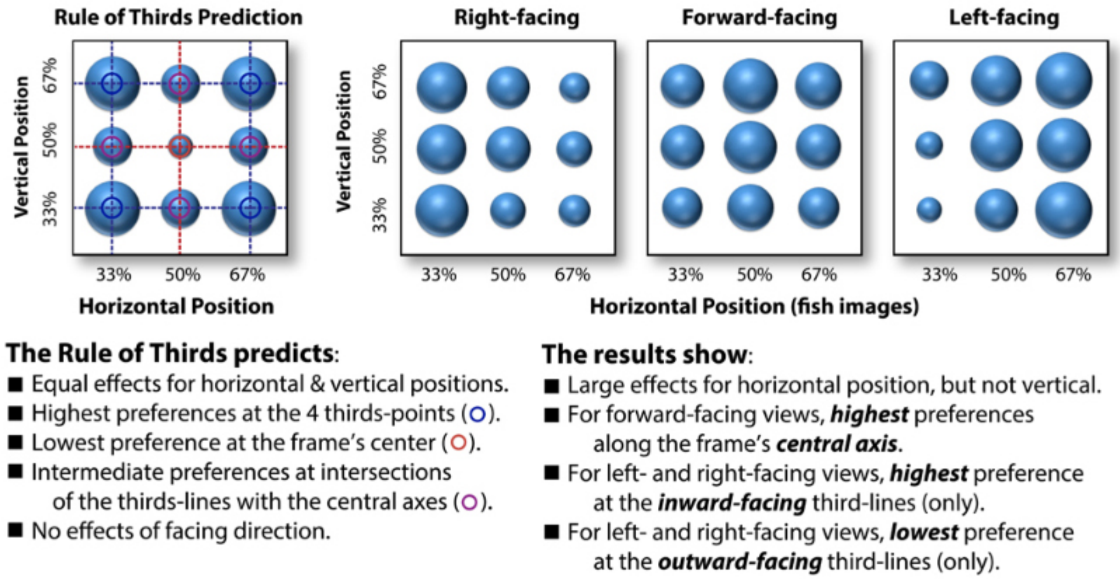
to the ROT heuristic. But again, coincidence and correlation are not necessarily evidence for causation.

Here are a few pictorial biases supported by empirical research which shows how the ROT may seem to “work” in some instances, but not others:

Inward Bias: Studies have demonstrated that when an object with a salient “front” is placed nearer the border of a frame than a center, observers tend to find the image more aesthetically pleasing if the object faces inward (toward the center) than if it faces outward (away from the center) (Chen et al., 2014) . I believe that this may have much to do with the idea of understanding our brain as a “prediction machine”. Again, “*A still photograph of an object in motion may convey dynamic information about the position of the object immediately before and after the photograph was taken (implied motion)*” - (Kourtzi and Kanwisher, 2000). If we can see more of where an object may be “headed”, we can make a better prediction about a future state of the objects being observed. This bias can sometimes seem to reconcile with rule of thirds just as it appears to in the above picture of a figure in a snowy field.

Center Bias: In studies regarding front-facing subjects, preference was greatest for pictures whose subject was located at or near the center of the frame and decreased monotonically and symmetrically with distance from the center (Palmer, Gardner & Wickens, 2008). The reason that people prefer the object’s salient front region to be as close to the center as possible may result from a number of factors. The greatest influence MAY come from the way in which we usually engage with what we see as a front-facing subject. This center bias may reflect an advantageous viewing position for extracting information from such scenarios. I would like to note here that center bias is not the same that as central fixation bias. They may be related in some way, but not in a way that I can show support for at this time. Central fixation bias is a tendency for observers to begin an exploration of a visual scene at the center. Numerous visual perception experiments have borne this out (e.g., Buswell, 1935, Mannan et al., 1995, Mannan et al., 1996, Mannan et al., 1997, Parkhurst et al., 2002 and Parkhurst and Niebur, 2003). The prevalence of central fixation bias suggests that it is a key feature of scene viewing, but the basis of this effect remains poorly understood. In any case, the center bias contradicts the ROT's main claims.

It should be noted here that current research has shown both center and inward biases to influence preferences in the vertical dimension as well (Sammartino and Palmer, in press). Additionally, vertical preferences have been shown to be consistent with an ecological bias toward its viewer-relative position in the environment (Sammartino & Palmer, 2011).

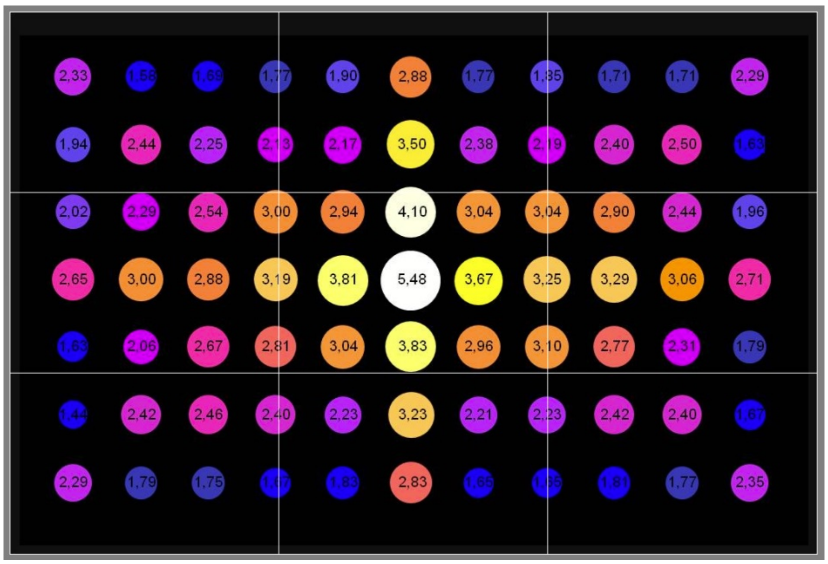


Adapted from the 2014 VSS Poster (How the "Rule of Thirds" is Wrong: Let us Count the ways) by Stephen E. Palmer, Yurika S. Hara, & William S. Griscom.

Goodness-of-Fit: Psychologist Rudolph Arnheim, author of the Power of the Center: A Study of Composition in the Visual Arts, claimed that the center was the most "balanced and stable" point in the framed space. Personally, I am not one to reference the seemingly nebulous principles of the Gestaltists (principles defined by subjective terms like "good", "simple" or "stable"), but Arnheim's work inspired subsequent research that may be insightful.

Numerous studies have shown that balance around the center of a rectangular frame plays a crucial role in spatial composition, as measured in a variety of different tasks, including participant-controlled adjustments of pictorial elements (Locher et al., 1998; Puffer 1903), explicit judgments of balance (McManus et al., 1985; Locher et al., 2005), and explicit judgments of aesthetic preference (Bertamini et al., 2011; Palmer et al., 2008)

In 2012, researchers Stephen E. Palmer and Stefano Guidi studied what they called "goodness-of-fit ratings" with circles at different positions in rectangular frames. Their experiments demonstrated that the "best-fitting" position was reported at the center, followed by positions along the global symmetry axes. The next "best" was along local symmetry axes located at the corners of the frame. The poorest fit was at asymmetric positions, like those that are deemed "ideal" with the contemporary application of the ROT.

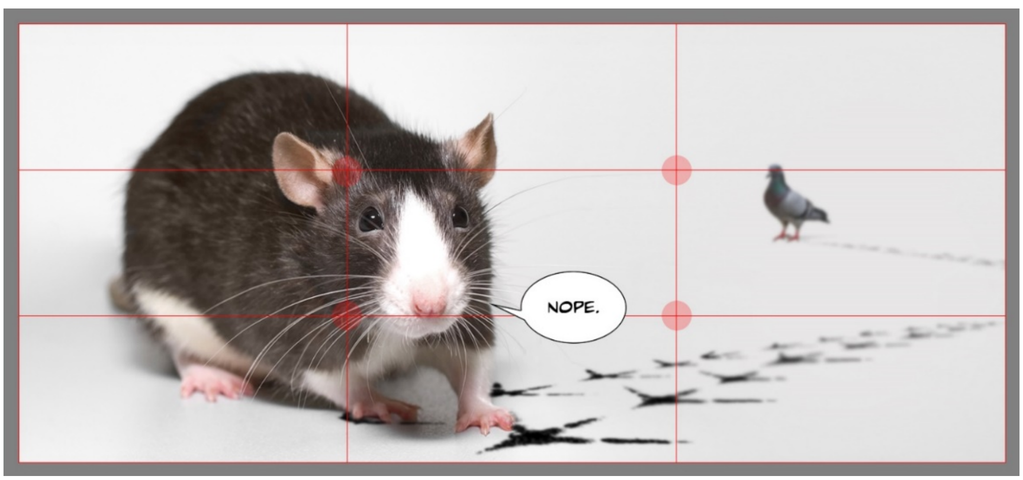


Adapted from the 2014 VSS Poster (How the "Rule of Thirds" is Wrong: Let us Count the Ways) by Stephen E. Palmer, Yurika S. Hara, & William S. Griscom. Experimental results by Palmer and Guidi (2008) using a "goodness of fit" rating task show that the structural skeleton of a rectangular frame are the preferred location with the center being the most potent location (the point of intersection of its vertical and horizontal axis of symmetry). The rule-of-thirds armature is shown in white.

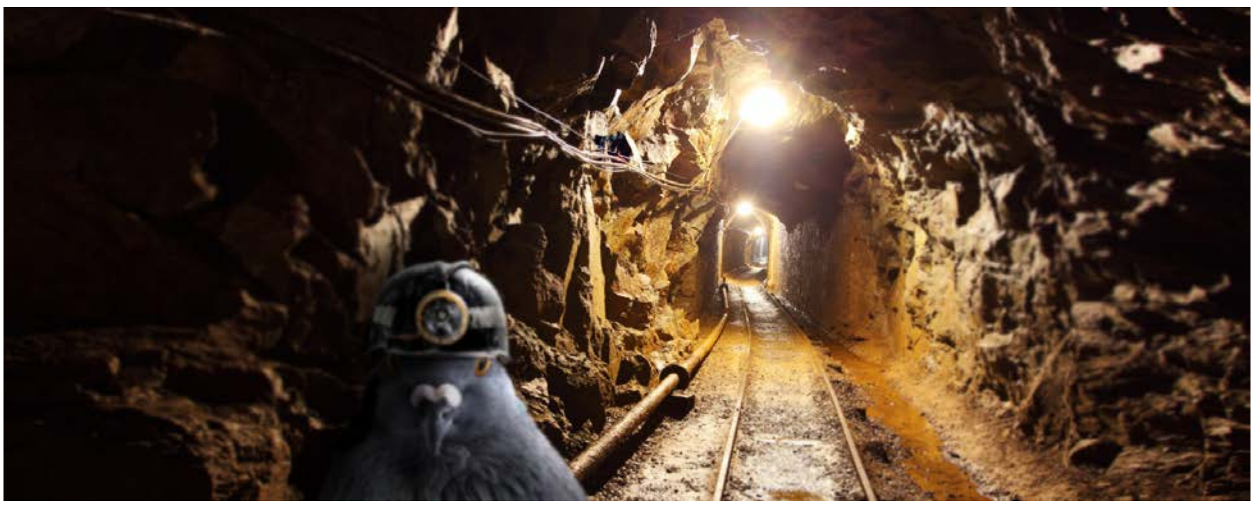
So as we can see, there is no real evidence to support the idea that element placement along the axes or intersections of the ROT (or related armatures) is communicatively or aesthetically advantageous. In fact, current evidence seems to support the exact opposite. **What we do find**

is that general placement preferences are sensitive to an object's function or "facing" direction. This may sometimes coincide with the armature of the ROT–but the ROT is as responsible for the resulting preferences as garbage was for the spontaneous generation of rats (or maybe even a tad less.) **Furthermore, it seems that many compositional preferences seem driven by affordance spaces (functional regions around objects) that can facilitate better prediction tasks.** This is something to keep in mind as our journey continues.

And in case you were wondering...

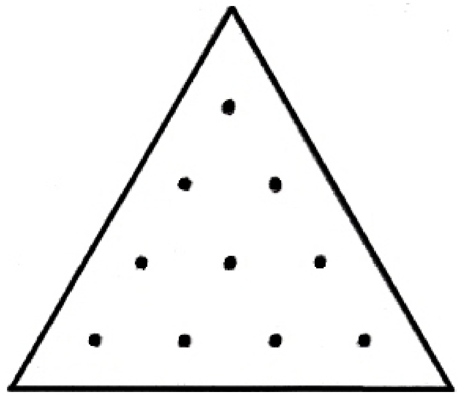


Fool's Gold. A Primer on Pictorial Composition. (Part V)



"*Simple mathematics tells us that the population of the Universe must be zero. Why? Well given that the volume of the universe is infinite there must be an infinite number of worlds. But not all of them are populated; therefore only a finite number are. Any finite number divided by infinity is zero, therefore the average population of the Universe is zero, and so the total population must be zero.*" -Douglas Adams.

Imagine a math class that began with the assertion that the number ten was the "holiest" of all numbers. This is so because ten is the result of adding the numbers one, two, three and four–numbers that represent (respectively) a point with no dimension, a line with one dimension, a plane with two dimensions, and a solid with three dimensions.



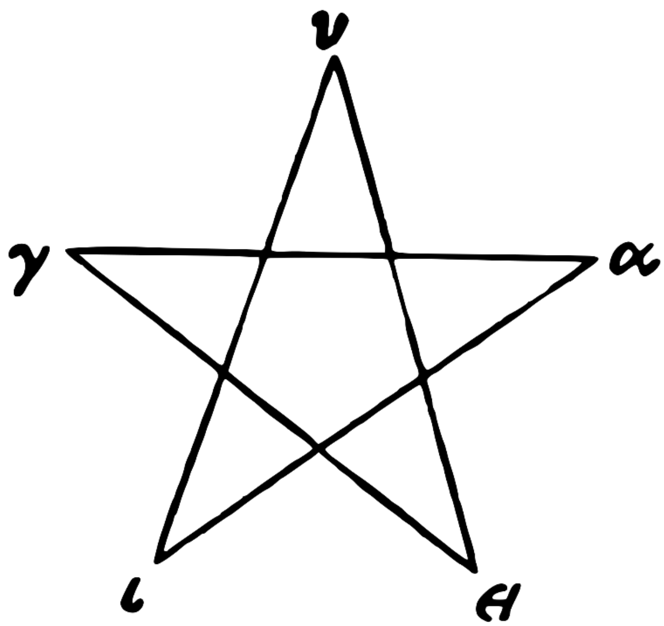
The tetractys (Greek: τετρακτύς), or tetrad, or the tetractys of the decad is a triangular figure consisting of ten points arranged in four rows: one, two, three, and four points in each row, which is the geometrical representation of the fourth triangular number.

So if it is true that 1+2+3+4=10, does it follow that ten is indeed the holiest of numbers? Before you dismiss the above assertion (and proof) as nonsense, consider that this concept did not come from some new-age pseudoscience guru, but was indeed part of a belief system held by a figure that many consider to be the first “true” or “pure” mathematician in human history. I am of course speaking of none other than the Greek philosopher and mathematician Pythagoras of Samos (c. 580–c. 500 BCE). He and his secretive society of followers (Pythagoreans) are credited with some considerable contributions to the development of mathematics including the theorem which states that the square of the hypotenuse of a right-angle triangle is equal to the sum of the squares of the other two sides as well as the discovery of irrational numbers. (*When the ratio of lengths of two line segments is irrational, the line segments* *are also described as being incommensurable—this is an idea we will revisit in depth shortly*.)

As you may suspect, the problem with the above claim lies not with the math, but with the properties and descriptions that are arbitrarily assigned to each number. This arbitrary assigning or association of numbers with people, events, or properties is known as *numerology*. While often masquerading as a science, numerology is nothing more than a systematic manifestation of superstition—just like the pseudoscientific concepts of astrology and biorhythms.

So what does all of this have to do with devices for pictorial composition? Unfortunately quite a bit. The use of numerology to substantiate myth has given rise to many pseudoscientific devices and heuristics in the visual arts. We begin this installment by examining one of the most viral myths to infiltrate the science of visual imagery–**the Golden Ratio.**

It was not the Pythagorean's contributions to modern day numerology that identified them as the ideal starting point for this installment, but rather their connection to irrational numbers. Such numbers are real numbers that cannot be expressed as the ratio of two integers. They have decimal expansions that neither terminate nor become periodic. Common irrational numbers include Pi (3.141592…), √2 (1.414213…), Euler's Number (2.718…), and Phi (1.618033…) The first proof of the existence of such numbers is usually attributed not to Pythagoras, but to one of his followers, Hippasus of Metapontum. As the story goes, Hippasus realized that the sides of a square were incommensurable with its diagonal and that this incommensurability could not be expressed as the ratio of two integers. This discovery was seen as an abomination to the Pythagoreans as they felt that only rational numbers could (or should) exist. Their reaction to this discovery was so severe that it is said that the Pythagoreans threw Hippasus from a ship at sea.



Oddly enough, Pythagoras and his followers used the five-pointed star as a symbol or sign of recognition and referred to it as *hugieia, or* "health". I state that this is odd as the diagonal and the side of the pentagon are also incommensurable. In his book, *The Golden Ratio: The Story of PHI, the World's Most Astonishing Number*, author Mario Livio writes: "*It is possible to establish a rigorous proof that the diagonal and the side of the pentagon are "incommensurable," i.e, that the ratio of their lengths cannot be expressed as a ratio of whole numbers….It has been suggested by several researchers that the Pythagoreans' discovery of this was the first appearance of incommensurability in history.*"

Many years would pass before another Greek mathematician would formally address this concept. In his book *Elements*, Euclid (c.300 BCE) wrote, “*a straight line is said to have been cut in extreme and mean ratio when, as the whole line is to the greater segment, so is the greater*

to the less.” In other words, as shown in the diagram above, point C divides the line in such a way that the ratio of AC to CB is equal to the ratio of AB to AC. Some elementary algebra shows that in this case, the ratio of AC to CB is equal to the irrational number 1.618 (precisely half the sum of 1 and the square root of 5). However, unlike Pythagoras and his followers, Euclid attached no numerological properties to the number, ultimately giving the ratio the seemingly unromantic moniker, “extreme and mean ratio”.

Centuries would pass before we would see another significant chapter in this tale being written. In 1202, a mathematician named Leonardo Bonacci (also known as Fibonacci) published a text titled *Liber Abaci* (Book of Calculation). This important text not only introduced the western world to the Hindu-Arabic numeral system but, among a list of challenging brain-teasers, a fascinating number sequence that would be used to model or describe an amazing variety of mathematical concepts as well as natural phenomena. The sequence (which would eventually be named the “Fibonacci sequence” by French mathematician Édouard Lucas in the 19th century.) starts with a one or a zero, followed by a one, and proceeds based on the rule that each number is equal to the sum of the preceding two numbers. For example, if we look at the sequence of 0,1,1,2,3,5,8,13,21,..we can see that each number equals the sum of the two numbers before it. So after 1 and 1, the next number is 1+1=2, the next is 1+2=3, the next is 2+3=5 and so on. This is known as a recursion. It is a process of choosing a starting term and repeatedly applying the same process to each term to arrive at the following term.

Fibonacci applied this recursion to resolve the following problem contained in *Liber Abaci*:

"If a pair of rabbits is placed in an enclosed area, how many rabbits will be born there if we assume that every month a pair of rabbits produces another pair, and that rabbits begin to bear young two months after their birth?"

With a few assumptions in place, the solution would follow that we would see only one pair at the end of the first month, two pairs at the end of the second month, three by the end of the third, and five pairs by the end of the fourth (*the original female has produced another new pair, the female born two months ago produces her first pair also, making five pairs total.*) So starting with one pair in this scenario, the sequence that we find for the solution IS the Fibonacci sequence.

So what does this recursive number series have to do with the extreme and mean ratio defined by Euclid?

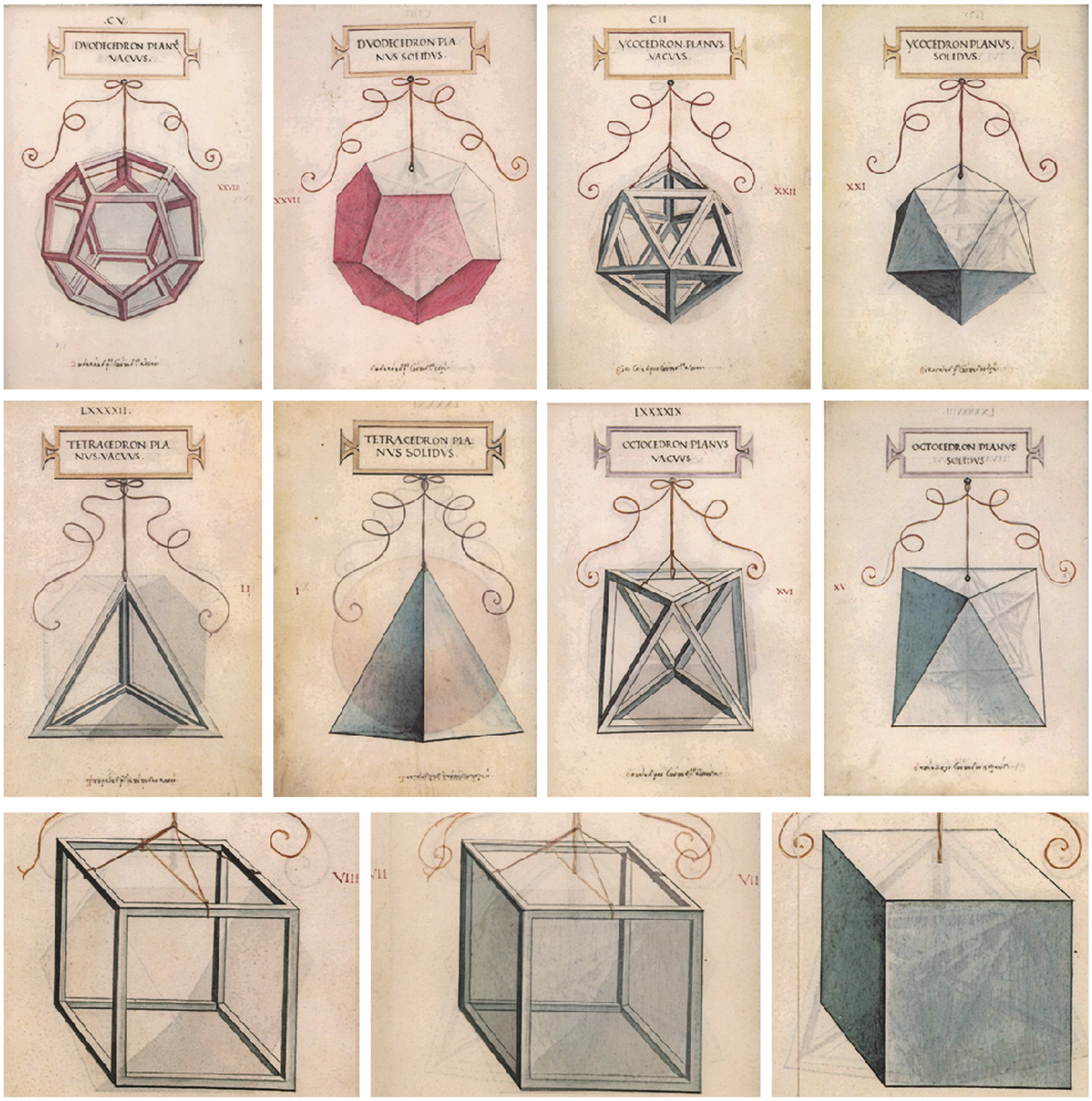
While it might seem completely unrelated at first, closer examination reveals that dividing each number in the Fibonacci sequence by the previous number in the sequence give rise to numbers nearing the extreme and mean ratio. For example:

The Fibonacci sequence is: 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, …

So, if we divide each number by the previous number gives: 1 / 1 = 1, 2 / 1 = 2, 3 / 2 = 1.5, and so on up to 144 / 89 = 1.6179…. The resulting sequence is: 1, 2, 1.5, 1.666…, 1.6, 1.625, 1.615…, 1.619…, 1.6176…, 1.6181…, 1.6179…, or a series of numbers that seems to oscillate very near the numerical value of phi, 1.618…

While this relationship would not be proven until many years later by the Scottish mathematician Robert Simpson (1687-1768), the linking of these concepts would eventually do much to expand the mysticism of this interesting number.

Even though Euclid and Fibonacci did not seem to promote the same numerology that permeated the work of Pythagoras and his followers– the mysticism would not disappear into history quietly. In 1509, a three-volume work by Luca Pacioli titled *De Divina Proportione* (The Divine Proportion) was published. Pacioli, a Franciscan friar, was known mostly known as a mathematician, but he was also trained in, and keenly interested in, art. Leonardo Da Vinci, a longtime friend and collaborator of Pacioli's created a number of illustrations for *Divina*.



Illustrations by Leonardo Da Vinci for Luca Pacioli's De Divina Proportione.

Just as Pythagoras saw divinity in mathematics, Pacioli saw religious significance in the ratio. As such, Pacioli renamed Euclid's extreme and mean ratio, **The Divine Proportion** (the same title as the three-volume treatise). So why was this number said to be divine? He offers five reasons:

1. "That it is one and only one and not more". That is, there's only one value for the divine proportion and only one Christian God.

2. The geometric expression of divine proportion involves three lengths and God also contains three component parts (the Father, Son, and Holy Ghost).

3. “Just like God cannot be properly defined, nor can be understood through words, likewise our proportion cannot be ever designated by intelligible numbers, nor can be expressed by rational quantity, but always remains concealed and secret, and is called **irrational** by mathematicians.”

4. The omnipresence and invariability of God is like the self-similarity associated with the divine proportion: its value is always the same and does not depend on the length of the line being divided or the size of the pentagon in which ratios of lengths are calculated.

5. Just as God has conferred being to the entire cosmos through the fifth essence (the fifth essence being beyond the four simple elements (earth, water, air and fire)), represented by the dodecahedron, so does the divine proportion confer being to the dodecahedron, since one cannot construct the dodecahedron without the divine proportion,

And there you have it. With the publication of *De Divina Proportione*, Pacioli fuels a reweaving of numerology with mathematics. What’s more, *Divina* went beyond the mystical flourishing of numbers that defined the Pythagoreans. Rather, it married mysticism with both mathematics and the arts. In fact, the very first page of *Divina* contains Pacioli’s desire to reveal to artists the “*secret of harmonic forms*” via the divine proportion. He states that his book is “*…a work necessary for all the clear-sighted and inquiring human minds, in which everyone who loves to study philosophy, perspective, painting, sculpture, architecture, music and other mathematical disciplines will find a very delicate, subtle and admirable teaching and will delight in diverse questions touching on a very secret science.*’”

With this strong emphasis on the importance of the divine proportion, it might be surprising to find that the second text of Pacioli’s three-volume work was based on the work of Roman architect Marcus Vitruvius Pollio (born c. 80–70 BC, died after c. 15 BC) who advocated a system of measurement based on rational numbers—not irrational ones. Further compounding the aforementioned influences of numerology, this favoring of the Vitruvian system would be later misrepresented in a book published in 1799. **In Mario Livio's book, *The Golden Ratio: The Story of Phi, the World's Most Astonishing Number*, he writes, "*Author Roger Herz-Fischler traced the fallacy of the Golden Ratio [Divine Proportion] as Pacioli's canon for proportion to a false statement made in the 1799 edition of Histoire des mathématiques (History of mathematics) by the French mathematicians Jean Etienne Montucla and Jérôme de Lalande*" (Livio, p135).**

Both the divine proportion and the Fibonacci sequence would get another boost in the 17th century with a German mathematician, astronomer, and astrologer named Johannes Kepler. It can be demonstrated that Kepler did understand the divine proportion's relationship to Fibonacci's sequence via a 1608 letter he penned to a professor. He revisited this connection in 1611, in a 24-page essay titled, "*In De nive sexangula*" (On the Six-Cornered Snowflake):

"*Of the two regular solids, the dodecahedron and the isohedron…both of these solids, and indeed the structure of the pentagon itself, cannot be formed without the divine proportion as the geometers of today call it. It is so arranged that the two lesser terms of a progressive series together constitute the third and the two last, when added, make the immediately subsequent term and so on to infinity, as the proportion continues unbroken…the further we advance from the number one, the more perfect the example becomes.*"

Over the years, mysticism would indeed continue to swirl around these mathematical concepts, and in 1835, the German mathematician Martin Ohm (younger brother of physicist Georg Ohm) would be the first to refer to the extreme and mean ratio as "Golden". In the second edition of Die *Reine Elementar-Mathematik*, Ohm writes:

"One also customarily calls this division of an arbitrary line in two such parts the golden section [Goldene Schnitt]."

40 years later, James Sulley's 1875 article on aesthetics in the 9th edition of the Encyclopedia Britannica would be the first instance of the term in an English textbook. And so the "Golden Ratio" had finally received a moniker that reflected its mystic gilding. In 1909, an American mathematician would use the Greek letter phi (Φ) to designate this proportion. This may sound a tad less "sacred", but Barr felt the letter, taken from the name of the Greek sculptor Phidias whom he believed applied the ratio in his work (c. 480 – 430 BC), was apt.

The nineteenth and twentieth centuries brought additional contributions to the merging of the Golden Ratio (GR), the Fibonacci sequence, mysticism, and art. Pareidolia and GR gave birth to elaborate geometrical armatures for pictorial composition that persist to this day. Like Pythagoras, many believed that the numbers related to these geometries held special powers, or at the very least–**some aesthetic advantage for the artist.**

Several artists published books that aimed to demonstrate that the irrational number that may have once led a bunch of cranky mathematicians to drown a man at sea, held a “secret” formula for beauty. One such book, *Dynamic Symmetry*, was written by a Canadian-born American artist named Jay Hambidge in 1920. We will explore this book in more detail a little later on.

One of the largest contributors to the marriage of the Golden Ratio and art was German psychologist, Adolf Zeising (24 September 1810 – 27 April 1876). Zeising’s work in this area began with a series of publications (described by mathematician Mario Livio as “crankish”) including an 1854 work titled *A New Theory of the proportions of the human body, developed from a basic morphological law which stayed hitherto unknown, and which permeates the whole nature and art, accompanied by a complete summary of the prevailing systems.* (Yes, that is all one title). After Zeising’s death, this and other publications would be combined into a large book titled *Der Goldne Schnitt* (The Golden Section). In his writings, Zeising claimed that in the Golden Section “*is contained the fundamental principle of all formation striving to beauty and totality in the realm of nature and in the field of the pictorial arts, and that it, from the very first beginning was the highest aim and ideal of all figurations and formal relations, whether cosmic or individualizing, organic or inorganic, acoustic or optical, which had found its most perfect realization however only in the human figure.*” Of Zeising’s work, Mario Livio writes, “*In these works, Zeising combined his own interpretation of Pythagorean and Vitruvian ideas to argue that “the partition of the human body, the structure of many animals which are characterized by well-developed building, the fundamental types of many forms of plants,...the harmonics of the most satisfying musical accords, and the proportionality of the most beautiful works in architecture and sculpture” are all based on the*

Golden Ratio. To him, therefore, the Golden Ratio offered the key to the understanding of all proportions in "the most refined forms of nature and art".

