DATA VIZ 103
DESIGN FOR DELIGHT

This deck was designed as a guide for staff looking for resources about basic visual design principles.

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JSI

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Design is creativity with strategy.

--Rob Curedale, Designer & Author

Why Design Matters

"Without good design, it's easy to miss the point."

--Bjarni Wark

According to <u>Fusion Charts</u>, when you look at something, your eyes and your brain work in parallel to take in new information and break it down into consumable bits through a process called "chunking." Then, at the same time, your eyes and your brain process these chunks to find meaning.

Memory plays an important role in this process. Your long-term memory is formed by past experiences and is the reason why you expect to find the x and y axes—and other consistent chart elements discussed in this deck—always in the same place.

Your working memory stores just the memory you need at the moment. It can only hold about three chunks of information. **When you design a graph, chart, illustration, or dashboard, limit the number of prominent chunks of information that you want your audience to notice, and pack as much information as possible into each chunk**. In this way you can **avoid information overload and direct the attention of the viewer in a natural way.**

Understanding consistent design features, preattentive attributes, and Gestalt principles will help you **create strategies to keep your visualizations simple for the brain to process but still packed with information.** These principles of design will be explained in this slide deck and demonstrated in practice in later sessions of this series.
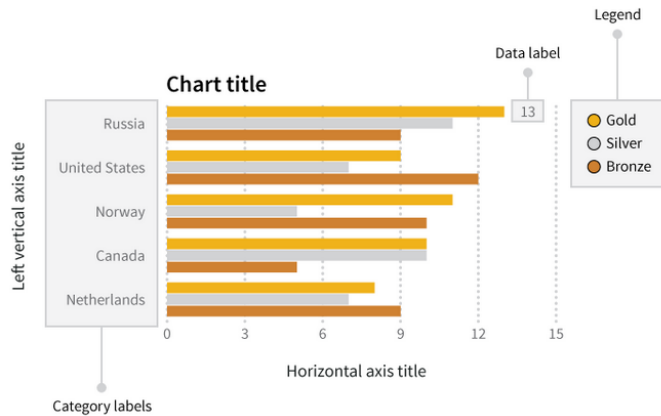
Features of Chart Design

Anatomy of a Graphic

Pulled from the Data + Design eBook

The text components of a graph give your audience visual clues that help you tell your data story—never assume your audience will walk away with the message you intended, so be explicit with text. Your labels should allow your visualization to stand alone without a supporting narrative, but be careful to avoid cluttering your visualization and reducing its impact with excessive text. Always be simple and direct. Don't hesitate to experiment with different labels until you find the right balance.

Clear and Relevant Axes: Use axis titles to give your audience a summary description of the variables you're displaying. Be specific, but concise. Don't truncate your axes as this can be misleading.

Units: Don't forget to include the units you're using to display information (percent, dollars, population in millions, etc.) Write out the full unit instead of using abbreviations or acronyms. If you use a symbol, like $, specify which currency you mean (US$ vs. Mex$). Make sure you're consistent if you display multiple types of data using a dual axis graph.

Data Labels: Data labels (comprised of numbers and/or text explanations) are useful if you want to highlight certain points, but make sure you don't add unnecessary clutter. Labeling data points can allow you to remove gridlines, but if you can effectively convey your message without data labels don't feel pressured to add them. Reserve labels for occasions when you need that level of detail and for visualizations that are confusing without specific figures (like pie charts).

Anatomy of a Chart Graphic

Pulled from the Data + Design eBook

Legends: A legend ensures that your reader knows what your graph's colors or patterns mean. When you're only showing one kind of data where color or pattern doesn't carry any special meaning, keep it simple and remove the legend. But if you have multiple kinds of data represented, a legend is essential. Consider readability of your visualization when placing your legend as it can visually help your reader interpret your graph.

Position and Format: Horizontal axis titles should be aligned parallel to the axis labels in a font that is large enough to be legible but not so large that it dominates the graph. Vertical axis titles should be horizontal to make them legible, but if they are too long to fit they should be rotated 90˚.

Individual category labels should be clearly marked and easy to read. Where possible, avoid rotating text on an angle. Try changing your chart type to make labels easier to read (see left). Simplify your labels without losing meaning. Use boldface text and italics sparingly and only to deliberately create emphasis.

Titles: Use your title as an opportunity to succinctly tell your reader the message of your chart in 1-2 sentences. You don't have to use complete sentences, but avoid complicated language and syntax. Consider who your audience is and what they want from your visualization. You can be straightforward and just state what your visualization shows, or you can use your title as an opportunity to share the conclusion your readers should draw from your graph.

Chart Types
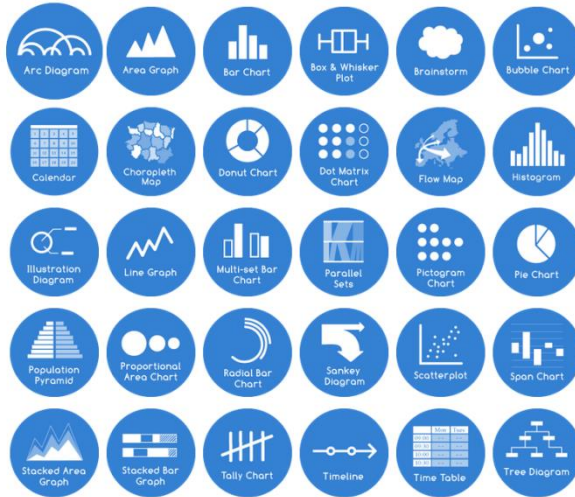
Different charts are useful for displaying different relationships from comparisons to proportions, hierarchies to locations, and distributions to data over time.