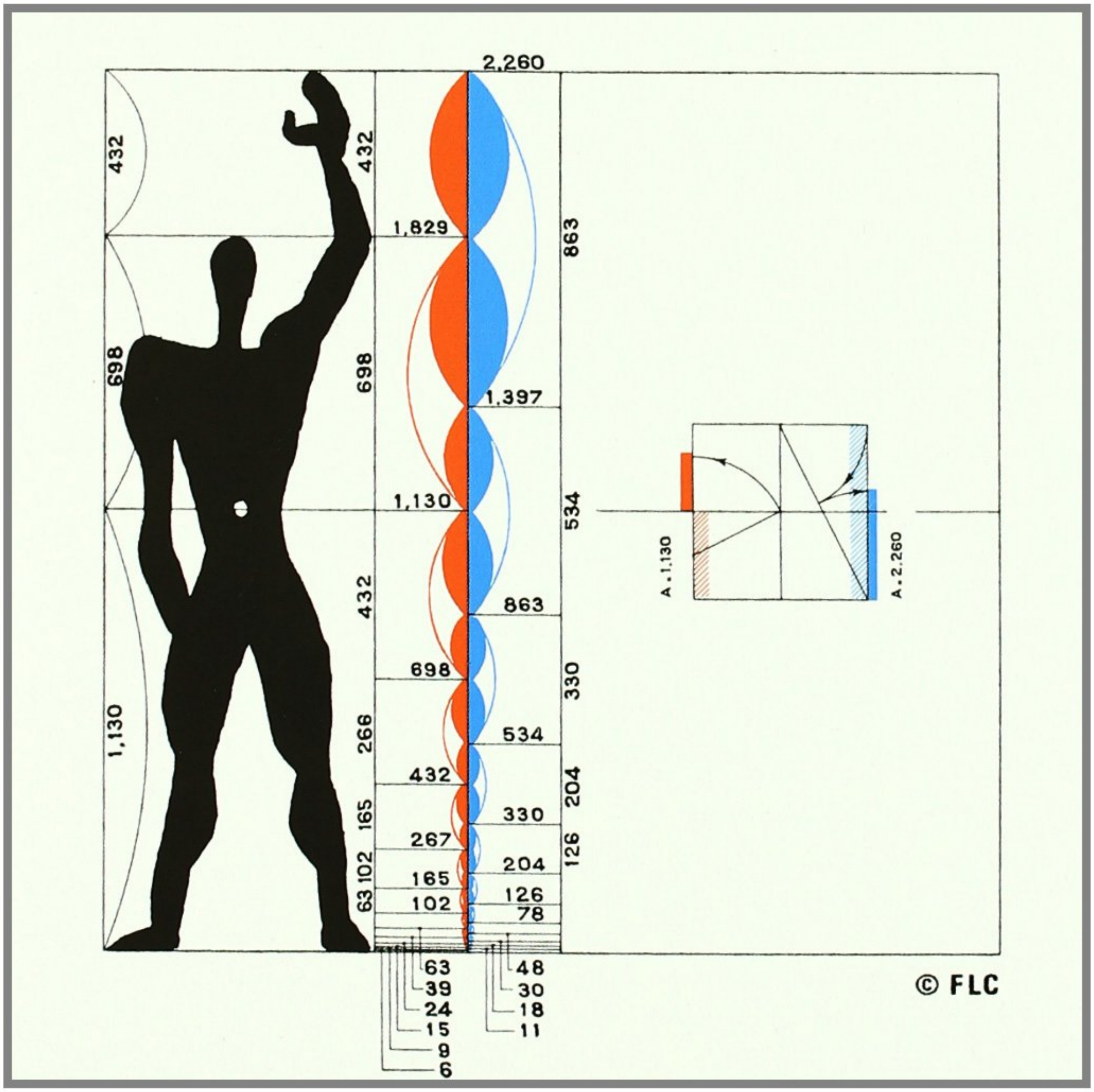


Illustration from Le Corbusier's The Modulor.

This idea that the human body exhibited the proportions of the Golden Ratio would next be picked up by Swiss-French architect and artist Charles-Édouard Jeanneret-Gris (1887- 1965), (better known as Le Corbusier). It has been stated that Le Corbusier was originally skeptical of the aesthetic claims associated with the Golden Ratio and Fibonacci—however, this did not stop him from developing a proportion system based on both. Titled *The Modulor*, his system was supposed to provide "*a harmonic measure to the human scale, universally applicable to architecture and mechanics*." *The Modulor* presented a six-foot (about 183-centimeter) man, with his arm upraised (to a height of 226 cm; 7'5"). The total height (from the feet to the raised arm) was also divided in a Golden ratio (into 140cm and 86 cm) at the level of the wrist of a downward-hanging arm. The two ratios (113/70) and (140/86) were further subdivided into smaller dimensions according to the Fibonacci series.

Books by Romanian author and mathematician Matila Ghyka (1881-1965) and American Author David Bergamini (1928-1983) made many misstatements about the use of the Golden Ratio among artists. Of the two most influential book by Ghyka, author Mario Livio states "***Both books are composed of semimystical interpretations of mathematics. Alongside correct descriptions of the mathematical properties of the Golden Ratio, the books contain a collection of inaccurate anecdotal materials on the occurrence of the Golden Ratio in arts***." Livio's assessment here is very important as it describes not only the content of Ghyka's books—but the typical proponent strategy used to reinforce the idea that the GR holds aesthetic influence via claims of celebrated artist's "historical use".

Arguably the two most commonly-referenced historical applications of the Golden Ratio are the Parthenon and the Great Pyramids**.** Unfortunately, these claims are not supported by any evidence aside from superimposed graphics that are often comically 'fudged' into place. Furthermore, many proponents often claim ballpark measurements as evidence, but as mathematician Roger Herz-Fischler points out in his 1981 paper, How *to find the golden number without really trying.*, this is an extremely problematic approach. He writes:

"However measurements, no matter how accurate, cannot be used to reconstruct the original system of proportions used to design an object, for many systems may give rise to approximately the same set of numbers; see [6,7] for an example of this. The only valid way of determining the system of proportions used by an artist is by means of documentation. A detailed investigation of three cases [8, 9, 10, 11] for which it had been claimed in the literature that the artist in question had used the "golden number" showed that these assertions were without any foundation whatsoever."

A number of authors attempted to substantiate the claims that the GR was present in the Great Pyramid with a host of documented measurements. Martin Gardner, Herbert Turnbull, and David Burton essentially repeat the same story (referencing the 5th-century Greek historian Herodotus as the source):

"*Herodotus related in one passage that the Egyptian priests told him that the dimensions of the Great Pyramid were so chosen that the area of a square whose side was the height of the great pyramid equaled the area of the face triangle.* ([Bur; p. 62]"

A translation of Herodotus' *History Book II* states:

“The Pyramid itself was twenty years in building. It is a square, eight hundred feet each way, and the height the same, built entirely of polished stone fitted together with the utmost care. The stones of which it is composed are none of them less than thirty feet in length”

Not only would these measurements not qualify as proof of design via a specific system of proportions (see Fischler above), but an often cited paper on this topic by mathematician and computer scientist George Markowski demonstrates that the Herodotus’s measurements are not even remotely accurate. .

“A variety of people have looked for phi in the dimensions of the Great Pyramid of Khufu (Cheops), which was built before 2500 BC. According to [Tas; p12] the length of the sides of the base of the Great Pyramid range from 755.43 to 756.08 feet, so it is not a perfect square. The average length is 755.79 feet. The height of the Great Pyramid is given at 481.4 feet. Every source that I have checked for dimensions gives values within 1% of these (e.g., [Gil; p. 185]). Throughout this section, I will use 755.79 feet as the length of the base and 481.4 feet as the height.”

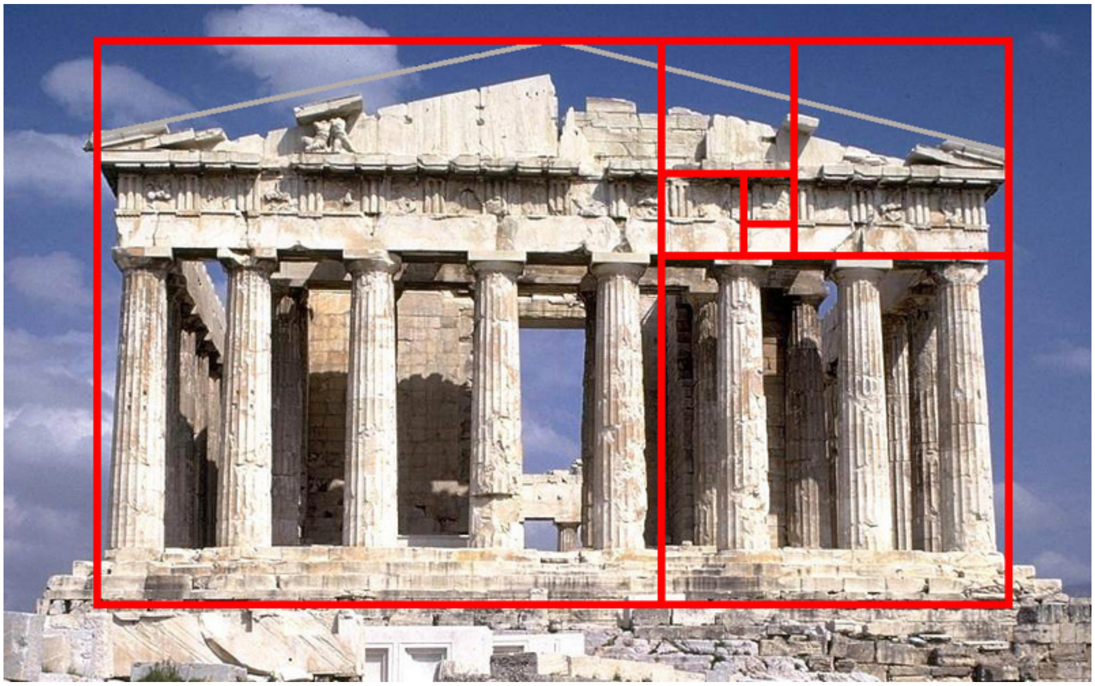
Professor Markowsky goes on to state:

“Furthermore, Herodotus’s figures about the dimensions of the Great Pyramid are wildly off. The Great Pyramid neither is nor ever was (it has lost some height over the years) anywhere near 800 feet tall nor 800 feet square at the base. Finally, we should note that Herodotus wrote roughly two millennia after the Great Pyramid was constructed.

The distorted version of Herodotus's story makes little sense. Even the authors who quote it do not give a reason why the Egyptians would want to build a pyramid so that its height was the side of a square whose area is exactly the area of one of the faces. This idea sounds like something dreamt up to justify a coincidence rather than a realistic description of how the dimensions of the Great Pyramid were chosen. It does not appear that the Egyptians even knew about the existence of phi much less incorporated it in their buildings (see [Gil; pp238-9])." – *Markowsky, George. "Misconceptions about the Golden Ratio." The College Mathematics Journal 23.1(1992): 2-19. Web. 17 April 2010.*

More often than recorded measurements, evidence for GR's use in the design of the Parthenon is presented via a superimposed series of "Golden Rectangles". George Markowsky cautions readers against this rather nebulous (but common) mechanism of investigation. He writes, "*In some cases, authors will draw golden rectangles that conveniently ignore parts of the object under consideration. In the absence of any clear criteria or standard methodology, it is not surprising that they are able to detect the golden ratio.*"

*…I will call such unsystematic searching for phi the **Pyramidology Fallacy**. Pyramidologists use such numerical juggling to justify all sorts of claims concerning the dimensions of the Great Pyramid.*"

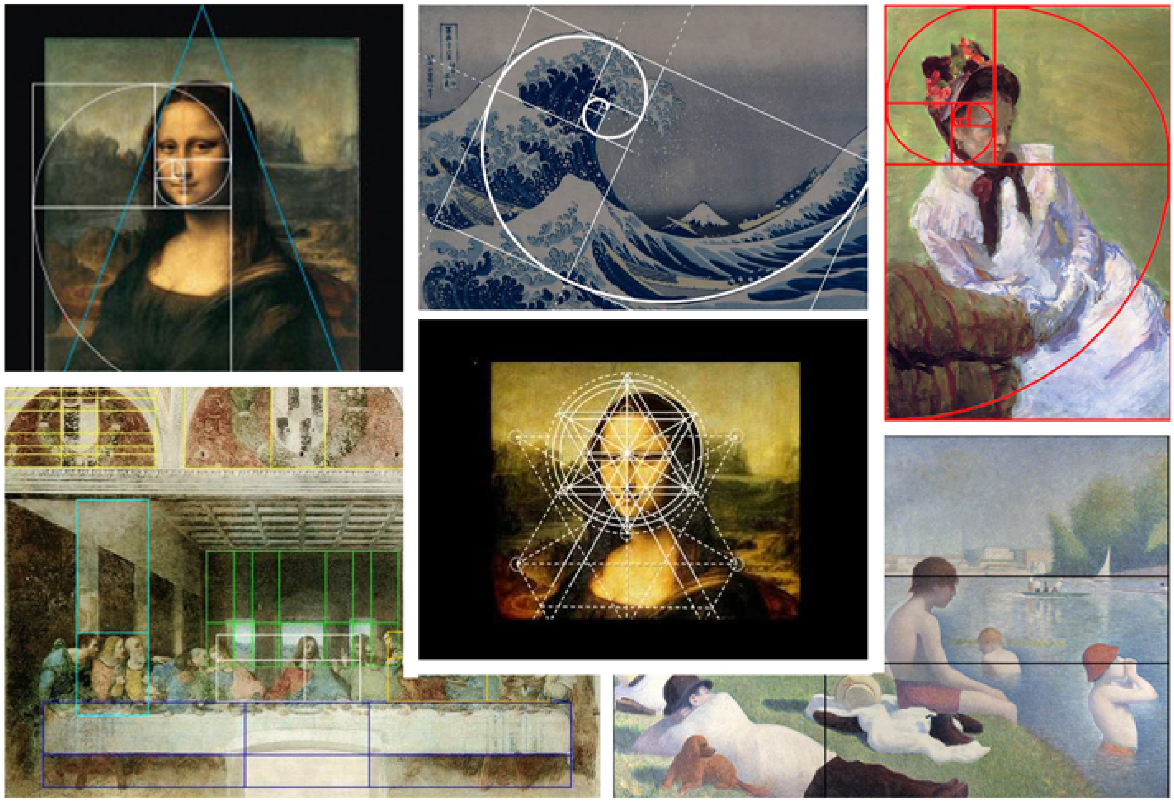


Brian Dunning of Skeptoid writes: “*Perhaps the best-known pseudo-scientific claim about the golden ratio is that the Greek Parthenon, the famous columned temple atop the Acropolis in Athens, is designed around this ratio. Many are the amateurs who have superimposed golden rectangles all over images of the Parthenon, claiming to have found a match. But if you've ever studied such images, you've seen that it never quite fits, at least not any better than any other rectangle you might try. That's because there's no credible historical or documentary evidence that the Parthenon's designers, who worked more than a century before Euclid was even born, ever used the golden ratio in any way, or even knew of its existence*”.

Now, rather than spend any more time challenging GR “application” in architecture, sculpture, poetry and music (all of which hold claims of GR use in design)—let us examine some historical claims regarding visual artists “using” the Golden Ratio for pictorial composition. (I place parenthesis around the word “using” here (as well around related terms) as advocates seem to have great difficulty in stating what the Golden Ratio actually does.)

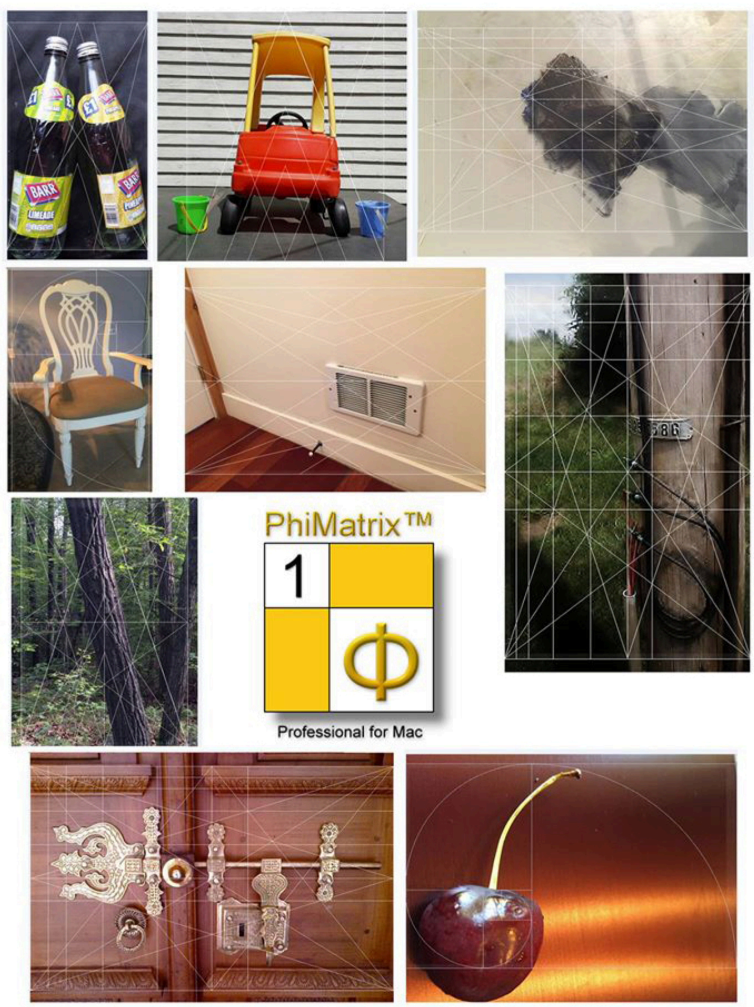
It is claimed by many that countless artists throughout history have attempted to “apply” the Golden Ratio into the design of their works and indeed, a few left evidence that they have. Salvador Dali, Paul Serusier, Juan Gris, Giro Severini, Le Corbusier, Jay Hambidge, Maxfield Parrish, George Bellows, Denman Ross, and Al Nestler are among the more well-known visual artists that have documented at one time or another that they have indeed “used” or experimented with the Golden Ratio. Of the group, Dali, Serusier, Gris, and Severini all “*seem to have been experimenting with GR for its own sake rather than for some intrinsic aesthetic reason*.” states mathematician Keith Devlin in his 2007 paper, “The Myth That Will Not Go Away.” *Mathematical Association of America*. Devlin goes on to state that “*…the Cubists did organize an exhibition called “Section d’Or” in Paris in 1912, but the name was just that; none of the art shown involved the golden ratio*.”

Many other artists like Da Vinci, Botticelli, Michelangelo, Rafael, and Seurat are also said to have employed the golden ratio in their work. While it is possible that these artists may have experimented with the GR, there is no credible evidence to support the claims that they, in fact, did. Much like with the Parthenon, geometric overlays showing arbitrary intersections (confirmed via pareidolia) are offered as “proof”. Again, as Markowski states “*In the absence of any clear criteria or standard methodology it is not surprising that they are able to detect the golden ratio*.”



Examples of geometric overlays that are used to "prove" the use of Golden Ratio as well as related design devices.

To demonstrate the problematic (and pareidolic) nature of this strategy, I posted a call on social media for examples of terrible composition. I then proceeded to use a program called PhiMatrix, which is "design and analysis software for Windows and Mac, inspired by Phi, the Golden Ratio.", to add the same overlays used to "verify" GR use in masterworks, to the submissions. What I found was that the armatures did in fact, intersect with the image content in the same way that they do with masterworks. So does this prove that these geometric armatures are in fact a means to bad composition? Using the rationale of many golden section hypothesis proponents—it would seem so. To further confirm historical "use", German scientist Gustav Fechner (a scientist whose work we will explore in depth shortly) conducted a detailed analysis in 1878 of 10,558 images from 22 European art galleries. Unfortunately for golden ratio proponents, Fechner found that the typical ratio of painting height-to-widths clearly deviated from the "expected" golden ratio. (It should also be noted here that some of the most common standard sizes for artist canvases today do not adhere to the Golden Ratio. They are (in inches) 8×10″, 5×7″ 6×8″, 11×14″, 9×12″ and 12×16″ holding ratios 0.8, 0.714, 0.75, 0.786, 0.75 and 0.75 respectively.



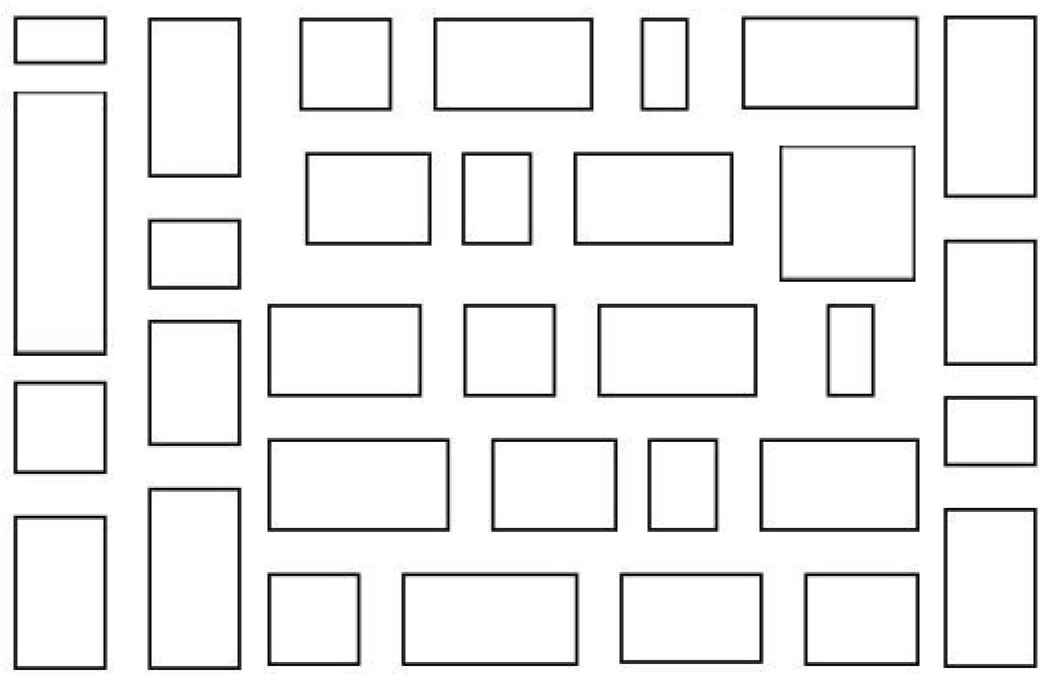
Demonstration of Golden Ratio armatures and other geometric overlays applied to images considered to be examples of bad composition.

So are there any viable reasons to believe that the Golden Ratio holds any true aesthetic quality that ***can*** be applied visual art? The answer to that question would again turn our attention to biology.

In the first installment of this series, we defined aesthetic qualities as the characteristics of a stimulus that elicit adaptive responses that have evolved to reinforce or discourage specific behaviors. However, many resources will define visual aesthetics much more narrowly, as the psychological assignment of beauty to certain visual stimuli. While the latter is arguably problematic, either definition will suffice for our assessment of the GR in regards to demonstrable aesthetic quality.

With either definition in play, it will be necessary for us to be able to perceive the Golden Ratio visually. In fact, the term aesthetics is derived from the Greek word “aisthetikos” which means “pertaining to sense perception.”

Markowsky points out in his aforementioned essay that *The New Columbia Encyclopedia* describes a “Golden Rectangle” as a rectangle whose length and width are the segments of a line divided according to the Golden Section. They go on to state that the shape occupies an important position in painting, sculpture, and architecture because its proportions have long been considered the most attractive to the eye. So let’s see if you can pick out this “most attractive” rectangle (I’ll reveal the answer at the bottom of the paper):



In an effort to determine whether or not the Golden Ratio (or Golden Rectangle) indeed presented aesthetic qualities, experimental psychologist Gustav Fechner presented test subjects with a similar challenge in the 1860s. He placed 10 rectangles before each a subject and asked them to select the "most pleasing" rectangle. The rectangles varied in their height/length ratios from 1.00 (square) to .40. The Golden Rectangle had a ratio of .62. Fechner reported that 76% of all choices centered on three rectangles having the ratios of .57, .62, and .67 (with a peak at the .62 "Golden Rectangle".)

While this data may seem initially compelling, many mathematicians, including Mario Livio, have refuted the results of the experiment. Fechner was unable to explain a psychological basis for the preference and a significant number of experiments failed to replicate his results. Of the experiment, Livio writes, *"Fechner's motivation for studying the subject was not without prejudice. He himself admitted that the* *inspiration for the research came to him when he "saw the vision of a unified world of thought, spirit and matter, linked together by the mystery of numbers." While nobody accuses Fechner of altering the results, some speculate that he may have subconsciously produced circumstances that would favor his desired outcome. In fact, Fechner's unpublished papers reveal that he conducted similar experiments with ellipses, and having failed to discover any preference for the Golden Ratio, he did not publish the results.*"

The design of Fechner's experiment has also been criticized. "*Several authors criticized Fechner's test arrangement because the composition of the presented rectangles could have advantaged the selection of the medial one, which was the "golden" ("trend to the mean" – phenomenon). The other points of [critique] are that the subjects were not [randomly] selected and could have been influenced in their decisions by knowing Fechner's hypothesis.*" -Do *People Prefer Irrational Ratios? A New Look at the Golden Section–University of Bamberg.*

Some that have attempted to replicate Fechner's original study as closely as possible found that the golden ratio was indeed **not a "preferred proportion"**. Professor of Psychology Holger Höge writes of his own study, "*Thus, as there are so many results on the golden section hypothesis showing contradictory outcomes it seemed necessary to replicate Fechner's original study as far as possible: giving the same proportions, using white cards on black ground. Other specifics could not be kept constant because Fechner's report on the experiment is not very precise (cf. Fechner, 1876/1925/1997). As a complete replication is not possible, three experiments were carried out, each of them being* *slightly different in methodology. However, regardless of the conditions under which the choices were made, the golden section did not turn out to be the preferred proportion. The comparison with Fechner's results makes this research only quasi-experimental in character and, hence, inevitably there are some restrictions with respect to the strength of the conclusions to be drawn. But, nevertheless, the nice peak of preference Fechner reported for the golden section seems to be either an artifact or it is an effect of still unknown factors. Two possible hypotheses (change-of-taste and color-of-paper) are discussed. It is concluded that the golden section hypothesis is a myth.*"

The only aspect of Golden Ratio preference experimentation seems to be the inconsistency of their results. Christopher Green's *All that glitters: a review of psychological research on the aesthetics of the golden section* contains a wonderful glimpse into a history of the many experiments testing the aesthetic preferences for the Golden Ratio. Green writes, "*What has been found? Apart from the Fechner and Witmer studies—the ones that are consistently put forward by advocates of the golden section—the early study by E Pierce (1894) revealed a popular preference for the golden section (despite Pierce's own efforts to minimize the finding). Angier (1903) found a preference for line divisions near the golden section on average but did not find that it was preferred by individuals. Haines and Davies (1904) found no sizable effect, but Lalo (1908), replicating Fechner's procedure, found an effect nearly as strong as had Fechner himself. Studies by Thorndike (1917) and Weber (1931) revealed general trends in favor of figures with proportions in the range of the golden section, but nothing specific. Farnsworth (1932), on the other hand, found fairly strong support for a preference for the golden rectangle. Davis (1933) found* *modal preferences at √3, √4, and √5, but not at phi. Importantly, however, he was the first to suggest that the proximity of phi to other 'basic' proportions, such as √2 and √3, might be masking an otherwise reliable effect. Interestingly, although this kind of 'Pythagorean' attitude has not been popular in mainstream psychology, it was the metaphysical backbone of the psychophysics developed by Weber and Fechner in the 19th century. Thompson (1946), Shipley et al (1947), and Nienstedt and Ross (1951) all showed trends in favor of golden rectangles, but their use of median rankings, rather than modes or raw frequencies, make their results suspect in the eyes of many critics.*

Schiffman (1966, 1969) failed to find any effect for the golden rectangle, confirming the growing suspicion that golden-section research was a wild-goose chase. Eysenck and Tunstall (1968) found golden-rectangle effects, especially for introverts, but used the dubious tool of mean rankings. Berlyne (1970) found similar effects among Canadian subjects, using mean rankings as well, but showed, as had Angier in the early part of the century, that this does not accurately reflect individuals' preferences. The research of Hintz and Nelson (1970, 1971), however, revealed modal preferences quite close to the golden rectangle. Significantly, modes are not subject to the criticisms that have historically been made of means in this area of research. Godkewitsch (1974) claimed to show that historically established preferences for the golden rectangle were nothing but artifacts of poorly conceived experimental procedures, but he did not treat those studies in which other procedures and methods of analysis had been used. Still, the replication of Godkewitsch's finding by Piehl (1976) boded ill for golden-section research. Reversing this apparent fate, Benjafield (1976) showed that a more carefully conceived experiment *would give rise to the traditional effect for the golden rectangle, even when Godkewitsch's criticisms were taken into account. The results of Piehl (1978) supported this conclusion, and golden-section research was restored to the psychological agenda. An interestingly parallel case occurred in the case of research on divided lines. McManus's (1980) result, too, lent some additional, though inconclusive, credence to at least group preferences for the golden rectangle. Schiffman and Bobko (1978) claimed to refute the positive findings of Svensson (1977), but again, an experiment carefully conceived and conducted by Benjafield etal (1980) restored an effect that had been lost in less-exacting work. Boselie (1984a, 1984b) has argued that apparent preferences for complex proportions, such as square roots and <^ are, in fact, the result of subordinate simple proportions, 966 C D Green such as equality. Boselie (1992) showed that the 1.5:1 rectangle may also be preferred to (|>. The failures of Nakajima and Ohta (1989) and of Davis and Jahnke (1991) to find positive results are both beset by methodological problems.*

Even with the many "positive-result" experiments that Green lists, he too seems to realize that the GR hypothesis ultimately remains unsubstantiated–stating that "if" such preferences do exist, they are "fragile". Green writes" *I am led to the judgment that the traditional aesthetic effects of the golden section may well be real, but that if they are, they are fragile as well. Repeated efforts to show them to be illusory have, in many instances, been followed up by efforts that have restored them, even when taking the latest round of criticism into account. Whether the effects, if they are in fact real, are grounded in learned or innate structures is difficult to discern. As Berlyne has pointed out, few other cultures have made mention of the golden section* *but, equally, effects have been found among people who are not aware of the golden section. In the final analysis, it may simply be that the psychological instruments we are forced to use in studying the effects of the golden section are just too crude ever to satisfy the skeptic (or the advocate, for that matter) that there really is something there.*"

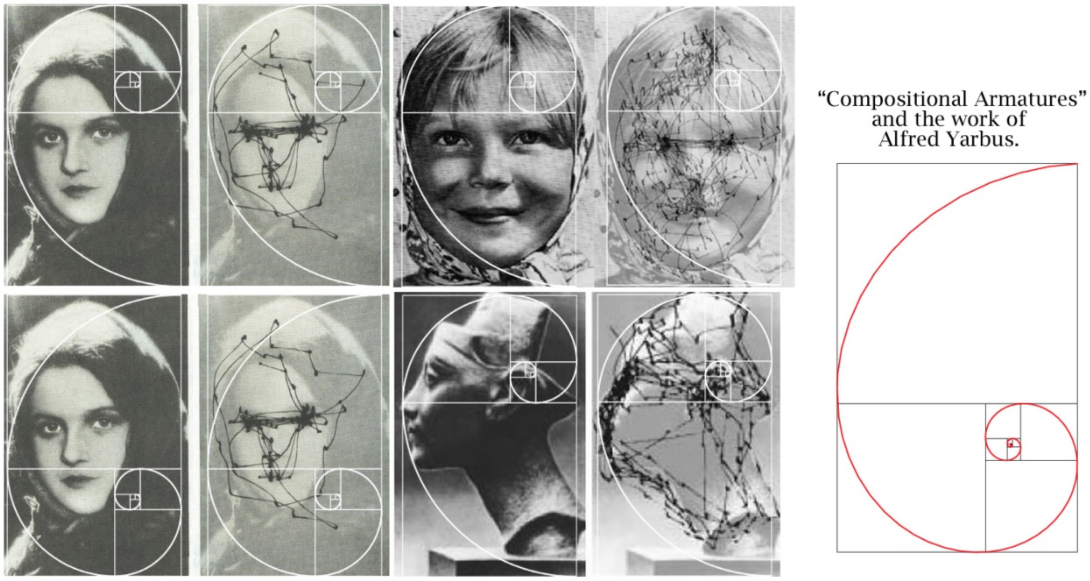
Many contemporary mathematicians and researchers seem to be increasingly dismissive of the Golden Ratio hypothesis. British mathematician and author Keith Devlin states that "*the idea that the golden ratio has any relationship to aesthetics at all comes primarily from two people, one of whom was misquoted [Pacioli], and the other of whom was just making shit up [Zeising].*" Devlin, the executive director of Stanford's Human Sciences and Technologies Advanced Research Institute, has been debunking Golden Ratio myths for years now. He states, "*It's like Creationism. You can believe it if you want, but there's no evidence…If you believe it, you're not being scientific.*"

In a recent interview with writer John Brownlee Devlin states, "*Let's put it this way, if someone comes along tomorrow with a scientific explanation for why the Golden ratio would play a role in aesthetics and whatever else, then we'd all revise our opinion,...But on the science side, there's no evidence.*"

Some modern researchers attempted to uncover psychological or neurobiological underpinnings that might support the golden section hypothesis. One such attempt came American psychologists L.A. Stone and L.G. Collins. They put forward a hypothesis that suggested the shape of the binocular visual field may determine the supposed preference for rectangles possessing dimensions similar to those of the golden section. Stone and Collins tested this hypothesis by simply asking study participants to draw pleasing rectangles. The “average rectangle” contained a length-to-width ratio of about 1.5. As with Fechner’s original experiment, subsequent experiments failed to replicate even these results. In 1966, Rutgers University’s H. R. Schiffman performed a similar experiment that resulted in an average length-to-width ratio of 1.9.

Inspired by this idea of finding a rationale for golden section preference in the mechanisms of biological vision, I returned to the eye-tracking work of Russian psychologist Alfred Yarbus (introduced in the second installment of this series) to see if there was any detectable saccade pattern that would seem related to the structure of an armature based on the golden ratio.

In the above examples from Yarbus’ experiments, I’ve applied the classic golden section armature in the manner that seemed to ‘fit” best (a “proof” in and of itself for many that these images were indeed “designed” with the golden ratio.) With the armature visibly in place, we can easily see that the recorded eye patterns do not seem to correlate in any way.



Golden Ratio spiral overlays combined with Alfred Yarbus' eye-tracking results.

In a 2007 study titled "*The golden beauty: brain response to classical and renaissance sculptures*." Di Dio, Cinzia, Emiliano Macaluso, and Giacomo Rizzolatti used an fMRI to explore the possibility of an objective, biological basis for the experience of beauty in art. They wrote in the 2007 study, ""The main question we addressed in the present study was whether there is an objective beauty, i.e., if objective parameters intrinsic to works of art are able to elicit a specific neural pattern underlying the sense of beauty in the observer. Our results gave a positive answer to this question. The presence of a specific parameter (the golden ratio) in the stimuli we presented determined brain activations different to those where this parameter was violated. The spark that changed the perception of a sculpture from "ugly" to beautiful appears to be the joint activation of specific populations of cortical neurons responding to the physical properties of the stimuli and of neurons located in the anterior insula."

While this may once again seem like a reason to consider the possibility that the GR preference may be supported by evidence, a review of the experiment materials quickly reveals a rather comical methodology. Here is one of the images that the participants were presented with in order to assess “beauty” (incorporating the golden ratio):

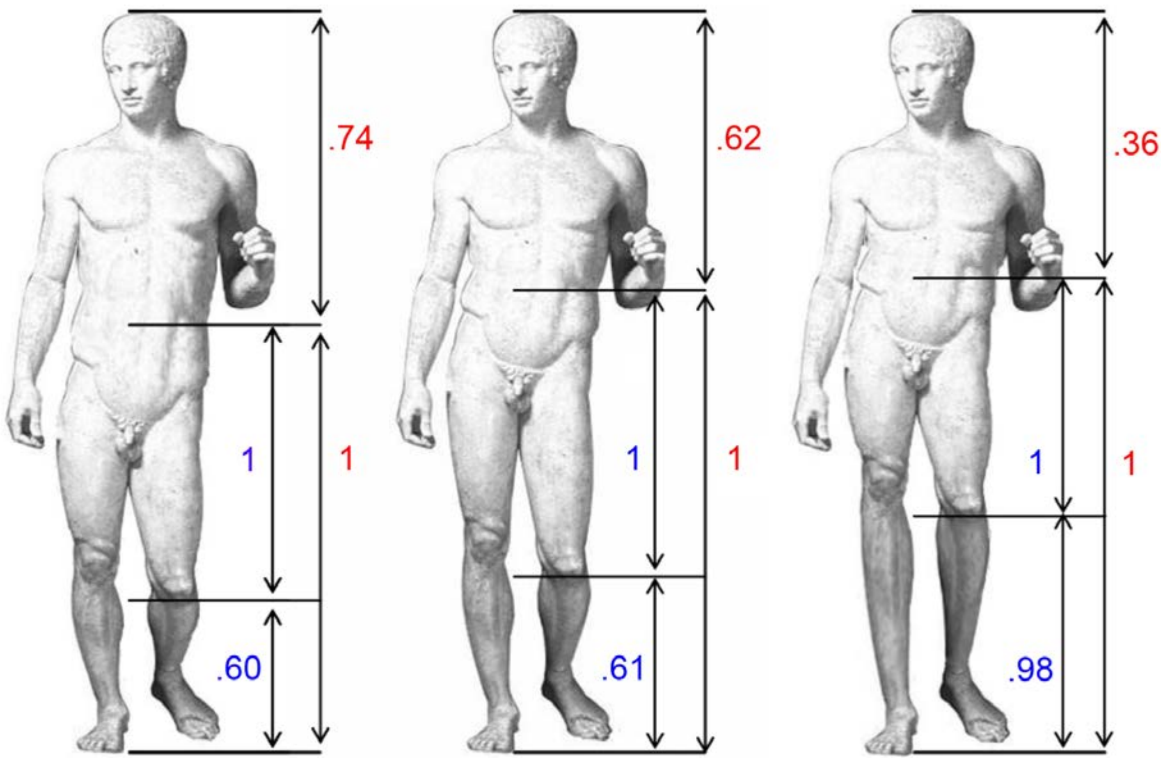
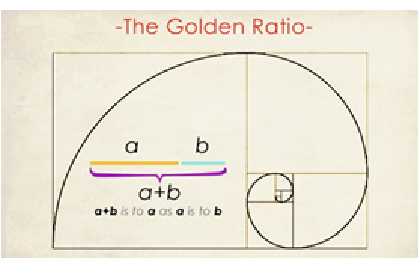
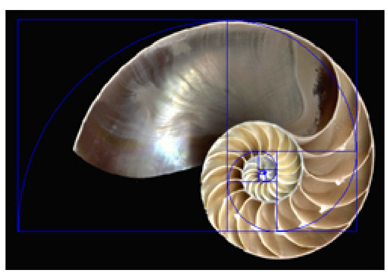


Figure 1. Example of canonical and modified stimuli. The original image (Doryphoros by Polykleitos) is shown at the centre of the figure. This sculpture obeys to canonical proportion (golden ratio = 1:1.618). Two modified versions of the same sculpture are presented on its left and right sides. The left image was modified by creating a short legs:long trunk relation (ratio = 1:0.74); the right image by creating the opposite relation pattern (ratio = 1:0.36). All images were used in behavioral testing. The central image (judged-as-beautiful on 100%) and left one (judged-as-ugly on 64%) were employed in the fMRI study. -Di Dio, Cinzia, Emiliano Macaluso, and Giacomo Rizzolatti. “The golden beauty: brain response to classical and renaissance sculptures.” PloS one 2.11 (2007): e1201.

As you can quickly see from this example of the experiment stimuli, the stimulus that carries the “golden ratio” does so with an arbitrary division at the naval and is compared against distorted versions of the same stimuli that “violate the ratio”. Using this strategy, you can conclude that any ratio is pleasing. Just pick one.

Another strategy for promoting the golden ratio hypothesis is to focus on the prevalence of phi in nature. And while the GR and Fibonacci sequence both crop up with surprising regularity in many living systems, some of the “occurrences” cited are indeed misrepresentations. Pinecones, pineapples, the pattern of sunflower seeds, the arrangement of leaves on a stem of plants (phyllotaxis), nautilus shells, hurricanes, whirlpools, the double-helix of DNA, and spiral galaxies are just a few of the natural phenomena that are associated with phi.

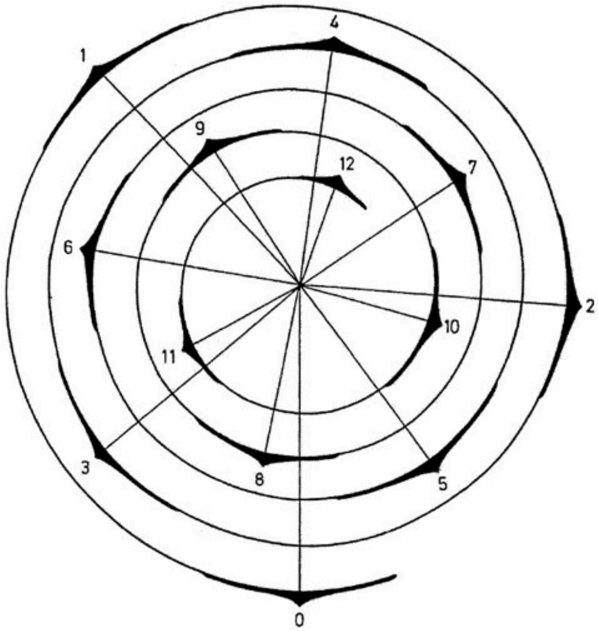





Probably the most commonly used representation of phi in nature is the nautilus shell. While the shell is indeed a logarithmic spiral, (also known as an equiangular spiral or growth spiral) it is NOT a “golden spiral” (a golden spiral is a logarithmic spiral that grows outward by a factor of the golden ratio for every 90 degrees of rotation (pitch about 17.03239 degrees). It can be approximated by a “Fibonacci spiral”, made of a sequence of quarter circles with radii proportional to Fibonacci numbers.) Similar errors are made in regards to spiral galaxies and hurricanes.

Here you can see a logarithmic spiral based on the Golden Ratio next to a spiral of the nautilus shell. If you think these spirals are the same, then the aesthetic “effectiveness” of the Golden Ratio should be the least of your concerns.

One of the most fascinating TRUE occurrences of phi in nature is phyllotaxis. In botany, phyllotaxis or phyllotaxy is the arrangement of leaves on a plant stem (from Ancient Greek phýllon “leaf” and táxis “arrangement”). Phyllotactic spirals form a distinctive class of patterns in nature. Although the first person to discover the relationship between phyllotaxis and the Fibonacci sequence was astronomer Johannes Kepler (1571-1639), and the name coined by coined in 1754 by Swiss naturalist Charles Bonnet, it would be nineteenth century German botanists Karl Friedrich Schimper(1830), Alexander Braun (1835), French physician/scientist Louis François Bravais and his brother, crystallographer Auguste Bravais (1837) that would “*discover the general rule that phyllotactic ratios could be expressed by ratios of terms of the Fibonacci series and also noted the appearance of consecutive Fibonacci numbers in the parastichies of pinecones and pineapples*”. -Mario Livio



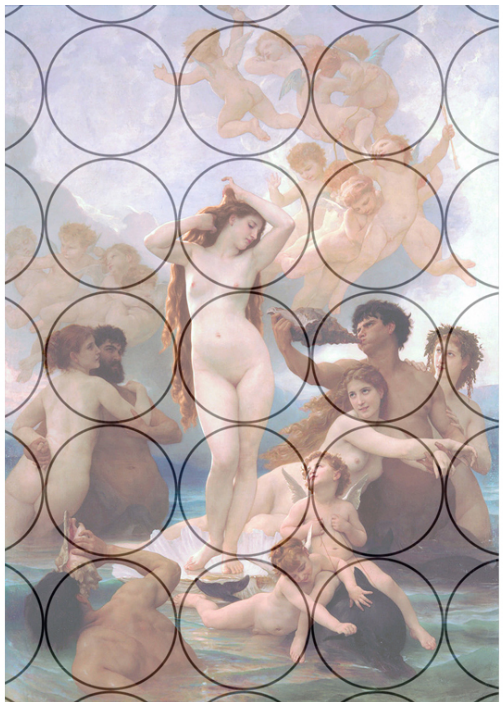
So is the fact that phi can be found in sunflowers, pine cones, and pineapples some type of validation for the aesthetic claims surrounding the golden ratio? We might answer that by looking to how often these natural manifestations of phi appear in artworks. We have long since celebrated those things we have deemed "beautiful" on paper and canvas. Therefore, if phi holds significant aesthetic quality, and the aforementioned objects are natural manifestations of phi, and natural occurrences of phi are often put forward as "evidence" of likely biological influence, then it would seem reasonable that many celebrated artworks would feature pinecones, pineapples, and sunflower florets.

So how many pinecones and pineapples have populated your favorite drawings and paintings? Now I would concede that sunflowers have long been in many celebrated paintings over the years–but take a moment to consider those representations. How many actually feature an accurate representation of the spiral floret patterns that exhibit phi? Or, have the artists opted to abstract the Fibonacci-laden central region to instead focus on the surround of colorful petals. You would think that if natural manifestations of a mathematical formula for aesthetic preference actually existed, these manifestations would find more “canvas-time” than they have.

So at this point I am hopeful that the nature of the Golden Ratio is a bit more clear for you. If not, you may want to consider the “***Divine Circle Matrix***”:

The Divine Circle Matrix is the oldest secret in the visual arts. For many years, creatives have measured aspects of nature in the hopes of uncovering the secrets of beauty. However, for centuries it has been known to a select few that the secret is found not in the external environment–but hidden within in the eye itself. Anatomically, the size of the human retina from ora to ora is 32mm (Van Buren, 1963.), while the fovea, which is the only part of the human eye that permits 100% visual acuity, measures 1.5mm (Polyak, 1941). These measurements reveal a ratio of 1.5:32, (or 3:64). If we look to the Bible we can find an astounding correlation: Lamentations 3:64: You will recompense them, O LORD, According to the work of their hands. Incredible!

So is there something special, or possibly divine, inherent to this root 1.5mm measurement? You bet there is! You can take any masterwork, apply a circle with the diameter of 3 (inches, centimeters, or any applicable unit) in the center (1.5 for each eye), and you will find that every circle tiled outward will capture an important aspect of the image. The more circles that capture important events in the image—the more beautiful the artwork.



Does that sound unbelievable? It should as it is complete nonsense. I manufactured this concept in about 10 minutes. To be clear–***The math is correct, the biology is correct, and the quote from the bible is correct.*** So with a few bits of accurate math, several references to biology, a far-reaching coincidental connection to the bible, and a hint at a centuries-old standing secret and instantly we have a new divine formula for beauty. With a bit of collective effort, I am sure it would not be too long before this idea would “snowball”–soon being taught in a design class near you.

So if the Golden Ratio remains unsubstantiated after so many years of study—why does it persist? Keith Devlin answers this question best in his interview with writer John Brownlee:

“Devlin says it’s simple. “We’re creatures who are genetically programmed to see patterns and to seek meaning,” he says. It’s not in our DNA to be comfortable with arbitrary things like aesthetics, so we try to back them up with our often limited grasp of math. But most people don’t really understand math, or how even a simple formula like the golden ratio applies to complex system, so we can’t error-check ourselves. “People think they see the golden ratio around them, in the natural world and the objects they love, but they can’t actually substantiate it,” Devlin tells me. “They are victims to their natural desire to find meaning in the pattern of the universe, without the math skills to tell them that the patterns they think they see are illusory. If you see the golden ratio in your favorite designs, you’re probably seeing things.”-Brownlee, John. Co. Design: The Golden Ratio: Design’s Biggest Myth w/ Keith Devlin.

Now if you can still stick with me, we have one more topic to cover in this installment before we close, Jay Hambidge’s Dynamic Symmetry. This still-popular work contains many of the same fundamental problems inherent to the Golden Section hypothesis so an examination of his efforts should not take long.

As I mentioned earlier in this paper, *The Elements of Dynamic Symmetry* was written by a Canadian-born American artist named Jay Hambidge in 1920. Dynamic symmetry is a proportioning system and natural design methodology that uses dynamic rectangles, including root rectangles based on ratios such as √2, √3, √5, the golden ratio (φ = 1.618...), its square root (√φ = 1.272...), and its square (φ2 = 2.618....), and the silver ratio (2.4142135623....).

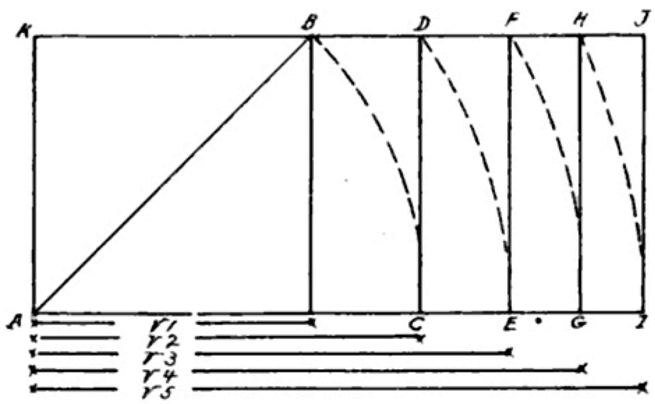


Fig. 10.

What you can probably glean from this brief description is that the ideas presented are just as nebulous and problematic as the golden section hypothesis explored above. Hambidge just goes a bit further to include additional related ratios. Therefore, when one’s pareidolia fails to produce the (hopefully) now familiar 1.618…, we can expand the search to include this ratio, or that one, because they all carry an aesthetic advantage. Again, like our “holy” ten, the math is correct—but there is absolutely no substantiating evidence that any of the ratios hold an aesthetic advantage.

Essentially, *Dynamic Symmetry* is a larger net for catching fairies.

In his celebrated work on Phi, Mario Livio dismissed Hambidge efforts quite succinctly. *“Another art theorist who had great interest in the Golden Ratio at the beginning of the twentieth century was the American Jay Hambidge (1867-1924). In a series of articles and books,* *Hambidge defined two types of symmetry in classical and modern art. One, which he called "static symmetry," was based on regular figures like the square and equilateral triangle, and was supposed to produce lifeless art. The other, which he dubbed "dynamic symmetry," had the Golden Ratio and the logarithmic spiral in leading roles. Hambidge's basic thesis was that the use of "dynamic symmetry" in design leads to vibrant and moving art. Few today take his ideas seriously."*

Let's take a look at some of the claims in Elements of *Dynamic Symmetry* and see if they seem familiar:

DS: "*The basic principles underlying the greatest art so far produced in the world may be found in the proportions of the human figure and in the growing plant.*"

This claim should sound familiar. It is a simple rehash of the nonsense spewed by Adolf Zeising in the 1850s. Remember that Zeising felt that the Golden Ratio was the basis for ""the partition of the human body, the structure of many animals which are characterized by well-developed building, the fundamental types of many forms of plants,...the harmonics of the most satisfying musical accords, and the proportionality of the most beautiful works in architecture and sculpture..." Once again, while there are many proportions to be found in nature–there is no substantial evidence–no biological reason or rationale—to support that any one would be any more aesthetically pleasing than any other independent of context.

DS: *"The principles of design to be found in the architecture of man and of plants have been given the name "Dynamic Symmetry." This symmetry is identical with that used by Greek masters in almost all the art produced during the great classical period."*

"The analysis of the plan of a large building, such for example as the Parthenon, often is not so difficult as the recovery of the plans of many minor design forms."

Within a few sentences of Hamidge's introduction, we have jumped from evidence-via-natural-prevalence to evidence-via-assertions-of-historical-use. Anyhow, we can assume here that Hambidge is referring to the Classical period of 4th and 5th century BCE. So did the artists of this period use Dynamic Symmetry in "almost all art produced" during this period?

Just as I demonstrated with the Parthenon (created 438 BCE) above, the answer is "hardly". The dimensions of the base of the Parthenon are 69.5 by 30.9 meters (228 by 101 ft.). The height pf the Parthenon is 45 feet, 1 inch while the width is 101 feet 3.75 inches. The length is 228 feet and ⅛ inches. This gives us a width to height and length to width ratio of 2.25. Stuart Rossiter, renowned philatelist and scholar, gives the height of the apex above the stylobate as 59 feet.in his book *Greece*. This height produces a ratio of 1.71—closer but still outside of the range of the golden ratio.

Now we can go through every piece of Greek art from the classical period and measure EVERYTHING (like Fechner with his survey of over 10,000 works of art) but as Fischler stated in his paper, without supporting documentary evidence, we cannot definitively confirm that any design scheme was or was not used. There is no documentation that any Greek artist from the classical period (let alone ALL) consciously employed the Golden Ratio in their work. Keep in mind that the extreme and mean ratio would not be formally defined for at least another hundred years with Euclid's *Elements*.

After an introduction riddled with falsehoods and misrepresentations, Hambidge goes on to present the Fibonacci sequence, phyllotaxis, logarithmic spirals, root rectangles, whirling squares, diagonals, reciprocals, compliments, the gnomon, ratios and a host of other concepts that honestly do seem fairly interesting. The problem is that while the concepts are indeed accurate, the application of the concepts, and their functionality for pictorial composition, is never adequately addressed. The book's only connection to pictorial composition seems to be via the misstatements and misrepresentations made explicit and implicit by the author.

I would argue though that you CAN use some of the geometries contained within *Dynamic Symmetry* to partition pictorial space—possibly to introduce some previously unconsidered locations for subject placement—however, the same could be said for tossing a handful of pebbles onto a flat surface to determine spatial placement.

In any case, I have seen both Hambidge's work and the golden ratio hypothesis staunchly championed by a handful of contemporary colleagues, and unfortunately, some contemporary educators. None of them have been able to adequately answer (with substantiation) the questions **“What does the Golden Ratio or Dynamic Symmetry actually do?”** or, **“How do these devices function?”**

While the responses to this question may vary, most are little more than an exercise in deflection. Many put forward seemingly misunderstood concepts involving biological perception, cognitive psychology, and mathematics. This recent response to an inquiry into evidence for Dynamic Symmetry truly captures the attitude from those that will dogmatically believe in the fruits of the devices mentioned in this paper regardless of the scientific evidence to the contrary.

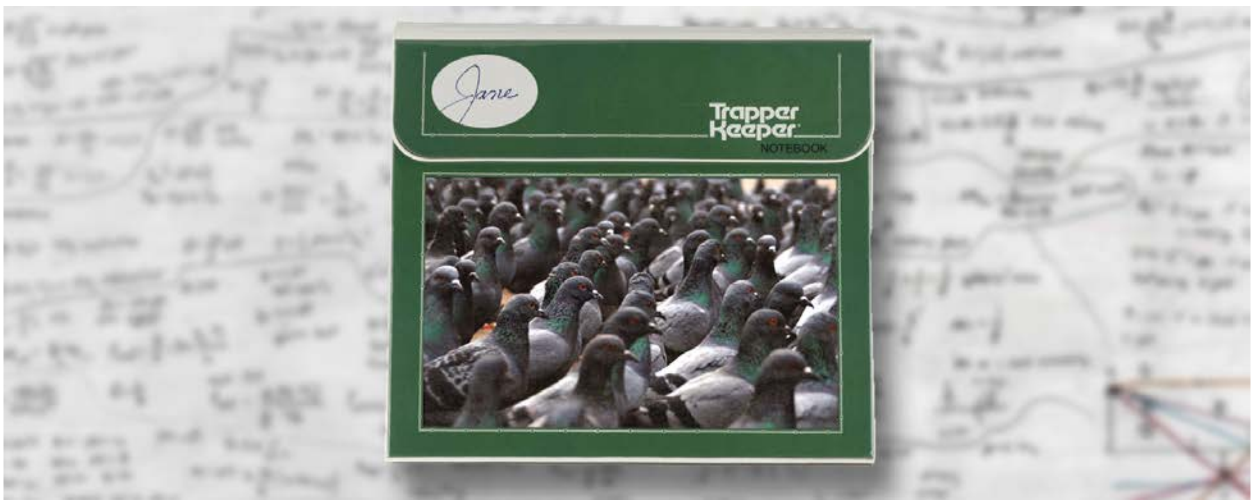
“*…when grandmaster artists and designers like Maxfield Parrish and George Bellows extol the virtues of dynamic Symmetry in composition, you’ll have to forgive me for siding with them over an astrophysicist or anyone else attempting to diminish dynamic symmetry as powerful tool. Astrophysicists and researchers are not designers, side with them if you like, I won’t.*”

Fortunately, in my experience, this attitude is not the prevailing one. As educational resources improve and the dissemination of information continues to grow, it would seem that the days of infusing science and mathematics with mysticism are coming to an end.

GOLDEN RECTANGLE ANSWER:

The rectangle containing the ratio closest to phi is on the bottom row, third from the right.

Getting Organized… A Primer on Pictorial Composition. (Part VI)



***"The trouble with organizing a thing is that pretty soon folks get to paying more attention to the organization than to what they're organized for."* -Laura Ingalls Wilder**

Of the many issues that call into question the validity or functionality of a compositional "device", the absence of a biological or psychological basis for the device's aesthetic, communicative or perceptual attributes is by far the most significant. While some may argue that this absence of evidence is not evidence of absence, or that our current understanding of the issue is merely a *provisional* truth—the same arguments can be used as support for the existence of leprechauns or Bigfoot.

One area of psychology that many HAVE attempted to use as a basis for a salvo of nebulous compositional heuristics is the Gestalt principles of perceptual organization. I'll share my thoughts on why this area of study seems to be a "go-to" for many fans of the famously-unsubstantiated, but first, let me explain a bit about the Gestalt principles or "laws" of perceptual organization.

The Gestalt school of psychology was founded in the 20th century and has provided the foundation for the modern study of perception. Gestalt theory emphasizes the ideas that that the whole of anything is greater than its component parts and that the attributes of the whole are not deducible from analysis of the parts in isolation. Gestalt is a German word that roughly translates to "s*hape, form, whole, figure, configuration, or appearance.*"

The earliest Gestalt work focused on the perceptual organization of visual elements and seemed to revolve around a fundamental principle dubbed *prägnanz* (German for pithiness or succinctness), which states that we tend to order our experience in a manner that is regular, orderly, symmetrical, and simple. In other words, the neural and perceptual organization of any set of stimuli will form as good a "Gestalt", or whole, as the prevailing conditions will allow.

In his book *Vision Science*, psychologist and researcher Stephen E. Palmer writes, "M*ax Wertheimer, one of the founding fathers of Gestalt psychology first posed the problem of perceptual organization. He asked how people are able to perceive a coherent visual world that is organized into meaningful objects rather than the chaotic juxtaposition of different colors that stimulate the individual retinal receptors.*"

Palmer goes on to state that "*Wertheimer's initial assault on the problem of perceptual organization was to study the stimulus factors that affect perceptual grouping: how the various elements in a complex display are perceived as "going together" in one's perceptual experience.*" The first organization principle, or "law", to emerge from this line of investigation was proximity. This principle states that elements tend to be perceived as aggregated into groups if they are near each other. It was an easily demonstrable effect and would soon lead to several others including:

Similarity—elements tend to be integrated into groups if they hold similar attributes.

Closure—elements tend to be grouped together if they are perceived as parts of a closed figure.

Symmetry—when two symmetrical elements are unconnected the mind perceptually connects them to form a coherent shape.

Common Fate—elements tend to be perceived as grouped together if they move together.

Continuity—elements of objects tend to be grouped together, and therefore integrated into perceptual wholes if they are aligned within an object.

Good Gestalt—elements of objects tend to be perceptually grouped together if they form a pattern that is regular, simple, and orderly.

Past Experience—implies that under some circumstances visual stimuli are categorized according to past experience.

Figure–ground—the perceptual process of assigning regions of the visual field or specific contours to a foreground object or a surrounding background. Though this principle was embraced by the Gestaltists, it originated with Danish psychologist Edgar John Rubin.

While these principles are extremely useful in many contexts and continue to evolve in modern vision science, some current areas of study consider them to be redundant or uninformative. Modern developments in cognitive psychology and computational neuroscience have led many to conclude that Gestalt theories of perception are descriptive rather than explanatory in nature.