The following are web-based resources to help you select and then create the appropriate chart for your data visualization. You can also make these charts in Excel, however, or using a pen and paper, if you're more comfortable with familiar interfaces.

DataViz Catalogue helps you select the best type of visualization for the function or relationship you'd like to depict, from standard bar graphs to histograms and timelines. Each method has a description, examples, and links to online resources to help you create the type of graph you have selected.

Excel Charts allows you to chose the appropriate chart for the relationship you wish you portray and includes a basic classification chart.

Blockspring features different visualization methods. Choose one and then upload your data from a spreadsheet.

Diagrammer allows you to search for different downloadable templates.

Simple is Beautiful

I strive for two things in design: simplicity and clarity. Great design is born of those two things.

--Lindon Leader, Designer

Never undervalue simplicity as an integral feature of chart design.

Don't add content that could distract from your main message or confuse your audience. The benefits of data visualizations are that they are more eye-catching and quicker to understand than long-form reports. Don't bury this advantage in masses of detail or unnecessary visual noise. Leave white space. Remove unnecessary gridlines. Edit, edit, edit, and be prepared to start over if you have to.

Every choice, from color selection to content placement, should be deliberate and should serve the telling of your data story. Create drafts and ask your co-workers to evaluate your designs for simplicity and clarity. To that end, consider preattentive attributes, Gestalt principles, and design principles, covered in the next sections.

Cole Nussbaumer's blog Storytelling with Data is a worthwhile reference as her consistent blue/gray Excel chart motif is an excellent example of simple design.

Psychology of Design

Preattentive Attributes
What are they?

Preattentive processing is the unconscious accumulation of information from your environment. Your eyes and brain absorb large amounts of information and then filter and process what is important. Information that stands out because of certain stimuli or because it is relevant to what you are thinking about is selected for more attentive (conscious) processing.

Preattentive attributes are the basic building blocks of visualization because they take advantage of this process by providing stimuli for you to recognize quickly. They can be perceieved in less than 10 milliseconds, even before we make a conscious effort to notice them.

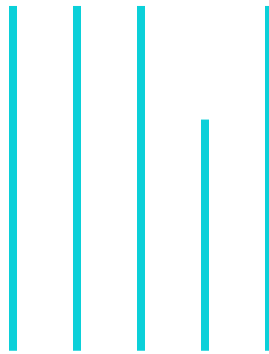These stimuli can be related to form, color, and spatial position, as are reviewed on the next slides.
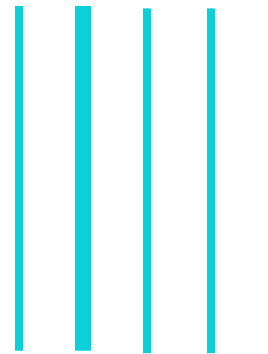
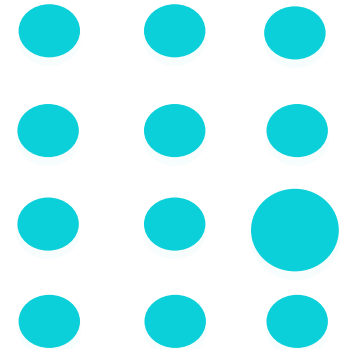# Preattentive Attributes
Form

Orientation:

Line Length:

Line Width:

Size:

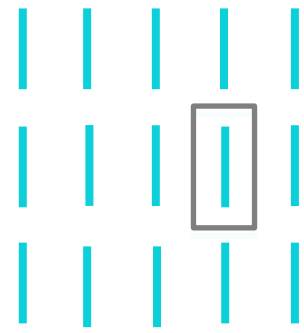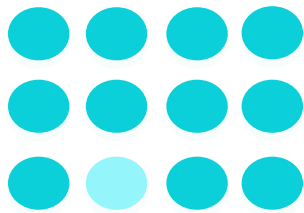**Shape:**

Curvature:
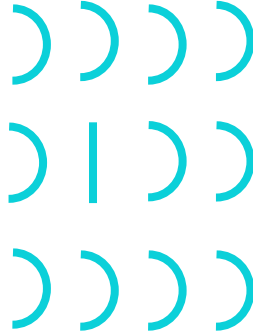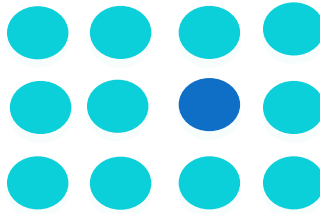

Added Marks:
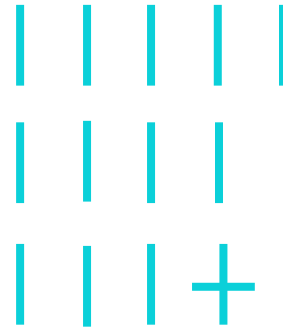
Enclosure:

Preattentive Attributes
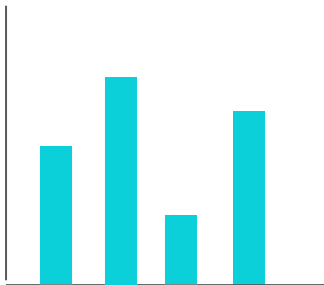
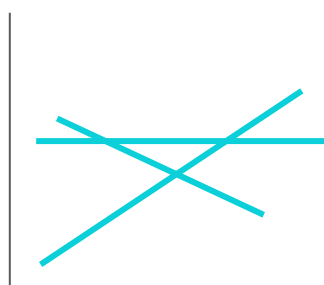## Color and Spatial Position