"*The physiological theory of the Gestaltists has fallen by the wayside, leaving us with a set of descriptive principles, but without a model of perceptual processing. Indeed, some of their "laws" of perceptual organization today sound vague and inadequate. What is meant by a "good" or "simple" shape, for example?*"-Bruce, Vicki, Patrick R. Green, and Mark A. Georgeson. Visual Perception: Physiology, Psychology, & Ecology. Psychology Press, 2003.

Much like how Fechner could not provide a psychological basis for the Golden Ratio preference, Gestaltists seemed unable to provide a substantiated neural basis for their principles of perceptual organization. This was not for lack of trying though. Gestalt psychologist Kurt Lewin developed the idea of

“field-forces” that became part of Gestalt theory. This idea proposed that many aspects of perception and behavior can be explained by field-like forces of attraction and repulsion in the “behavioral environment”, or the internal perceptual copy of the external world. Unfortunately, the idea did not stand up to experimentation.

“*A major determinant of perceptual organization for them was couched in terms of certain “field forces” that they thought operated in the brain. The Gestaltists maintained a Doctrine of Isomorphism, according to which there is, underlying every sensory experience, a brain event that is structured similar to that experience. Thus when one perceives a circle, a “circular trace” is established, and so on. Field forces were held to operate to make the outcome as stable as possible, just as the forces operating on a soap bubble are such that its most stable state is a sphere. Unfortunately, no evidence has been provided for such field forces…*”-Bruce, Vicki, Patrick R. Green, and Mark A. Georgeson. Visual Perception: Physiology, Psychology, & Ecology. Psychology Press, 2003.

Another problematic aspect of the Gestalt principles of organization is their ‘*ceteris paribus*’ (all other things being equal) clause. That is, each principle is supposed to apply given that the other principles do not apply or are being held constant. If two (or more) principles apply for the same input, and they favor the same grouping, it will tend to become strengthened; however, if they disagree, usually one wins or the organization of the percept is unclear. Palmer writes “*The difficulty with ceteris paribus rules is that they provide no general purpose scheme for* *integrating several potential conflicting factors into an overall outcome–that is, for predicting the strength of their combined influences.*"

In my experience, it seems more likely that the Gestalt principles of perceptual organization are simply a series of ad-hoc descriptors for what is better explained by the **empirical ranking theory of vision** presented earlier in this series. For example, we will indeed see a percept that contains the fruits of grouping by proximity, closure, or similarity if such a percept has served us well in the past. Again, the conceptual basis of this empirical ranking theory is that the percept elicited by any particular stimulus parameter corresponds not to a statistically determined value of the relevant qualities in the physical world, but rather to the relative frequency of occurrence of that particular stimulus parameter in relation to all other instances of that parameter experienced in the past. It's true that gestalt theories include a past-experience principle, but it has historically remained one of the more "ignored" players on the bench.
So why do proponents of the "devices" like the Golden Ratio (GR), Dynamic Symmetry (DS) or the Rule-of-Thirds (ROT) seem to gravitate to Gestalt principles as their psychological basis for these devices?

Believe it or not, it is **NOT** something called the "*phi phenomenon*". That's right, in 1912 psychologist and Gestalt founder Max Wertheimer named the tendency to perceive a series of still images, when viewed in rapid succession, as continuous motion, the phi phenomenon. However, it seems that this naming was completely arbitrary and has nothing to do whatsoever with Phi or the Golden Ratio.

Rather, I believe that it is the ambiguity of Gestalt concepts like prägnanz and "good figure" that makes some pursue gestalt theory an attractive "psychological basis" for the GR/DS/ROT. Remember that prägnanz states that we tend to order our experience in a manner that is regular, orderly, symmetrical, and simple while the attributes of a good figure or form include stability, simplicity, ease of recognition, memorability, regularity, familiarity, unity, symmetry, balance, and proportion. It can be argued that the GR/DS/ROT inherently contains many of the attributes of "good form"–so does it follow that Gestalt theory supports that the GR/DS/ROT leads to good form? **Not quite.**

Whereas it may be relatively simple to point out the presence of Gestalt principles (proximity, continuity, closure, symmetry, etc.), or attach the subjective assignments of "good form", we are ultimately left with vague descriptors and an absence of a means of practical measurement. Furthermore, while many can indeed attempt to hide the GR/DS/ROT in the nebulous forest of gestalt theory–modern vision science and empirical aesthetics quickly dispel the fog to reveal the concepts are still without adequate substantiation.

Much like the Gestaltists, designers have also come to recognize a set of organizing principles. These "design principles" are not to be confused with the visual elements presented in **A Spurious Affair. A Primer on Pictorial Composition. (Part IV)**, (**Line, Shape, Color, Texture, Value, Form, Space, Depth**), but rather, the design principles are ***higher-order configurations of such visual elements***. These principles include **Balance, Movement, Repetition, Pattern, Rhythm, Variety/Contrast, Emphasis/Dominance-Subordination, Perspective, Harmony,**

and Unity. This list will indeed vary from one text to the next, but these principles seem to be among the most common.
Let's take a closer look at each principle so that we may better understand how they may function in our compositional efforts.

Balance:

According to art theory, pictorial balance is a sense of equilibrium achieved through implied weight, attention, or attraction, created by manipulating the visual elements in an artwork. The balancing of elements is thought to be similar to balancing mechanical weights in a framework of symmetry axes. There are several different "types" of pictorial balance including symmetrical (even distribution of elements relative to a central axis), asymmetrical (irregular or uneven element arrangement), radial (elements arranged radially around a central point), ambiguous/neutral (equilibrium in spite of characteristically unclear element relationships or seeming randomness).

Many properties can contribute to the "visual weight" of an object. These attributes can include, *"size (Berlyne 1966, 1971, 1974; Pierce 1894; Puffer 1903), color (Arnheim 1974; Bullough 1907; Pinkerton and Humphrey 1974), and perhaps coarse texture, contrast, and interest."*- Gershoni, Sharon, and Shaul Hochstein, "Measuring pictorial balance perception at first glance using Japanese calligraphy." *i-Perception* 2.6 (2011): 508-527.

As with most other aspects of pictorial composition, our sense of balance is born from our own biology. Particular preferences can be traced back to specific biological mechanisms. For example, *"Paintings and* *drawings are perceived differently when viewed in mirror image; left and right have different roles in expressing action, motion, or power (Chatterjee 2002), and the left half of visual space may attract more attention, due to right parietal lobe specialization in attention and emotion (McManus 2002). Similarly, using the ecological view that in natural scenes visual field bottom is generally more crowded, it was suggested that weight at the top should be perceived as "heavier" than at the bottom (Arnheim 1974, 1981).*"-Gershoni, Sharon, and Shaul Hochstein. "Measuring pictorial balance perception at first glance using Japanese calligraphy." *i-Perception* 2.6 (2011): 508-527.

Here are some of the findings from the Gershoni study above. They offers a wonderful insight into understanding "balance":

"*...We review here the most salient elements that seem to drive balance perception, leaving detailed study of these trends to further systematic study:*

Horizontal and vertical elements*. The most-balanced sets are composed mainly of horizontal and vertical elements. In the less-balanced stimulus sets the main feature is a lack of straight lines. This is consistent with the aesthetics oblique effect; for example, observers show aesthetic preference for Mondrian paintings oriented with vertical and horizontal elements over rotated versions with oblique elements (Latto and Russel-Duff 2002; Latto et al 2000; Plumhoff and Schirillo 2009).*

Vertical mirror symmetry*. In the more balanced images vertical symmetry is either maintained or, with grouping of a number of non-*

vertical elements, even enhanced. With 90° rotation there is a switch from vertical symmetry to horizontal symmetry. As a result, vertical symmetry may be violated and the image is perceived as less balanced. This effect is exacerbated for ±45° rotations, when the symmetry is around the diagonals. These results are consistent with previous studies that found vertical mirror symmetry salience compared with horizontal or centric mirror symmetry in a variety of object perception tasks and suggested that vertical mirror symmetry is used as a cue for figure–ground segregation and element grouping in a display of Gabor elements (Machilsen et al 2009; Wenderoth 1994, 1995). We now suggest that vertical symmetry is also a critical cue for perceived balance.

Imprecision of verticality and horizontality. *According to Japanese calligraphy tradition, all seemingly horizontal lines are in fact either slanted or slightly arched. Yet they are satisfactorily perceived as horizontal. For example, in the very top set of Figure 10 the horizontal lines are curved mostly above or below the horizontal axis, yet are perceived as resting on the horizontal axis. This is in line with Arnheim's (1974) observation that visual experience cannot be described in terms of precise property measurement units. For example, when people see a 93° angle they perceive "an inadequate right angle". Likewise, almost perfectly parallel lines are as likely to be perceived as parallel or as not parallel (Kukkonen et al. 1996). Quasi-invariant properties such as near parallelism are influential in object recognition over novel viewpoints and rotations."*

While a sense of equilibrium may appeal to our preference for stability, an "unbalanced" composition may elicit a sense of tension and unease.

Keep this in mind when you are considering how to incorporate "balance" into your compositions.

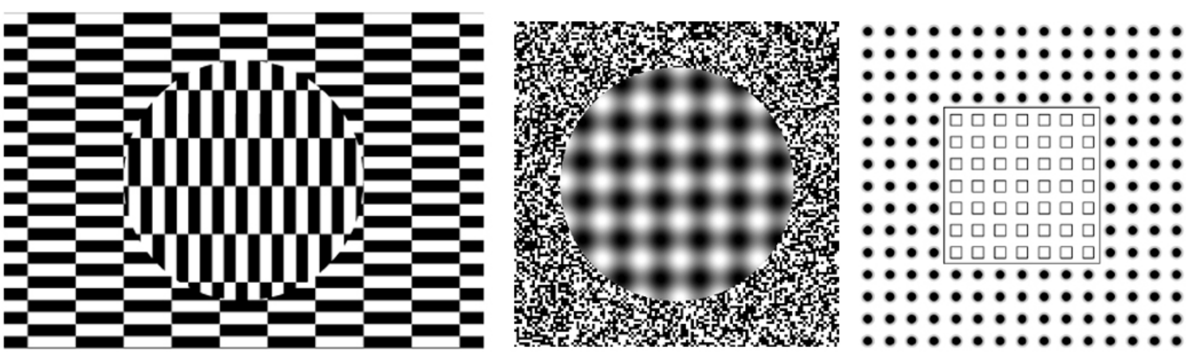
Movement:

While the idea of movement in a static image may initially seem counter-intuitive, there is much to garner from considering this principle. It should be pointed out though, that this principle is often misrepresented by some that are under the impression that our eye movements are governed by a natural tendency to follow lines. ***This is completely false.*** (See Yarbus, A. (1967). Eye movements and vision (B. Haigh & L. A. Riggs, Trans.). New York: Plenum Press.)

Here is one example of how Movement in static pictorial composition is often problematically discussed by starting with erroneous claims about vision: "*Because the eye tends to move along lines, different types of lines create different feelings of movement. This effect is sometimes referred to as "vectors" and "kinetics." Verticals go up and down to cooperate with or defy gravity; horizontals shift from side to side; diagonals cut across the scene with force and unresolved tension; curved lines, which continually change direction, present graceful flow or quick acceleration depending on their degree of bend; s-lines and zig-zags oscillate back and forth in either predictable or unpredictable fashions*." -John Suler's Photographic Psychology: Image and Psyche.

Again, as seen in the work of Yarbus and others, while the contrast inherent to a line, or an implied line, may be attractive to one's gaze, there is absolutely no evidence that eye movements "follow" the lines that are experienced within a visual field.

Eye movements CAN give rise to some sensations of movement as we explore certain configurations of visual elements—but again, it is not the visual elements themselves that strictly govern the eye's path of investigation. One such demonstration of illusory movement via visual element configuration can be seen with the Ouchi illusion, named after Japanese artist Hajime Ouchi. In this illusion, a central region containing an array of vertical bars seems to "quiver" independently of the background (an array of horizontal bars) when moving the eyes around the figure. The more appropriate definition for **movement** (or **implied movement**) in regards to pictorial composition is the implication of motion, or potential motion, through the configuration of visual art elements and design principles. Unbalanced or seemingly unstable configurations can elicit a sense of impending motion.



Left: 'Ouchi Illusion" (Ouchi 1977, Spillmann et al 1986). Middle: Akiyoshi Kitaoka's version titled "Out of Focus". Right: Recreation by Michael Bach of a related illusion titled "Floating Motion" from Pinna & Spillmann (2002).

A paper from the Morris Museum of Art titled *The Language of Art* lists some of the following techniques for achieving a sense of motion in a static image.

ƒ"***Repetition:*** *Figures are repeated in such a manner to suggest sequential moments in time (such as in a comic strip). Often the repeated figure, rather than being shown in a sequence of small pictures, merely reappears in one unified composition.*

Fuzzy outlines: *The outlines of a figure or element are blurred in an attempt to capture a moment in time. This technique is similar to what happens when a slow shutter speed is used to photograph movement.*

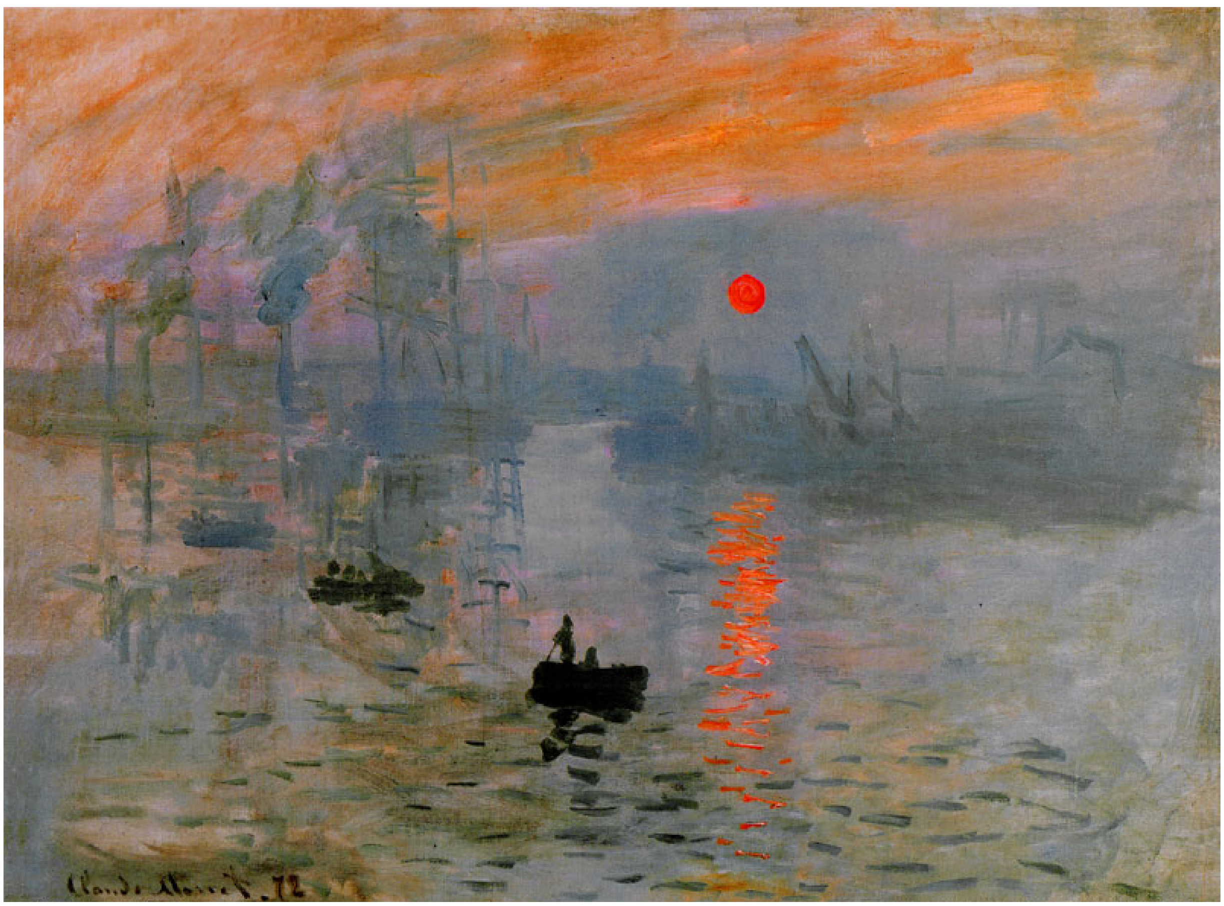
Multiple images: *When one figure in an overlapping sequence of poses is slightly changed in each successive position.*

Lines of force: *Lines added to show the pathways of movement (again, this technique is often used in comic strips).*"

ƒThe implication of motion, potential motion, or movement in static imagery is believed to be one of the contributing factors to certain spatial biases within pictorial space. This was addressed in **A Spurious Affair. A Primer on Pictorial Composition. (Part IV)** regarding inward bias:
Inward Bias: Studies have demonstrated that when an object with a salient "front" is placed nearer the border of a frame than a center, observers tend to find the image more aesthetically pleasing if the object faces inward (toward the center) than if it faces outward (away from the center) (Chen et al., 2014) . I believe that this may have much to do with the idea of understanding our brain as a "prediction machine". Again, "*A still photograph of an object in motion may convey dynamic information about the position of the object immediately before and after the photograph was taken (implied motion)*" -(Kourtzi and

Kanwisher, 2000). If we can see more of where an object may be "headed", we can make a better prediction about a future state of the objects being observed.

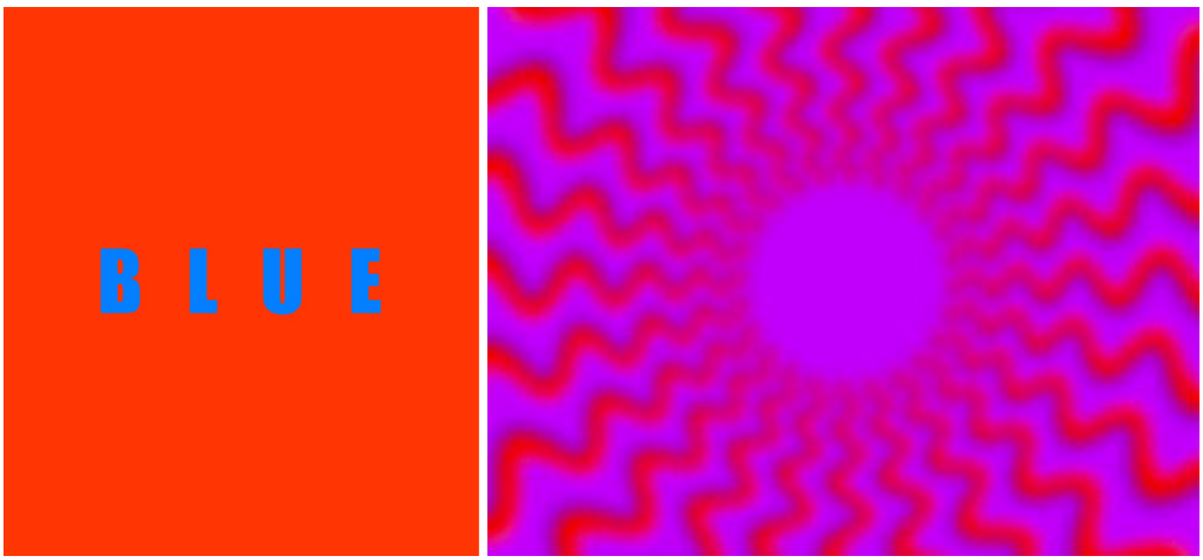
Another means of generating the sensation of movement, specifically vibration, may be through the use of equiluminant colors. One of the most famous uses of this technique can be seen in Claude Monet's *Impression Sunrise*. In the piece, many reported that the sun within the image appeared to "vibrate." This may be due to the two different visual processing pathways that we have in the brain.



Impression, Sunrise by Claude Monet 48 cm × 63 cm (18.9 in × 24.8 in), Oil on canvas, 1872

Grayscale version of Impression, Sunrise by Claude Monet. Notice how the sun is nearly invisible due to its equiluminance with the surrounding clouds.

Neurobiologist Margaret Livingstone explains the peculiarity of Monet's equiluminant sun in her book *Vision and Art: The Biology of Seeing*, "*The sun in this painting seems both hot and cold, light and dark. It appears so brilliant that it seems to pulsate. But the sun is actually no lighter than the background clouds, as we can see in the grayscale version. It is precisely equiluminant with–that is, it has the same lightness as–the gray of the background clouds. This lack of luminance contrast may explain the sun's eerie quality: to the more primitive subdivision of the visual system (which is concerned with movement and position) the painting appears as it does in the grayscale version; the sun almost invisible. But the primate-specific part of the visual* *system sees it clearly. The inconsistency in perception of the sun in the different part of the visual system gives it this weird quality.* ***The fact that the sun is invisible to the part of the visual system that carries information about position and movement means that its position and motionlessness are poorly defined, so it may seem to vibrate or pulsate.*** *Monet's sun really is both light and dark, hot and cold."*



Equiluminance (left) can indeed be a powerful device for achieving a sensation of vibration or pulsation–however, specific variations in contrast, color and element orientation can give rise to even more powerful perceptions of motion such as those created by psychologist Akiyoshi Kitaoka to demonstrate the effect of "Perceptual Drift" (right).

Since we are on the topic of implied movement and eye movement, I would like to take a few minutes to address the concept of "**resting areas**".

Resting areas are often defined as regions of a pictorial composition where a fatigued eye can find respite from the demands of a complex image. In fact, there are quite a few books, magazines, and websites that still frame the concept of a visual "resting place" in this manner:

"*…background shapes are known as the "negative" space, and is that area the artist would not intend to draw attention to. So long as the positive elements are much less in total space in the picture plane, the negative space will act as a resting area or "neutral" zone which demands nothing of the eyes, and makes it easier for the eyes to follow along in scrutinizing the positive elements.*" –Composition: Understanding it – Using it! by Larry Seiler

"*Another element that impacts rhythm and tempo is what we may called visual "rests." Quiet spaces for the eye add importance to busy areas because they change the rhythm and provide contrast.*" –A Painter's Guide to Design and Composition by Margot Schulzke"

"*Sometimes blank space is just as important as space filled with lines, shapes, and colors. If the focal point is very busy, the eye needs a resting place in the picture. Leave some blank areas (in an interesting shape of course) for a resting place.*" Acrylic Painting For Dummies by Colette Pitcher

"*Negative space is sometimes thought of as a resting place for the viewer's eyes.*" –The Design Elements of Composing a Drawing (For Dummies).

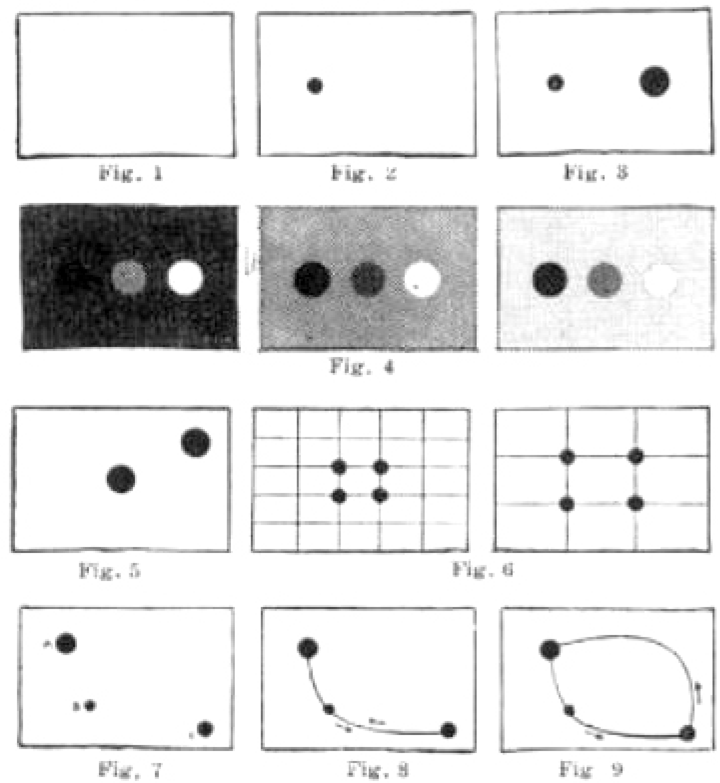
Unfortunately, these descriptions of a "resting place" demonstrate a significant misunderstanding of how we visually interact with a complex stimulus. The idea of a "resting place" can be found in resources for numerous pursuits such as drawing, painting, graphic design, advertising, interior design and gardening. While some resources present the above-mentioned concept in regards to a visual “resting place,” there are many that present it in a much different way. Let’s start by looking at a book that was written during the 1920’s:

“*Emphasis can be obtained in many different ways; by isolation, by the elimination of everything else that might compete with the principal object, by the position of the principal object in the picture-space, by the radiation of lines leading the eye directly to the principal object, by contrast of tone, and so on. The little child in Plum Island (Fig. 13) is obviously the chief object of interest in the picture. He is the only human being in sight, he is placed in a strong position in the picture-space, the line of the surf leads the eye directly to him and he is strongly emphasized by contrast in tone. Thus we have, in this picture, a definite object to provide a resting place for the eye and to prevent it from wandering outside the picture margins, and a feeling of unity is established*.” –Pictorial Composition in Photography by Arthur Hammond 1920. (I should point out here that Hammond’s comment, “*radiation of lines leading the eye directly to the principal object*” may have more to do with a response to a simulation of optic flow and not the erroneous claim that the eye instinctively follows any specific line.)

Fig. 13. Plum Island

Now that sounds like something completely different than the earlier definition. That makes a "resting place" sound more like what many would understand as a focal point. Let's take another look at a fun resource I found that may be one of the best walk-through presentations for a "resting place":

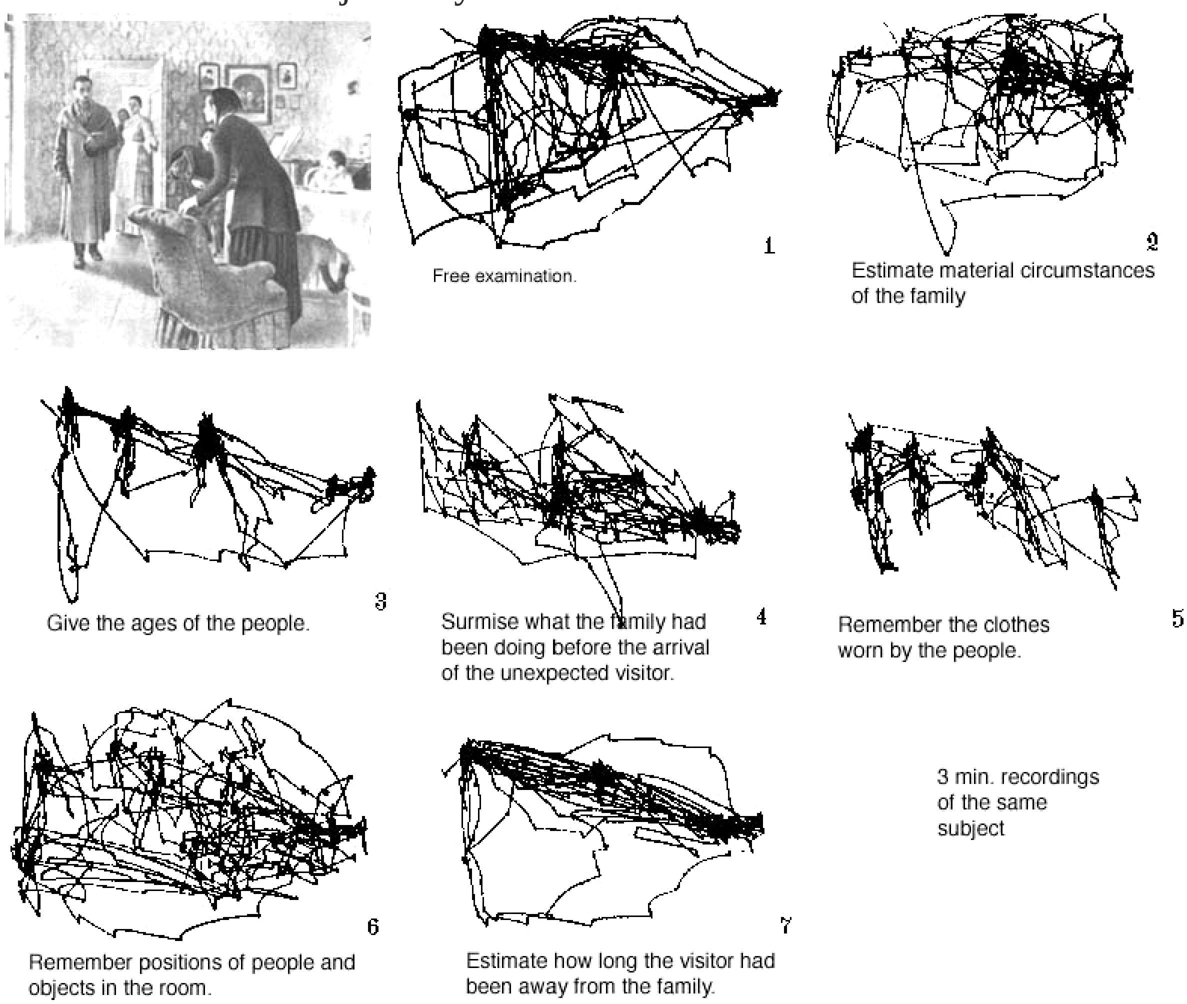
"*Suppose we represent our picture space by a blank rectangle the size and shape of the finished picture; (Fig.1) The eye roams over the entire space, resting nowhere. But if we place a single spot in this rectangle,* *the eye finds a resting place; that is a center of interest; (Fig 2.) Now if we place a second, larger, spot in the rectangle, the eye sees both, but rests longer on the larger one, and propositions II and III(a) are proved.*" Boys' Life May 1935. (Image Right)



In addition to these older resources, we can find this latter explanation of a visual "resting place" in many contemporary resources. But… which one truly makes more sense? Which interpretation of the concept is actually correct? To best answer that we should briefly revisit the eye-tracking work of work of Alfred Yarbus. For a more thorough look at Yarbus' experiments, I would recommend reviewing ***Henri Breuil and Alfred Yarbus Walk into a Bar…A Primer on Pictorial Composition. (Part III).***

Yarbus states: "*Human eyes voluntarily and involuntarily fixate on those elements of a visual scene that carry essential and useful information. The more information is contained in an element, the longer the eyes stay on it. The distribution of fixations on the elements of a scene changes depends on the purpose of the observer, i.e., it is determined by information to be obtained and the thought process accompanying the analysis of this information. Hence people who think* *differently also, to some extent, see differently*". – A. L. Yarbus (1067) Eye Movements and Vision. New York: Plenum Press (Translated from the 1965 Russian edition by Basil Haigh.)

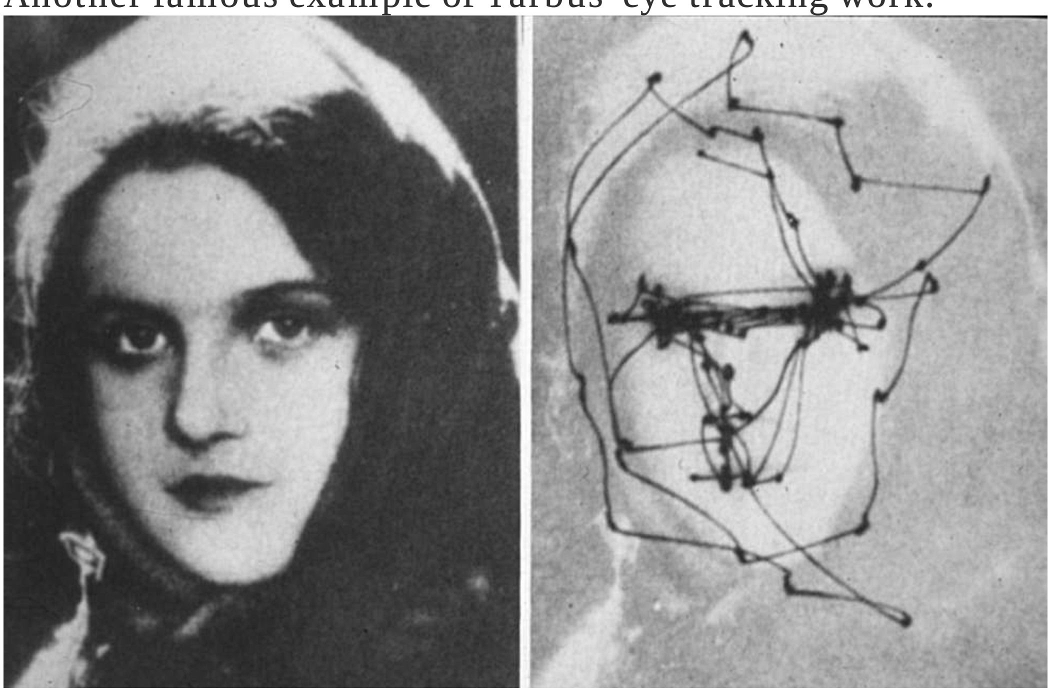
Yarbus' experiments showed the task given to a subject has a very large influence on the subject's eye movement:



Here you can see that eye movements (saccades and fixations) are guided from information gathering saccadic sweeps and fixated investigations—all working to elicit information from a visual field. It is important to notice that there is not much fixation or "resting" in areas that have little information to offer. Areas bearing little information (or the former concept of a “resting place” in this article) sees very little activity in comparison to areas of more robust content.

“Yarbus suggested an alternative logic to the distribution of attention, speculating that the eye instinctively gravitates toward details that promise to “explain” an image…. our patterns of looking relate to the task of solving a picture, by which he meant discerning its narrative logic. Presented with an image, the eye begins a rapid fact-gathering mission, filtering out extraneous visual information and honing in on bits of explanatory detail. Given opportunity for extended looking, we do not turn our attention to an unexplored corner, but compulsively reinvestigate those elements that “allow the meaning of the picture to be obtained.”-2 Ways of Seeing by Sasha Archibald – – Issue 30, The Underground Summer 2008

Another famous example of Yarbus’ eye tracking work:



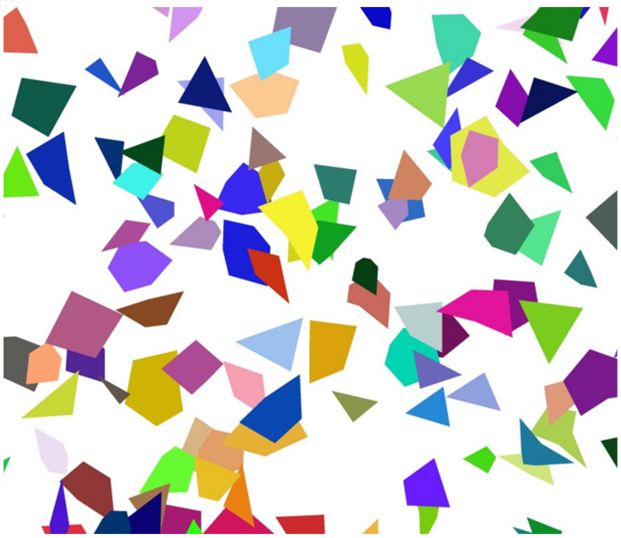
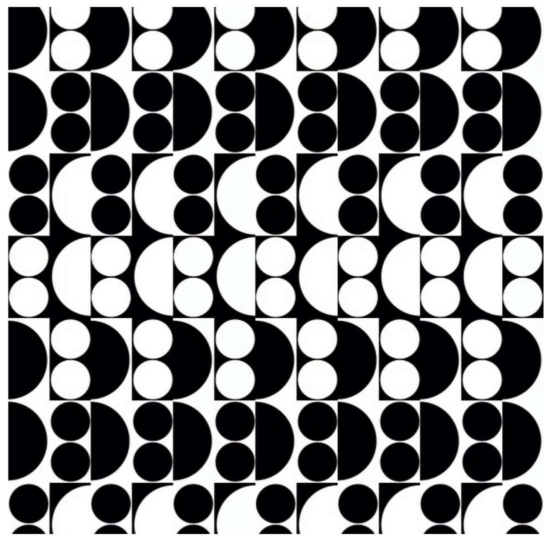
It is very important to remember that the visual system seems to be not all that interested (relatively) in gradual changes in the visual field, rather—our eyes tend to glide over subtle changes towards areas of increasing contrast or complexity in an effort to elicit information. So if we are taking the work of Yarbus into account, it seems that a "resting place" is more akin to a focal point than a piece of negative space. Saccadic movement stops at a fixation point, gathers information, and then continues the search for information. While it is true that certain cells involved in vision can become fatigued (leading to commonly experienced phenomena like "after-images"), I am unaware of any specific "image exploration fatigue" that would force the eye into some negative space for recovery.

Rhythm/Repetition/Pattern

I am grouping these three design principles together as they are very closely related and may have a good degree of overlap in their meaning/application.

Repetition: Repeated use of a visual element, motif, or principle. Repetition can be distinguished from pattern as it need not occur with discernible regularity. In other words, while a pattern is a form of repetition—a repetition may not necessarily result in a pattern.

Pattern: A pattern is a form of repetition that occurs with discernible regularity. As such, the elements of a pattern repeat in a predictable manner. A geometric pattern is a kind of pattern formed of geometric shapes and typically repeating with an underlying mathematical structure. Natural patterns include spirals, meanders, waves, foams, tilings, cracks, and those created by symmetries of rotation and reflection.

The images seen here both contain repetition—but the one on the right contains repetition that occurs with discernible regularity (a pattern.) While this may seem a clear way to separate these two concepts—know that there may be some visual contexts in which the line between the two is less clear.

Rhythm: (from Greek ῥυθμός, rhythmos, "*any regular recurring motion, symmetry*" (*A Greek-English Lexicon*, Liddell and Scott 1996)) generally means a "*movement marked by the regulated succession of strong and weak elements, or of opposite or different conditions*" (*The Compact Edition of the Oxford English Dictionary II*, 1971, 2537). While most often used in the performance arts to indicate the timing of events on a human scale; of musical sounds and silences, the steps of a dance, or the meter of spoken language and poetry, visual artists often apply this term to static work to indicate an implied motion or development over time achieved via a repetition of elements that change or “evolve” at discernible intervals.

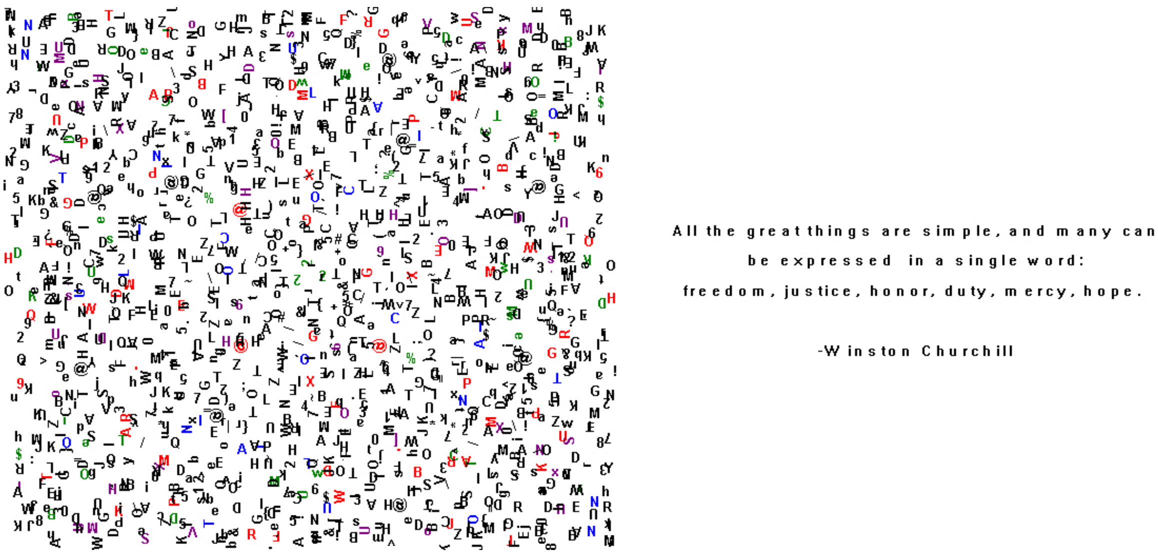
Two examples of what may be described as rhythm in imagery. (Left) Nude Descending a Staircase (No. 2) Marcel Duchamp, American (born France), 1887 – 1968 and (right) the logarithmic spiral/growth spiral (self-similar spiral curve) of a nautilus shell (sorry, still not a golden spiral—but that would work here as well!).

Variety/Contrast

I am addressing variety and contrast together. Just as with movement, pattern, and rhythm, variety and contrast are closely related and have a good degree of overlap in their meaning/application.

Variety

Variety can be defined as diversity among visual elements, motifs, representations or design principles in a pictorial composition. While variety is often said to increase interest in a work, I am not aware of any context-independent link between increased variety and interest. In fact, one may argue that excess variety may lead to problems with effective communication.



One may find greater variety in the characters on the left which may elicit a greater interest in investigation—however it may come at the cost of a clear message as can be seen with the statement on the right containing a less diverse arrangement of characters.

Contrast

In the context of pictorial composition, contrast can be defined somewhat broadly as a juxtaposition of pictorial components, or more narrowly, in terms of specific disparities perceived between element characteristics like lightness or color. For example, regarding perceived luminance, contrast may be defined as the relative difference of one perceived lightness/brightness value and another within a field of view (contrast ratios.) Both contrast and variety involve differences among visual elements or their attributes. However, variety tends to describe a general diversity among pictorial elements/attributes, as opposed to contrast which involves specifically “opposing” pictorial attributes/elements, the results of such pictorial element/attribute juxtaposition(s), or the relative differences between comparable pictorial elements/attributes.

Neuroscientist and neuroaesthetics pioneer VS Ramachandran brings the broad and narrow concepts of contrast together quite well. He writes, “*Extracting contrast involves eliminating redundant information and focusing attention. Cells in the retina, the lateral geniculate body or relay station in the brain, and in the visual cortex respond predominantly to step changes in luminance rather than homogeneous surface colors. Smooth gradients are much harder for the visual system to detect rather than segmented divisions of shades resulting in easily detectable edges. Contrasts due to the formation of edges may be pleasing to the eye. The importance of the visual neuron's varying responses to the orientation and presence of edges has previously been proven by David H. Hubel and Torsten Wiesel. This may hold evolutionary significance since regions of contrast are information rich requiring reinforcement and the allocation of attention. In contrast to the principle of grouping, contrasting features are typically in close proximity eliminating the need to link distant, but similar features.*”

You may remember that we addressed the idea of contrast in my first installment, *So what's with Jane already? A Primer on Pictorial Composition. (Part I)*, Try and read this sentence:

Now try to read this one:

[redacted]

Now this:

Jane walked down the street.

All three sentences are constructed with the same content and grammar. How they differ is in the visual elements that manifest that content and grammar. The characters of the first sentence are so thin and spatially condensed that parsing out the individual letters to successfully read the sentence is nearly impossible. The second sentence offers no contrast between the background and the foreground characters. This lack of contrast also produces a stimulus that is incapable of conveying the intended information. These first two examples demonstrate one way in which our biology may define successful communication. Light outside the visible spectrum, contrast lower than our minimum contrast sensitivity, or a stimulus that is on a scale beyond the limits of our angular resolution is not going to be of much use in regards to visual communication.

The third sentence above is constructed with a configuration of visual elements that allows for a reader, fluent in the conventions of the English language, to successfully elicit the intended meaning. The reader can quickly garner that at some point in the past, an individual named Jane had walked down a street. The sentence is a visually viable, self-contained unit of meaning that effectively conveys information according to the logic of the language's grammar.

The importance of contrast in regards to vision, and therefore visual art, cannot be overstated. As Margaret Livingstone states in her book *Vision and Art*, "*Many visual perceptions, such as luminance, color, motion, and depth, exhibit greater sensitivity to abrupt rather than gradual change, and in each modality this selectivity is due to an underlying center/surround organization. The image above illustrates this point for luminance with the Cornsweet Illusion. The center/surround organization of the cells in our visual system makes us more sensitive to the light-to-dark transitions at the middle then to the gradual changes of exactly the same magnitude on either side of the discontinuity.*"

Again, we are not light meters or spectrophotometers. We utilize contrasts instead of absolute luminance measurements to elicit information from the visual world. We are drawn to regions of discontinuity while generally ignoring homogeneous areas within our visual field. Always keep this in mind when composing imagery. While we have addressed a number of problematic claims about how the eyes will move throughout a picture—they will indeed be drawn to contrast.

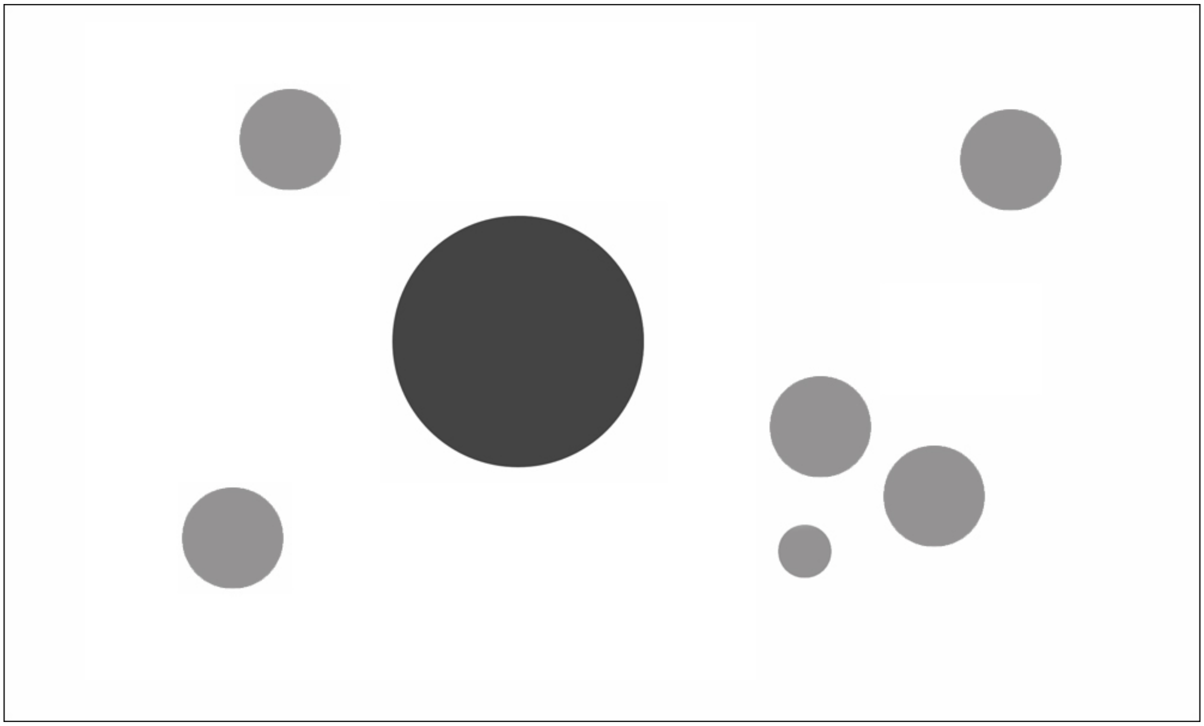
Emphasis/Dominance-Subordination

Dominance, subordination, and emphasis are all aspects of what many would understand as a pictorial “hierarchy”.

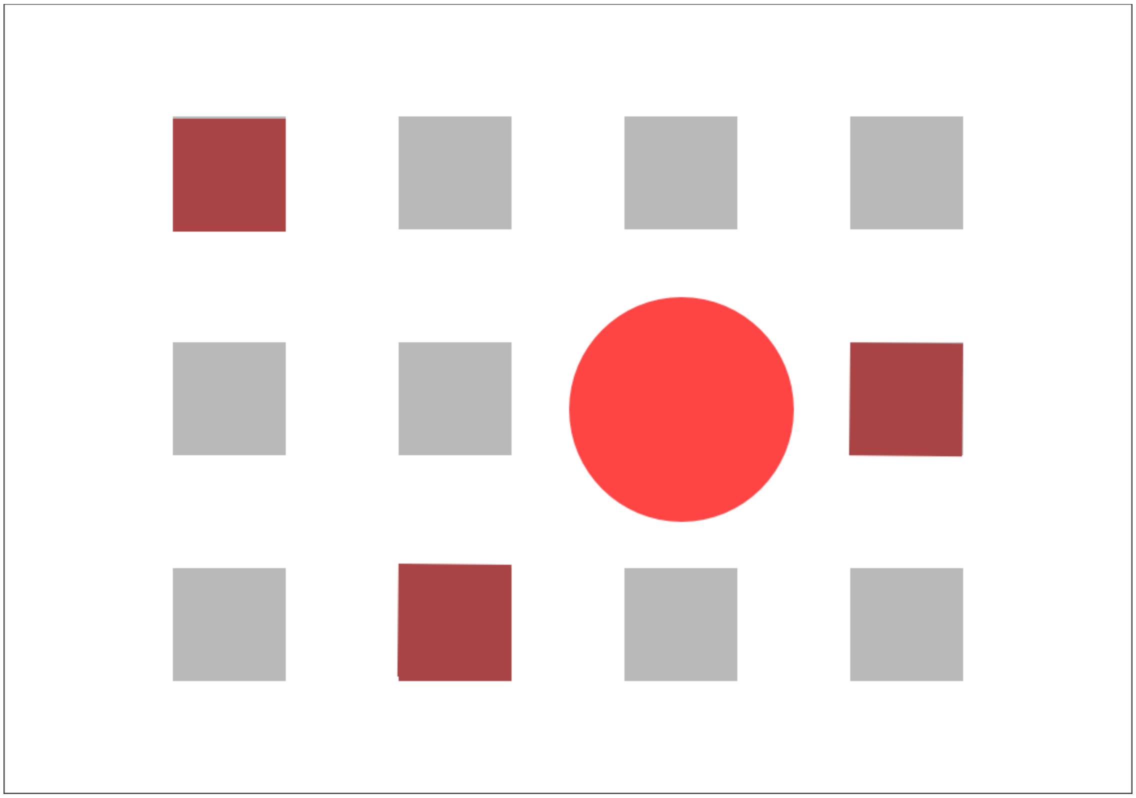
Emphasis – The application or configuration of visual elements or design principles in a manner that increases visual prominence or communicates importance.

Dominance – a condition in which one or more regions, visual elements, motifs, representations, or organizational principles is emphasized to appear visually prominent or important relative to other regions, visual elements, motifs, representations, or organizational principles.

Subordination – a condition in which one or more regions, visual elements, motifs, representations, or organizational principles is deemphasized to appear less visually prominent or important relative to other regions, visual elements, motifs, representations, or organizational principles.



Here we see an element made dominant with a larger size, higher contrast (against surround), and preferred orientation (near center). It should be understood that a clear hierarchy of elements is sometimes difficult to discern (esp. with very complex images). Much like the Gestalt principles of perceptual organization, means by which to promote dominance or subordination can seem to be limited via a set of ceteris paribus rules.



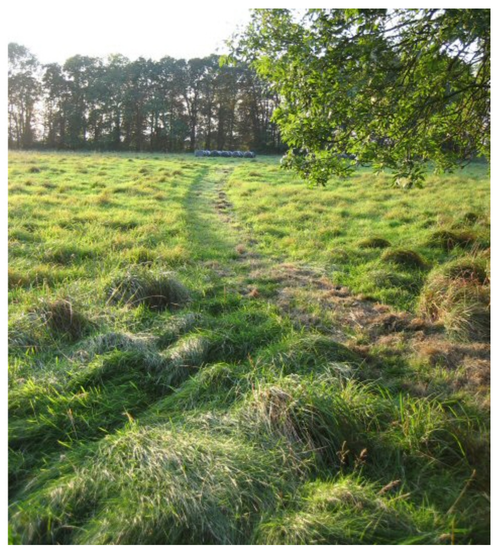
"The circle and the three reddish squares are all focal points because they stand out from the majority of other elements in the graphic. They contrast with the mass of gray squares. The large bright red circle stands out the most. It's the dominant focal point, or the dominant element in this image." –Smashing Magazine, Design Principles: Dominance, Focal Points And Hierarchy by Steven Bradley.

Just as we may emphasize certain words in a sentence to communicate importance–specific regions, visual elements, motifs, representations, or organizational principles may need to be emphasized in order to establish their importance. The most emphasized or dominant components of a visual artwork are often referred to as "focal points." In the context of pictorial composition, a focal point (or principal focus) is one or more regions, visual elements, motifs, representations, or organizational principles intended to elicit the greatest level of interest, or attention. Focal points can be created via contextual emphasis by way of size, color, contrast, texture, shape, position, etc. Alternatively, subordinate areas can be created by contextual deemphasis via the same attributes. While some resources are quick to state that one visual attribute may be universally dominant relative to another, it should be understood that–*as with all aspects of visual perception*—**context** will define which attributes will promote dominance and which will promote subordination.

Perspective/Viewpoint/Depth

Perspective – (from Latin: *perspicere* to see through) in the visual arts is an approximate representation, on a flat surface, of an image as it is seen by the eye.

Viewpoint (or **Station Point**) – While often used colloquially as a synonym for perspective, the viewpoint is the point from which an environmental science is observed.



Notice how the image on the left and the one on the right place the viewer at two significantly different heights relative to the depicted subjects.

Depth – is the radial distance from an observer to a surface or an object in a three-dimensional environment. Depth perception arises from a variety of depth cues. These are typically classified into binocular cues that are based on the receipt of sensory information in three dimensions from both eyes and monocular cues that can be represented in just two dimensions and observed with just one eye.

As these design principles all relate to the perception of a three-dimensional environment via depth cues, let's take a quick look at the cues themselves to better understand how they might be deployed in a compositional effort. *Note that all of the following cues are not applicable to two-dimensional art.*

Monocular cues *(depth information that can be elicited from one eye)* *(***(M)*** indicates that motion is required).*

Motion parallax (M) – When an observer moves, the apparent relative motion of several stationary objects against a background gives hints about their relative distance.

Depth from motion (M) – When an object moves toward the observer, the retinal projection of an object expands over a period of time, which leads to the perception of movement in a line toward the observer. Another name for this phenomenon is depth from optical expansion.

Linear Perspective – The property of parallel lines converging in the distance, at infinity, allows us to reconstruct the relative distance of two parts of an object, or of landscape features.

Relative Size – If two objects are known to be the same size (e.g., two trees) but their absolute size is unknown, relative size cues can provide information about the relative depth of the two objects. If one subtends a larger visual angle on the retina than the other, the object which subtends the larger visual angle appears closer.

Familiar size – Since the visual angle of an object projected onto the retina decreases with distance, this information can be combined with previous knowledge of the object's size to determine the absolute depth of the object.

Absolute size – Even if the actual size of the object is unknown and there is only one object visible, a smaller object seems further away than a large object that is presented at the same location

Aerial perspective – (also known as atmospheric perspective) Due to light scattering by the atmosphere, objects that are a great distance away have lower luminance contrast and lower color saturation. (Cues often associated with atmospheric perspective – size reduction, value lightness, texture (grain) reduction, color neutralization, contrast reduction)

Accommodation – This is an oculomotor cue for depth perception. When we try to focus on far away objects, the ciliary muscles stretch the eye lens, making it thinner, and hence changing the focal length. The kinesthetic sensations of the contracting and relaxing ciliary muscles (intraocular muscles) is sent to the visual cortex where it is used for interpreting distance/depth. Accommodation is only effective for distances less than 2 meters.

Occlusion – (also referred to as interposition) happens when near surfaces overlap far surfaces. If one object partially blocks the view of another object, humans perceive it as closer. However, this information only allows the observer to create a “ranking” of relative nearness.

Curvilinear Perspective – At the outer extremes of the visual field, parallel lines become curved, as in a photo taken through a fisheye lens. This effect, although it is usually eliminated from both art and photos by the cropping or framing of a picture, may significantly enhance the viewer’s sense of being positioned within a real, three-dimensional space.

Texture gradient(s) – Fine details on nearby objects can be seen clearly, whereas such details are not visible on faraway objects. Texture gradients are grains of an item. For example, on a long gravel road, the gravel near the observer can be clearly seen of shape, size, and color. In the distance, the road’s texture cannot be clearly differentiated.

“Shape from Shading” – The way that light falls on an object and reflects off its surfaces, and the shadows that are cast by objects provide an effective cue for the brain to determine the shape of objects and their position in space.

Defocus blur – Selective image blurring is very commonly used in photographic and video for establishing the impression of depth. This can act as a monocular cue even when all other cues are removed. It may contribute to the depth perception in natural retinal images, because the depth of focus of the human eye is limited

Elevation – When an object is visible relative to the horizon, we tend to perceive objects which are closer to the horizon as being farther away from us, and objects which are farther from the horizon as being closer to us

Binocular cues *provide depth information when viewing a scene with both eyes.*

Stereopsis, or retinal (binocular) disparity, or binocular parallax (NA) – Each eye views a slightly different angle of an object seen by the left and right eyes. This happens because of the horizontal separation parallax of the eyes. If an object is far away, the disparity of that image falling on both retinas will be small. If the object is close or near, the disparity will be large.

Convergence – This is a binocular oculomotor cue for distance/depth perception. Because of stereopsis the two eyeballs focus on the same object. In doing so they converge. The convergence will stretch the extraocular muscles. As happens with the monocular accommodation cue, kinesthetic sensations from these extraocular muscles also help in depth/distance perception. The angle of convergence is smaller when the eye is fixating on far away objects. Convergence is effective for distances less than 10 meters.

Shadow Stereopsis – Retinal images with no parallax disparity but with different shadows are fused stereoscopically, imparting depth perception to the imaged scene.

Of these various cues, only convergence, accommodation and familiar size provide absolute distance information. All other cues are relative (i.e., they can only be used to tell which objects are closer relative to others). Stereopsis is merely relative because a greater or lesser disparity for nearby objects could either mean that those objects differ more or less substantially in relative depth or that the foveated object is nearer or further away (the further away a scene is, the smaller is the retinal disparity indicating the same depth difference.)

See how many of the depth cues you can identify in these two images:

Harmony and Unity

Harmony and Unity are design principles that are often quite subjective. **Harmony** can be defined as a state of visual order or as aesthetically pleasing relationships among the component parts of a whole. **Unity**, on the other hand, can be defined as the state of being in full agreement, or sometimes, *as a condition of harmony*. As you probably suspect, it is somewhat nebulous ideas like "being in full agreement" or "a state of visual order" that opens the door to a wealth of subjectivity. In any case—it is important to note that harmony is an aesthetic quality of component relationships while unity is the manner of relationship between components or between a component and the whole. For example, I think that we can safely state that all pictures have an inherent "unity", if only for the spatial proximity of the component parts of the image. All of the component parts of a picture are "unified" by the shared quality that they all exist within a fixed perimeter. However, this fact does NOT mean that the parts themselves have an aesthetic "harmony."

To better understand that we will need to consider what was presented in the first installment of this series regarding "aesthetic quality."

"…our behavior is constantly influenced by the aesthetic qualities of external stimuli. These qualities are the characteristics of a stimulus that elicit adaptive responses that have evolved to reinforce or discourage specific behaviors. We may prefer one type of sensory experience over another—describing one as repulsive and the other beautiful. However, aesthetic qualities should not be confused with individual tastes. Many refer to aesthetic properties as personal preferences and this, I believe, is a serious mistake. Like most concepts involving evolution, concepts of "aesthetics" and "beauty" seems to be most productive when considered on the level of populations and not the individual. For example, it is not important that Jane may prefer Vanilla over Chocolate—but rather that Jane, if human, would most likely have a biological predilection for sugar and fat.

Paul Bloom touches on this topic in his 2010 book How Pleasure Works: The New Science of Why We Like What We Like:

"*It is true that we can imagine cultures in which pleasure is very different, where people rub food in feces to improve taste and have no interest in salt, sugar, or chili peppers; or where they spend fortunes on forgeries and throw originals into the trash; or line up to listen to static, cringing at the sound of a melody. But this is science fiction, not reality.*

One way to sum this up is that humans start off with a fixed list of pleasures and we can't add to that list. This might sound like an insanely strong claim, because of course one can introduce new pleasures into the world, as with the inventions of the television, chocolate, video games, cocaine, dildos, saunas, crossword puzzles, reality television, novels, and so on. But I would suggest that these are enjoyable because they are not that new; they connect—in a reasonably direct way—to pleasures that humans already possess. Belgian chocolate and barbecued ribs are modern inventions, but they appeal to our prior love of sugar and fat. There are novel forms of music created all the time, but a creature that is biologically unprepared for rhythm will never grow to like any of them; they will always be noise."

Oliver Reichenstein, the founder of Information Architects, also addresses the problem with discussing individual tastes when exploring design and aesthetic concepts in his 2013 paper, Learning to See:

"*Whether I like pink or not, sugar in my coffee, red or white wine, these things are a matter of personal taste. These are personal preferences, and both designers and non-designers have them. This is the taste we shouldn't bother discussing.*"

Therefore, to assess whether or not an image holds a true aesthetic harmony between its component parts, as opposed to the concept of harmony as a matter of personal preference, we would need to present the psychological or biological basis for the claim.