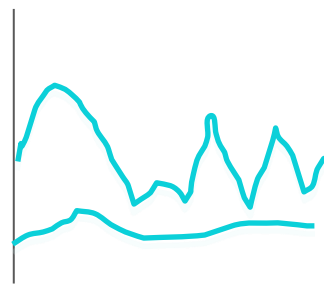**Intensity:**

Hue:

2-D Position:

You identify and combine preattentive attributes to analyze patterns in a visualization. For example:
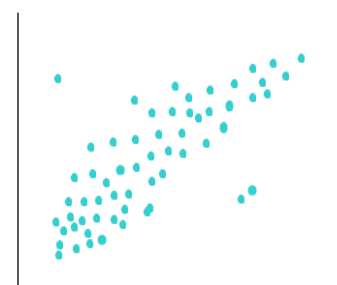
High, low & in between | Going up, down, & remaining flat | Steady & fluctuating | Normal & abnormal

Preattentive Attributes

How to apply them to increase the impact of data visualizations

Preattentive attributes can help you decide which type of chart to use for your data. For example, consider the following two visualizations that demonstrate percentage of country GDP spent on healthcare in 2011. It is much more difficult to recognize differences in health expenditure on the pie chart than on the bar graph because the preattentive attribute for line length allows you to process the second graph more quickly.
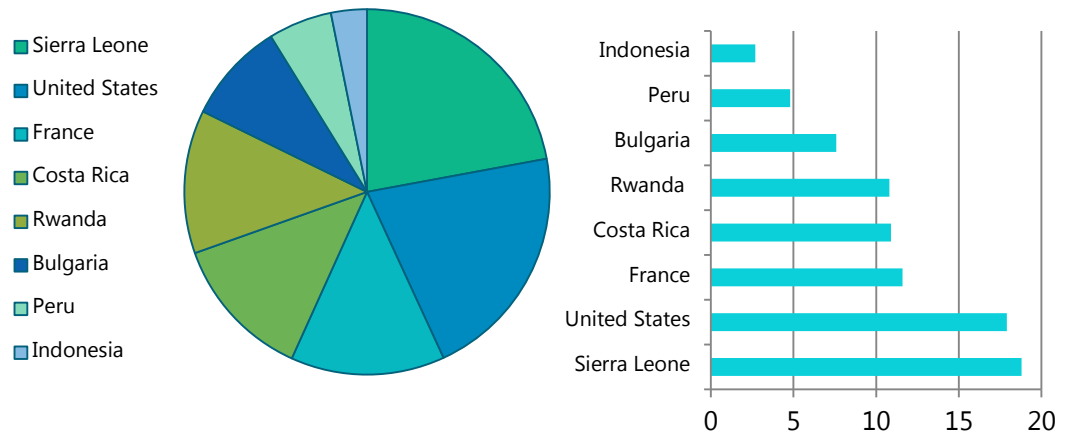
If you are writing a report on two countries in particular but would like to contextualize their expenditure by including more countries in your visualization, you could use hue and intensity to highlight specific data.
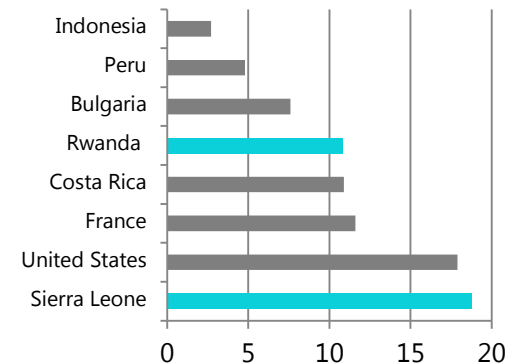
Design is the method of putting form and content together. Design, just as art, has multiple definitions; there is no single definition. Design can be art. Design can be aesthetics. Design is so simple, that's why its so complicated.
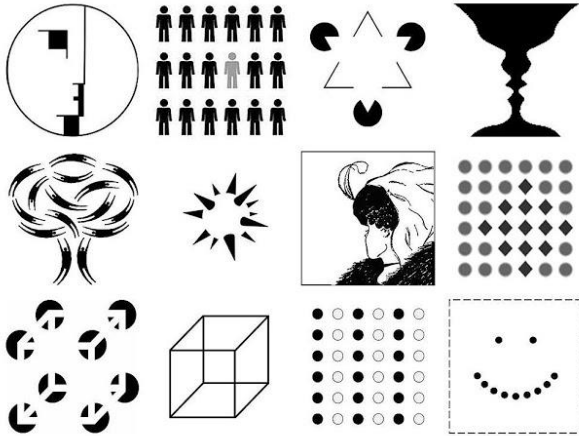
--Paul Rand, Graphic Designer

Gestalt Principles

What are they?

The Gestalt Principles refer to visual perception theories developed by German psychologists in the 1920s that describe how you organize visual elements into groups in order to visually and psychologically create structure from seemingly disconnected bits of information. In other words, these principles explain how you see a simple whole that is greater than the sum of its parts. They work with preattentive attributes by allowing you to highlight certain patterns over others.

Two primary Gestalt principles are:

› **The Law of Prägnanz** (Conciseness): The human brain loves simplicity and processes patterns that are regular, even, and orderly faster than patterns that are more complex. The data viz takeaway? **Arrange data logically and systematically at every opportunity.**

› **The Law of Isomorphic Correspondence**: People interpret and respond to images based on their past experiences. For example, the color red is commonly used for profit loss and green is used for profit gains. The data viz takeaway? **Keep in mind your users and their preconceived notions; stick to popular convention and best practices if possible.**

More principles will be unpacked on following slides.