With these concepts in tow, I believe that we are now ready to move into the final installment in this series. Part VII will pull from neuroscience, neuroaesthetics, vision science, and cognitive psychology to share the many approaches to pictorial composition that DO carry the support of empirical testing. I look forward to sharing this last piece of the project with you all!

Finale: A Primer on Pictorial Composition. (Part VII)

"How often people speak of art and science as though they were two entirely different things, with no interconnection. An artist is emotional, they think, and uses only his intuition; he sees all at once and has no need of reason. A scientist is cold, they think, and uses only his reason; he argues carefully step by step, and needs no imagination. That is all wrong. The true artist is quite rational as well as imaginative and knows what he is doing; if he does not, his art suffers. The true scientist is quite imaginative as well as rational, and sometimes leaps to solutions where reason can follow only slowly; if he does not, his science suffers." — Isaac Asimov "Prometheus", The Roving Mind (1983)

"I believe in evidence. I believe in observation, measurement, and reasoning, confirmed by independent observers. I'll believe anything, no matter how wild and ridiculous, if there is evidence for it. The wilder and more ridiculous something is, however, the firmer and more solid the evidence will have to be." —Isaac Asimov, The Roving Mind (1983)

It is unfortunate that during a time when the dissemination of information is the greatest it has been in human history, there still exists deliberate efforts to insulate oneself from scientific concepts that could potentially provide great insight into one's area of practice. I have spent many years trying to introduce contributions from present-day science into the art classroom only to find that some perceive the arts and sciences as components of a zero-sum game. Obviously, this could not be further from the truth. However—I do understand why some might see certain scientific concepts as unwelcome guests in the studio. Freelance writer Philip Ball effectively explores one of the perceived hazards of the merging of modern science and art in a 2013 Nature Magazine article:

"*For one thing, to suggest that the human brain responds in a particular way to art risks creating criteria of right or wrong, either in the art itself or in individual reactions to it. Although it is a risk that most researchers are likely to recognize, experience suggests that scientists studying art find it hard to resist drawing up rules for critical judgements. The chemist and Nobel laureate Wilhelm Ostwald, a competent amateur painter, devised an influential theory of colour in the early twentieth century that led him to declare that Titian had once used the 'wrong' blue. Paul Klee, whose intuitive handling of colour was impeccable, spoke for many artists in his response to such hubris:*

"That which most artists have in common, an aversion to colour as a science, became understandable to me when, a short time ago, I read Ostwald's theory of colours ... Scientists often find art to be childish, but in this case, the position is inverted ... To hold that the possibility of creating harmony using a tone of equal value should become a general rule means renouncing the wealth of the soul. Thanks but no thanks."

-Philip Ball, Neuroaesthetics is Killing your Soul, Nature, March 2013.

Now while this short excerpt may initially seem to demonstrate a valid concern for some, a closer look may reveal some faults in the argument. For example, Ball states that "t*o suggest that the human brain responds in a particular way to art risks creating criteria of right or wrong, either in the art itself or in individual reactions to it. Although it is a risk that most researchers are likely to recognize, experience suggests that scientists studying art find it hard to resist drawing up rules for critical judgments.*" This may <u>not</u> come as a surprise to most of you, but we already contend with a significant amount of restrictive criteria as well as rules for critical judgment when eliciting information from the visual world. Biologically speaking, human vision is limited to a very narrow band of the electromagnetic spectrum and requires a level of contrast above our minimum contrast sensitivity as well as a stimulus that is on a scale within the limits of our angular resolution. If we deviate from these parameters within a visual arts endeavor, we will fail to create something that can be experienced visually. At that point, further consideration is moot.

As to critical judgments, I believe that I can safely state that humans are already well versed in their use. The ability or propensity to make critical judgments is not something new that science is about to spring on the art world from out of the blue. What science can offer is information to make more informed judgments. Funny enough, two sentences after Ball warns us of the impending threats from critical judgment, he himself falls prey to temptation by deeming Paul Klee's intuitive handling of color to be "*impeccable*."

Klee's response to Ostwald featured in Ball's article further promotes this apparent pseudo-incompatibility between science and art. While I am not advocating for any of Ostwald's ideas, Klee's response does seem to be hyperbole resulting from an attempt to cram an analog concept into a digital filter. Additionally, I am not sure how to begin to adequately address the claim that a general rule may be responsible for "renouncing the wealth of the soul".

Further increasing anxieties regarding the infiltration of art by the sciences are satirical efforts like the "*People's Choice*" project carried out by Russian-born American artists Vitaly Komar (1943-) and Alexander Melamid (1945-) in the mid to late 1990s. The project involved the conducting of scientific polls in 11 countries to discover aesthetic preferences in painting. Taking the aggregate results, the artists then produced works dubbed *The Most Wanted* and *The Least Wanted* from each country. With this effort, Komar and Melamid felt that they could determine what art would look like if it were designed by committee to please the greatest number of people. In a publication following the project, Komar said, "*Our interpretation of polls is our collaboration with various people of the world. It is a collaboration with a[sic] new dictator—Majority*." -Wypijewski, JoAnn, ed. Painting by Numbers:

Komar and Melamid's Scientific Guide to Art, New York: Farrar Straus Giroux, 1997.

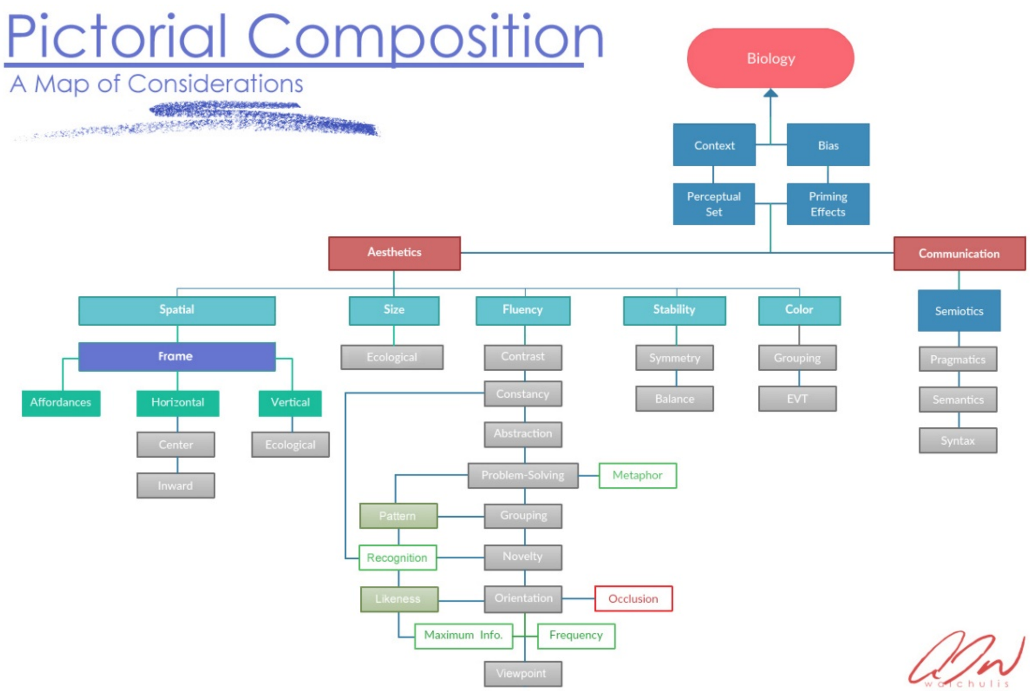
The most favored painting from the *People's Choice* project was a mostly-blue landscape with water, people, and animals while the least favored painting was an abstract design of jagged shapes featuring a thick impasto and the disliked colors of gold, orange, and yellow.

You can see the full survey results here:
http://awp.diaart.org/km/surveyresults.html
And a gallery of the resulting work
here: **http://awp.diaart.org/km/painting.html**

As you might suspect, the "scientific" survey was problematic, and the resulting paintings were—well—just plain bad (and yes, I am making a critical judgment here). The artists muddled important factors (including aesthetic preference and individual taste) and produced a collection of works that most roadside motels would be hesitant to hang. But it was not the mere muddling of factors that produced the less-than-stellar artworks—**it was the idea that a component preference in one context could transfer such qualities to an aggregate in another.** The philosopher Denis Dutton offered this comparison in regards to the efforts of Komar and Melamid, "*Let's imagine offering to discover for Americans their Most Wanted Food. To be accurate and avoid inappropriate elitism, we do a careful, demographically adjusted survey of gustatory preferences, hiring the Gallup organization to conduct scientific polls, renting church halls for focus groups (videotaped), and talking to everyone who wants to be heard. It's expensive, to be sure, but we manage to persuade a respectably liberal* *nonprofit foundation to fund our research — after all, we're finding out what the people want. As the results come in, we discover that Americans' tastes in food are wide-ranging, whimsical and imaginative, often traditional, but also ethnic in every direction. Despite the vast variety, however, we determine that numerically dominating the food taste list are preferences for hamburgers, pizza, ice cream, and chocolate. So we put our culinary skills to work and come up with the ultimate dish. Here, America, is your Most Wanted Food: hamburger-flavored ice cream with chocolate-coated pizza nuggets. Eat it!*"

Now don't worry—I do not plan to continue down this path at present. I have no intention of thoroughly exploring the psychology of what makes some people more or less resistant to the ongoing contributions from modern day scientific research. Such a complex topic is far beyond the scope of this series. What I would like readers to appreciate, though, is that there are indeed many areas of modern research (empirical aesthetics, neuroaesthetics, vision science, cognitive psychology, evolutionary psychology, etc...) that can offer AMAZING insight into the art experience. Can scientific insights be misapplied to aspects of the creative process? Of course–but you don't throw out the arithmetic book when someone gets a math problem wrong.

Rather, with the last installment of this primer, I would like to pull together the many concepts that we have explored thus far into one cohesive map of considerations for the navigating of pictorial composition. While I will present what I hope is a clear overview of each entry on the map, I strongly encourage you to research these ideas further. This map, like this primer, is a starting point for a truly productive exploring of this complex topic. The map is not a shortcut or a heuristic. There are no mystical numbers or magical devices to be found. And as with most fruitful educational resources, it will require some work on the reader's part to make the most of it.



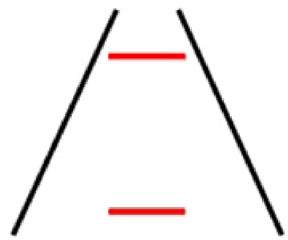
Biology

Our map begins with the one factor that determines our ability to elicit visual information, experience aesthetic qualities, and engage in communication–our biology. As we have explored in the previous installments of this series (as well as earlier in this installment), human vision is limited to a very narrow band of the electromagnetic spectrum and requires a level of contrast above our minimum contrast sensitivity as well as a stimulus that is on a scale within the limits of our angular resolution. These biological parameters are paramount, and as stated earlier, a stimulus existing outside these parameters will fail to be perceived—at which point further consideration is moot.

Context

If our biology weaves the world we see then context is everything else conspiring to make it so. A fundamental fact of vision is that any given light pattern falling onto the retina can have an almost infinite number of sources in the environment. The pattern projected on the retina is ultimately an ambiguous conflation of reflectance, illumination and transmittance attributes (as well as other variables that influence these factors.) One of the ways that humans seem to contend with such ambiguity is through the development of reflexive neural responses that incorporate a consideration of context, shaped by experience.

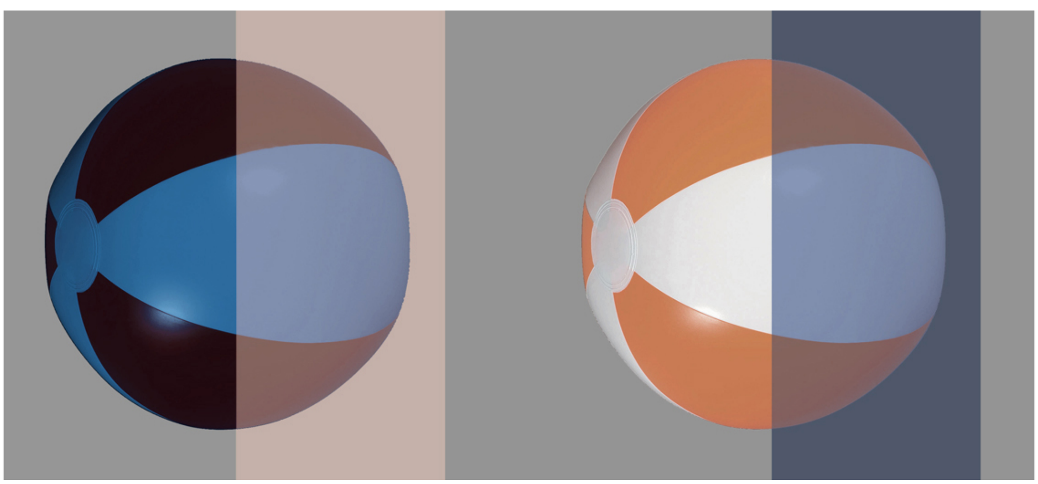
Dejan Todorović wrote in the 2010 Review of Psychology: "*In our everyday perception, when we look at an object, intuitively it seems obvious that what we are aware of are just the properties of that object itself, and not of something else, beyond the object. However, contextual effects do exist, ranging from weak but noticeable to strong and perplexing, and present major challenges to our understanding of the working of perceptual mechanisms and cognitive processes in general.*"



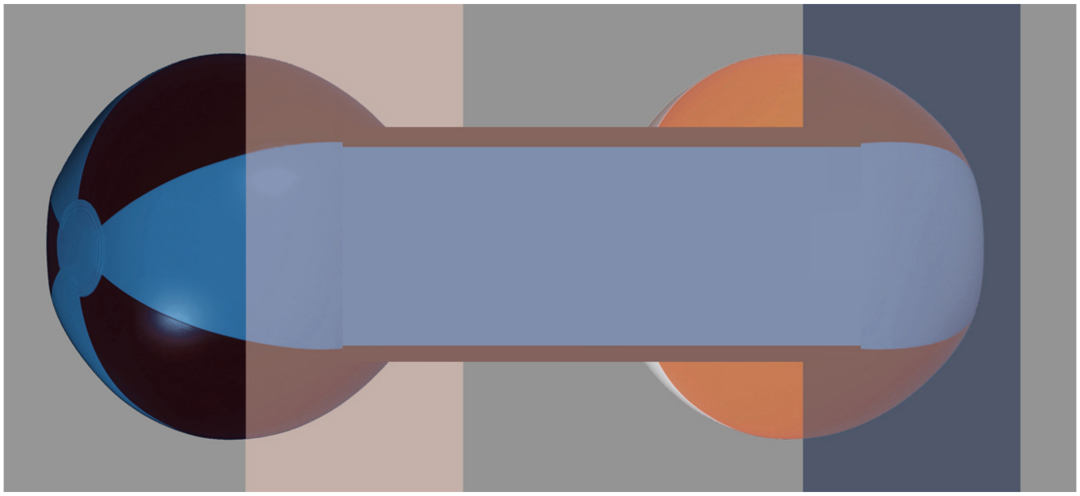
The Ponzo Illusion. Both red lines are of the same length but appear different due to surrounding context.

Context influences our perceptions of geometry, value, color, depth/form as well as more complex perceptual tasks like object recognition. For example, we may perceive the length of a particular line quite differently as the surrounding context of the line is altered (both red lines are physically identical in length.)

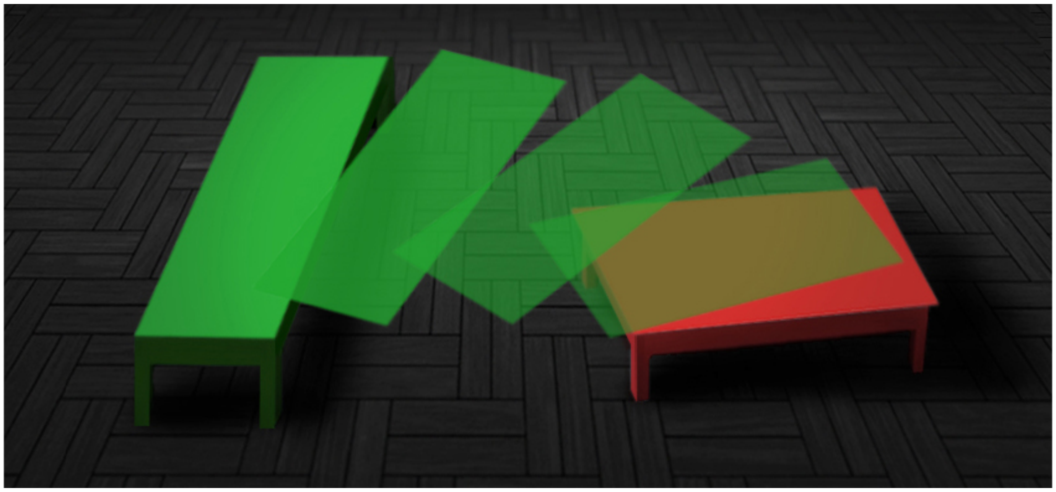
Let’s look at a few examples of how context influences what we see:



Here we see two beach balls of different colors that appear to be influenced by a bar of semi-transparent color. In reality, the regions of the beach balls that appear to be influenced by the bar of semi-transparent color are actually identical.



This illustration is an example of an illusion known as Shepard’s Tables. It was first published by Roger Shepard as “Turning the Tables” in his book Mind Sights. The green table top on the left seems longer and thinner than the red table top on the right. However, both table tops are identical in shape. The context of the image leads us to perceive the shapes as drastically different.



Some contextual influences can be controlled by the artist while others cannot. For example, while the artist may be able to control all of the elements within a work of art, he or she may have no control over the manner in which the work may be used or exhibited. The manner of use or exhibition may significantly influence the way in which the image is perceived or how well the work may communicate meaning. Therefore, if you can garner knowledge of how your work may be used or exhibited, it will allow you to make better decisions regarding composition.

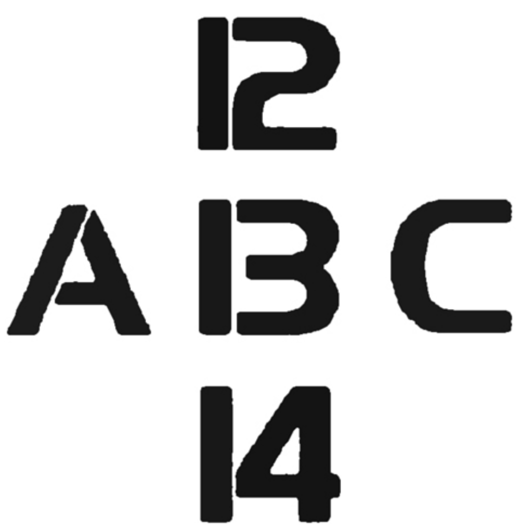
Bias

Bias can be described as a biological predilection as well as a particular tendency, trend, inclination, feeling, or opinion, especially one that is preconceived or unreasoned. While some biases may be derived from a biological imperative–others are learned from experience (e.g., implicitly within cultural context.) Cognitive biases can be considered heuristics or cognitive shortcuts–sometimes leading us to irrational conclusions–but sometimes serving an adaptive purpose (e.g., allowing us to reach decisions quickly in situations when time is of the essence.) As you will soon see, the aesthetic qualities that we experience are ultimately a collection of biases.

Perceptual Set/Priming Effects

Two additional high-level variables are perceptual set and priming effects. While controlling these factors may often be beyond the reach of the artist–knowledge of your target audience may allow you to predict these variables with reasonable success.

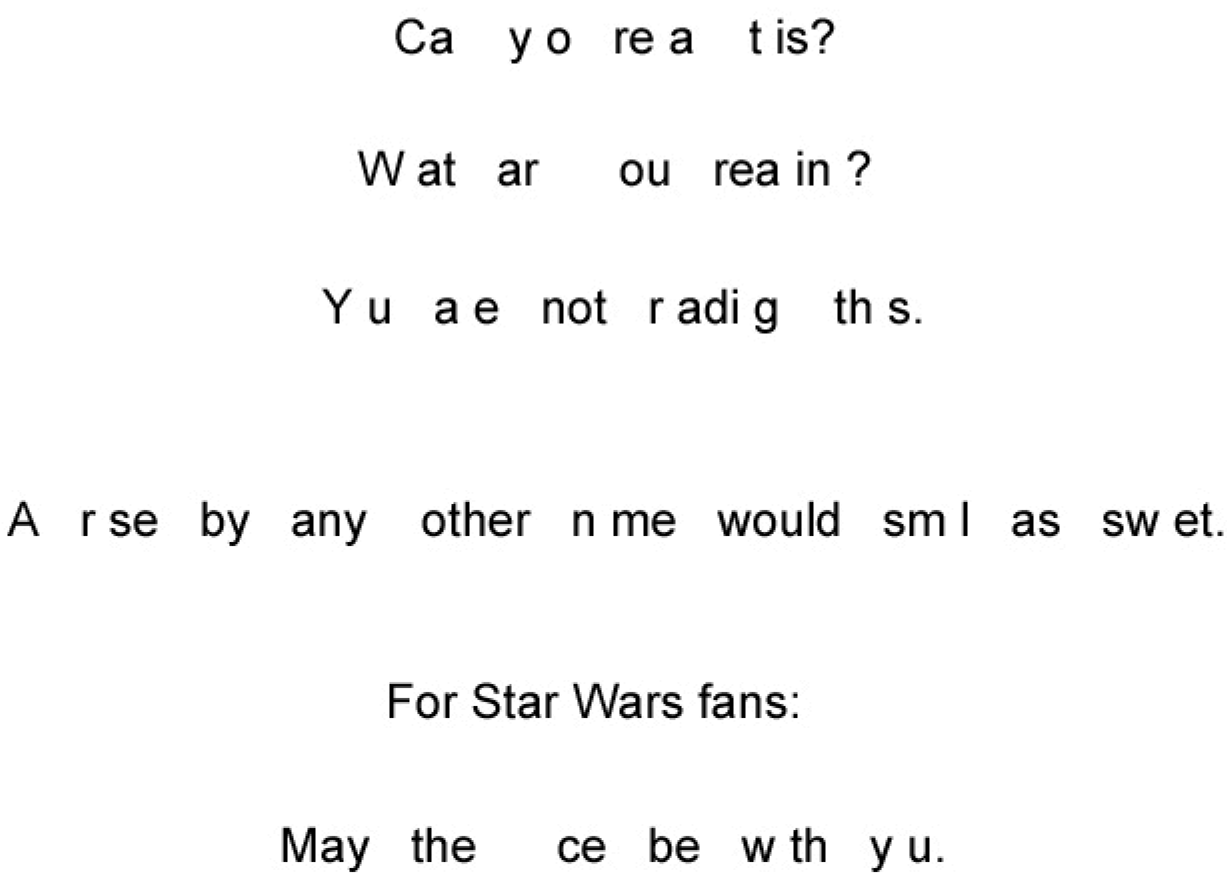
Perceptual set is an observer's tendency to perceive or notice some aspects of the available sensory data and ignore others. It has been found that a number of variables, or factors, influence perceptual set, and set in turn influences perception. The factors include expectations, emotion, motivation, and culture. In 1955, American psychologist Gordon Willard Allport defined perceptual set as: "*A perceptual bias or predisposition or readiness to perceive particular features of a stimulus.*"



One of the best examples for understanding the role of context and perceptual set is this simple illustration from Bruner & Minturn (1955). The illustration demonstrates how our expectation could influence whether the ambiguous center figure is the number 13 or the letter B based on surrounding context.

Another strong demonstration of the influences of context and perceptual set was presented in my first installment, So what’s with Jane already? A Primer on Pictorial Composition. (Part I):

See if you can “read” the following text:

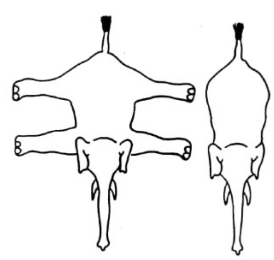


The image above shows several strings of spaced letters that can be “read” as sentences. The first three sequences have been used by Dr. Beau Lotto (director of LottoLab) to successfully demonstrate how the visual system uses past experience/frequency of occurrence data in perception. We insert the letters that our experience deems “most likely” based on the available information.

The quote from Shakespeare ("a rose by any other name would smell as sweet") contains the letter grouping sm l in the sentence which could easily become the word smile instead of the word smell. I would think it may be reasonable to suspect that an aesthetic "word-preference survey" could easily yield that, independent of context, the word smile would find aesthetic preference over the word smell (as the concept for the former may be generally more attractive than the latter for a number of biological reasons), but in the above context, if your past experience warrants, your brain opts for smell over smile.

The same holds for the more common pop-culture phrase made famous by the popular Star Wars franchise ("may the force be with you"). You can just as easily fit in the word peace instead of force. Again, you can probably conduct a survey to find that more people would prefer the word peace over the word force in isolation, without supporting context (as we have seen with the above efforts of artists Komar and Melamid)– however, we again find the potential aesthetic preference of an individual variable surpassed by context.

On the influence of culture on perceptual set, psychologist and author Saul McLeod writes,



Elephant drawing split-view and top-view perspective. The split elephant drawing was generally preferred by African children and adults. -Saul McLeod, simplypsychology.org

“Deregowski (1972) investigated whether pictures are seen and understood in the same way in different cultures. His findings suggest that perceiving perspective in drawings is in fact a specific cultural skill, which is learned rather than automatic. He found people from several cultures prefer drawings which don’t show perspective, but instead are split so as to show both sides of an object at the same time.

In one study he found a fairly consistent preference among African children and adults for split-type drawings over perspective-drawings. Split type drawings show all the important features of an object which could not normally be seen at once from that perspective. Perspective drawings give just one view of an object. Deregowski argued that this split-style representation is universal and is found in European children before they are taught differently.

Hudson (1960) noted difficulties among South African Bantu workers in interpreting depth cues in pictures. Such cues are important because they convey information about the spatial relationships among the objects in pictures. A person using depth cues will extract a different meaning from a picture than a person not using such cues.

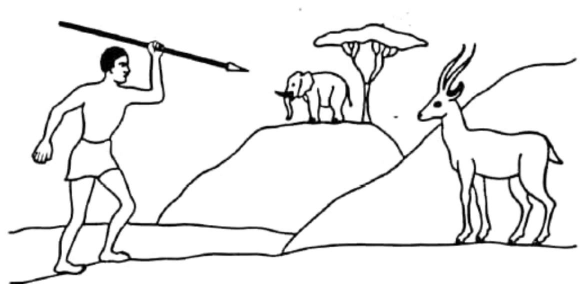
Hudson tested pictorial depth perception by showing participants a picture like the one below. A correct interpretation is that the hunter is trying to spear the antelope, which is nearer to him than the elephant. An incorrect interpretation is that the elephant is nearer and about to be speared. The picture contains two depth cues: overlapping objects and known size of objects. Questions were asked in the participant’s native language such as:

What do you see?

Which is nearer, the antelope or the elephant?

What is the man doing?

The results indicated that both children and adults found it difficult to perceive depth in the pictures.



The cross-cultural studies seem to indicate that history and culture play an important part in how we perceive our environment. Perceptual set is concerned with the active nature of perceptual processes and clearly there may be a difference cross-culturally in the kinds of factors that affect perceptual set and the nature of the effect." -Saul McLeod, Perceptual Set, SimplyPsychology.org

I briefly touched on the issue of cultural influences on pictorial communication in "The concept of a 'picture' is by no means universal, not even on our own planet. Let us not forget the curious story from Henri Breuil, a French Catholic priest and amateur archaeologist, which describes a Turkish officer who was incapable of recognizing a drawing of a horse, "because he could not move round it." Being a Muslim, the officer was entirely unfamiliar with depictive art. Such stories could

easily lead many to argue that the eliciting of meaning from a two-dimensional representation is not an innate human ability.
The third installment of this series, **Henri Breuil and Alfred Yarbus Walk into a Bar…A Primer on Pictorial Composition. (Part III)**, explored this idea even further:

"*Data collected among the Baganda of Uganda indicates that pictorial perceptual skills are positively and significantly related to relative amounts of exposure to Western culture. Both urban and relatively more acculturated rural residents make overall more correct identifications of pictorial objects and more consistent use of cues to pictorial depth than more traditional Baganda. These results offer support for the proposition that visual perceptual skills are related to culturally constituted experience.*" -Kilbride, Philip L., and Michael C. Robbins. "Pictorial depth perception and acculturation among the Baganda." American Anthropologist 71.2 (1969): 293-301.

"*Reports of difficulty in pictorial perception by members of remote, illiterate tribes have periodically been made by missionaries, explorers, and anthropologists. Robert Laws, a Scottish missionary active in Nyasaland (now Malawi) at the end of the 19th century, reported: "Take a picture in black and white and the natives cannot see it. You may tell the natives, 'This is a picture of an ox and a dog,' and the people will look at it and look at you and that look says that they consider you a liar. Perhaps you say again, 'Yes, this is a picture of an ox and a dog.' Well, perhaps they will tell you what they think this time. If there are a few boys about, you say: 'This is really a picture of an ox and a dog. Look at the horn of the ox, and there is his tail!' And the boy will say: 'Oh! Yes and there is the dog's nose and eyes and ears!' Then* *the old people will look again and clap their hands and say, 'Oh! Yes, it is a dog.' When a man has seen a picture for the first time, his book education has begun.*" -Deregowski, Jan B. "Pictorial perception and culture." Scientific American (1972). Nov.:82-88.

Priming is an implicit memory effect in which exposure to one stimulus influences the response to another stimulus. It can occur following perceptual, semantic, or conceptual stimulus repetition. For example, if a person reads a list of words including the word table, and is later asked to complete a word starting with tab, the probability that he or she will answer table is greater than if they are not primed.

There are several types of priming and the effects can be very salient and long lasting. Unconscious priming has been shown to affect word choice on a word-stem completion test long after the words have been consciously forgotten.

Priming works best when the two stimuli are in the same modality. For example, visual priming works best with visual cues and verbal priming works best with verbal cues. But priming also occurs between modalities, or between semantically related words such as "doctor" and "nurse".

The influence of such effects can be seen with the eye-tracking work of Russian psychologist Alfred Yarbus (another scientists whose work was referenced throughout this series). In his 1967 work, *Eye movements and vision*, Yarbus writes, "*Depending on the task in which a person is engaged, i.e., depending on the character of the information which he must obtain, the distribution of the points of fixation on an object will vary correspondingly because different' items of information are* *usually localized in different parts of an object. This is confirmed by Fig. 109. This figure shows that, depending on the task facing the subject, the eye movements varied. For example, in response to .the instruction "estimate the material circumstances of the family shown in the picture," the observer paid particular attention to the women's clothing and the furniture (the armchair, stool, tablecloth, and so on). In response to the instruction "give the ages of the people shown in the picture," all attention was concentrated on their faces. In response to the instruction "surmise what the family was doing before the arrival of the 'unexpected visitor,'" the observer directed his attention particularly to the objects arranged on the table, the girl's and the woman's hands, and to the music. After the instruction "remember the clothes worn by the people in the picture," their clothing was examined. The instruction 'remember the position of the people and objects in the room," caused the observer to examine the whole room and all the objects. His attention was even drawn to the chair leg shown in the left part of the picture which he had hitherto not observed. Finally, the instruction 'estimate how long the 'unexpected visitor' had been away from the family," caused the observer to make particularly intensive movements of the eyes between the faces of the children and the face of the person entering the room. In this case he was undoubtedly trying to find the answer by studying the expressions on the faces and trying to determine whether the children recognized the visitor or not."*

Records of the eye movements after an instruction are interesting because they help in the analysis of the significance of eye movements during the free examination of a picture; they show clearly that the importance of the elements giving information is determined by the *problem facing the observer, and that this importance may vary within extremely wide limits.*

...In conclusion, I must stress once again that the distribution of the points of fixation on an object, the order in which the observer's attention moves from one point of fixation to another, the duration of fixations, the distinctive cyclic pattern of examination, and so on are determined by the nature of the object and the problem facing the observer at the moment of perception." -Yarbus, A. (1967). Eye movements and vision (B. Haigh & L. A. Riggs, Trans.). New York: Plenum Press

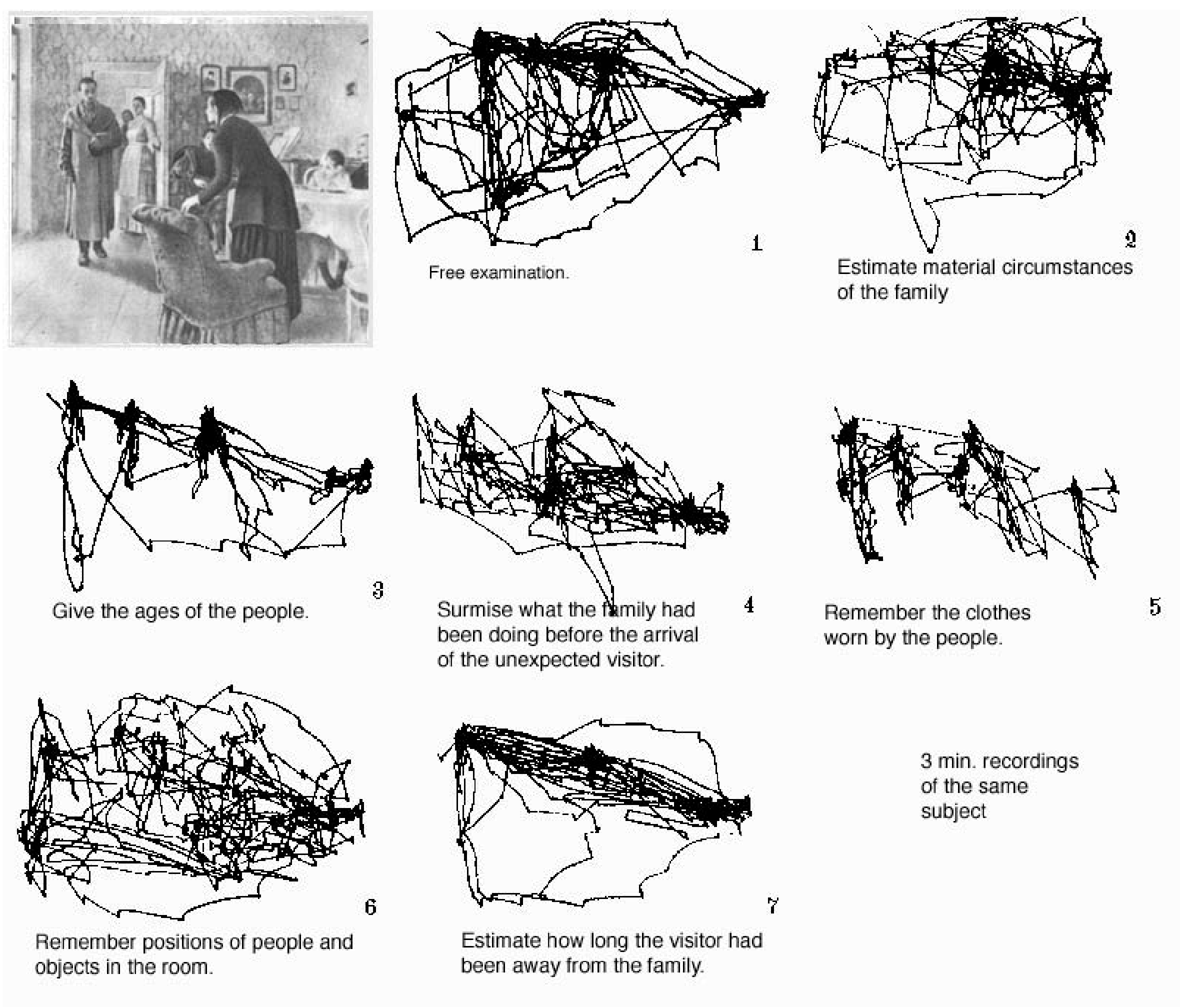


Fig. 109. from Eye movements and vision by Alfred Yarbus, (1967). Seven records of eye movements by the same subject. Each record lasted 3 minutes. The subject examined the reproduction with both eyes. 1) Free examination of the picture. Before the subsequent recording sessions, the subject was asked to: 2) estimate the material circumstances of 'the family in the picture; 3) give the ages of the people; 4) surmise what the family had been doing before the arrival of the 'unexpected visitor": 5) remember the clothes worn by the people; 6) remember the position of the people and objects in the room; 7) estimate how long the "unexpected visitor' had been away from the family.

So while Bias, Perceptual Set and Priming may seem an uncontrollable variable in many cases, knowing something about how your work may be displayed and potential audience that may view it (e.g., if the work will be used to illustrate a story, featured in a publication that holds a special focus, exhibited in a showcase with a particular theme) can allow you to make some informed, reasonable assumptions regarding all three during the composition phase of your work.

It is here that the map splits into two main categories that can be found in our initial definition of pictorial composition:

Pictorial composition can be defined as the specific content of an image as well as the spatial relationship of its elements with respect to aesthetic quality and communication efficacy.

Communication

Thoroughly exploring a topic as complex as human communication would require an effort that is far beyond the scope of this paper. Rather, I would like to introduce the aspects of it that I consider applicable to our focus here (visual communication). As such we can define communication here simply as the act of conveying intended meanings/information from one entity or group to another through the use of mutually understood signs and semiotic rules. More specific to our focus, visual communication is the communication of ideas via the visual display of information.

Some would argue that visual communication is the type of communication that people rely on most. This might make sense as nearly 30% of the human cortex is dedicated to vision (compared with 8% percent for touch and just 3% percent for hearing.)

When I am considering the “communication” aspects of a work, I am thinking about what information I am intending to pass on to the viewer. I need to consider:

What conventions (signs/symbols/representations) of visual communication will be most effective for my purposes?

How might bias, priming effects, and perceptual set affect those conventions?

How will those conventions be affected by my aesthetic considerations?

While our map of considerations separates communication and aesthetic qualities, there will indeed by overlap. In fact, you may discover that some consideration points may apply to both categories (metaphor, for example, can be a communication consideration as well as an aesthetic one.)

A more formal breakdown of my considerations of visual communication can be understood by the rules of semiotics. **Semiotics** is the study of meaning-making, the study of sign processes and meaningful communication. This includes the study of signs and sign-using behavior, indication, designation, likeness, analogy, metaphor, symbolism, signification, and communication.

Semiotics is closely related to the field of linguistics, which, for its part, studies the structure and meaning of language more specifically. The semiotic tradition explores the study of signs and symbols as a significant part of communications. As different from linguistics, however, semiotics also studies non-linguistic sign systems.

The type of communication that I am concerned with can be seen as processes of information transmission with three levels of semiotic rules:

Pragmatic (concerned with the relations between signs/expressions and their users)

Semantic (study of the relationships between signs and symbols and what they represent)

Syntactic (formal properties of signs and symbols).

These levels translate to my process as:

Pragmatic (*What context can I build from visual elements and design principles to facilitate meaning and minimize apparent ambiguity***?**)

Semantic (*What "meaning" can create with visual stimuli and what visual relationships can I create between visual elements and design principles to facilitate recognition and maximize the chances for the successful transmission of information?*)

Syntactic (*What conventions of visual perception and cognition can I make use of to reduce ambiguity and maximize the chances for the successful transmission of information?*)

To further explore some ideas about communicating visually I would turn your attention to the second installment of this series, **"To the makers of music – all worlds, all times" A Primer on Pictorial Composition. (Part II)**.

Aesthetics

Moving to the other side of our consideration map we find our considerations for those qualities that are characteristics of a stimulus that elicit adaptive responses that have evolved to reinforce or discourage specific behaviors. As presented in my first installment of this series, we may prefer one type of sensory experience over another—describing one as repulsive and the other beautiful. However, aesthetic qualities should not be confused with individual tastes. Many refer to aesthetic properties as personal preferences and this, I believe, is a serious mistake. Like most concepts involving evolution, concepts of "aesthetics" and "beauty" seems to be most productive when considered on the level of populations and not the individual. For example, it is not as relevant to our goals here that someone may prefer Vanilla over

Chocolate—but rather, to consider the overall biological predilection for fat and sugar.

So let's take a look at the different biases that define our aesthetic preferences:

Spatial Biases/Aesthetics

It is important to note that the following biases exist relative to a frame. This frame may be any closed region of the visual field, or, in some cases, the visual field itself. For our purposes, we will be primarily considering the frame to be the image area of a two-dimensional artwork.

From Jonathan Sammartino Gardner & Stephen E. Palmer's 2010 VSS presentation: *Representational Fit in Position and Perspective: A Unified Aesthetic Account*: "*Previous research on aesthetic preference for spatial compositions has shown robust and systematic preferences for object locations within frames, such as the center bias, the inward bias, and various ecological biases (Palmer, Gardner, & Wickens, 2008; Gardner & Palmer, VSS-2006, VSS-2008, VSS-2009). These preferences can be dramatically altered, however, by changing contextual meaning through different titles for the same picture (Gardner & Palmer, VSS-2009).*"

Horizontal (Inward Bias): Studies have demonstrated that when an object with a salient "front" is placed nearer the border of a frame than a center, observers tend to find the image more aesthetically pleasing if the object faces inward (toward the center) than if it faces outward (away from the center) (Chen et al., 2014) . I believe that this may have much to do with the idea of understanding our brain as a "***prediction***

machine". Again, "*A still photograph of an object in motion may convey dynamic information about the position of the object immediately before and after the photograph was taken (implied motion)*" - (Kourtzi and Kanwisher, 2000). If we can see more of where an object may be "headed", we can make a better prediction about a future state of the objects being observed.

Horizontal (Center Bias): In studies regarding front-facing subjects, preference was greatest for pictures whose subject was located at or near the center of the frame and decreased monotonically and symmetrically with distance from the center (Palmer, Gardner & Wickens, 2008). The reason that people prefer the object's salient front region to be as close to the center as possible may result from a number of factors. The greatest influence MAY come from the way in which we usually engage with what we see as a front-facing subject. This center bias may reflect an advantageous viewing position for extracting information from such scenarios. I would like to note here that center bias is not the same that as central fixation bias. They may be related in some way, but not in a way that I can show support for at this time. Central fixation bias is a tendency for observers to begin an exploration of a visual scene at the center. Numerous visual perception experiments have borne this out (e.g., Buswell, 1935, Mannan et al., 1995, Mannan et al., 1996, Mannan et al., 1997, Parkhurst et al., 2002 and Parkhurst and Niebur, 2003). The prevalence of central fixation bias suggests that it is a key feature of scene viewing, but the basis of this effect remains poorly understood.

Vertical (Ecological Bias): Current research has shown both center and inward biases do in fact influence preferences in the vertical dimension (Sammartino and Palmer, in press). However, such biases in the vertical dimension seem to be different from those in the horizontal dimension. Palmer and Sammartino write, "*The inward bias in the vertical dimension differs from that in the horizontal dimension, however, in that it arises for different objects rather than different facing directions of the same object: a lower bias for a bowl and swimming stingray versus an upper bias for a light fixture and a flying eagle. The inward bias in the vertical dimension appears to arise from multiple relatively high-level factors, including what we call functional asymmetry effects, ecological effects, and possibly perspective effects*." - Sammartino, J., Palmer, S.E. (2012). Aesthetic issues in spatial composition: Effects of vertical position and perspective on framing single objects. Journal of Experimental Psychology: Human Perception and Performance, 38(4), 865-879.

Research into spatial preferences in the vertical dimension also point to ecological effects (possibly arising from fluency bias) that seem to be contributing to certain preferences. These effects are referred to as 'ecological' because they appear to be driven by people preferring images in which the spatial properties of the image of the depicted object within its frame fit the ecological properties of the physical object relative to the viewer.

Palmer and Sammartino again write, "*Ecological effects are based on the fact that some objects tend to be located higher than the observer in the environment (e.g., flying eagles and light fixtures) and others tend to be located lower (e.g., bowls and swimming stingrays). It appears to cause strong and pervasive inward height biases in the present results in that people prefer the vertical position of an object within the frame to be consistent with the vertical position of the object relative to the* *observer: i.e., eagles and light fixtures to be high and bowls and stingrays to be low*." -Sammartino, J., Palmer, S.E. (2012). Aesthetic issues in spatial composition: Effects of vertical position and perspective on framing single objects. Journal of Experimental Psychology: Human Perception and Performance, 38(4), 865-879.

Affordances

Affordance spaces in regard to pictorial composition are the regions surrounding an object that could allow for object function or interaction. These regions seem to contribute to prediction tasks as well as recognition and categorizations tasks.

"*What we are calling functional asymmetry effects would arise because people's interactions with many objects are not equally distributed over the space surrounding them. The fact that fronts of objects are almost always more salient in interactions than their sides and backs can explain the inward bias found by Palmer, Gardner, and Wickens (2008) in the horizontal placement: people prefer the more salient functional parts of the object to be closer to the center.*

A simpler and more elegant explanation of the results can be devised by positing the existence of what we will call an "affordance space" around an object that reflects the extent and/or importance of functions that take place in that region around the object, where "affordances" are the functions of an object that an observer can perceive from its visible structure (Gibson, 1977). If the affordance space around an object is asymmetrical, as suggested above, then what we are calling an inward bias may actually be understood as a center bias that operates on an *asymmetrical affordance space that contains more surrounding area on the functionally more salient side(s). That is, if viewers implicitly prefer the affordance space around an object to be centered in the frame, and if that affordance space is asymmetrical with more space in front of horizontally facing objects (e.g., a person, chair, or vehicle), on top of "upward facing" objects (e.g., a bowl), and toward the bottom of "downward facing" objects (e.g., a light fixture), then at least some of the inward biases in both horizontal and vertical dimensions we have found may actually be understood as center biases operating on affordance spaces rather than as inward biases operating on the objective boundaries of the physical objects. We are currently devising ways to measure the shapes of affordance spaces for different objects empirically to find out whether the results conform to the inward biases we have found in aesthetic judgments of spatial composition*." - Sammartino, J., Palmer, S.E. (2012). Aesthetic issues in spatial composition: Effects of vertical position and perspective on framing single objects. Journal of Experimental Psychology: Human Perception and Performance, 38(4), 865-879.

The version of the phone on the right may find preference as it offers a greater affordance space for recognition, categorization, and prediction tasks.

Size Biases/Aesthetics

The preferences for size in a pictorial composition seem to emerge from the same mechanisms that gives rise to our preferences for objects in the vertical dimension. In general, relatively small physical objects tend to be preferred when their images are small within a frame while relatively large physical objects are preferred when their images are large within a frame. Again, this can be considered an “ecological bias” as it appears to be driven by people preferring images in which the properties of the objects depicted within its frame mirror the ecological properties of the physical objects relative to the viewer.

“*Akin to studies on canonical perspective, we provide evidence that existing object representations also have canonical visual sizes, which* *depend on the assumed size of the object in the world relative to a frame of space. Both perspective and visual size are spatial dimensions that are under the control of an active observer, in this sense canonical views connect physical objects to a viewer in an environment. In fact, if one combines canonical perspective at the canonical visual size, this object knowledge specifies the optimal place in 3D space from which to view an object.*" -Konkle, Talia, and Aude Oliva. "Canonical visual size for real-world objects." Journal of experimental psychology: human perception and performance 37.1 (2011): 23.

Fluency

Processing fluency is the ease with which information is processed. Perceptual fluency is the ease of processing stimuli based on manipulations to perceptual quality. Research in cognitive neuroscience and psychology has shown that processing fluency influences different kinds of judgments. For instance, perceptual fluency can contribute to the experience of familiarity when fluent processing is attributed to the past. Repeating the presentation of a stimulus, (a means by which to bring about the aforementioned priming effects) is one method for enhancing fluency.

Some research into aesthetics has given rise to a theory that attributes a good deal of aesthetic experience to processing fluency. The theory is known as the **processing fluency theory of aesthetic pleasure**. The theory holds four basic assumptions:

1. Objects differ in the fluency with which they can be processed. Variables that facilitate fluent processing include objective features of stimuli, like goodness of form, symmetry, figure-ground contrast, perceptual priming, clarity, context, duration, repetition, well as

experience with a stimulus, for example repeated exposure or prototypicality (the idea that prototypical and “average” forms are preferred over nonprototypical one.)

2. Processing fluency is itself hedonically marked (that is, it possesses an inherent affective quality) and high fluency is subjectively experienced as positive.
3. In line with the “feelings-as-information” account, processing fluency feeds into judgments of aesthetic appreciation because people draw on their subjective experience in making evaluative judgments, unless the informational value of the experience is called into question.
4. The impact of fluency is moderated by expectations and attribution. On one hand, fluency has a particularly strong impact on affective experience if its source is unknown and fluent processing comes as a surprise. On the other hand, the fluency-based affective experience is discounted as a source of relevant information when the perceiver attributes the experience to an irrelevant source. This helps explain the inverted U-shaped function often found in research on the effect of complexity on preferences: Very complex patterns are not judged as beautiful because they are disfluent, and patterns are judged as more beautiful when they become less complex. When viewers perceive a simple pattern, they are often able to detect the source of fluency—the pattern’s simplicity—and do not use this experience of ease for judging the beauty of the pattern.

“*Multiple theoretical notions converge on the assumption that high fluency is positively marked. The basic idea in all these notions is that high fluency says something about a positive state of affairs, either within the cognitive system or in the world (see Winkielman et al., 2003, for a more comprehensive treatment). Specifically, high fluency may elicit positive affect because it is associated with progress toward successful recognition of the stimulus, error-free processing, or the availability of appropriate knowledge structures to interpret the stimulus (Carver & Scheier, 1990; Derryberry & Tucker, 1994; Fernandez-Duque, Baird, & Posner, 2000; Schwarz, 1990; Simon, 1967; Ramachandran & Hirstein, 1999; Vallacher & Nowak, 1999). High fluency may also feel good because it signals that an external stimulus is familiar, and thus unlikely to be harmful (Zajonc, 1968, 1998).*” - Reber, Rolf, Norbert Schwarz, and Piotr Winkielman. “Processing fluency and aesthetic pleasure: Is beauty in the perceiver’s processing experience?.” Personality and social psychology review 8.4 (2004): 364-382.

The idea that the amount of information that may be elicited from a sensory experience is an important determinant for the experience of “beauty” has a long history in the study of aesthetics (e.g., Arnheim, 1974; Gombrich, 1984). While I do not think that fluency is the sole wellspring of the aesthetic experience, I do believe that it may contribute to the majority of the experiences. For example, while symmetry is included in many studies of fluency, I find this consideration to be more effectively filed under a preference for stability (what I consider to be an ecological effect). Again, we may see some significant overlap between some of these ideas and how you choose to organize them for yourself should trump my map. What matters most here is how these considerations will ultimately serve your creative planning process.

Contrast

It is very important to remember that the visual system seems to be not all that interested (relatively) in gradual changes in the visual field, rather–our eyes tend to glide over homogenous regions and subtle changes in perceived luminance towards areas of increasing contrast or complexity in an effort to elicit information. It is at regions of discontinuity that we find the most robust amounts of visual information regarding our environment. “*These abrupt changes are particularly important because they signify either a change in the reflectance of a surface (e.g., from one material to another), a change in the amount of light falling on it (e.g., due to a shadow), or a change in surface orientation relative to the light source (since most surfaces at different angles to the light source reflect different amounts of light into the eye). For these and other reasons, luminance edges are almost universally* *agreed to be important image-based features.*" -Stephen E. Palmer, Vision Science.

Research has also shown that recognition speed, a standard measure of fluency, is faster for stimuli high in figure-ground contrast (e.g., Checkosky & Whitlock, 1973). This does not mean that increases in contrast alone (nor increases in any independent attribute explored here) will result in a greater aesthetic experience. As shown by the origination of the consideration map, context is a governing factor in how these fluency attributes are processed by a viewer.

Constancy

Perceptual Constancy is the ability to perceive the unchanging properties of external objects rather than the more transient properties of their retinal images. The brain has the unique ability to retain knowledge of constant and essential properties of an object and discard irrelevant dynamic properties. This applies not only to the ability to always see a banana as the color yellow but also the recognition of faces at varying angles.

While it would seem that perceptual constancy isn't something that we can "add" to a picture, it is listed here as its consideration may help some to distil an object down to its most essential visual properties (which may be different from the way in which we actually "see" it). In fact, some may argue that the creation of many visual representations are modeled off of this primitive neural function. I touched on this idea in another paper titled **Regarding Accuracy...**, *"So if my goal is to emulate an accurate percept and I find length measurements of a distal stimulus has limited applicability, and length measurements of a proximal stimulus are easily prone to error, then shouldn't I opt to chase an accurate visual simulacrum by just drawing or painting "what I see"?*

No, not really.

Even though we are indeed attempting to generate an accurate recreation of a percept, attempting to draw or paint veridically from a percept without measurement will often lead to significant inaccuracies. Let me say that again—painting accurately, strictly from a percept without policing from proximal/distal stimulus measurement, will most often not result in an accurate recreation of that percept. Let me explain–if I observe object (A), my brain will generate a reflexive response percept (A1). Therefore if I paint true to percept (A1), a subsequent viewing may elicit percept (A2) (or (A1(artist)+1(viewer)) as their reflexive response to my simulacrum is also not veridical. While this is not "bad" in itself—the more distant (A1) is from (A), the less realistic the resulting effort will appear."

Skillfully distilling an object down to visual essentials may allow room for the "visual contributions" of a viewer.

Abstraction

A consideration of abstraction here may seem quite similar to our efforts regarding an accounting for constancy—and indeed it is. However, abstraction is the manner (e.g., hierarchical coordination) in which we choose to reduce complexity to a form that may be more efficiently processed. So while can look at the consideration of constancy as a tool to reveal WHICH attributes remain “constant”, abstraction is the means of simplification that may differentiate these attributes from unessential ones.

It is worth noting here that Professor Semir Zeki, one of the founders of the emerging field of neuroaesthetics, proposes that the visual brain holds two supreme laws: **constancy** and **abstraction**.

The next several considerations are closely connected in many ways:

Perceptual Problem-Solving

A consideration of problem-solving here may seem redundant as it some may see it as inherent to the concept of fluency already (e.g. the problem of how to best acquire and/or process information). However, the consideration of problem-solving in this context comes from another pioneer of neuroaesthetics, neuroscientist VS Ramachandran. Among his eight laws of artistic experience, he includes problem-solving (being tied to the detection of contrast and grouping) as the idea that a visual “discovery” after a struggle is more pleasing than one which is instantaneously obvious. The mechanism ensures that the struggle is reinforcing so that the viewer continues to look until the discovery. From a survival point of view, this may be important for the continued search for predators. Ramachandran suggests for the same reason that a model whose hips and breasts are about to be revealed is more provocative than one who is already completely naked. A meaning that is implied is more alluring than one that is explicit.

This is a consideration that I explore quite often. I make a significant effort with most of my works to “layer” information so that extended investigations/explorations will hold the possibility of new discoveries after more cursory elements are familiar.

I would also like to make a note here that the effects of perceptual problem-solving may actually benefit works (in regards to viewer attention) that contain significant deviations from familiar percepts (e.g., drawing/painting errors, heavy stylization, etc.). Some studies into the manner in which we engage with pictures have shown that we will often return to “problem areas” in a complex stimulus, over and over in an attempt to effectively find a resolve to the issue(s).

Visual Metaphor – Ramachandran defines a metaphor as a mental tunnel between two concepts that appear grossly dissimilar on the surface, but instead share a deeper connection. Similar to the effects of perceptual problem solving, grasping an analogy is rewarding. It enables the viewer to highlight crucial aspects that the two objects share. Although it is uncertain whether the reason for this mechanism is for effective communication or purely cognitive, the discovery of similarities between superficially dissimilar events leads to activation of the limbic system to create a rewarding process.

Perceptual Grouping

Perceptual grouping refers to the process by which the various elements in an image are perceived as “going together” in the same perceptual unit of experience.

While the image here may initially be perceived as a jumble of blotches–the grouping of some blotches with other will give rise to an image of a Dalmatian sniffing at the ground. The realization of this percept often gives a pleasing experience–caused perhaps by activation of the limbic system by the temporal lobe cortex. With this example you can see how the effect is closely related to perceptual problem-solving.

Of perceptual grouping, Ramachandran states that the source of the pleasure may have come about because of the evolutionary necessity to give organisms an incentive to uncover objects, such as predators, from noisy environments. For example, when viewing ink blots, the visual system segments the scene to defeat camouflage and link a subset of splotches together. This may be accomplished most effectively if limbic reinforcement is fed back to early vision at every stage of visual processing leading up to the discovery of the object. The key idea is that due to the limited attentional resources, constant feedback facilitates processing of features at earlier stages due to the discovery of a clue which produces limbic activation to draw one's attention to important features.Though not spontaneous, this reinforcement is the source of the pleasant sensation. The discovery of the object itself results in a pleasant 'aha' revelation causing the organism to hold onto the image.

Novelty

While it seems that most artists are always striving to create something novel, an extremely novel representation may lead to issues in recognition. The challenge for an artist seeking a novel representation is to balance recognition with the interest from a problem-solving effort. Making something too distant from well-understood conventions of visual communication may result in your message going unheard.

At this point we should take a look at some concepts of recognition including pattern and likeness.

Recogntion – is a term that describes a cognitive process that matches information from a stimulus with information retrieved from memory.

There are several fascinating hypothesis regarding our mechanisms for recognition, but the ones that are most applicable here are recognition of pattern or likeness. While **pattern recognition** may be defined in most contexts as mere categorization, I am choosing to define it more specifically (for our purposes) as our ability to achieve recognition through visual repetition or grouping that occurs with discernible regularity. This might allow us to more fruitfully explore novel representations as the recognition may be augmented by a familiarity inherent to the interval/relationships rather than the actual occurrence at the interval. **Recognition by likeness** would in turn be the manner of matching information from a stimulus with an existing categorical classification.

As with the other aspects of aesthetic sensation describes here, recognition often gives a pleasing experience. In this context, I assume that it is clear how recognition is connected to constancy, perceptual problem-solving, and grouping. Additional considerations of fluency (perspective and orientation) are also closely connected to recognition.

Orientation/Canonical Perspective

Orientation of a representation may have much to do with how well it may be perceptually processed. This consideration is often regarded as "canonical perspective". Studies into recognition have shown systematic variations in naming latencies suggesting that certain manners of orientation affect perceptual fluency. While there are a few ideas to explain these canonical perspective effects–the two most obvious are:

Frequency Hypothesis: Our canonical perspectives are determined by an "ecological bias" in that the preferred orientation is that view which aligns with the orientation most frequently encountered in the physical world.

Maximal Information Hypothesis: Our canonical perspectives are determined by the perspective that offers the greatest amount of information about the object and its potential function.

In his book Vision Science, Stephen E. Palmer writes of these two hypotheses, "*It is likely that both hypotheses contain some measure of truth and that the perspective effects Palmer et al. reported depend jointly on both. Canonical views appear to provide the perceiver with what might be called the most diagnostic information about the object: the information that best discriminates it from other objects, given what the perceiver knows, derived from the views from which it is most often seen.*"

I would also like to take a moment here to address a more "semantic" issue in regards to orientation preferences in a pictorial context. Some studies have indicated very clearly that, beyond some minimum distance, there exists a preference for related objects to be relatively close together, but unrelated objects to be relatively far apart. (Leyssen, Mieke HR, et al.2012). Additionally, there seems to be general non-preference for occlusion. **Occlusion** is the condition in which light reflected from a farther object is blocked from reaching the viewer's eye by an opaque object between the viewer and the occluded object. While I do not think that this would be the case in all contexts, with a basic framework of how we garner pleasure from processing fluency, you can see how some contexts might make this so.

Viewpoint

Another of VS Ramachandran's eight laws of the artistic experience is called *The Generic Viewpoint*. The visual system dislikes interpretations which rely on a unique vantage point. Rather it accepts the visual interpretation for which there is an infinite set of viewpoints that could produce the class of retinal images. For example, in a landscape image, it will interpret an object in the foreground as obscuring an object in the background, rather than assuming that the background figure has a piece missing. In theory, if an artist is trying to please the eye, they should avoid such coincidences. However, in certain applications, the violation of this principle can also produce a pleasing effect.

Stability

In many ways, stability may be very closely connected to orientation. However, I feel that the preferences for balance and symmetry may emerge from survival instincts regarding shelter and reproduction (e.g., preference for a shelter that is not likely to fall or give way; resources likely to continue or last; a sign of health in a potential mate, etc.) instead of preferences based on processing fluency.

Balance/Symmetry

According to art theory, pictorial balance is a sense of equilibrium achieved through implied weight, attention, or attraction, created by manipulating the visual elements in an artwork. The balancing of elements is thought to be similar to balancing mechanical weights in a framework of symmetry axes. There are several different “types” of pictorial balance including symmetrical (even distribution of elements relative to a central axis), asymmetrical (irregular or uneven element arrangement), radial (elements arranged radially around a central point), ambiguous/neutral (equilibrium in spite of characteristically unclear element relationships or seeming randomness).

Many properties can contribute to the “visual weight” of an object. These attributes can include, “size (Berlyne 1966, 1971, 1974; Pierce 1894;

Puffer 1903), color (Arnheim 1974; Bullough 1907; Pinkerton and Humphrey 1974), and perhaps coarse texture, contrast, and interest."- Gershoni, Sharon, and Shaul Hochstein, "Measuring pictorial balance perception at first glance using Japanese calligraphy." i-Perception 2.6 (2011): 508-527.