Gestalt Principles

Laws of Grouping
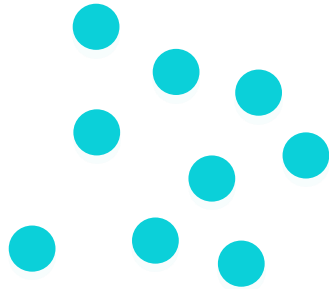
Proximity: You first see nine individual dots because they are placed without proximity. But when the dots are placed closer together, unity occurs and you see one group in the shape of a square. Be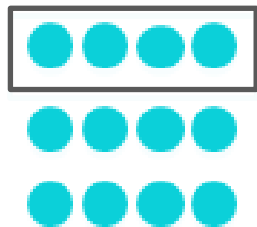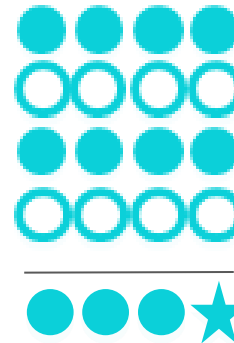cause the dots are closer horizontally than vertically, you might see 3 rows instead of 4 columns. The data viz takeaway? **Know your chart's information priority and create groupings through proximity to support that priority.**

Similarity: You see objects that are similar as part of the same group (lines 1 & 3 and 2 & 4). An object can be emphasized if it is dissimilar to others, as demonstrated by the star in the group of dots. This is called the law of **Focal Point**. The data viz takeaway? **Use similar characteristics (color, size, shape, etc.) to establish relationships and to encourage groupings of objects. Alternatively, use distinctive characteristics to highlight focal points.**

Enclosure: You group the first four dots separately because they are enclosed. The data viz takeaway? **Enclose data points on, for instance, a scatter plot to make them stand out and show they are related.**
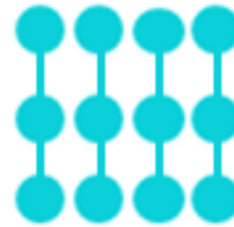
Connection: You see connected dots as belonging to the same group. The data viz takeaway? **Connect data points on a line graph showing multiple chunks of information in order to see which point belongs to which data set.**

Gestalt Principles

Laws of Grouping

Closure: Although these shapes are incomplete, your mind fills in the gaps and you automatically see a square and a circle instead of three disconnected paths. This works for more complex shapes too, like the WWF panda logo and the "invisible" triangle in which enough of the image is present for your perception to complete the shape.

The data viz takeaway? Be careful, Excel Charts warns sometimes these principles can lead you astray. Consider this chart with missing values:

Closure/continuity might encourage you to fill in the gap with a smooth line when in fact the graph looks like:

Don't unconsciously jump to conclusions not supported by the data.

Continuity: Your eye is compelled to move through one object and continue to another, so you see one line instead of three separate ones. This occurs in the H because your eye naturally moves through curves, in this case from the smooth crossbar to the leaf. The data viz takeaway? **Arrange objects in a line to facilitate grouping and comparison.**

Figure and Ground: Your eye differentiates an object from its surrounding area. You either notice two silhouettes looking at each other or a vase; which ever you notice becomes the figure and the other the ground. The data viz takeaway? **Ensure there is enough contrast between your foreground and background so that charts and graphs are more legible.**

Gestalt Principles

How to apply them to increase the impact of data visualizations

Without Gestalt principles
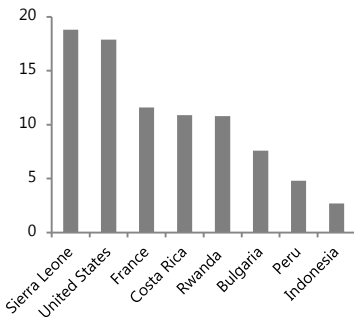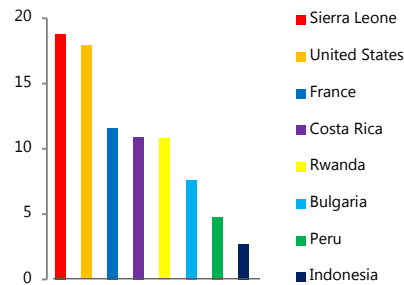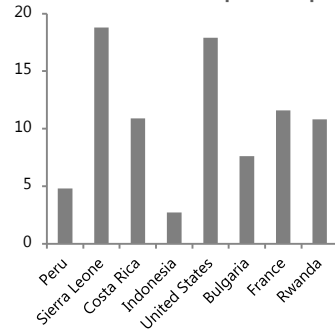
Implementing Gestalt principles
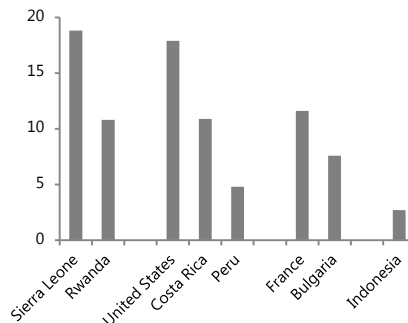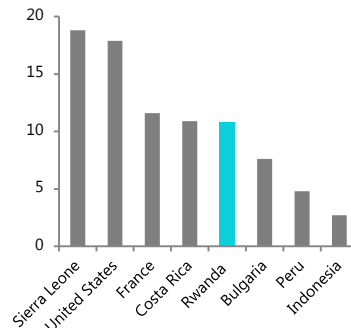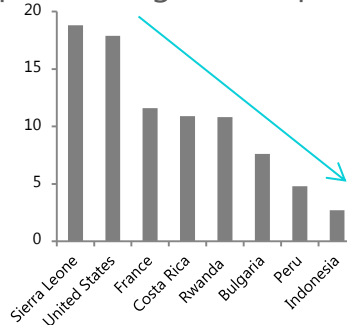
The law of prägnanz and the law of continuity make it easier to read the second graph because the eye can follow an orderly, continuous path.