As with most other aspects of pictorial composition, our sense of balance is born from our own biology. Particular preferences can be traced back to specific biological mechanisms. For example, "Paintings and drawings are perceived differently when viewed in mirror image; left and right have different roles in expressing action, motion, or power (Chatterjee 2002), and the left half of visual space may attract more attention, due to right parietal lobe specialization in attention and emotion (McManus 2002). Similarly, using the ecological view that in natural scenes visual field bottom is generally more crowded, it was suggested that weight at the top should be perceived as "heavier" than at the bottom (Arnheim 1974, 1981)."-Gershoni, Sharon, and Shaul Hochstein. "Measuring pictorial balance perception at first glance using Japanese calligraphy." i-Perception 2.6 (2011): 508-527.

Here are some of the findings from the Gershoni study above. They offers a wonderful insight into understanding "balance":

"*…We review here the most salient elements that seem to drive balance perception, leaving detailed study of these trends to further systematic study:*

Horizontal and vertical elements*. The most-balanced sets are composed mainly of horizontal and vertical elements. In the less-*

balanced stimulus sets the main feature is a lack of straight lines. This is consistent with the aesthetics oblique effect; for example, observers show aesthetic preference for Mondrian paintings oriented with vertical and horizontal elements over rotated versions with oblique elements (Latto and Russel-Duff 2002; Latto et al 2000; Plumhoff and Schirillo 2009).

Vertical mirror symmetry*. In the more balanced images vertical symmetry is either maintained or, with grouping of a number of non-vertical elements, even enhanced. With 90° rotation there is a switch from vertical symmetry to horizontal symmetry. As a result, vertical symmetry may be violated and the image is perceived as less balanced. This effect is exacerbated for ±45° rotations, when the symmetry is around the diagonals. These results are consistent with previous studies that found vertical mirror symmetry salience compared with horizontal or centric mirror symmetry in a variety of object perception tasks and suggested that vertical mirror symmetry is used as a cue for figure–ground segregation and element grouping in a display of Gabor elements (Machilsen et al 2009; Wenderoth 1994, 1995). We now suggest that vertical symmetry is also a critical cue for perceived balance.*

Imprecision of verticality and horizontality*. According to Japanese calligraphy tradition, all seemingly horizontal lines are in fact either slanted or slightly arched. Yet they are satisfactorily perceived as horizontal. For example, in the very top set of Figure 10 the horizontal lines are curved mostly above or below the horizontal axis, yet are perceived as resting on the horizontal axis. This is in line with Arnheim's (1974) observation that visual experience cannot be* *described in terms of precise property measurement units. For example, when people see a 93° angle they perceive "an inadequate right angle". Likewise, almost perfectly parallel lines are as likely to be perceived as parallel or as not parallel (Kukkonen et al. 1996). Quasi-invariant properties such as near parallelism are influential in object recognition over novel viewpoints and rotations.*"

While a sense of equilibrium may appeal to our preference for stability, an "unbalanced" composition may elicit a sense of tension and unease. Keep this in mind when you are considering how to incorporate "balance" into your compositions.

Color

There are vast resources available today on the topic of color preferences and color harmonies. I do not wish to spend any time here entertaining ideas of how "yellow makes you feel this way" and "blue makes you feel that", or what color do people "like most", rather I would like to address two color considerations that I contemplate during composition efforts: Color Grouping preferences and EVT (Ecological Valence Theory). If you are interested in studies about general color preference, I would direct you to: Palmer, S. E., & Schloss, K. B. (In press). Human color preference. In N. Moroney (Ed.), Encyclopedia of Color Science and Technology. Springer. If you would like to learn more about general object color preferences: Schloss, K. B., Strauss, E. D. & Palmer, S. E. (2012). Object color preferences. Color Research & Applications.

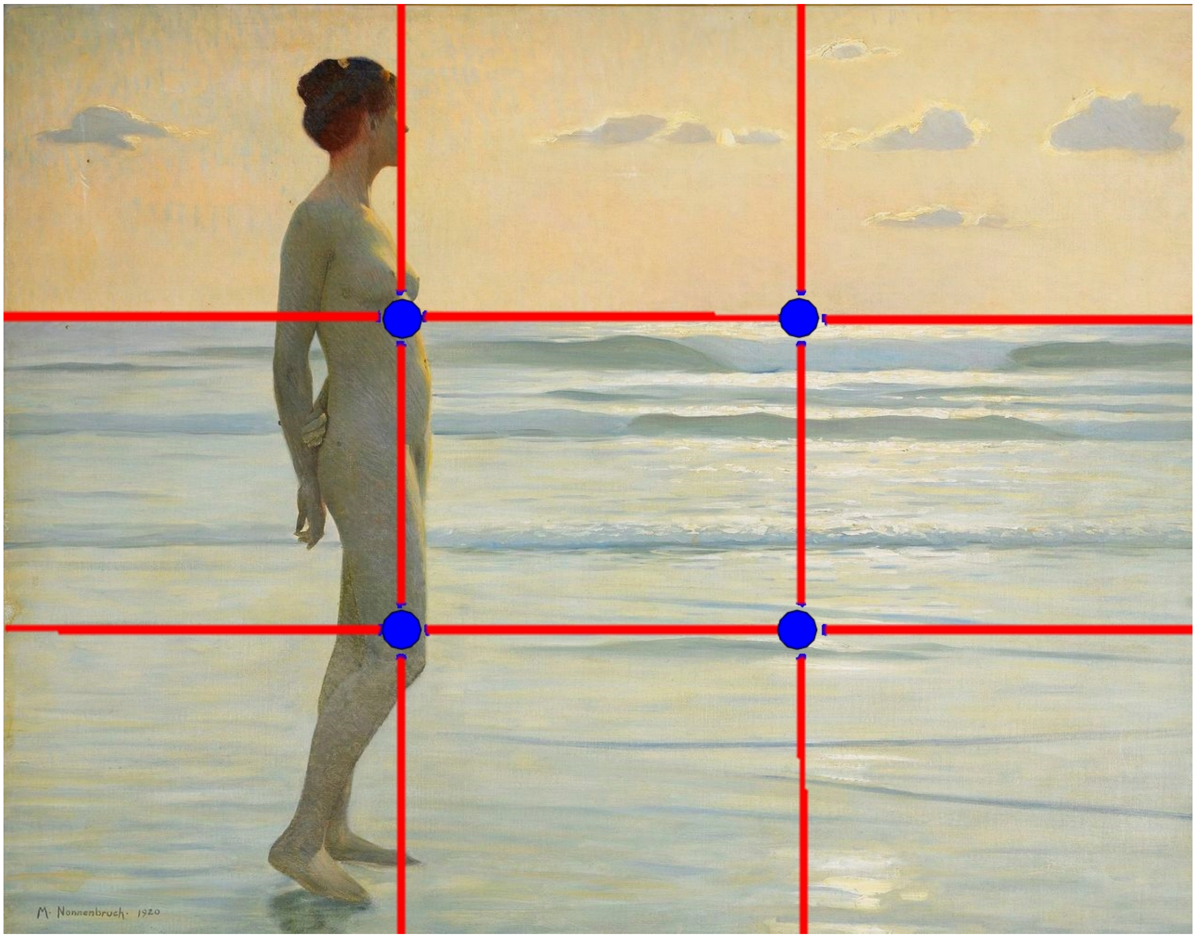
Color Grouping

As far as general color combination preferences go, studies have shown that there is a general preference for harmonious combinations of the same (or similar) hues that differ in lightness. Although it is not immediately obvious why this might be the case from an ecological viewpoint, some suggested that it might stem from ecological color statistics in natural images corresponding to different areas of the same ecological object. A red sweatshirt, for example, would be darker red where it was in shadow and lighter red where it was brightly illuminated. Such findings for spatial preferences based on similar attributes are reminiscent of preferences for semantically related objects to be close together and unrelated objects far apart. (Leyssen, Linsen, Sammartino & Palmer, 2012).

This idea always made great sense to me. The EVT states that color preferences arise from people's average affective responses to color-associated objects. Empirical testing shows very strong support for this theory. For example, "*People like colors strongly associated with objects they like (e.g., blues with clear skies and clean water) and dislike colors strongly associated with objects they dislike (e.g., browns with feces and rotten food). Relative to alternative theories, the ecological valence theory both fits the data better (even with fewer free parameters) and provides a more plausible, comprehensive causal explanation of color preferences.*" -Palmer, Stephen E., and Karen B. Schloss. "An ecological valence theory of human color preference." Proceedings of the National Academy of Sciences 107.19 (2010): 8877-8882.

And there you have it. A full walk-through of my considerations for pictorial composition along with the scientific support to demonstrate how and why it works. There is much more that can be added here but again, this is only meant to be a starting point. Remember that this map is not a unidirectional flowchart—but rather, like some well-illustrated concepts of visual processing, is a framework of bottom-up and top-down considerations that outlines a highly dynamic process.

I would like to close by stating that using the popular heuristics that we discussed in the earlier installments (golden ratio, rule-of-thirds, dynamic symmetry, etc.) is not necessarily a "bad" practice. They will not necessarily make your artwork "bad". They are just a means by which to organize elements in a pictorial space. **The problem is that they hold no better utility than random chance. Their apparent "success" is only seen when they happen to coincide with one of the above preferences by chance.** For example, if you placed a figure near the left intersections of the rule-of-thirds armature, and the figure is facing inward, it may look great. Again, this is not due to placement at a heuristic armature intersection but is rather due to the fact that figure is appealing to an inward bias where spatial preferences within a frame are concerned. I hope at this point you can understand this fact.



Remember that just because you come across some food when you were waving your arm does not mean that the movement of your arm caused the food to appear.

Happy Painting. ☺

RESOURCES

Among the many resources that I have used for this entire primer, two of the most valuable have been the websites of Dr. Dale Purves (purveslab.net) and the website of Dr. Stephen E. Palmer (socrates.berkeley.edu). From visual perception and its neurobiological underpinnings to the study of the aesthetics of color and spatial arrangement—I could not imagine two more valuable online resources.

Arnheim R. Art and Visual Perception: A Psychology of the Creative Eye. Berkeley, CA: University of California Press; 1974.
Ball, Phillip. Neuroaesthetics is Killing your Soul, Nature, March 2013.

Battaglia, Fortunato, Sarah H. Lisanby, and David Freedberg. “Corticomotor excitability during observation and imagination of a work of art.” Frontiers in human neuroscience 5 (2011): 79.

Bergamini, David. “The Editors of Life.” Mathematics. New York: Time Incorporated (1963).

Berlyne D E. “Les measures de la préférence esthétique” Sciences de l’Art. 1966;3:9–22.

Berlyne D E. Aesthetics and Psychobiology. New York: McGraw-Hill; 1971.

Berlyne D E. Studies in the New Experimental Aesthetics. Washington, DC: Hemisphere; 1974.

Bertamini, Marco, Kate M. Bennett, and Carole Bode. “The anterior bias in visual art: The case of images of animals.” Laterality: Asymmetries of Body, Brain and Cognition 16.6 (2011): 673-689.

Bloom, Paul. How Pleasure Works: The New Science of why We Like what We Like, W. W. Norton & Company, 2010.

Boselie F, 1992. “The golden section has no special aesthetic attractivity!” Empirical Studies of the Arts 10 1-18.

Boselie F, 1997 “The golden section and the shape of objects” Empirical Studies of the Arts 15 131-141.

Bovet, Dalila, and Jacques Vauclair. “Picture recognition in animals and humans.” Behavioral brain research 109.2 (2000): 143-165.

Boys’ Life May 1935.

Bradley, Steven. Design Principles: Dominance, Focal Points And Hierarchy, Smashing Magazine.

Brownlee, John. Co.Design: The Golden Ratio: Design’s Biggest Myth w/ Keith Devlin. 04.13.15

Bruce, Vicki, Patrick R. Green, and Mark A. Georgeson. Visual Perception: Physiology, Psychology, & Ecology. Psychology Press, 2003.

Bruner, Jerome S., and A. Leigh Minturn. “Perceptual identification and perceptual organization.” The Journal of General Psychology 53.1 (1955): 21-28.

Bullough E. “On the apparent heaviness of colours” British Journal of Psychology. 1907;2:111–152.

Buswell, Guy Thomas. “How people look at pictures: a study of the psychology and perception in art.” (1935).

Burton, David M. “The History of Mathematics, Wm. C.” (2000).

Calderone, Julia. The one formula that’s supposed to ‘prove beauty’ is fundamentally wrong. Tech Insider, Oct. 5, 2015 http://www.techinsider.io/the-golden-ratio-fibonacci-numbers-mathematics-zeising-beauty-2015-9

Chatterjee, Anjan (2011-01-01). “Neuroaesthetics: a coming of age story”. Journal of Cognitive Neuroscience 23 (1): 53–62. doi:10.1162/jocn.2010.21457. ISSN 1530-8898. PMID 20175677.

Chatterjee A. “Portrait profiles and the notion of agency” Empirical Studies of the Arts. 2002;20:33–41. doi: 10.2190/3WLF-AGTV-0AW7-R2CN

Chen, Yi-Chia, and Brian J. Scholl. “Seeing and liking: Biased perception of ambiguous figures consistent with the “inward bias” in aesthetic preferences.” Psychonomic bulletin & review 21.6 (2014): 1444-1451.Kourtzi and Kanwisher, 2000)

Checkosky, Stephen F., and Dean Whitlock. “Effects of pattern goodness on recognition time in a memory search task.” Journal of Experimental Psychology 100.2 (1973): 341.

Chen, Yi-Chia, and Brian J. Scholl. “Seeing and liking: Biased perception of ambiguous figures consistent with the “inward bias” in aesthetic preferences.” Psychonomic bulletin & review 21.6 (2014): 1444-1451.

Coren, Stanley, and Joan S. Girgus. Seeing is deceiving: The psychology of visual illusions. Lawrence Erlbaum, 1978.

Corbusier, Le. The Modulor and Modulor 2. Vol. 1. Springer Science & Business Media, 2004.

Davis S T, Jahnke J C, 1991 “Unity and the golden section: Rules for aesthetic choice?” American Journal of Psychology 104 257 ^ 277

Deregowski, Jan B. “Pictorial perception and culture.” Scientific American (1972) Nov;227(5):82-88.

Devlin, K. “The Myth that Will Not Go Away.” Devlin’s Angle. The Mathematical Association of America, 1 May 2007. Web. 22 Aug. 2012. http://www.maa.org/devlin/devlin_05_07.html

Di Dio, Cinzia, Emiliano Macaluso, and Giacomo Rizzolatti. “The golden beauty: brain response to classical and renaissance sculptures.” PloS one 2.11 (2007): e1201.

Dudley, Underwood. “The Golden Section by Hans Walser Reviewed by Underwood Dudley.” Read This! The MAA Online book review column. Mathematical Association of America, 15 December 2001. Web. 17 April 2010.

Dunning, B. “The Golden Ratio.” Skeptoid Podcast. Skeptoid Media, 28 Aug 2012. Web. 9 Jul 2016. http://skeptoid.com/episodes/4325Euclid, Heath, T. L., & Densmore, D. (2002). Euclid’s Elements: All thirteen books complete in one volume : the Thomas L. Heath translation. Santa Fe, N.M: Green Lion Press.

Eydt, Rebecca A. “How Good is Gold? Recognition of The Golden Rectangle.” (2013).

Falbo, Clement. “The golden ratio—a contrary viewpoint.” The College Mathematics Journal 36.2 (2005): 123-134.

Fantz, R., ‘The origin of form perception’, Scientific American, (1961), 204, pp. 66–72.

Fischler, Roger. “How to find the golden number without really trying.”Fibonacci quarterly 19 (1981): 406-410. http://www.herz-fischler.ca/ARTICLES/how_to_find.pdf

Fischler, Roger. “An investigation of claims concerning Seurat and the golden number.” Gazette des Beaux Arts (1980).

Fischler, R. “An examination of claims concerning The Golden Number. Seurat, Gris, Mondrian, Ozenfant, Jeanneret.” Gazette des Beaux-Arts.

Gardner, M., The cult of the golden ratio, Skeptical Inquirer 18 (1994) 243247. Gillings, Richard J. Mathematics in the Time of the Pharaohs. Courier Corporation, 1972.

Gardner, J. S., Austerweil, J. L., & Palmer, S. E. (2010). Vertical position as a cue to pictorial depth: Height in the picture plane versus distance to the horizon. Attention, Perception and Psychophysics, 72, 445-453.

Gershoni, Sharon, and Shaul Hochstein, “Measuring pictorial balance perception at first glance using Japanese calligraphy.” i-Perception 2.6 (2011): 508-527.

Ghyka, Matila Costiescu. The geometry of art and life. Courier Corporation, 1946.

Ghyka, Matila C. A practical handbook of geometrical composition and design. No. 2. Alec Tiranti, 1952.

Gibson, James J. The ecological approach to visual perception: classic edition. Psychology Press, 2014.

Godkewitsch, Michael. “The’golden section’: an artifact of stimulus range and measure of preference.” The American journal of psychology (1974): 269-277.

Gombrich, E.H. (1984). A sense of order (2nd ed.). London: Phaidon.

Gogel, Walter C., and Robert E. Newton. “Depth adjacency and the rod-and-frame illusion.” Perception & Psychophysics 18.2 (1975): 163-171.

Green, C. “All That Glitters: A Review of Psychological Research on the Aesthetics of the Golden Section.” Perception. 1 Aug. 1995, Volume 24, Number 8: 937-968.

Hambidge, Jay. The elements of dynamic symmetry. Courier Corporation, 2012.

Hammond, Arthur. Pictorial Composition in Photography. American photographic publishing Company, 1920.

Hawkins, Jeff, and Sandra Blakeslee. On intelligence. Macmillan, 2007.

Hochberg, Julian, and Virginia Brooks. “Pictorial recognition as an unlearned ability: A study of one child’s performance.” The American journal of psychology 75.4 (1962): 624-628.

Höge Holger, 1995 “Fechner’s experimental aesthetics and the golden section hypothesis today” Empirical Studies of the Arts 13 131-148.

Höge Holger, 1997 “Why a special issue on the golden section hypothesis? An introduction” Empirical Studies of the Arts 15 111-114

Höge, Holger. “The golden section hypothesis—its last funeral.” Empirical studies of the arts 15.2 (1997): 233-255.

Ishizu, T. & Zeki, S. (2011) Toward A Brain-Based Theory of Beauty. PLoS ONE, 6: e21852. doi:10.1371/journal.pone.0021852.

Ishizu, T. & Zeki, S. (2013). The brain’s specialized systems for aesthetic and perceptual judgment. European Journal of Neuroscience, 37, 1413–1420.

Kawabata, Nobuo, Kiyoshi Yamagami, and Morikazu Noakl. “Visual fixation points and depth perception.” Vision Research 18.7 (1978): 853-854.

Kepler, Johannes. The six-cornered snowflake. Paul Dry Books, 2010.

Kourtzi, Zoe, and Nancy Kanwisher. “Activation in human MT/MST by static images with implied motion.” Journal of cognitive neuroscience 12.1 (2000): 48-55.

Kilbride, Philip L., and Herschel W. Leibowitz. “Factors affecting the magnitude of the Ponzo perspective illusion among the Baganda.” Perception & Psychophysics 17.6 (1975): 543-548.

Kilbride, Philip L., and Michael C. Robbins. “Pictorial depth perception and acculturation among the Baganda.” American Anthropologist 71.2 (1969): 293-301.

Knowlton, James Q. “On the definition of “picture”.” AV Communication Review 14.2 (1966): 157-183.

Konkle, Talia, and Aude Oliva. “Canonical visual size for real-world objects.” Journal of experimental psychology: human perception and performance 37.1 (2011): 23.

Kourtzi, Zoe, and Nancy Kanwisher. “Activation in human MT/MST by static images with implied motion.” Journal of cognitive neuroscience 12.1 (2000): 48-55.

Kukkonen H, Foster D, Wood J, Wagemans J, Van Gool L. “Qualitative cues in the discrimination of affine-transformed minimal patterns” Perception. 1996;25:195–206. doi: 10.1068/p250195.

Latto, Richard, Douglas Brain, and Brian Kelly. “An oblique effect in aesthetics: Homage to Mondrian (1872–1944).” Perception 29.8 (2000): 981-987.

Latto, Richard, and Kirsty Russell-Duff. “An oblique effect in the selection of line orientation by twentieth century painters.” Empirical studies of the arts 20.1 (2002): 49-60.

Leibowitz, Herschel W., and Herbert A. Pick. “Cross-cultural and educational aspects of the Ponzo perspective illusion.” Perception & Psychophysics 12.5 (1972): 430-432.

Leyssen, Mieke HR, et al. “Aesthetic preference for spatial composition in multiobject pictures.” i-Perception 3.1 (2012): 25-49.

Liddell, Henry George, Robert Scott, and Henry Drisler. A greek-english lexicon. Harper & brothers, 1894.

Linsen, S., Leyssen, M. H. R., Gardner, J. S., & Palmer, S. E. (2011). Aesthetic preferences in the size of images of real-world objects. Perception. 40 (3), 291-298. T

Livio, M. The Golden Ratio: The Story of Phi, The World’s Most Astonishing Number. New York: Broadway Books, 2003.

Livingstone, M. Foreword by David H. (2002). Vision and art : the biology of seeing. New York: Harry N. Abrams. ISBN 0-8109-0406-3.

Locher, Paul, Kees Overbeeke, and Pieter Jan Stappers. "Spatial balance of color triads in the abstract art of Piet Mondrian." Perception 34.2 (2005): 169-189.

Locher, Paul J., Pieter Jan Stappers, and Kees Overbeeke. "The role of balance as an organizing design principle underlying adults' compositional strategies for creating visual displays." Acta Psychologica 99.2 (1998): 141-161.

Lucht, M. "Fee, Phi, Flim, Flam." The Skeptic. 1 Jul. 2007, Volume 27, Number 2: 27-31.

Machilsen, Bart, Maarten Pauwels, and Johan Wagemans. "The role of vertical mirror symmetry in visual shape detection." Journal of Vision 9.12 (2009): 11-11.

Mannan, S., K. H. Ruddock, and D. S. Wooding. "Automatic control of saccadic eye movements made in visual inspection of briefly presented 2-D images." Spatial vision 9.3 (1995): 363-386.

Mannan, Sabira K., Keith H. Ruddock, and David S. Wooding. "The relationship between the locations of spatial features and those of fixations made during visual examination of briefly presented images." Spatial vision 10.3 (1996): 165-188.

Mannan, Sabira K., Keith H. Ruddock, and David S. Wooding. "Fixation patterns made during brief examination of two-dimensional images." Perception 26.8 (1997): 1059-1072.

Markowsky, George. “Misconceptions about the Golden Ratio.” The College Mathematics Journal 23.1(1992): 2-19. Web. 17 April 2010.

McManus, I. C., D. Edmondson, and J. Rodger. “Balance in pictures.” British Journal of Psychology 76.3 (1985): 311-324.

McManus, Ian Christopher. “The aesthetics of simple figures.” British Journal of Psychology 71.4 (1980): 505-524.

McManus I C. Right Hand, Left Hand: The Origins of Asymmetry in Brains, Bodies, Atoms and Cultures. Cambridge, MA: Harvard University Press; 2002.

Miller, R. J. “Pictorial depth cue orientation influences the magnitude of perceived depth.” Visual Arts Research (1997): 97-124.

Montucla, Jean-Étienne, and La Lande. Histoire des mathématiques: dans laquelle on rend compte de leurs progrès depuis leur origine jusqu’à nos jours,... chez Henri Agasse, 1802

Myres, John Linton. Herodotus, father of history. Clarendon Press, 1953.

Newman, Colin V., and Barbara M. Newman. “The Ponzo illusion in pictures with and without suggested depth.” The American journal of psychology(1974): 511-516.

Ohm, Martin. “Die reine Elementar-Mathematik.” Berlin: Jonas Veilags-Buchhandlung (1835).

Ouchi, H., Japanese Optical and Geometrical Art, Dover, New York (1977)

Oxford University Press. The Compact Edition of the Oxford English Dictionary. Oxford University Press, 1971.

Pacioli, Luca, and Venice De Divina Proportione. “1509.” Divina proportione (1969). https://archive.org/details/divinaproportion00paci

Palmer, Stephen E. Vision science: Photons to phenomenology. MIT press, 1999.

Palmer, Stephen E., and Karen B. Schloss. “An ecological valence theory of human color preference.” Proceedings of the National Academy of Sciences 107.19 (2010): 8877-8882.

Palmer, S. E., & Schloss, K. B. (In press). Human color preference. In N. Moroney (Ed.), Encyclopedia of Color Science and Technology. Springer.

Palmer, S. E., & Gardner, J. S. (2008) Aesthetic issues in spatial composition: Effects of position and direction on framing single objects. Spatial Vision, 21, 421-449.

Palmer, Stephen E., and Stefano Guidi. “Mapping the perceptual structure of rectangles through goodness-of-fit ratings.” Perception 40.12 (2011): 1428-1446.

Palmer, Stephen, Yurika Hara, and William Griscom. “Why the Rule of Thirds is Wrong.” Journal of Vision 14.10 (2014): 367-367.

Patterson, Robert, and Robert Fox. “Depth separation and the Ponzo illusion.” Perception & psychophysics 34.1 (1983): 25-28.

Parkhurst, Derrick, Klinton Law, and Ernst Niebur. “Modeling the role of salience in the allocation of overt visual attention.” Vision research 42.1 (2002): 107-123.

Pierce R E. “Aesthetics of simple forms: Symmetry” Psychological Review. 1894;1:483–495.

Pinna, Baingio, and Lothar Spillmann. “A new illusion of floating motion in depth.” Perception 31.12 (2002): 1501.

Pinkerton E, Humphrey N K. “The apparent heaviness of colors” Nature. 1974;250:164–165. doi: 10.1038/250164a0

Pisano, Leonardo, and L. E. Sigler. “Fibonacci’s Liber abaci.” A translation into modern English of Leonardo Pisano’s Book of calculation. Translated by LE Sigler, Springer, New York (2002).

Pitcher, Colette. Acrylic Painting For Dummies. John Wiley & Sons, 2009.

Plumhoff, Jordan E., and James A. Schirillo. “Mondrian, eye movements, and the oblique effect.” Perception 38.5 (2009): 719-731.

Puffer E D. “Studies in symmetry” Psychological Review. 1903;4:467–539.

Ramachandran, V.S.; Hirstein, William (1999). “The Science of Art: A Neurological Theory of Aesthetic Experience” (PDF). Journal of Consciousness Studies 6 (6-7): 15–51.

Rock, David. Your brain at work. New York: Harper Business, 2009.

Russell, P.A. (2000). Testing the aesthetic significance of the golden-section rectangle. PERCEPTION-LONDON-, 29, 1413-1422.

Sammartino, J., Palmer, S.E. (2012). Aesthetic issues in spatial composition: Effects of vertical position and perspective on framing single objects. Journal of Experimental Psychology: Human Perception and Performance, 38(4), 865-879.

Schloss, K. B., Strauss, E. D. & Palmer, S. E. (2012). Object color preferences. Color Research & Applications.

Schiller, Peter, and Wiener, Morton. "Binocular and stereoscopic viewing of geometric illusions." Perceptual and motor skills 15.3 (1962): 739-747.

Schiffman, H. R. "Golden section: Preferred figural orientation." Perception & Psychophysics 1.3 (1966): 193-194.

Schulzke, Margot. A painter's guide to design and composition. North Light Books, 2006.

Seewald, Nick., http://goldenratiomyth.weebly.com/index.html

Seiler, Larry, Composition: Understanding it – Using it!

Smith, John Thomas. Remarks on Rural Scenery. Nathaniel Smith, 1797.

Socrates, G. Taseos. "Back in Time 3104 BC to the Great Pyramid." (1990).

Sonnenburg, C., et al., Do People Prefer Irrational Ratios? A New Look at the Golden Section, University of Bamberg.

Spillmann, L., Heitger, F., & Schüller, S. (1986). Apparent displacement and phase unlocking in checkerboard patterns. Poster presented at 9th European Conference on Visual Perception.

Stone, LeRoy A., and L. Glenn Collins. "The golden section revisited: A perimetric explanation." The American journal of psychology 78.3 (1965): 503-506.

Suler, J. "John Suler's Photographic Psychology: Image and Psyche." (2011).

Tatler, Benjamin W. "The central fixation bias in scene viewing: Selecting an optimal viewing position independently of motor biases and image feature distributions." Journal of Vision 7.14 (2007): 4-4.

Todorović, Dejan. "Context effects in visual perception and their explanations." Review of Psychology 17.1 (2010): 17-32.

Tung, K. Topics in Mathematical Modeling. Princeton: Princeton University Press, 2007.

Wagemans, Johan, et al. "A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure–ground organization." Psychological bulletin 138.6 (2012): 1172.

Wallschlaeger, Charles, Cynthia Busic-Snyder, and Meredith Morgan. Basic visual concepts and principles for artists, architects, and designers. Wm. C. Brown Publishers, 1992.

Wenderoth, Peter. “The salience of vertical symmetry.” Perception 23.2 (1994): 221-236.

Wenderoth, Peter. “The role of pattern outline in bilateral symmetry detection with briefly flashed dot patterns.” Spatial vision 9.1 (1995): 57-77.

Wypijewski, JoAnn, ed. Painting by Numbers: Komar and Melamid’s Scientific Guide to Art, New York: Farrar Straus Giroux, 1997.

Yarbus, A. (1967). Eye movements and vision (B. Haigh & L. A. Riggs, Trans.). New York: Plenum Press

Zeki, Semir. (2001). Artistic Creativity and the Brain. Science, 293(5527), 51-52

Zeki, Semir. (1999). Inner Vision: an exploration of art and the brain. Oxford University Press

Zeki, Semir. (2008). Splendours and Miseries of the Brain, Wiley Blackwell

Zeki, Semir. “Statement on Neuroesthetics.” Neuroesthetics. Web. 24 Nov 2009.

Zeki, Semir (2008): Splendors and Miseries of the Brain. Love, Creativity, and the Quest for Human Happiness. Oxford: Blackwell.

Zeising, Adolf. “Neue Lehre von den Proportionen des menschlichen Körpers…” (1854).

Zeising, Adolf . Der goldene Schnitt. Engelmann in Komm., 1884.

Additional sites:

The Cult of the Golden Ratio.” Laputan Logic. 19 January 2007. Web. 20 April 2010. <http://www.laputanlogic.com/articles/2005/04/14-1647-4601.html>.

http://www.phimatrix.com/

Dr. Beau Lotto’s LottoLab (**http://www.labofmisfits.com/**)

The Design Elements of Composing a Drawing (For Dummies). (dummies.com)

Saul McLeod’s Simply Psychology (**http://www.simplypsychology.org/**)