The multi-colored graph is harder to read because the color use is disruptive. The Gestalt law of similarity in the first row of all-gray graphs removes the extra cognitive overload, as does labeling the bars on the axis rather than with a color-coded key. Deliberate color use, however, can make specific data stand out with the law of focal point.

Suppose you'd like to compare different regions to one another. This is easier on the second graph than the first because the law of proximity states that objects that are close together are perceived as a group.

# Gestalt Principles

How to apply them to increase the impact of data visualizations

Without Gestalt principles
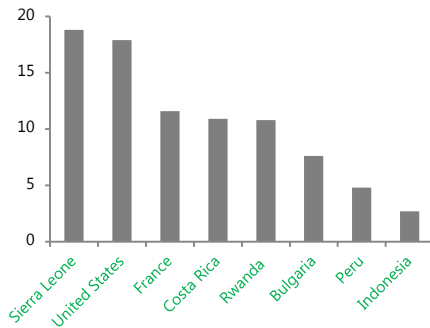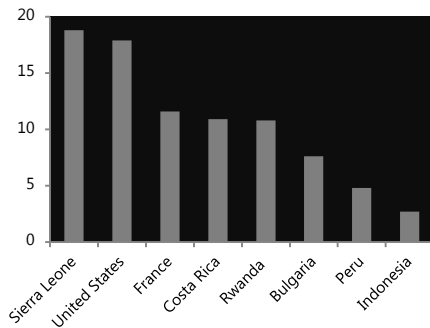
Implementing Gestalt principles
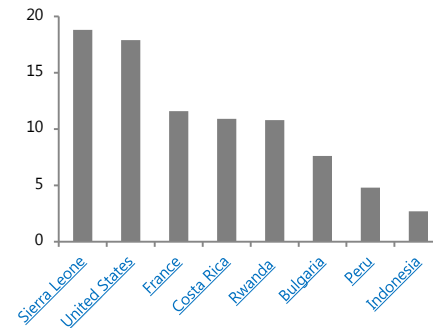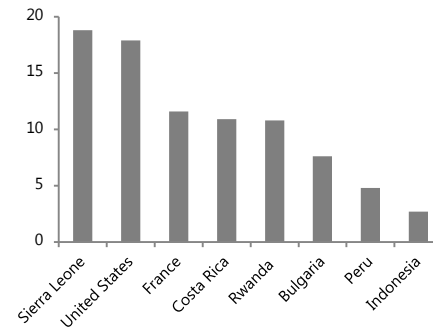
The law of figure/ground means that you should contrast between the figure and background to remove cognitive load and improve readability. On data visualizations, leave white space rather than packing in content.

Suppose you'd like the country names to be clickable links to more information. On the first graph, your audience might not recognize this feature, but on the second the law of isomorphic correspondence causes them to realize that URLs are typically blue and underlined.

Now let's look at some infographics from JSI, USAID and WHO that effectively use preattentive attributes and Gestalt principles. Some are implemented more than others, but all of them can help you enhance your data visualizations.

Example

Preattentive Attributes and Gestalt Principles in practice

Preattentive attributes for orientation and curvature cause this "umbilical chord" of text to catch your eye. Gestalt law of continuity brings your eye down the chord and through the center column of content.

Law of isomorphic correspondence: you expect this chalkboard and font to contain information about education.

Gestalt law of closure allows you to recognize this incomplete image as a pregnant woman

Preattentive attribute for size allows some of these words and figures to stand out

Gestalt law of focal point & preattentive attribute for hue cause this orange text to pop and grab your attention

Gestalt law of figure/ground: because it is colorful and packed with text, the center of this image is the figure even though the face outlines provide a dynamic ground.

For the rest of the graphic the background is muted to allow content to stand out.

World Population Day 2013 **ADOLESCENT PREGNANCY**

ABOUT **16 MILLION GIRLS** AGED **15–19** GIVE BIRTH **EACH YEAR.**

IN **9** OUT OF **10** OF THESE CASES, THE **GIRL** IS ALREADY **MARRIED.**

COMPLICATIONS FROM **PREGNANCY** AND **CHILD BIRTH** CONTINUE TO BE A **LEADING CAUSE OF DEATH** AMONG **ADOLESCENT GIRLS** AGED 15–19 IN LOW-AND MIDDLE-INCOME COUNTRIES.

STILLBIRTHS AND DEATH ARE

50%

MORE LIKELY FOR **BABIES BORN** TO **MOTHERS** YOUNGER THAN **20** THAN FOR

babies

BORN TO **MOTHERS** AGED **20–29.**

Young women who avoid unintended pregnancy are more likely to stay in school, participate in the work force and have healthier, better-educated children.

ADOLESCENT GIRLS HAVE LIMITED ACCESS TO AND USE OF FAMILY PLANNING.

IN DEVELOPING COUNTRIES OVERALL,

22% OF ADOLESCENT GIRLS (AGED 15–19) WHO ARE MARRIED OR IN A UNION USE CONTRACEPTIVES,

COMPARED TO **61**% OF MARRIED GIRLS AND WOMEN AGED **15–49.**

We must work together to expand access to sexual and reproductive health services for the 1.8 billion young people in the world today.

USAID
FROM THE AMERICAN PEOPLE

Sources:
UNFPA (2012). Marrying Too Young: End Child Marriage. UNFPA, New York.
WHO Fact Sheet (2012). Adolescent Pregnancy http://www.who.int/mediacentre/factsheets/fs364/en/.
Black, R., et al. Maternal and child undernutrition: Global and regional exposures and health consequences. The Lancet vol. 371, no. 9608, 19 January 2008, pp. 243-260.

Examples

Preattentive Attributes and Gestalt Principles in practice

Law of figure/ground: both feature muted backgrounds that don't distract or overload your brain

Law of continuation: arrow draws eye up and highlights 60% figure which provides the explanation for why this matters

Law of enclosure: the green dotted lines group certain numbers, text, and images together to separate facts from one another
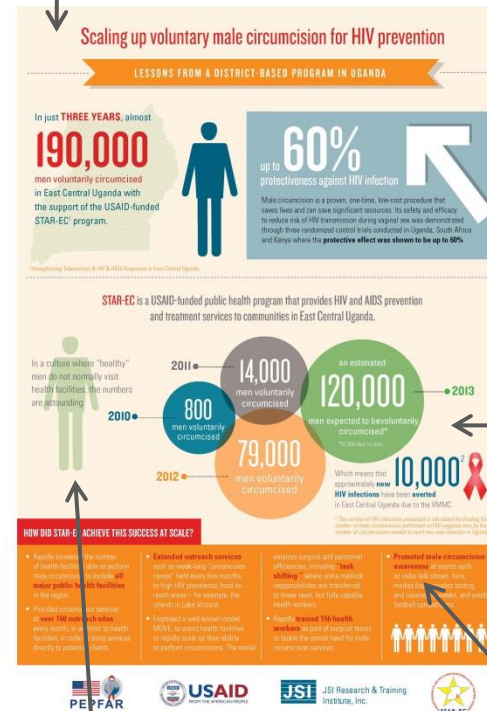
Preattentive attributes for size and hue causes select content to stand out

Law of isomorphic correspondence: green is often associated with positive things while neutral gray symbolizes inaction

Law of proximity and law of focal point; you expect these figures to be related and the yellow one stands out

Preattentive attribute for intensity downplays less important content to reduce stimuli

Preattentive attribute for size enhances understanding of increase from 2010-2013 aided by actual figures

In the text heavy section enclosed by a block of orange, change of hue and size (bold) creates focal points highlighting certain text

Example

Preattentive Attributes and Gestalt Principles in practice
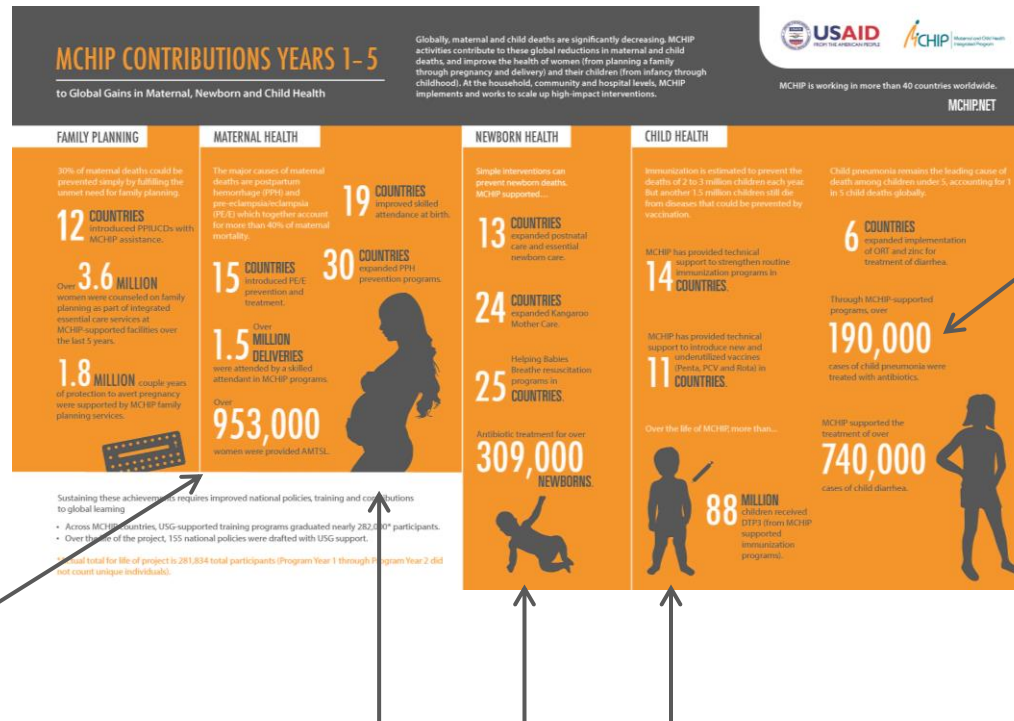
The law of proximity dictates that figures close to each other are related and part of one group

Law of enclosure: the thin white lines create four sections that further group content together

Preattentive attributes for size and intensity highlight numbers

Law of prägnanz: the simple silhouettes of birth control, a pregnant woman, a baby, and children are ordered logically and allow you to quickly recognize what facts will be in what section

Principles of Visual Design

Design Elements

Pulled from j6 design, usability.gov, Incredible Art, and artist John Lovett's blog.

Before discussing visual design principles, its important to review elements of design. Elements are the basic things that can be seen, and design is all about how to best arrange these elements in an orderly composition.

› **Line**: the linear marks made with a pen or brush, or the edge created when two shapes meet.
› **Shape:** a 2D self contained defined area of geometric or organic form. A positive shape automatically creates a negative shape around it.
› **Form:** a 3D object with volume and thickness; it can be physical or visually implied with light and shading techniques.
› **Direction:** all lines have direction—horizontal, vertical, and diagonal. Horizontal lines suggest calmness, stability and tranquility. Vertical lines give feelings of balance, formality and alertness. Diagonal lines suggest movement and action.
› **Size:** the relationship of the area occupied by one shape to that of another.
› **Texture:** the surface quality of a shape—rough, smooth, hard, glossy; it can be physical or visual.
› **Color/Hue:** the light reflected off objects.
    › **Value/Tone:** the lightness or darkness of a color; contrast is extreme changes between values.
    › **Intensity:** how bright or dull a color is.
› **Typography:** the size, alignment, color, and spacing of a font.
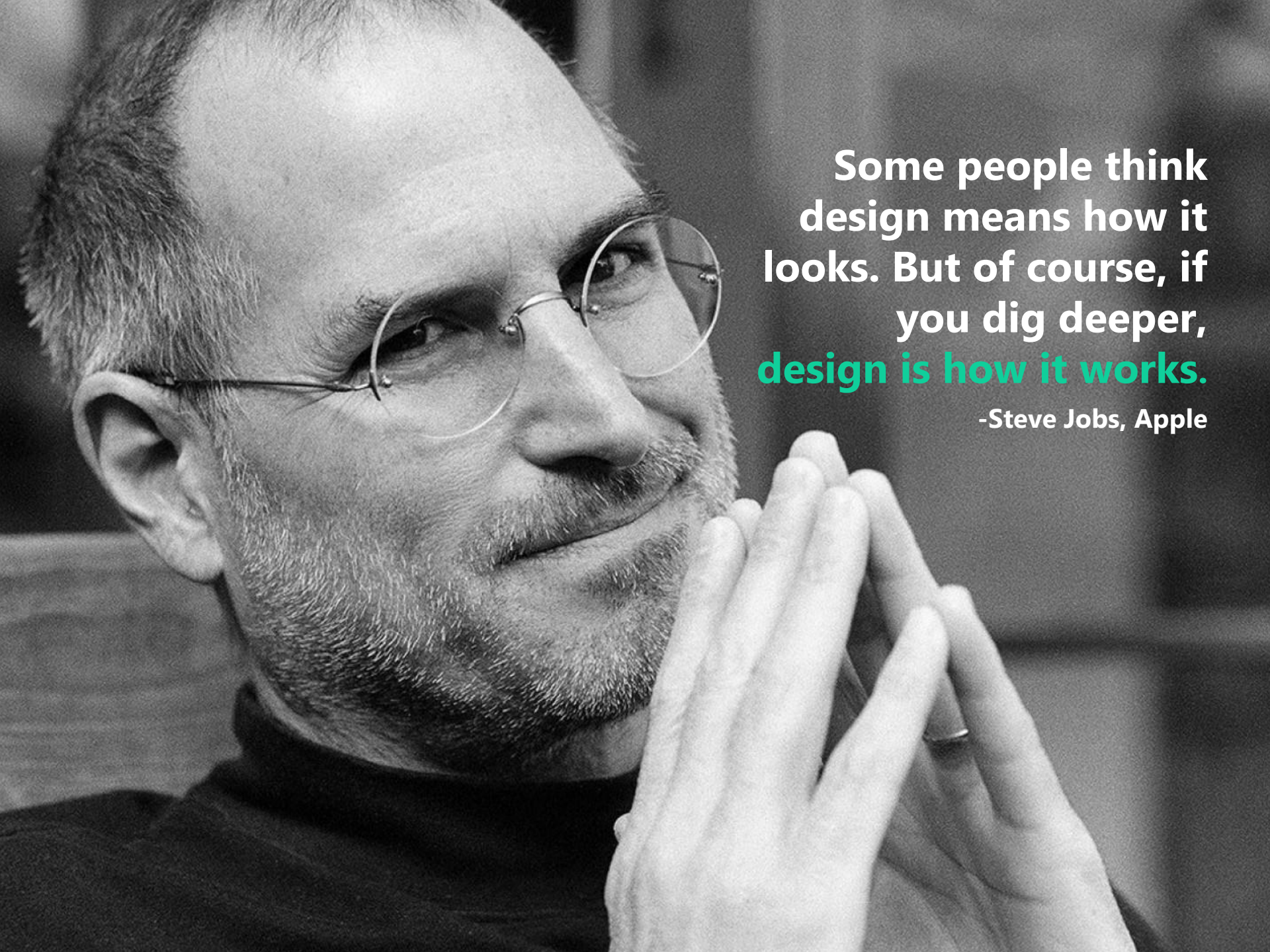
Some people think design means how it looks. But of course, if you dig deeper, **design is how it works.**

-Steve Jobs, Apple

Digging Deeper: Design Principles

› **Space:** is the distance or area between, around, above, below, or within elements. Both positive and negative space are important to reduce visual clutter and enhance readability.

› **Balance:** provides stability and structure to a design. It's the equal distribution of weight in a design with regard to the placement of elements. It does not necessarily imply symmetry: a large shape close to the center can be balanced by a small shape close to the edge.

› **Proximity:** provides a focal point. It doesn't mean that elements have to be placed together, but that they should be somehow visibly connected to create relationships between them.

› **Alignment:** creates order and organization by creating visual connections between elements.

› **Repetition:** creates association and consistency and strengthens design by tying together individual elements.

    › **Rhythm:** is a feeling of organized movement that can be created by repetition

› **Contrast:** is the juxtaposition of opposing elements (opposing colors on the color wheel, light and dark values, or horizontal/vertical directions) that allows you to emphasize key elements in your design.

› **Unity/Harmony:** is the appearance that all elements visually belong together; design must balance unity with variety to avoid a dull or overwhelming design.

› **Hierarchy:** differentiates significance between elements created by size, color, and placement.

› **Scale:** creates interest and depth by demonstrating how each item relates to each other based on size.

› **Dominance/Center of Interest:** focuses on having one element as the focal point and the others being subordinate.

› **Similarity:** creates continuity throughout a design without direct duplication. It helps users learn an interface quickly.

› **Gradation:** adds interest and direction of movement to a shape. A gradation from dark to light causes the eye to move along a shape.
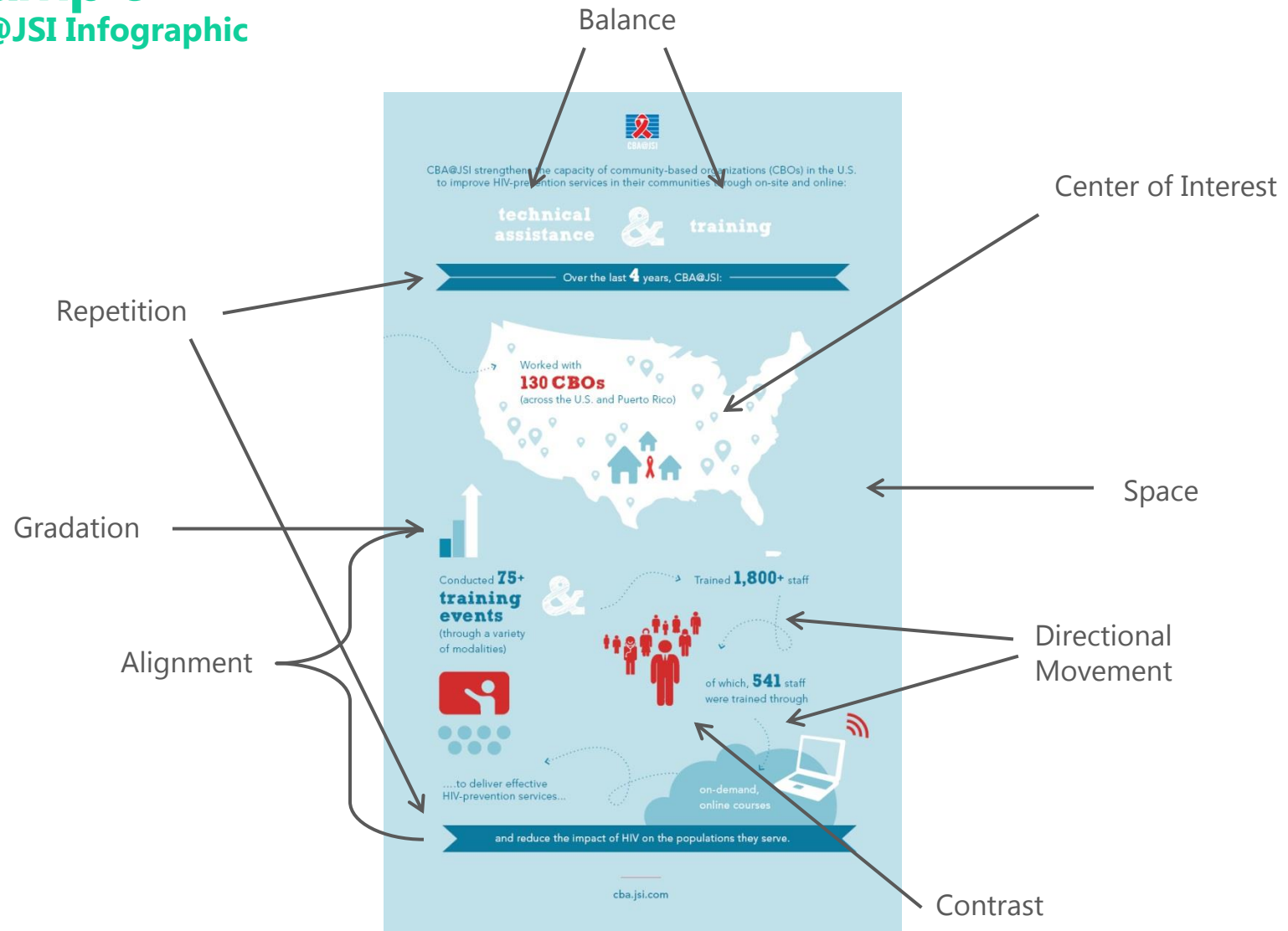
Example
The JSI Homepage

Gradation

Scale

Alignment

Hierarchy

Contrast

Unity and Repetition

Example
CBA@JSI Infographic

Balance

Center of Interest

Repetition

Space

Gradation

Alignment

Directional Movement

Contrast

Connect

DataVizHub.co

Questions, updates, ideas, or suggestions?
Amanda Makulec | amakulec@jsi.com